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Report

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Abstract: Nature-based Solutions and their Governance Structures for Climate Action in the Alpine Region

This report analyses the potential of Nature-based Solutions (NbS) in the Alpine area to tackle challenges of climate change and biodiversity loss while simultaneously addressing societal challenges. NbS use ecosystem functions to address societal challenges while simultaneously providing human well-being and ecological benefits. In this way, they integrate key dimensions of sustainable development – ecology, economy and the social sphere. They are therefore considered an important element on a realistic transition path towards a future proof economy and social system.

This leads to the conviction that the NbS concept is a promising approach to meet the profound societal challenges faced by the Alpine region as a climate change and biodiversity hotspot in view of the rapidly progressing climate and biodiversity crises.

This report is based on a comprehensive analysis of eight successfully implemented NbS model projects with regard to their impacts on biodiversity, climate change mitigation or adaption, their socio-economic benefits as well as their governance characteristics. The authors of this report have listed the opportunities that NbS projects provide for Alpine-specific challenges, implementation barriers, success factors, and requirements for NbS-promoting framework conditions. Starting out from practical examples, this analysis is condensed into recommendations for practice-orientated starting points to foster NbS in the Alpine region. They refer to strategic considerations, policy and legal instruments, economic aspects, practical tools and different governance aspects, including trans- and interdisciplinary approaches, communication mechanisms, educational requirements and stakeholder involvement.

The findings confirm the hypothesis that NbS offer great potential for a future proof development of the Alpine region, revealing that successful projects are characterised by interdisciplinary approaches, comprehensive stakeholder involvement, clear organisational structures, and solution-oriented conflict management. It is, however, necessary to further promote these aspects and mainstream the idea of NbS projects. To achieve this, coordinated action is needed across sectors, administrative levels and disciplines, using appropriate legal frameworks, targeted and partly innovative funding mechanisms as well as governance mechanisms that support the above-mentioned success factors.

As well-established, internationally operating institutional framework, the Alpine Convention in particular has the potential to provide an overarching framework and valuable political support to further promote the establishment of NbS in the Alpine region.

Kurzbeschreibung: Naturbasierte Lösungen und ihre Governance-Strukturen für Klimaschutz und Klimawandelanpassung im Alpenraum

Der vorliegende Bericht analysiert das Potenzial naturbasierter Lösungen (NbL) im Alpenraum. NbL nutzen Ökosystemfunktionen, um gesellschaftliche Herausforderungen zu bewältigen und dabei gleichzeitig einen sozio-ökonomischen und ökologischen Mehrwert zu gewährleisten. Auf diese Weise integrieren sie die drei grundlegenden Dimensionen nachhaltiger Entwicklung – Ökologie, Ökonomie und soziale Aspekte. Sie werden daher als zentrale Elemente einer realistischen Transformation hin zu einem zukunftsfähigen Wirtschafts- und Gesellschaftssystem angesehen.

Hieraus folgt die Überzeugung, dass das Konzept der NbL ein vielversprechender Ansatz ist, um den tiefgreifenden gesellschaftlichen Herausforderungen zu begegnen, denen der Alpenraum als Klimawandel- und Biodiversitäts-Hotspot angesichts der rasch voranschreitenden Klimakrise und Biodiversitätskrise gegenübersteht.

Dieser Bericht basiert auf einer umfassenden Analyse von acht erfolgreich umgesetzten NbL-Modellprojekten (hinsichtlich ihrer Auswirkungen auf Biodiversität und Klimawandelminderung oder -anpassung, ihrer sozioökonomischen Vorteile sowie ihrer Governance-Merkmale). Die Autor*innen befassten sich sowohl mit den Chancen, die NbL-Projekte für alpenspezifische Herausforderungen bieten, als auch mit Umsetzungshindernissen, Erfolgsfaktoren und notwendige Rahmenbedingungen für die Förderung von NbL. Diese von praktischen Beispielen ausgehende Analyse mündete in Empfehlungen, die möglichst praxisorientierte Ansatzpunkte zur Förderung von NbL im Alpenraum liefern sollen. Sie beziehen sich auf strategische Überlegungen, politische und rechtliche Instrumente, wirtschaftliche Aspekte, praktische Instrumente sowie auf verschiedene Governance-Aspekte, einschließlich trans- und interdisziplinärer Ansätze, Kommunikationsmethoden, Bildungserfordernissen und Beteiligungsprozessen.

Die Ergebnisse bestätigen die Hypothese, dass NbL großes Potenzial für eine zukunftsfähige Entwicklung des Alpenraums bieten und zeigen, dass erfolgreiche Projekte durch interdisziplinäre Ansätze, die umfassende Beteiligung von Interessensgruppen, klare Organisationsstrukturen und lösungsorientiertes Konfliktmanagement gekennzeichnet sind. Für die umfassende Etablierung von NbL im Alpenraum ist es jedoch notwendig, diese Aspekte weiterhin dezidiert zu fördern und das Konzept von NbL-Projekten weiter zu verbreiten. Dies erfordert ein koordiniertes Handeln über Sektoren, Verwaltungsebenen und Disziplinen hinweg. Damit verbunden ist die Schaffung geeigneter rechtlicher Rahmenbedingungen, zielgerichteter und teilweise innovativer Finanzierungsmechanismen und Governance-Mechanismen, welche die genannten Erfolgsfaktoren unterstützen.

Insbesondere die Alpenkonvention als etablierte, international agierende Institution hat das Potenzial, einen übergeordneten unterstützenden Rahmen und wertvolle politische Unterstützung für die weitere Etablierung von NbL im Alpenraum zu bieten.

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List of abbreviations

Abbreviation	Explanation
ACB	Alpine Climate Board
ACTS	Alpine Climate Target System
AG	Action Group
AT	Austria
CAP	Climate Action Plan
CAPA	Climate Adaptation Platform for the Alps
CH	Switzerland
CICES	Common International Classification of Ecosystem Services
CIPRA International	International Commission for the Protection of the Alps
CoE	Council of Europe
DE	Germany
ESPON	European Observation Network for Territorial Development and Cohesion
EU	European Union
EU NRL	EU Nature Restauration Law
EUSALP	EU Strategy for the Alpine region
FR	France
GI	Green Infrastructure
GIS	Geographic Information System
IIASA	International Institute for Applied System Analysis
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IT	Italy
IUCN	International Union of Nature Conservation
LEP	Landesentwicklungsprogramm Bayern (Bavarian State Development Programme)

Abbreviation	Explanation
LI	Liechtenstein
MC	Monaco
MEA	Millennium Ecosystem Assessment
NbL	Naturbasierte Lösungen
NbS	Nature-based Solutions
NGO	Non-Governmental Organisation
PLANALP	Natural Hazards Working Group of the Alpine Convention
PLU	Plan Local d'Urbanisme (Local Town Planning Scheme)
PSAC	Permanent Secretariat of the Alpine Convention
ROI	Return on investment
SI	Slovenia
SME	Small and Medium Enterprises
TF	Task Force
TF-MFSUT	Task Force on Multifunctional Forests and Sustainable Use of Timber
TWB	Thematic Working Body
UBA	Umweltbundesamt (German Environment Agency)
UN	United Nations
UNA	Urban Nature Atlas
UNEP	United Nations Environment Programme
VET	Vocational Education and Training
WBSCD	World Business Council for Sustainable Development
WG	Working Group
WISO	Wild Ungulates and Society Working Group
WP	Work package
WWF	World Wide Fund for Nature

Summary

Project objectives and tasks

The German Federal Environment Agency initiated the project 'Nature-based solutions in the Alpine region: Using ecosystem functions to promote climate mitigation and adaptation measures. Creating new nature-centred governance mechanisms across sectors and policy levels' to raise awareness about the fundamental relevance of nature-based solutions (NbS) for the Alpine area. A climate change hotspot, its ecological functions, rich biodiversity, economic opportunities, and settlement patterns are all under great pressure. This report analyses options for implementing NbS as a promising way to address these challenges while simultaneously protecting biodiversity and enhancing human well-being and hence as important elements of an auspicious transition path towards a sustainable economy. A particular focus lies on (innovative) governance mechanisms promoting NbS implementation and ensuring the success of NbS projects at different scales.

Within this project, the research units *ifuplan* and *CIPRA International*:

- Compiled an overview of the evolution and definition of the NbS concept (Chapter 2).
- Selected and analysed successful NbS projects in the Alpine region aimed at adapting to and mitigating climate change, as well as the governance mechanisms behind them, evaluating key success factors and challenges (Chapter 3).
- Derived conclusions and hypotheses regarding the barriers to and requirements for the widespread establishment of NbS in the Alpine area. These were discussed at an international workshop in September 2024 where specific approaches and key players for the practical implementation of NbS were added (Chapters 4, 5).
- Summarised the results and findings as well as providing a detailed explanation of instruments able to promote the establishment of NbS in the Alpine region (Chapter 6).
- Documented the results of the detailed project analysis in Project Factsheets (Appendix A.2).

One further outcome is an unpublished Input Paper for the Alpine Conference 2025. Summarising the preliminary results of the project analysis, the workshop inputs as well as the derived conclusions, this presents recommendations.

Definition of Nature-based Solutions

The authors of this report use the UNEP (2022b) definition of NbS:

> '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'.

As an umbrella concept, NbS unify several ecosystem-based approaches which have in common that they use ecosystem functions to specifically tackle one or more societal changes, while simultaneously providing benefits for human well-being and ecosystems or biodiversity (Chapter 2).

Analysis of selected Nature-based Solution model projects

The in-depth analysis covers eight successful NbS model projects (Chapter 3 and Appendix A.2) with various implementation sites in Austria, Germany, France, Italy, Liechtenstein, Slovenia and Switzerland. Covering several sectors of the Alpine Climate Target System (*Ecosystems and Biodiversity*, *Mountain Agriculture*, *Mountain Forestry*, *Natural Hazards*, *Soil*, *Tourism*, and

Water), the projects vary greatly in terms of size, sectors addressed, and number of stakeholders involved. The analysis revealed important characteristics of NbS projects with respect to biodiversity, climate change mitigation and adaption, socio-economic impacts and governance aspects.

Regarding biodiversity, the projects achieved benefits, among others, through restoring habitats and establishing habitat networks. Moreover, adapted land use practices show a significant positive effect on flora, fauna and soil functions. All projects contribute to climate change adaptation (particularly through water management and natural hazard protection), while half of them additionally help to actively mitigate climate change (mainly through sequestering greenhouse gases). The socio-economic analysis showed that NbS create added value through enhanced recreational qualities, environmental education, and cost savings in infrastructure maintenance, while also fostering community engagement and preserving cultural heritage. The governance analysis highlights varying forms of cooperation depending on project size, with successful projects characterised by broad stakeholder involvement, clear organisational structures and professional conflict management. Key success factors include early stakeholder engagement, transparent communication and motivated individuals.

Establishing Nature-based Solutions in the Alpine area

The cross-project analysis demonstrates that NbS provide valuable opportunities for counteracting various challenges particularly relevant to the Alpine area based on cross-sectoral and transdisciplinary approaches.

In this context, Chapter 4.1 explores these opportunities and specific starting points for selected sectors, namely urban planning, water management, energy, transport and tourism. Cross-sectoral synergies and multiple benefits are highlighted as key advantages of NbS projects. Possible measures include green roofs and facades, vegetated infiltration swales, peatland restoration, ecological high voltage powerline corridors, “green bridges” as a combination of cycle / hiking paths and wildlife corridors across roads or railway lines, or the promotion of “wilderness” areas as nature experience and/or tourist areas.

While NbS offer significant potential for addressing the climate crisis and other societal challenges in the Alpine region, their successful implementation depends on overcoming various barriers (Chapter 4.2):

- Knowledge and communication barriers (including data gaps).
- Language barriers in the multilingual Alpine region.
- Insufficient knowledge transfer mechanisms.
- Coordination challenges stemming from the complexity of integrating diverse stakeholder interests and fostering multi-level collaboration across transboundary jurisdictions.

Framework-related obstacles include a lack of capacities and incentives, insufficient evidence regarding NbS efficacy, and "grey path dependency" favouring traditional infrastructure projects. The analysis further revealed practical challenges such as deficits in cross-sectoral cooperation, lack of clear legal frameworks, inadequate governance standards, limited incentives for landowner participation, and space constraints in Alpine valley floors.

Thus, coordinated action at multiple levels and across different sectors is needed to promote the establishment of NbS in the Alpine region. More specifically, the authors derived the following hypotheses on the framework conditions necessary for the successful and further establishment of NbS (Chapter 4.3):

- With regard to scale, two approaches are identified: a bottom-up-approach, starting from small projects and then upscaling them; and a top-down approach, implementing large-scale solutions at individual project sites or combining multiple small-scale solutions to form a large-scale one.
- Adapted temporal management approaches have to be considered: While some projects, especially proven and directly effective small-scale NbS, need targeted promotion and funding to be rapidly spread, NbS based on complex natural processes require (new) concepts for long-term thinking, long-term management and adaptive governance.
- A smart combination of public funding and private financial resources, supported by adapted institutional frameworks, is needed. Public funding and business models for enterprises need to be developed, promoted and made easily accessible for project applicants across sectors.
- Efforts are required to build up a binding legal framework, standardised evaluation criteria, and institutionalised support structure.
- There is a need to raise public awareness and to build up capacities by offering easily accessible education and training on theoretical NbS approaches.
- With regard to communication, clear and positive messages are needed to motivate key stakeholders, especially landowners.
- Good and case-adapted governance mechanisms are crucial to facilitate cross-sectoral and interdisciplinary collaboration with a special focus on transparency and continuous communication. This can increase the acceptance of NbS among landowners, (private) investors, planners, public administration and policymakers.

Feasibility checklist for practical implementation

A nine-step feasibility checklist is proposed, providing practical and early guidance as to whether new NbS projects are feasible. The checklist considers the importance of stakeholder engagement, technical requirements, legal frameworks, and cross-sectoral synergies (Chapter 4.4).

Existing institutions and networks supporting the establishment of Nature-based Solutions

The widespread establishment of NbS, the Alpine region benefits from three key institutional frameworks (Chapter 5): The Alpine Convention with its thematic working bodies, the EU Macroregional Strategy for the Alpine Region (EUSALP), and the Alpine Space Programme. These institutions facilitate transnational cooperation through various mechanisms. For instance, the Alpine Climate Board, (as the thematic working body of the Alpine Convention dedicated to climate action) chose NbS as a focus topic and integrated them into the Climate Action Plan 2.0 (PSAC 2021), while the EUSALP's Action Groups promote multifunctional forests and green infrastructure. Launched in 2000, the Alpine Space Programme is the first transnational EU cooperation programme for the Alps specifically promoting NbS to address climate change and biodiversity loss.

In addition, numerous platforms and networks offer support for establishing NbS, providing general information, options for knowledge exchange, best-practice examples, scientific findings, evaluation methods, tools, etc.

Recommendations for promoting Nature-based Solutions in the Alpine area

Summarised in recommendations linked to various aspects – from strategic considerations to practical application tools –, the results of the entire project are intended to address political decision-makers as well as administrative practitioners and project managers in the Alpine region (Chapter 6).

Strategic actions

NbS offer significant potential for addressing environmental and socio-economic challenges in the Alpine region. To realise this potential, they need to be strategically integrated into policy, across different sectors and in the relevant plans and programmes at local, regional, national and pan-Alpine level.

As an essential factor, this includes promoting active cooperation between different stakeholders to ensure transparent and inclusive planning processes and to achieve consent on compensation mechanisms. This again requires education and training of NbS project stakeholders.

An Alpine-wide strategy or action plan would be a promising instrument to effectively coordinate efforts across sectors and regions, promote cooperation and establish NbS as key instruments for sustainable development in the Alpine region.

Practical implementation

The practical implementation of NbS in the Alpine region requires their integration into existing policies and instruments in the fields of nature conservation, environmental, landscape and spatial planning. It further necessitates an adaptive planning cycle and clearly defined project scopes, while considering social, legal, institutional and ecological dimensions and challenges, and allowing room for visions. Implementation pathways can be either top-down or bottom-up, and can take place at local, regional, national and Alpine-wide level.

To support NbS projects, consultants specialised in governance, management, financing and technical expertise can provide crucial assistance, particularly for project owners lacking resources or expertise. This support can include network development and administrative guidance, for example in the communication field.

Tools supporting transparency, stakeholder engagement and evidence-based decision-making are relevant for successful implementation. Key components include effective data management, mapping capabilities, monitoring systems, and assessment frameworks to ensure NbS can be properly evaluated and compared with conventional alternatives. The stepwise introduction of NbS feasibility checks (which should be mandatory in the final step) can help to identify and foster opportunities for NbS as alternative solutions in an early stage.

In addition, knowledge sharing through best practice collections, glossaries and centralised platforms can enhance understanding and cooperation. The development of standardised tools and a freely accessible, interactive platform is an option to allow stakeholders across the entire Alpine region to access NbS-related information, view implemented projects and propose new implementation sites.

Standards

The standardisation of NbS and the assessment of their impact can demonstrate their effectiveness. The IUCN has developed a global standard that provides a framework for assessing and certifying NbS (IUCN 2020b), although adaptations may be necessary for specific contexts such as the Alpine region.

In addition, already existing standards in different fields (such as river restoration, land management) can be used for the practical implementation of NbS, though may need to be adapted.

Selected legal instruments

Legal instruments as found in spatial planning, public procurement and environmental law are to be considered in the implementation of NbS in the Alpine region, potentially supporting NbS as binding frameworks while maintaining case-specific flexibility.

Regarding spatial planning, existing frameworks such as the Alpine Convention's "Spatial Planning and Sustainable Development" Protocol offer the opportunity to transnationally harmonise environmental and land-use objectives. However, specific guidelines and enforcement mechanisms for promoting NbS in the Alpine region need further development. Nevertheless, there are promising examples of binding and voluntary legal frameworks at national and regional level.

Public procurement rules already offer great potential to promote sustainable development. NbS can be supported within procurement rules through mechanisms such as product specifications, life-cycle cost analyses and challenge-based approaches. There is, however, a lack of binding rules prioritising NbS and insufficient knowledge in applying these instruments.

Economic assessment and funding

NbS benefits can be categorised as public, private, common or club goods, each requiring different approaches to financing and revenue generation.

NbS implementation costs must be evaluated alongside their benefits in economic assessments considering both short- and long-term effects as well as monetary and non-monetary aspects. Assessment interpretation varies between private and public investors due to their different interests.

The EU Biodiversity Strategy highlights NbS as a way to address biodiversity loss and climate change, albeit requiring substantial budgets in excess of public funding capabilities. Private investment is thus to be seen as an important additional financial source. However, private NbS investments face challenges, particularly because public goods created by NbS often do not generate short-term revenues – in general a relevant issue for private investors.

Currently used financing instruments are primarily limited to grants and various types of loans, while promising additional instruments include equity instruments, guarantees and different types of bonds. Alternative funding sources include tax breaks/credits and insurance payments for damages caused by climate change-related events.

Key recommendations include encouraging private investment, fostering public-private partnerships, and ensuring fair benefit distribution. Further research and training are needed to better understand transaction costs for larger stakeholder groups and develop the economic expertise of stakeholders in NbS implementation.

Successful governance mechanisms

Establishing effective governance mechanisms for Nature-based Solutions in the Alpine region necessitates a multifaceted approach involving cross-sectoral collaboration, skills development, and rigorous monitoring and evaluation processes.

Communication

Effective communication mechanisms are fundamental for promoting NbS in the Alpine region. NbS acceptance and implementation can be significantly enhanced by:

- Developing positive narratives.
- Engaging transparently with stakeholders.
- Addressing concerns sensitively.
- Raising awareness through educational campaigns, utilising diverse platforms.
- Continuous evaluating efforts.

Education and training

NbS education and training foster acceptance, confidence, mutual understanding among different stakeholders, while helping them to gain more self-confidence in dealing with complex systems and processes in the Alpine region.

Participation and utilisation of social engagement

Social engagement and community participation are helpful to implementing NbS, using innovative approaches like competitive initiatives, youth involvement, experiential learning, and volunteer engagement. All these aspects can contribute to fostering environmental stewardship and sustainable practices in the Alpine region.

Zusammenfassung

Projektziele und Aufgaben

Das deutsche Umweltbundesamt initiierte das Projekt Naturbasierte Lösungen im Alpenraum: Nutzung von Ökosystemfunktionen zur Förderung von Klimaschutz- und Klimaanpassungsmaßnahmen. Schaffung neuer naturorientierter Governance-Mechanismen über Sektoren und Politikebenen hinweg, um das Bewusstsein für die grundsätzliche Bedeutung naturbasierter Lösungen (NbL) für den Alpenraum zu stärken. Als ein Hotspot des Klimawandels erfährt der Alpenraum erhebliche Auswirkungen auf seine ökologischen Funktionen, seine Biodiversität, seine wirtschaftlichen Möglichkeiten und seine Siedlungsstrukturen. Der vorliegende Bericht analysiert die Umsetzung von NbL als erfolgversprechenden Ansatz zur Bewältigung dieser Herausforderungen, der zugleich dem Schutz der Biodiversität und der Steigerung des menschlichen Wohlergehens dient. NbL werden als wichtige Elemente eines vielversprechenden Transformationsprozesses zu einer nachhaltigen Wirtschaft verstanden. Ein besonderer Schwerpunkt liegt dabei auf (innovativen) Governance-Mechanismen, welche die Umsetzung von NbL fördern und den Erfolg von NbL-Projekten unterschiedlicher Größenordnung sicherstellen.

Im Rahmen dieses Projekts haben *ifuplan* und *CIPRA International* als Forschungsnehmer

- einen Überblick über die Entwicklung und Definition des NbL-Konzepts erstellt (Kapitel 2);
- erfolgreich umgesetzte NbL-Projekte zur Klimawandelanpassung oder -vermeidung im Alpenraum und die dahinterstehenden Governance-Mechanismen ausgewählt und analysiert sowie die wichtigsten Erfolgsfaktoren und Herausforderungen evaluiert (Kapitel 3);
- Schlussfolgerungen und Hypothesen zu Hindernissen und Voraussetzungen für eine flächendeckende Etablierung von NbS im Alpenraum abgeleitet, die in einem internationalen Workshop im September 2024 diskutiert und um konkrete Ansätze und Hauptakteure für die praktische Umsetzung von NbL ergänzt wurden (Kapitel 4, 5);
- die Ergebnisse und Erkenntnisse sowie eine detaillierte Erläuterung von Instrumenten zur Förderung von NbL im Alpenraum (Kapitel 6) in diesem Bericht zusammengefasst und
- die Ergebnisse der detaillierten Projektanalyse in Projekt-Datenblättern dokumentiert (Anhang A.2).

Ein weiteres Ergebnis ist ein unveröffentlichtes Input-Papier als Beitrag zur Alpenkonferenz 2025, das die vorläufigen Ergebnisse der Projektanalyse, die Workshop-Beiträge sowie die abgeleiteten Schlussfolgerungen zusammenfasst und Empfehlungen präsentiert.

Definition von naturbasierten Lösungen

In Anlehnung an UNEP (2022a) definieren die Autoren*Autorinnen dieses Berichts NbL als

‚Maßnahmen zum Schutz, zur Erhaltung, Wiederherstellung, nachhaltigen Nutzung und Bewirtschaftung natürlicher oder veränderter Land-, Süßwasser-, Küsten- und Meeresökosysteme, mit denen soziale, wirtschaftliche und ökologische Herausforderungen wirksam und anpassungsfähig angegangen werden können und die gleichzeitig dem menschlichen Wohlergehen, den Ökosystemleistungen, der Widerstandsfähigkeit und der biologischen Vielfalt zugutekommen‘.

Als Rahmenkonzept vereinen NbL mehrere ökosystembasierte Ansätze, denen gemeinsam ist, dass sie Ökosystemfunktionen nutzen, um gezielt eine oder mehrere gesellschaftliche

Veränderungen anzugehen. Zugleich erzeugen sie einen Mehrwert für das menschliche Wohlergehen und Ökosysteme oder die biologische Vielfalt (Kapitel 2).

Analyse ausgewählter Modellprojekte zu naturbasierten Lösungen

Die eingehende Analyse umfasst acht erfolgreich umgesetzten NbL-Modellprojekten (Kapitel 3 und Anhang A.2) mit verschiedenen Umsetzungsstandorten in Österreich, Deutschland, Frankreich, Italien, Liechtenstein, Slowenien und der Schweiz. Die Projekte decken mehrere Sektoren des alpinen Klimazielsystems (*Ökosysteme und Biodiversität*, *Berglandwirtschaft*, *Bergwald*, *Naturgefahren*, *Boden*, *Tourismus* und *Wasser*) ab und unterscheiden sich deutlich in Bezug auf ihre Größe, die angesprochenen Sektoren und die Anzahl der beteiligten Akteure*Akteurinnen. Die Analyse der Projekte zeigte wichtige Merkmale von NbL-Projekten in Bezug auf Biodiversität, Klimawandelminderung und -anpassung, sozioökonomische Effekte und Governance-Aspekte auf:

In Bezug auf die biologische Vielfalt erzielten die Projekte unter anderem durch die Wiederherstellung von Lebensräumen und die Schaffung von ökologischen Verbundnetzen Erfolge. Darüber hinaus zeigen angepasste Landnutzungsformen in den Projekten signifikante positive Wirkung auf Flora, Fauna und Bodenfunktionen. Alle Projekte tragen zur Anpassung an den Klimawandel bei (insbesondere durch nachhaltige Wasserbewirtschaftung und den Schutz vor Naturgefahren). Die Hälfte der Projekte trägt zusätzlich zur aktiven Abschwächung des Klimawandels bei (vorwiegend durch die Bindung von Treibhausgasen). Die sozioökonomische Analyse zeigte, dass NbL einen Mehrwert durch verbesserte Erholungsqualität, Umweltbildung und Kosteneinsparungen bei der Instandhaltung von Infrastruktur generieren und gleichzeitig gemeinschaftliches Engagement und den Erhalt des kulturellen Erbes fördern. Die Governance-Analyse ergab, dass es je nach Projektgröße unterschiedliche Formen der Zusammenarbeit gibt. Dabei zeichnen sich erfolgreiche Projekte durch eine breite Beteiligung der Interessensgruppen, klare Organisationsstrukturen und professionelles Konfliktmanagement aus. Zu den wichtigsten Erfolgsfaktoren gehören die frühzeitige Einbindung der Interessensträger*innen, eine transparente Kommunikation und motivierte Einzelpersonen.

Etablierung naturbasierter Lösungen im Alpenraum

Die projektübergreifende Analyse zeigt, dass NbL auf der Grundlage von sektorübergreifenden und transdisziplinären Ansätzen wertvolle Lösungen für verschiedene besonders im Alpenraum relevante Herausforderungen bieten.

In Kapitel 4.1 werden diese Lösungen und spezifischen Ansatzpunkte exemplarisch für ausgewählte Sektoren – Stadtplanung, Wasserwirtschaft, Energie, Verkehr und Tourismus – vorgestellt. Sektorübergreifende Synergien und Mehrfachnutzen werden als Hauptvorteile von NbL-Projekten hervorgehoben. Dazu gehören Maßnahmen, wie z. B. Dach- und Fassadenbegrünungen, bepflanzte Versickerungsmulden, Moorrenaturierungen, die Gestaltung von Hochspannungsleitungen als ökologische Korridore, „Grünbrücken“ als Kombination von Rad-/Wanderwegen und Wildtierkorridoren über Straßen oder Bahnlinien sowie die Förderung von „Wildnis“-Gebieten als besonderes Naturerlebnis und touristische Attraktion.

Obwohl NbL ein erhebliches Potenzial für die Bewältigung der Klimakrise und anderer gesellschaftlicher Herausforderungen im Alpenraum bieten, hängt ihre erfolgreiche Umsetzung von der Überwindung verschiedener Hindernisse ab (Kapitel 4.2):

- Wissenslücken und Kommunikationsbarrieren einschließlich Datenlücken;
- Sprachbarrieren im mehrsprachigen Alpenraum;

- Unzureichende Mechanismen für den Wissenstransfer;
- Koordinative Herausforderungen aufgrund der Komplexität von unterschiedlichen, zu berücksichtigenden Interessen von Interessensgruppen und der Förderung grenzüberschreitender Mehrebenen-Zusammenarbeit.

Zu den Hindernissen bestehender Rahmenbedingungen, gehören fehlende Kapazitäten und Anreize, unzureichende Nachweise für die Wirksamkeit von NbL und einer ‚grauen Pfadabhängigkeit', die konventionelle Infrastrukturprojekte begünstigt. Die Analyse zeigte außerdem praktische Herausforderungen, die in Defiziten bei der sektorübergreifenden Zusammenarbeit, im Fehlen klarer rechtlicher Rahmenbedingungen, unzureichender Governance-Standards, begrenzter Anreize für die Beteiligung von Grundeigentümern und der räumlichen Beschränkungen in alpinen Tallagen bestehen.

Daher sind koordinierte, sektorübergreifende Maßnahmen auf mehreren Ebenen erforderlich, um die Umsetzung von NbL im Alpenraum zu fördern. Konkret wurden die folgenden Hypothesen zu den notwendigen Rahmenbedingungen für eine erfolgreiche weitere Etablierung von NbL abgeleitet (Kapitel 4.3):

- In räumlicher Hinsicht sind Mechanismen für zwei Ansätze möglich: für einen Bottom-up-Ansatz, bei dem NbL von kleinen Projekten ausgehend verbreitet oder hochskaliert werden, und für einen Top-down-Ansatz, bei dem groß-skalige NbL an einzelnen Projektstandorten umgesetzt oder viele kleine Lösungen zu einer großen Lösung zusammengefasst werden.
- Es sind für NbL zeitlich angepasste Managementansätze erforderlich: Während einige Projekte, insbesondere bewährte und unmittelbar wirksame NbL in kleinem Maßstab, (lediglich) gezielte Förderung und Finanzierung benötigen, um rasch verbreitet zu werden, erfordern NbL, die auf komplexen natürlichen Prozessen beruhen, (neue) Konzepte für langfristiges Denken, langfristiges Management und angepasste Governance-Strukturen.
- Es bedarf einer intelligenten Kombination aus öffentlicher und privater Finanzierung, unterstützt durch angepasste institutionelle Rahmenbedingungen: Öffentliche Finanzierungs- und Geschäftsmodelle von NbL für Unternehmen müssen sektorenübergreifend entwickelt, gefördert und für Projektantragsteller*innen leicht zugänglich gemacht werden.
- Es sind Anstrengungen zum Aufbau eines verbindlichen Rechtsrahmens, standardisierter Bewertungskriterien und einer institutionalisierten Unterstützungsstruktur erforderlich.
- Es sind eine Bewusstseinsschärfung der Öffentlichkeit und der Aufbau von Kompetenzen durch leicht zugängliche Aus- und Weiterbildungsangebote zu den (theoretischen) Ansätzen von NbL notwendig.
- Klare und positive Botschaften, welche die wichtigsten Interessensgruppen, insbesondere Grundeigentümer*innen, auf motivierende Weise ansprechen, sind für die Kommunikation förderlich.
- Gute, an den Einzelfall angepasste Governance-Mechanismen sind von zentraler Bedeutung, um eine sektorübergreifende und interdisziplinäre Zusammenarbeit mit besonderem Schwerpunkt auf Transparenz und kontinuierlicher Kommunikation zu ermöglichen und die Akzeptanz von NbL bei Grundeigentümern*Grundeigentümerinnen, (privaten) Investoren*Investorinnen, Planern*Planerinnen, der öffentlichen Verwaltung und politischen Entscheidungsträgern*Entscheidungsträgerinnen zu erhöhen.

Machbarkeits-Checkliste für die praktischen Umsetzung

Es wird eine neunstufige Machbarkeits-Checkliste vorgeschlagen, die bereits in einer frühen Planungsphase eine praktische Anleitung für die Prüfung bietet, ob neue NbL-Projekte realisierbar sind. Die Checkliste berücksichtigt die Bedeutung des Engagements der Interessensgruppen, der technischen Anforderungen, des rechtlichen Rahmens und der sektorenübergreifenden Synergien (Kapitel 4.4).

Bestehende Institutionen und Netzwerke, zur Unterstützung von naturbasierten Lösungen

Bei der angestrebten flächendeckenden Umsetzung von NbL kann der Alpenraum von drei bestehenden Institutionen profitieren (Kapitel 5): Die Alpenkonvention mit ihren thematischen Arbeitsgruppen, die makroregionale Strategie der EU für den Alpenraum (EUSALP) und das Alpenraumprogramm. Diese Institutionen erleichtern die transnationale Zusammenarbeit durch verschiedene Mechanismen. So wählte beispielsweise der Alpine Klimabeirat (als thematische Arbeitsgruppe der Alpenkonvention, die sich explizit dem Klimaschutz widmet) NbL als ein Schwerpunktthema und integrierte sie in den Klimaaktionsplan 2.0 (PSAC 2021), während die Aktionsgruppen der EUSALP multifunktionale Wälder und grüne Infrastrukturen fördern. Das Alpenraumprogramm, das im Jahr 2000 als erstes transnationales EU-Kooperationsprogramm für die Alpen ins Leben gerufen wurde, fördert speziell NbL, um dem Klimawandel und dem Verlust der biologischen Vielfalt zu begegnen.

Darüber hinaus bieten zahlreiche Plattformen und Netzwerke Unterstützung bei der Etablierung von NbL, etwa durch die Bereitstellung von allgemeinen Informationen, Möglichkeiten zum Wissensaustausch, Best-Practice-Beispiele, wissenschaftlichen Erkenntnisse, Bewertungsmethoden, Instrumenten usw.

Empfehlungen zur Förderung von naturbasierten Lösungen im Alpenraum

Die Ergebnisse des gesamten Projekts fließen in Empfehlungen ein, die sich auf verschiedene Aspekte beziehen - von strategischen Überlegungen bis hin zu praxisorientierten Anwendungsinstrumenten - und sich sowohl an politische Entscheidungsträger*innen als auch an Verwaltungspraktiker*innen und Projektmanager*innen im Alpenraum richten (Kapitel 6).

Strategische Maßnahmen

NbL bieten ein erhebliches Potenzial für die Bewältigung ökologischer und sozioökonomischer Herausforderungen im Alpenraum. Um dieses Potenzial auszuschöpfen, müssen sie strategisch in die Politik, in verschiedene Sektoren und in die entsprechenden Pläne und Programme auf lokaler, regionaler, nationaler und alpenweiter Ebene integriert werden.

Ein wesentlicher Faktor ist dabei die Förderung einer aktiven Zusammenarbeit zwischen den verschiedenen Interessensgruppen, um transparente und integrative Planungsprozesse zu gewährleisten und einen Konsens über Entschädigungsmechanismen zu erzielen. Dies wiederum erfordert die Ausbildung und Schulung der NbL-Projektakteure.

Eine alpenweite Strategie oder ein alpenweiter Aktionsplan wäre ein vielversprechendes Instrument, um die Aktivitäten über Sektoren und Regionen hinweg wirksam zu koordinieren, die Zusammenarbeit zu fördern und NbL als Schlüsselinstrumente für eine nachhaltige Entwicklung im Alpenraum zu etablieren.

Praktische Umsetzung

Die praktische Umsetzung von NbL im Alpenraum erfordert ihre Integration in bestehende Politiken und Instrumente von Naturschutz, Umwelt-, Landschafts- und Raumplanung. Darüber hinaus sind ein an den Einzelfall angepasster Planungszyklus und klar definierte

Projektumfänge erforderlich, wobei soziale, rechtliche, institutionelle und ökologische Dimensionen und Herausforderungen zu berücksichtigen sind, die auch Raum für Visionen lassen. Die Umsetzung von NbL sollte auf lokaler, regionaler, nationaler und alpenweiter Ebene erfolgen, wobei sowohl „Top-down"- als auch „Bottom-up"-Ansätze integriert werden.

Zur Unterstützung von NbL-Projekten können Institutionen, die zu Governance, Management, Finanzierung und technischer Umsetzung beraten, entscheidend unterstützen, insbesondere für Projektträger*innen, denen es an eigenen Ressourcen oder Fachwissen mangelt. Diese Unterstützung kann die Entwicklung von Netzwerken und administrative Unterstützung umfassen, etwa als Beratung oder im Bereich der Kommunikation.

Instrumente zur Förderung von Transparenz, der Einbeziehung von Interessensgruppen und einer evidenzbasierten Entscheidungsfindung sind für eine erfolgreiche Umsetzung entscheidend. Zu den Schlüsselkomponenten gehören ein effektives Datenmanagement, Kartierfähigkeiten, Monitoring und Bewertungsrahmen, um sicherzustellen, dass NbL und konventionelle Alternativen angemessen bewertet werden können. Eine schrittweise Einführung von Machbarkeitsprüfungen von NbL, die in einer abschließenden Phase verpflichtend sein sollten, könnte helfen, Chancen für NbL zu erkennen und die Berücksichtigung von NbL als alternative Lösungen zu einem frühen Zeitpunkt zu unterstützen.

Darüber hinaus kann der Wissensaustausch durch „Best-Practice"-Sammlungen, Glossare und zentrale Plattformen das Verständnis und die Zusammenarbeit verbessern. Es wird vorgeschlagen, standardisierte Instrumente und eine frei zugängliche, interaktive Plattform zu entwickeln, die es Interessensgruppen im gesamten Alpenraum ermöglicht, auf NbL-bezogene Informationen zuzugreifen, umgesetzte Projekte einzusehen und neue Umsetzungsstandorte vorzuschlagen.

Standards

Eine Standardisierung von NbL und der Bewertung ihrer Auswirkungen können ihre Wirksamkeit aufzeigen. Die IUCN hat einen globalen Standard entwickelt, der einen Rahmen für die Bewertung und Zertifizierung von NbL bietet (IUCN 2020b), wenngleich für spezifische Kontexte wie den Alpenraum Anpassungen erforderlich sein können.

Darüber hinaus können bereits bestehende Standards in verschiedenen Sektoren (z. B. Wasserwirtschaft, Flächenmanagement) für die praktische Umsetzung von NbL verwendet werden, müssen aber möglicherweise angepasst werden.

Ausgewählte Rechtsinstrumente

Rechtliche Instrumente aus den Bereichen Raumplanungsrecht, öffentliches Beschaffungsrecht und Umweltrecht müssen bei der Umsetzung von NbL im Alpenraum berücksichtigt werden. Sie können NbL durch die Schaffung von verbindlichen Rahmenbedingungen unterstützen und sollten gleichzeitig fallspezifische Flexibilität erlauben.

Im Bereich der Raumplanung bieten bestehende Rahmenwerke wie das Protokoll *Raumplanung und nachhaltige Entwicklung* der Alpenkonvention die Möglichkeit, grenzüberschreitend Umwelt- und Landnutzungsziele zu harmonisieren. Spezifische Leitlinien und Durchsetzungsmechanismen zur Förderung von NbL im Alpenraum müssen jedoch noch entwickelt werden. Auf nationaler und regionaler Ebene gibt es bereits vielversprechende Beispiele für verbindliche und freiwillige rechtliche Rahmenbedingungen.

Die Vorschriften für das öffentliche Beschaffungswesen bieten bereits ein großes Potenzial zur Förderung der nachhaltigen Entwicklung. NbL können hier durch entsprechende Anwendung von etwa Produktspezifikationen, Lebenszykluskostenanalysen und anforderungsbasierten

Ansätzen unterstützt werden. Es mangelt jedoch an verbindlichen Vorschriften, die NbL als Lösung Vorrang einräumen, sowie an ausreichendem Wissen über die Anwendung der oben genannten Instrumente.

Wirtschaftliche Bewertung und Finanzierung

Der Nutzen von NbL kann als öffentliche, private, gemeinschaftliche Güter oder Clubgüter kategorisiert werden, was jeweils unterschiedliche Ansätze der Finanzierung und für die Einnahmen bedeutet.

Die Kosten für die Umsetzung naturbasierter Lösungen müssen zusammen mit ihrem Nutzen in wirtschaftlichen Analysen bewertet werden, wobei sowohl kurz- und langfristige Auswirkungen als auch monetäre und nicht-monetäre Nutzen zu berücksichtigen sind. Die Bewertung wird von privaten und öffentlichen Investoren*Investorinnen aufgrund ihrer verschiedenen Interessen unterschiedlich interpretiert.

Die EU-Biodiversitätsstrategie legt den Schwerpunkt auf die Umsetzung von NbL, um dem Verlust der biologischen Vielfalt und dem Klimawandel entgegenzuwirken, was erhebliche finanzielle Mittel erfordern wird, welche die Möglichkeiten der öffentlichen Hand voraussichtlich übersteigen werden. Daher stellen private Investition eine wichtige zusätzliche Finanzierungsquelle dar. NbL stellen jedoch private Finanzinvestitionen vor Herausforderungen, insbesondere weil die durch NbL erzeugten öffentlichen Güter oft keine kurzfristigen Einnahmen bringen, die im Allgemeinen ein wesentlicher Anreiz privater Investoren sind.

Die derzeit eingesetzten Finanzierungsinstrumente beschränken sich in erster Linie auf Zuschüsse und verschiedene Arten von Darlehen, während vielversprechende zusätzliche Instrumente Eigenkapitalinstrumente, Garantien und verschiedene Arten von Anleihen sind. Zu alternativen Finanzierungsmaßnahmen gehören Steuererleichterungen, Kredite und Versicherungsleistungen.

Wichtige Empfehlungen umfassen die Förderung privater Investitionen, die Förderung öffentlich-privater Partnerschaften und die Gewährleistung eines gerechten Vorteilsausgleichs. Weitere Forschungs- und Ausbildungsmaßnahmen sind erforderlich, um die Transaktionskosten für größere Interessensgruppen besser zu verstehen und wirtschaftliches Fachwissen der Beteiligten für die Umsetzung von NbL zu entwickeln.

Erfolgreiche Governance-Mechanismen

Die Schaffung effektiver Governance-Mechanismen für naturbasierte Lösungen im Alpenraum erfordert einen vielschichtigen Ansatz, der sektorenübergreifende Zusammenarbeit, Kompetenzentwicklung und strenge Monitoring- und Evaluierungsprozesse umfasst.

Kommunikation

Wirksame Kommunikationsmechanismen sind für die Förderung von NbL im Alpenraum von grundlegender Bedeutung. Die Akzeptanz und Umsetzung von NbL kann erhöht werden durch

- die Entwicklung positiver Narrative,
- den transparenten Umgang mit Interessensgruppen,
- den sensiblen Umgang mit Bedenken der Interessensgruppen,
- die Sensibilisierung durch Aufklärungskampagnen, die Nutzung verschiedener Plattformen und die kontinuierliche Evaluierung von Aktivitäten.

Aus- und Weiterbildung

Die Aus- und Weiterbildung zu NbL fördert die Akzeptanz, das Vertrauen und das gegenseitige Verständnis zwischen den verschiedenen involvierten Interessensgruppen und hilft den Beteiligten, mit mehr Selbstvertrauen mit komplexen Systemen und Prozessen im Alpenraum umzugehen.

Beteiligung und Nutzung gesellschaftlichen Engagements

Gesellschaftliches Engagement und die Beteiligung der Bürgerschaft sind hilfreiche Instrumente zur Umsetzung von NbL. Dabei können innovative Ansätze wie Wettbewerbsinitiativen, Jugendbeteiligung, erfahrungsbasierte Lernen und ehrenamtliches Engagement eingesetzt werden und den verantwortungsvollen Umgang mit der Umwelt und nachhaltige Praktiken im Alpenraum fördern.

1 Report framework and objectives

The Alpine region is particularly sensitive to the effects of the climate crisis. In Germany, it is considered to be one of the hotspots of climate change (UBA 2022). Changes in precipitation, rising temperatures, extreme weather events and water runoff influence not only ecological functions but also economic and settlement opportunities in the Alps and neighbouring areas.

At the same time, the Alps provide a wealth of ecosystem services, such as water retention, wood biomass or landscape amenities, all of which are the foundation of human well-being and the Alpine economy. Yet these services are threatened by the aforementioned effects of climate change and loss of biodiversity. One promising approach is the targeted use of the various functions and services provided by Alpine ecosystems to fulfil human needs without exploiting or destroying nature but instead fostering it. This is the basic concept behind Nature-based Solutions (NbS), as discussed in greater depth in Chapter 2. NbS could thus 'offer a transition path with realistic incremental steps toward a sustainable economy' (Maes & Jacobs 2017, p. 121). Furthermore, the above-mentioned ecosystem services offer opportunities for integrated and cross-sectoral NbS approaches to mitigate the effects of and adapt to climate change.

To use NbS effectively, the importance of ecosystem services needs to be recognised and taken into account in decision-making processes at all political levels, backed by appropriate governance mechanisms. As Alpine NbS usually have cross-sectoral and cross-border effects, the Alpine Convention as a transnational agreement and institution is particularly well suited to address them and to help establish them in the entire Alpine region. The Alpine Climate Board (ACB) – as the Thematic Working Body of the Alpine Convention dedicated to climate action – has therefore integrated NbS into its Climate Action Plan 2.0 (PSAC 2021) and agreed to make them one of its three cross-sectoral focus topics for its current term of office (AC 2022).

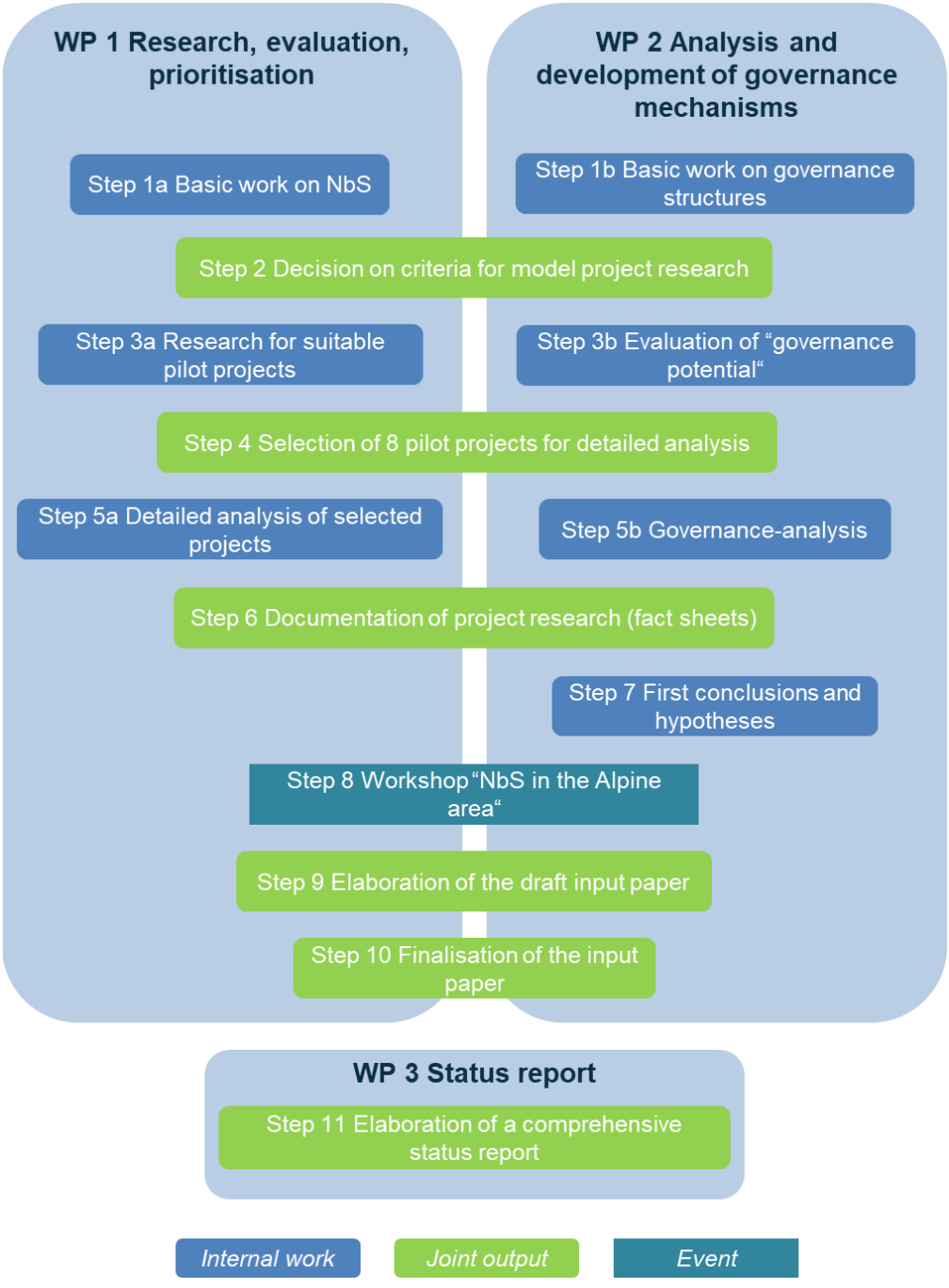
Against this background, the German Federal Environment Agency (Umweltbundesamt, UBA) initiated the project *Nature-based solutions in the Alpine region: Using ecosystem functions to promote climate mitigation and adaptation measures. Creating new nature-centred governance mechanisms across sectors and policy levels*. As part of this project, ifuplan and CIPRA International analysed completed NbS projects and their governance mechanisms in the Alpine region, examining key success factors and challenges and deriving prerequisites for successfully establishing NbS in the Alpine region.

This report documents the work carried out in the three project work packages illustrated in Figure 1: Desktop research on the concept of NbS and on governance structures (Step 1) helped define the selection criteria for suitable projects in different sectors within the perimeter of the Alpine Convention (Step 2). The project team searched for suitable pilot projects with promising governance structures (Step 3), ultimately selecting eight model projects (Step 4) for an in-depth analysis of their contributions to climate change mitigation or adaption, their benefits for biodiversity and human well-being, and their specific governance features (Step 5). The analysed NbS projects were documented in factsheets (Step 6). The derived conclusions and hypotheses (Step 7) were discussed in an international project workshop held in September 2024 (Step 8), while an unpublished input paper summarised the intermediate results for the Alpine Conference 2025 (Steps 9, 10). This report (Step 11) presents the results of the project analysis and the inputs from the international project workshop in September 2024, contextualising them with respect to related scientific literature. Furthermore, it presents

conclusions and recommendations for the Alpine Convention and further stakeholders in the Alpine area.

The findings can serve as a basis for the future work of the Alpine Climate Board in collaboration with other Thematic Working Bodies (TWBs) of the Alpine Convention. Recommendations and insights may be considered during the Italian and German Presidencies of the Alpine Convention 2025-2026 and 2027-2028, respectively.

Figure 1: Overview of project work packages



Source: Authors' own illustration, ifuplan.

2 Introduction to Nature-based Solutions

What are "Nature-based Solutions" and how are they linked to biodiversity and climate change issues? This chapter introduces the concept of NbS, clarifies their definition within the framework of this project, and differentiates them from other related approaches.

Society is facing the dual challenge of promoting the economy while eliminating its harmful effects, and of combating climate change and the loss of biodiversity. NbS can 'offer a transition path with realistic, incremental steps toward a sustainable economy' (Maes & Jacobs 2017, p. 121).

2.1 Evolution of the Nature-based Solutions concept

Functioning ecosystems and biodiversity are indispensable for human well-being but also for economic functioning and economic prosperity. The NbS concept combines the scientific analysis of ecosystem services with the benefits they offer for human well-being and for biodiversity.

According to IUCN (2020a), the origin of the NbS concept lies in several nature conservation approaches promoting a targeted management of ecosystems, such as Integrated Landscape Management, Forest Landscape Restoration, Integrated Coastal Zone Management, etc. Despite focusing on different perspectives, all these approaches aim not only to preserve intact natural conditions but also to provide societal benefits, such as protection against natural hazards, health protection, employment or higher land productivity. Hence, the former approach of safeguarding nature for its intrinsic values has been further developed towards a perception of nature's values as essential resources for safeguarding society, thereby extending the reach and acceptance of nature conservation issues. Both approaches, safeguarding nature for ecosystem-based reasons and safeguarding society through benefits from functioning ecosystems, form the two pillars considered as supporting NbS (Figure 2).

Figure 2: Main domains of conservation interventions

Source: IUCN (2020a).

The NbS concept has evolved out of other concepts for sustainable development. Nesshöver et al. (2019) have categorised the terms and concepts and their main authors that preceded and influenced the NbS concept (Table 1). According to this, the concept is one outcome of a paradigm shift beginning in the 1980s, in the course of which various terms and concepts were coined.

Table 1: Concepts preceding the NbS concept

Period	Concept	Main authors and publications
1980s	Sustainable Development	UN (1987) – Our Common Future ('Brundtland Report')
1990s	Biodiversity	Takacs (1996) – The Idea of Biodiversity: Philosophies in Paradise; Wilson (1988) – Biodiversity
1990s	Natural capital	Schumacher (1973) – Small is beautiful: A study of economics as if people mattered Costanza & Daly (1992)– Natural Capital and Sustainable Development Jansson et al. (1994)– Investing in natural capital: The ecological economics approach to sustainability Daly & Farley (2011) – Ecological Economics: Principles and Applications
2000	Ecosystem services	Daily (2013) – Nature's Services: societal Dependence on Natural Ecosystems Costanza et al. (1998) – The value of ecosystem services: Putting the issues in perspective MEA (2005) – Ecosystems and Human Well-being: Synthesis Gómez-Baggethun et al. (2010) – The history of ecosystem services in economic theory and practice: From early notions to markets and payment schemes

Source: Adapted from Nesshöver et al. (2017).

2.2 Definition of Nature-based Solutions

Because of the evolutional process of the conceptual development, different definitions of NbS exist. For this study, we follow the UNEP (2022b) definition. This definition of the United Nations Environment Assembly is the first definition of NbS agreed upon by a subject of international law with worldwide members. It builds on other definitions *inter alia* provided by IUCN (2016)[1] and EC (2021)[2].

'… nature-based solutions are 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 and resilience and biodiversity benefits, …' UNEP (2022b)

[1] 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.'

[2] Nature-based solutions are '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. Nature-based solutions must therefore benefit biodiversity and support the delivery of a range of ecosystem services.'

According to the NbS concept elaborated by the (IUCN 2020b), seven major societal challenges are addressed, as seen in Figure 3.

Figure 3: Major societal challenges addressed by NbS

Source: IUCN (2020b).

Following the IUCN (IUCN 2020b) definition, for a project to be considered in this report as an NbS it has to address one or more societal challenges. Moreover, if "ecosystem degradation" is addressed, at least one other societal challenge has to be included in the solution, thereby clearly differentiating them from measures with purely nature conservation objectives.

Due to their character, NbS provide measures to overcome these challenges while preserving ecosystems threatened by various factors, and to strengthen their integrity and resilience. The NbS concept has been widely adopted due to the fact 'that the concept of nature providing solutions is simple in construct and logical for non-specialist understanding' (Cohen-Shacham et al. 2019, p. 22). The IUCN (2016) NbS concept embraces eight principles (Table 2). As the NbS concept also considers at least five other concepts (the ecosystem approach, Forest Landscape Restoration, Ecosystem-based Adaptation, Ecological Restoration and Protected Areas) and even goes beyond these concepts, NbS can be considered as an umbrella concept.

Table 2: NbS principles

No.	Principle
1	NbS embrace nature conservation norms (and principles)
2	NbS can be implemented alone or in an integrated manner with other solutions to societal challenges (e.g., technological and engineering solutions).
3	NbS are determined by site-specific natural and cultural contexts that include traditional, local and scientific knowledge.
4	NbS produce societal benefits in a fair and equitable way in a manner that promotes transparency and broad participation.
5	NbS maintain biological and cultural diversity and the ability of ecosystems to evolve over time.
6	NbS are applied at a landscape scale.
7	NbS recognise and address the trade-offs between the production of a few immediate economic benefits for development, and future options for producing the full range of ecosystem services.
8	NbS are an integral part of the overall design of policies, and measures or actions, to address a specific challenge.

Source: IUCN (2016).

2.3 Delineation of Nature-based Solutions from other concepts

Nature-based Solutions and related approaches

NbS need to be delineated from other similar concepts, not only to avoid misunderstandings and promote acceptance, but also to prevent greenwashing effects. IUCN (2020a) explains that NbS use the power of functioning ecosystems as infrastructure to provide natural services benefiting society and the environment. There are four similar but distinct concepts:

- Nature-derived solutions contribute to a low-carbon future and include wind, wave and solar energy, being natural sources but not based on functioning ecosystems.
- Nature-inspired solutions include the innovative design and production of materials, structures or processes imitating ecological processes, but not based on functioning ecosystems.
- A form of nature-inspired solutions, biomimicry refers to examining models, designs or processes from nature and imitating it. It is not considered an NbS approach as it is not connected to ecosystems. Biomimicry is used in reference to artificially created materials or items mimicking natural ones (Cohen-Shacham et al. 2019).
- Ecosystem-based approaches focus on ecosystem functions and their maintenance, without clearly addressing societal challenges.

According to Cohen-Shacham et al. (2019), particularly the NbS principles (Table 2) No. 2 (implementation alone or in an integrated manner with other solutions to societal challenges), No. 6 (application at landscape scale) and No. 8 (integral part of the overall design of policies , and measures or actions, to address a specific challenge) are specific to NbS.

Nature-based Solutions, conventional solutions and nature conservation measures

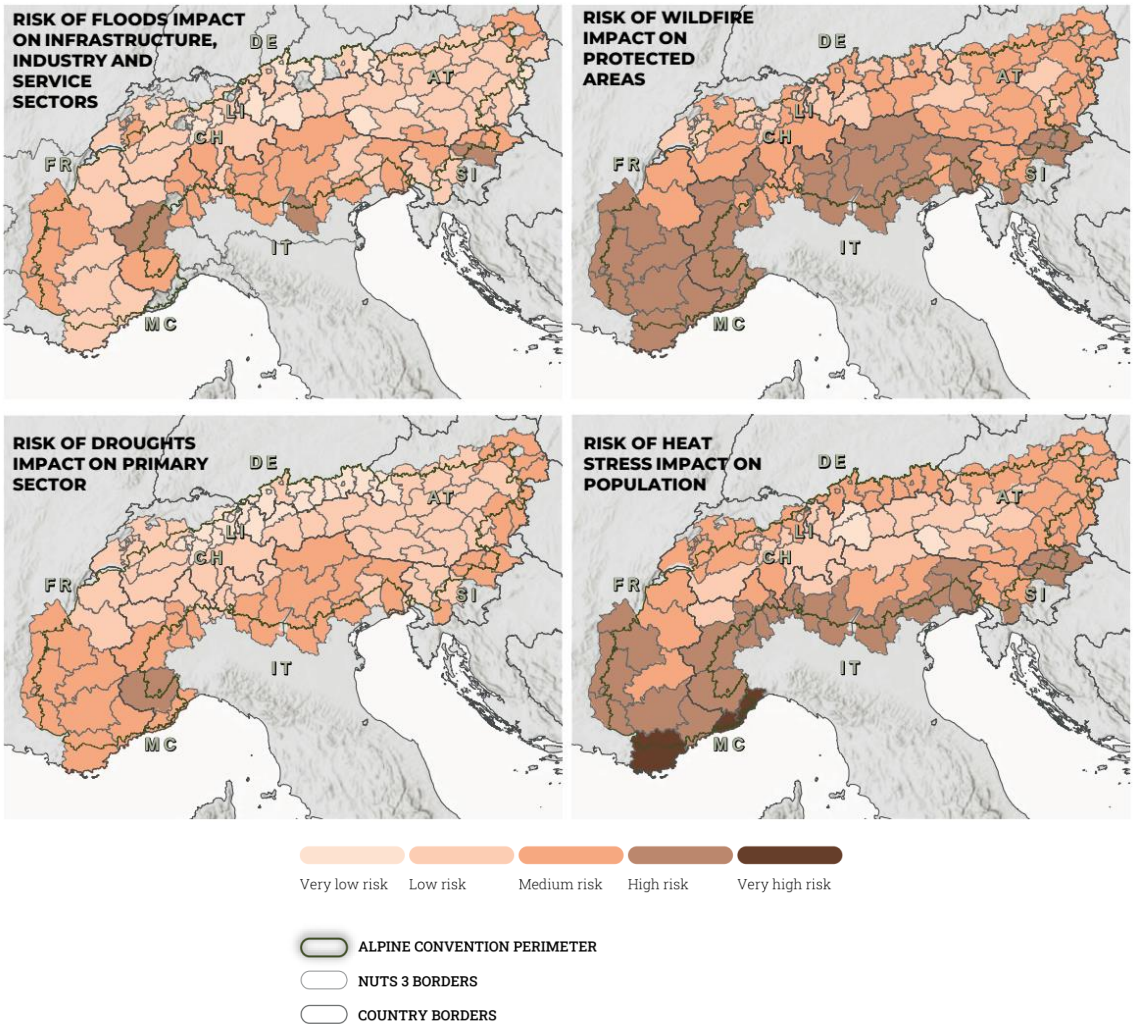
- NbS versus conventional solutions: When addressing NbS, the difference to "conventional solutions" (sometimes called "grey solutions") needs to be clarified. The latter are solutions considering neither societal challenges nor biodiversity aspects. In most cases, they are based on technical constructions using inorganic or synthetic materials, the use of machinery significantly jeopardising ecological functions, or on purely economic management objectives.
- NbS versus restoration measures and specific species protection programmes: Measures that focus solely on restoring, protecting or promoting habitats or species without addressing any other societal challenge are not considered NbS.

2.4 Relevance of Nature-based Solutions for sustainable development and for the Alpine area

NbS aim to address societal challenges, thereby potentially contributing to achieving the 2030 Agenda for Sustainable Development's (UN 2015) targets and its Sustainable Development Goals.

Characterised by a large variety of climate and vegetation zones, the Alps are home to a rich biodiversity sensitive to changes of environmental conditions. Offering exceptional recreation value, this landscape diversity and biodiversity richness constitute the economic basis for tourism and recreation enterprises.

Figure 4: Risk by 2100 of climate-related hazards in a very high emission scenario



Source: Marot et al. (2025). Data source: ESPON (2022).

The steep slopes of the Alps and their rapid surface water runoff combined with Alpine weather conditions encourage natural disasters, such as avalanches, mud slides, rock falls and flooding. Therefore, the Alpine region is particularly sensitive to the effects of the climate crisis, and at risk from different kind of impacts (Figure 4). Changes in precipitation and temperatures, extreme weather events and runoff not only influence ecological functions but also economic and settlement opportunities in the Alps and neighbouring areas. The Alps are a hotspot for climate change effects (UBA 2022), as seen by a few examples of expected climate change impacts (Gobiet et al. 2014; Roveri et al. 2024; UBA 2022):

- Glacier retreat and reduced snow cover will limit water retention capacity.
- Permafrost melting will reduce slope stability, increasing rock falls and mud slides.
- Higher frequency of extreme weather events will encourage natural hazards such as floods, mud slides and avalanches.
- Change of precipitation patterns and temperatures will cause shifts in Alpine flora and fauna.
- Natural hazards, heat waves, UV-radiation will have impacts on human health.

The Alps provide a wealth of ecosystem services, such as water retention through snow and ice and in bogs and forests, landscape amenities, wood biomass or large-scale natural habitats. These offer opportunities for integrated and cross-sectoral NbS approaches to mitigate the effects of and adapt to climate change.

A prerequisite for the effective use of NbS is to acknowledge the importance of ecosystem services and integrate them into decision-making processes, developing appropriate governance mechanisms at all levels. As NbS often have cross-sectoral and cross-border effects, they are particularly relevant for the Alpine Convention as a transnational agreement and are suitable for implementing throughout the Alpine region. The ACB has therefore agreed to make NbS one of its three cross-sectoral hotspots (AC 2022).

3 Nature-based Solutions in the Alpine region – An analysis of selected model projects

The following paragraphs provide an overview of the project analysis conducted as a basis for identifying success factors and challenges related to the widespread implementation of NbS in the Alpine region, for examining mechanisms that support their establishment, and for developing corresponding recommendations. After establishing a research procedure and defining selection criteria, the authors of this study used a two-stage selection process to choose a total of eight model projects for detailed analysis. The subsequent cross-project analysis presents findings on the key NbS aspects addressing climate change mitigation and adaptation.

3.1 Methodology

3.1.1 Selection criteria and procedure

According to their definition given in Chapter 2.2, NbS are characterised by three main criteria: They **address one or several societal challenges** (1) **and** are **beneficial for biodiversity** (2) **as well as for human well-being** (3). As outlined in Chapter 2.3, this threefold combination of effects is essential to distinguish an NbS from a pure nature conservation measure which does not necessarily provide any direct societal benefit apart from combating environmental degradation and biodiversity loss, and from a solely technology-based solution which does not use the functionality of a living ecosystem.

Based on these considerations, the authors of this study defined the criteria for selecting NbS projects to be analysed in detail as follows:

1. Each NbS project has to:
   a. show positive effects on biodiversity as well as human well-being and
   b. contribute to climate change adaptation and / or mitigation as the overall societal challenge to be tackled.
2. Furthermore, it must already be (at least partially) implemented – i.e., excluding purely theoretical approaches – and demonstrate relevant and possibly innovative governance aspects (see Section 3.1.2).
3. Since the overall project focuses on the Alpine region, the authors linked the NbS criterion of addressing social challenges to the Alpine Climate Target System (ACTS) of the Alpine Climate Board (PSAC 2019): Every selected NbS project has to address at least one of the fields “Water”, “Natural hazards”, “Mountain agriculture”, “Mountain forestry”, and “Soil”. Due to the nature of NbS, the “Ecosystems & Biodiversity” field is addressed by all NbS projects. Although not a focus topic, they often also foster “Tourism” as a side effect, as indicated in the present model project analysis (see 2.3).
4. Finally, each Alpine country should be represented.[3]

The definition of the criteria was followed by a two-stage selection process:

1. The authors carried out extensive research for NbS projects on various internet platforms related to NbS, including Interreg Alpine Space, PHUSICOS, OPPLA, the Urban Nature Atlas (UNA), and PORTAL. This was complemented by a general internet search for NbS projects, in particular in Slovenia, Liechtenstein, and Monaco via different search engines. 28 possibly

[3]The final model project selection achieves this goal partially, as no suitable NbS project in Monaco could be identified within the project’s timeframe and Liechtenstein is only considered via the *Bergwaldprojekt* (see Section 3.3).

interesting NbS model projects were identified and evaluated as to whether they met the criteria specified above (see Appendix A.1).

2. According to the defined criteria, the project team ranked the pre-selection by assessing the fulfilment of the NbS criteria, their contribution to climate change adaption or mitigation, and by estimating whether the applied governance mechanisms might provide interesting insights into key success factors of NbS projects. Considering the aim of a balanced distribution of the selected projects across the Alpine countries, the authors chose eight successful NbS model projects covering different project scales and involving different groups of partners and stakeholders.

Subsequently, the authors performed a detailed analysis of the selected model projects. For the governance analysis, they conducted interviews with representatives (e.g. project partners, representatives of regional governments in charge of NbS) of every selected project based on the predefined framework of relevant governance aspects to be examined in detail (see Section 3.1.2).

The results of the project analysis are outlined in Sections 3.2 and 3.3 as well as in Appendix A.2.

3.1.2 Governance analysis

Governance aspects play a central role in NbS implementation. As the size and complexity of NbS projects vary greatly, the corresponding governance mechanisms also feature a large variety of forms and scopes. In this report the term “governance” refers to the following aspects:

- **Collaborative governance**: This aspect refers to the interaction of actors from different institutional contexts, such as politics, administration, business, research and education, and civil society. For governance to be "good", it is crucial to determine which framework conditions and formats are suitable to enable the most constructive involvement and cooperation possible between the individual actors, considering their respective logics of action and institutional agendas.

- **Governance in a multi-level system**: Depending on the content and tasks, different levels are involved in governance processes: the local level (municipality), the regional level (county, district, etc.), the federal state level (region, province, département, federal state, etc.), the national level (state) and the transnational level (e.g. Alpine region, EU). Cross-border governance is a special form of bilateral or trilateral governance between neighbouring states. The more levels and states are involved, the more complex and demanding governance becomes. Here too, the question arises as to which innovative formats and cooperation models are suitable to enable the most effective cooperation between the various actors regarding regulation of responsibilities, competencies, decision-making models, etc.

- **Cross-sectoral governance**: Many collaboration processes, particularly in the field of NbS, involve actors from different sectors, e.g. nature conservation, agriculture, forestry, tourism, healthcare, water management, spatial and urban planning, construction etc. Here, the aim is to develop new forms of cooperation and innovative alliances that enable the effective implementation of measures and projects.

To cover multiple governance facets, the authors based the governance analysis on the topics and questions listed below. The interviews conducted with several stakeholders provided the corresponding information for every project (see A.2 and Section 3.3.4).

1. **Partners and stakeholders involved**

- Which partners and institutions are directly and indirectly involved?

2. **Form and intensity of cooperation**

- In which form do the actors involved work together? How are cooperation, internal and external communication regulated?
- Is there a project organisation with committees for specific tasks? Has a steering group been set up? Has a process design or flowchart been developed for the project?
- Has external process support and moderation been commissioned?

3. **Differences of interest, conflicts, and how to deal with them**

- What were the greatest differences of interest and conflicts among the actors involved? To what extent did these conflicts escalate?
- How were the conflicting interests and conflicts managed or negotiated?

4. **Successes and challenges**

- What were the main successes of the project from a governance perspective?
- What were the key success factors?
- What were the main obstacles regarding governance and how were they overcome?

5. **Transferability**

- What findings from the project can be transferred to other projects or be generalised?

3.2 Selected Nature-based Solution model projects

All of the evaluated NbS model projects – both the preselected ones as well as the model projects examined in detail – are included in the Alpine Convention Atlas:

https://www.atlas.alpconv.org/

The 28 preselected projects are listed in Appendix A.1, along with an indication as to whether they meet the predefined criteria.

With respect to the eight model projects selected for in-depth analysis, Table 3 provides an overview of their main characteristics and indicates to which extent the selection meets the predefined criteria.

Several of the eight selected model projects and their implementation sites are located in Germany, Italy, Austria, France and Switzerland. Liechtenstein and Slovenia are each represented by one project.

Three-quarters of the model projects are related to “Water”, while the ACTS fields “Soil”, “Natural hazards”, “Mountain agriculture”, and “Tourism” are addressed multiple times (in 5, 4, 3 and 4 projects, respectively). One project has a particular focus on “Mountain forestry”. To a smaller or larger extent, all projects provide approaches for adapting to climate change. Half of the projects help to actively mitigate climate change by enhancing the sequestration of greenhouse gases.

Table 3: Numerical overview of selected NbS model projects

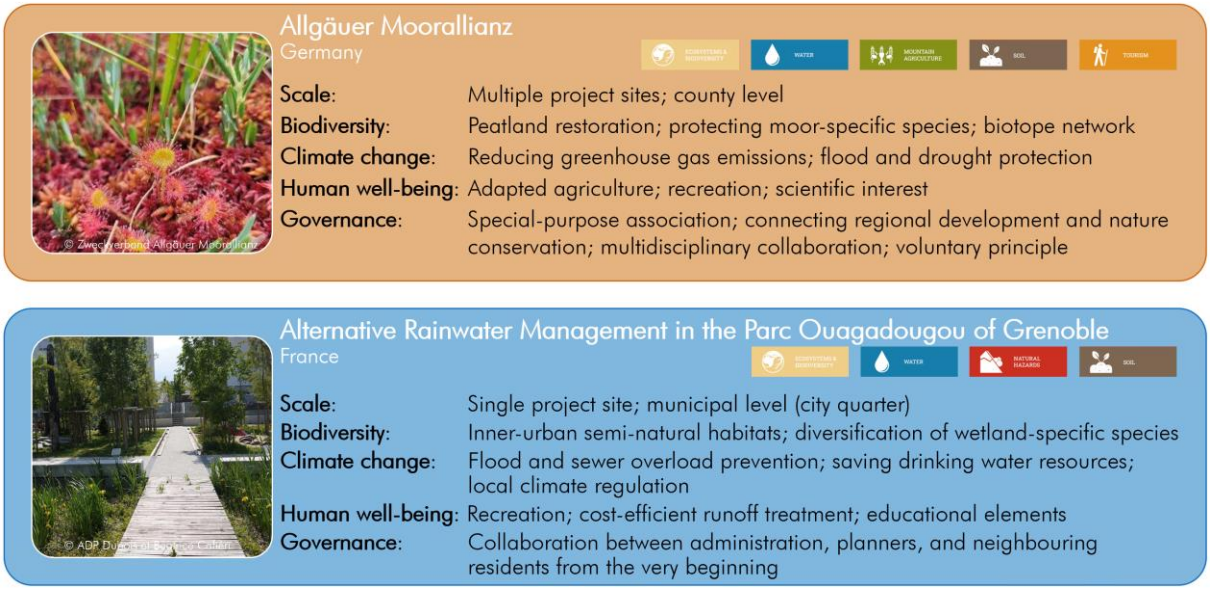
Alpine Countries	AT	CH	DE	FR	IT	LI	MC	SI
No. of projects	2	2	3	2	3	1	–	1

Sectors Alpine Climate Target System	Water	Natural Hazards	Mountain Agriculture	Mountain Forests	Soil	Tourism
No. of projects	6	4	3	1	5	4

NbS Criteria	Benefit for Biodiversity	Benefit for Human Well-being	Climate Change Mitigation	Climate Change Adaption	Imple-mentation	Governance Potential
No. of projects	8	8	4	8	8	8

The following info boxes (Figure 5) present the key facts of the selected model projects regarding their scale, their beneficial impacts for biodiversity and human well-being, their contribution to climate change adaptation or mitigation, as well as their characteristic governance aspects. Appendix A.2 contains the project factsheets with detailed information on the aspects mentioned.

Figure 5: Key facts of selected model projects



LIFE Lech – Dynamic River System Lech
Austria and Germany

Scale:	13 implementation sites; watershed level
Biodiversity:	Habitat restoration; species support measures
Climate change:	Flood protection (additional retention volume of ca. 200,000 m³)
Human well-being:	Fostering regional economy and job market; tourist attraction; education
Governance:	Cooperative and clear steering and implementation structures; external facilitation; few parties involved; *challenge*: demand for large surface areas

Zürcher Bachkonzept
Switzerland

Scale:	Various implementation sites; municipal level (City of Zurich)
Biodiversity:	Habitat creation; repopulation by native animal and plant species; freshwater network
Climate change:	Preventing urban flooding; increasing evaporation and groundwater recharge
Human well-being:	Urban quality of life; increasing efficiency of wastewater treatment
Governance:	Interdisciplinary approach; transparency; good technical implementation; *challenges*: technical and legal aspects, lack of knowledge, landowners

Bergwaldprojekt
Austria, Catalonia, Germany, Liechtenstein, Switzerland

Scale:	Multiple project sites; transnational level
Biodiversity:	Rebuilding climate-resilient near-natural forests; restoration of peatlands
Climate change:	Reducing greenhouse gas emissions; protective forests; water retention
Human well-being:	Sense of community; (active) recreation; education; forestry
Governance:	High level of institutionalisation and coordination; code of conduct; clear lead; transparency; extensive involvement of volunteers

I-SWAMP – Integrated Small Wetlands of the Alps Monitoring and Protection
Austria, Italy, Slovenia

Scale:	17 implementation sites; transnational level
Biodiversity:	Wetland habitat restoration; species support measures; biotope network
Climate change:	Reducing greenhouse gas emissions; water retention
Human well-being:	Education; natural heritage
Governance:	Low level of steering mechanism; interdisciplinary planning; early communication; transparency; involvement of volunteers; *challenge*: landowners

LIFE PASTORALP – Pastures Vulnerability and Adaption to Climate Change in the Alps
France and Italy

Scale:	2 pilot regions; transnational level
Biodiversity:	Protecting pasture-specific habitats
Climate change:	Options for climate-resilient pasture management
Human well-being:	Cultural heritage protection; facilitating management decisions; agriculture
Governance:	Interdisciplinary and participatory approach; open-access platform for easy replication and transferability

Rotational Pasture Management to increase the Sustainability of Mountain Livestock Farms in the Alpine Region
Italy

Scale:	Single project site; farm level
Biodiversity:	Positive effects on soil microbes and fauna, improved soil conditions
Climate change:	Reducing greenhouse gas emissions
Human well-being:	Cost savings (no need for supplementary feeding); longevity of pastures
Governance:	Easy transferability to other farms

Source: Authors' own illustration, ifuplan. (Photograph copyrights as indicated in the pictures.)

3.3 Results of a cross-project analysis

The following sections synthesise the results of the detailed project analysis with respect to biodiversity aspects, climate change mitigation and adaptation effects, socio-economic impacts, and governance. The evaluation of these aspects for the individual projects is summarised as keywords in the info boxes in Section 3.2 and explained in more detail in the project factsheets in Appendix A.2.

3.3.1 Biodiversity aspects of the selected model projects

NbS projects often achieve benefits for biodiversity by restoring specific habitat conditions, e.g. through restoring peatlands, wetlands or watercourses (Figure 6). These measures usually promote local biodiversity in individual habitats and/or protect endangered and rare species. In addition, they contribute to establishing comprehensive habitat networks. By fostering and safeguarding ecological connectivity, these NbS can provide a valuable long-term benefit for biodiversity. Further important prerequisites to ensure the sustained protection of habitats and hence a positive long-term effect on biodiversity are knowledge- and capacity-building combined with the involvement of local stakeholders. Many NbS projects integrate these aspects.

The model project analysis shows that land use and management practices concerning arable land, grassland, pastures and forests have a significant influence on the diversity of flora, fauna and fungi, as well as on soil functions. The projects protect biodiversity through adapted land use and management practices, such as rotational instead of continuous grazing, fencing off particularly sensitive habitats, wet cultivation methods on peatlands, etc. Coincidently, the conservation or promotion of biodiversity through NbS often has positive side effects with respect to improved ecosystem services, such as the creation or upgrading of recreational areas or better yields and more robust systems in agriculture and forestry.

Figure 6: ***LIFE Lech*** **– Restored section of the river Lech**

The restored river section provides valuable habitat structures for various species and is an important element of a comprehensive habitat network, while additionally providing retention volume for flood protection.
Source: Bernhard Kogelbauer, Land Tirol.

3.3.2 Climate change mitigation and adaption aspects of the selected model projects

NbS, notably those related to peatlands, wetlands, forests, or ecologically intact soil functions, can contribute to mitigating climate change by actively sequestering atmospheric carbon or reducing emissions of carbon dioxide and other greenhouse gases like methane and nitrous oxides from soils (Figure 7). Closely related to land use and management practices, the fixation of greenhouse gases can influence biodiversity. NbS usually promote ecologically sensitive land use methods, in particular regarding the intensity of agriculture or forestry, or adapted management strategies, for example a decentralised instead of a centralised rainwater management system.

All the analysed model projects contribute to adapting to climate change, as characterised by an increasing probability of extreme weather events, such as heavy rainfall or prolonged drought periods, occurring. In particular, the supply and drainage of water is becoming increasingly challenging as climate change progresses. It is therefore worth emphasising that many NbS relate to the regulation and partial restoration of the water balance, i.e. to reducing surface or flood runoff, to retaining water in the soil or in the landscape or to replenishing groundwater. In addition, NbS have local climatic effects through enhancing evapo(transpi)ration or cooling effects and hence counteracting climate change-induced phenomena like urban heat islands. NbS usually help strengthen the resilience of ecosystems to climate change and reduce the impacts of extreme weather events and associated natural disasters, like floods, mudslides, etc: intact protective forests, for instance, prevent large mudslides forming or slow them down; natural riverbeds with floodplain forests or other adjacent unsealed floodplains provide space for water retention during floods or heavy rainfall events and help prevent the flooding of settlements. This may be the most resounding argument from an economic perspective, as the compensation of damage caused by natural disasters is very costly – if not impossible, for example in the case of casualties.

Figure 7: ***Bergwaldprojekt*** **– Peatland restoration**

The rewetted peatland will regain its capacity to sequester large amounts of carbon and therefore help to mitigate climate change. Source: Bergwaldprojekt e.V.

3.3.3 Socio-economic aspects of the selected model projects

NbS create social added value by enhancing an area's recreational value and improving visitors' ability to experience ecosystem services. They achieve this through integrating environmental education programmes and developing engaging starting points for scientific research. In addition, NbS often foster a sense of community by creating spaces for interaction or involving local residents in project implementation. These opportunities for participation can also help counter feelings of powerlessness caused by the rapid pace of climate change (Figure 8).

Apart from that, implementing NbS often leads to cost savings or efficiency gains, for instance regarding the long-term maintenance for urban green spaces, improved wastewater treatment, or lower insurance costs due to the higher resilience of ecosystems. Furthermore, they can have positive effects for the (regional) labour market and the regional economy.

Many NbS projects help preserve cultural and natural heritage. They also support the protection or restoration of essential natural resources, such as groundwater for drinking water or soil fertility to ensure food security.

The One Health approach further enhances the socio-economic benefits of NbS by recognising the interconnectedness of human, animal and environmental health (EC 2024). This integrated approach can lead to more effective and sustainable solutions, potentially reducing healthcare costs and improving overall community well-being (WHO 2017). In the Alpine context, One Health strategies can support the development of resilient ecosystems benefiting both human and animal populations, while also contributing to the region's economic stability through improved agricultural practices and eco-tourism opportunities (Interreg 2022).

Figure 8: ***Bergwaldprojekt*** **– Voluntary efforts to actively counteract the climate crisis**

Many volunteers invest their time and energy to restore or strengthen protective forests and other ecosystems that help counteract the impacts of the climate crisis. They value the sense of community and the connectedness with nature.
Source: Bergwaldprojekt e.V.

3.3.4 Governance aspects of the selected model projects

The governance analysis of the selected model projects was based on the five topics and corresponding questions outlined in Chapter 3.1.2.

Partners and stakeholders involved

The number and types of directly or indirectly involved partners and stakeholders varied in tune with project size. However, apart from a few exceptions, all projects involved a wide range of stakeholders, e.g. various public administration departments (e.g. nature protection, agriculture, forestry, water management, spatial planning etc.), planning offices, consultants, research institutions, the private sector, NGOs, intermediary organisations or citizens.

Form and intensity of cooperation

The form and extent of governance mechanisms (e.g. executive bodies, steering bodies, rules for decision making, internal as well as external communication) varied according to project size and complexity (see Chapter 2.3). In smaller projects, loose cooperation between the partners involved was sufficient (e.g. *I-SWAMP*). Large projects (e.g. *LIFE Lech*, Figure 9) had clearly defined organisational structures with a description of roles, tasks and responsibilities of those involved as well as process designs (flowcharts linking the various activities or coordination and communication processes) up to complete institutionalisation (e.g. associations in the case of *Allgäuer Moorallianz* and the *Bergwaldprojekt*). For larger projects, steering mechanisms were established, and internal or external process facilitators and moderators commissioned.

Conflicts of interest and their management

In the projects examined, classic conflicts of interest were observed, e.g. between the various stakeholders (agriculture, forestry, water management, nature conservation, residents) and particularly between project operators and landowners as well as authorised users. In addition, there were conflicts within a certain field (e.g. nature conservation, agriculture and forestry, hydraulic engineering in *LIFE Lech*); for instance, tensions between those open to change and innovation and those wanting to preserve the status quo or adhere to traditional practices. Other, less important conflicts arose in connection with the topic of safety and regarding compatibility with existing (legal) regulations at different levels (e.g. *Zürcher Bachkonzept)*. Such differing interests were considered in the projects, with most conflicts resolved during project implementation. This happened partly through communication and sensitisation measures, as well as inspections. In addition, the interests of landowners and users were directly integrated into the project through their active involvement (e.g. the marketing of animal bedding in the *Allgäuer Moorallianz* project, see Appendix A.2).

Successes and challenges

The most important success factors for good cooperation and coordination among those involved were the presence and participation of all relevant stakeholders, the interdisciplinary and cross-sectoral approach, the formulation of clear project objectives, an evidence-based approach, a good distribution of tasks and responsibilities among the partners involved, clear leadership by the respective lead partners, the establishment of steering mechanisms, internal and external transparency, continuous and professional external communication and direct contacts and exchanges with those directly affected by the project, especially landowners. Another important success factor was the existence of negotiating leeway, whether in terms of content, organisation, time, space or funding. It was particularly important to get those affected on board at an early stage and to take their interests into account from the outset. For the

success factors mentioned to be effective, one thing in particular is necessary: careful and precise preparation.

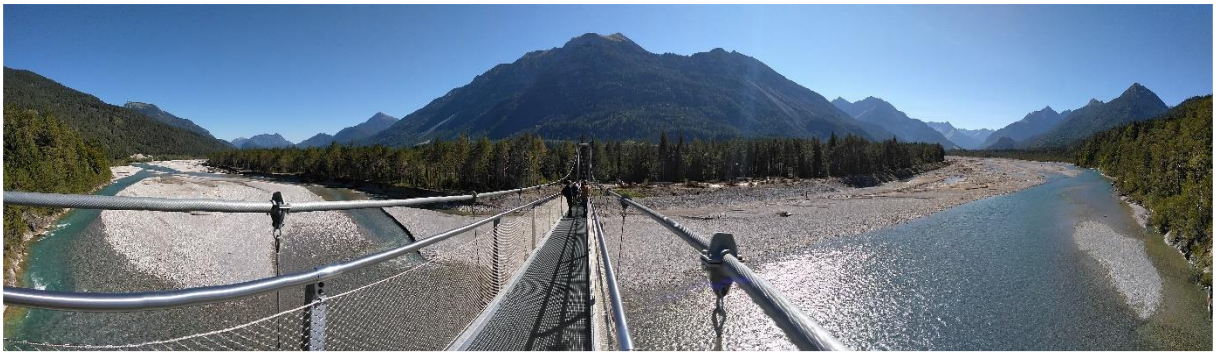
In addition to these systemic aspects, another key success factor lay with the individuals involved: successful project realisation depends on motivated and enthusiastic people endowed with flexibility and staying power.

The main challenge was the refusal of individual landowners and land users in some projects to collaborate. Another challenge – especially in some cross-border projects – was the lack of a common language.

Transferability

Generally speaking, the different approaches and concepts of the analysed model projects can be transferred to other (Alpine) regions with similar topographical and structural conditions. However, the specific implementation of NbS projects will vary in each case and needs site-adapted concretisation, considering, for instance, the local geology, fauna and flora, land use, administrative structure, national or regional legal requirements, political framework as well as cultural attitudes and practices.

Figure 9: *LIFE Lech* – Realising a large-scale project with a small and efficient project team



The *LIFE Lech* project demonstrates the potential of good governance: A small core project team realised a large-scale river restoration project with 13 implementation sites and was able to implement more measures than originally planned due to the very efficient project management and the successful involvement of affected stakeholders, e.g. the new suspension bridge in the picture.
Source: Bernhard Kogelbauer, Land Tirol.

With respect to governance aspects, the following findings can be generalised for all NbS projects, independent of their location: Successful NbS projects, especially those with multiple sites, partners or stakeholders, share several key characteristics. They involve all relevant stakeholders, particularly affected landowners, at an early stage. They provide a professional framework for cooperation, emphasise transparency and ongoing communication, and rely on highly motivated individuals who are both flexible and persistent. And last but not least, the high-quality implementation of the measures. These factors are key to the success of interdisciplinary and cross-sectoral approaches.

4 Establishing Nature-based Solutions in the Alpine region

Based on the characteristics of NbS, this chapter explains the opportunities, obstacles and requirements for the large-scale establishment of NbS in the Alpine region. Section 4.1 provides impulses for implementing NbS in selected fields, Section 4.2 addresses the identified challenges that exist especially in the Alpine region, while Section 4.3 discusses framework conditions needing to be established or strengthened in view of the findings gained so far. Section 4.4 provides practical guidance for realising NbS under the given conditions, while specific measures to facilitate future implementation are presented in detail in Chapter 6.

From a broader perspective, NbS use the multiple functions and services of ecosystems, offering a comprehensive approach to linking ecological and societal requirements. NbS can thus provide an effective strategy and be important tools to tackle the large-scale socio-economic transformation needed to combat the climate and biodiversity crises. As already mentioned in Chapter 1, NbS are considered to be solutions with a "transformative capacity", i.e. supporting the transformation towards a new system, when the existing system is no longer fit for purpose (Mehryar et al. 2022). In particular, they can help address climate change and demographic-induced challenges in the Alpine region, as they focus on a comprehensive view of different impact dimensions and generally promote the multifunctional use of spaces claimed by different interests in mountain areas. (See also Chapters 1 and 2.)

The cross-sectoral dimension of NbS encompasses at least the following aspects (discussed in more detail in Chapters 4.3 and 6.5 to 6.9) illustrating the broad social anchoring of NbS:

Education

NbS re-connect people to nature and raise their awareness of the benefits and services provided by nature. Serving as a tangible way of perceiving nature, they can foster environmental education at different levels, from schoolchildren to decision-makers, from civil servants working in offices to farmers out in the field all day. The educational approach ranges from tangibly perceiving individual species, via experiencing specific landscapes, to studying scientific concepts about ecological connectivity and the need to maintain biodiversity and protect the climate.

Collaboration and social engagement

Successful NbS implementation usually requires an intensive and interdisciplinary collaboration between stakeholders. Good NbS governance can foster mutual understanding and strengthen the future collaboration between those involved, while at the same time promoting the societal engagement of those affected by the NbS project.

Economic effects

NbS are multi-functional and often more cost-effective in the medium to long term than conventional solutions. For instance, restoring natural infiltration areas or watercourses, or reducing the hydraulic load on a sewage system, can reduce wastewater treatment costs significantly, as demonstrated by the *Zürcher Bachkonzept*; a protective forest may have substantially lower maintenance costs than a technical avalanche protection system, especially if the forest generates income through selling timber (see the *Bergwaldprojekt*). Furthermore, it is significantly cheaper to preserve existing ecological systems and use their functions than to restore them or develop new ones to compensate for ecological losses.

4.1 Nature-based solutions as opportunities for selected main sectors in the Alpine region

For the selected main fields, a brief introduction of opportunities but also challenges are presented in the following subchapters, opening the door for stakeholders to consider their options to use NbS in their fields. Each of these subchapters introduces their opportunities together with

- a selection of generic examples and their potential effects,
- concrete examples from the projects analysed,
- interlinkages and potential synergies with other sectors,
- options for NbS implementation at different scales, and
- the potential role of different stakeholder groups.

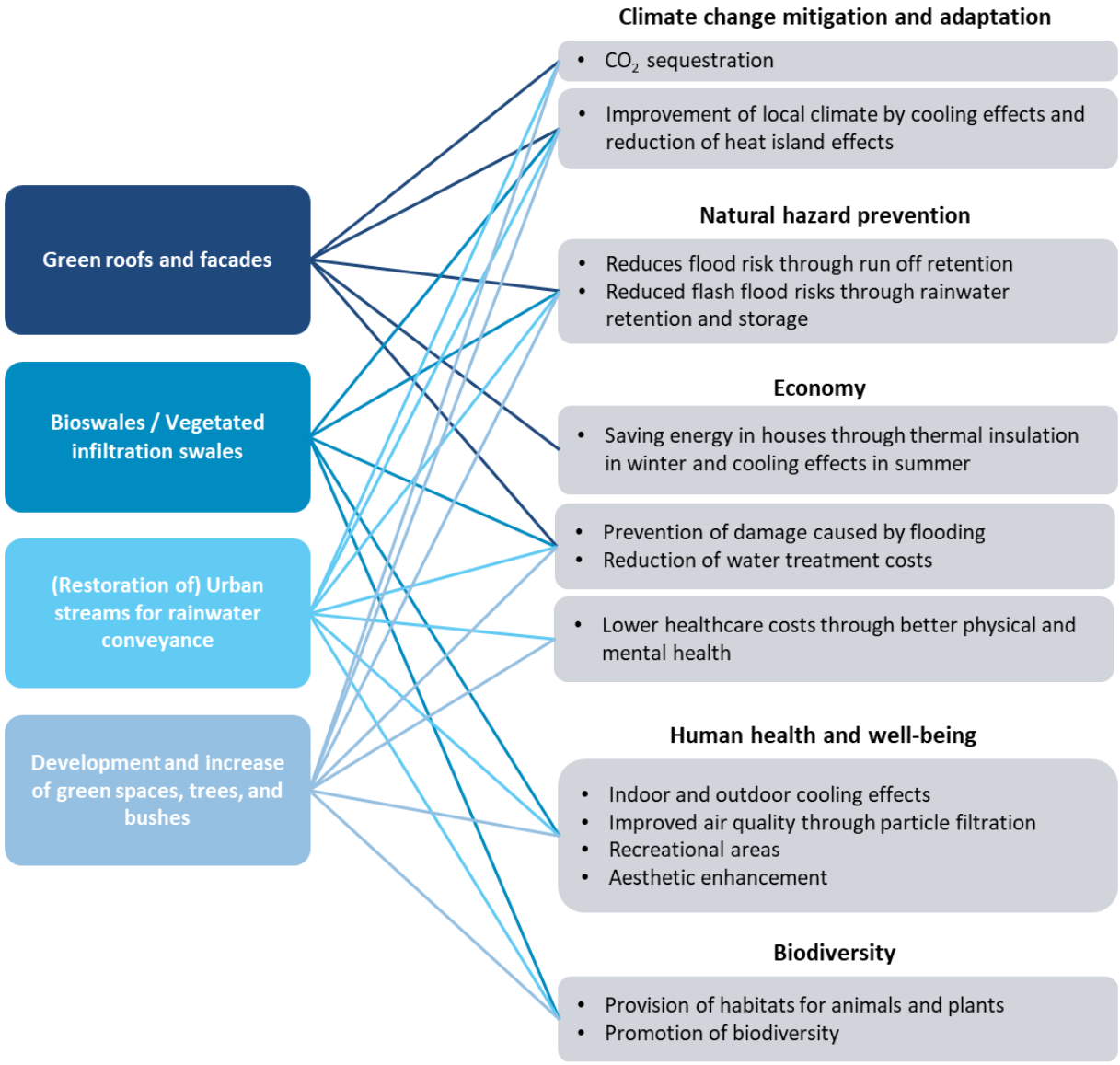
Sectors covered include urban planning, water management, energy, transport, and tourism and recreation. Although energy and transport are not directly linked to traditional NbS, they are important sectors in which NbS can play an indirect but valuable role in future, particularly in bridging technical and sustainability requirements of modern societies.

4.1.1 Urban planning

Cities and towns often are negatively affected by large-scale surface sealing, transport infrastructures, vehicle and production emissions and a lack of open, green spaces. From this point of view they can greatly benefit from NbS that improve local climate conditions, promote unsealing, enhance air quality, retain water after heavy rainfall, reduce surface runoff, restore habitats, and create recreational areas. Indirectly, this will provide benefits for local food supplies and the health of urban populations. NbS in cities and towns are usually linked to blue-green infrastructure (see Figure 10).

> We at the Swiss Association of Wastewater and Water Protection Experts (VSA) work on good sponge city examples, bring practical knowledge to the people and provide contacts to other municipalities that can help with specific issues. This knowledge and our network are particularly valuable for small and medium-sized municipalities, as they often do not have their own experts.
>
> *Stefan Hasler, Association of Swiss Wastewater and Water Protection Experts (VSA)*

Figure 10: Examples of NbS and their potential effects in the urban planning sector



Source: Author's own illustration, ifuplan.

Urban planning examples from the project analysis

The *Parc Ouagadougou* in Grenoble demonstrates how NbS were used to turn an urban brownfield into an attractive recreation area which also functions as a retention area for rainwater, where road runoff is treated and purified, and where an inner-urban climate regulation area was installed.

Zurich developed the *Zürcher Bachkonzept* to reopen culverted streams and divert clean water away from the sewage system, thereby reducing loads on sewage treatment plants and promoting streams as valuable elements of a blue-green infrastructure. The concept revitalises natural habitats for animals and plants, while the population benefits from better recreational opportunities and nature experiences in urban areas.

Interlinkages and potential synergies with other sectors

To activate cross-sectoral synergies like those stated below, NbS in cities and towns should be developed cooperatively by representatives from urban planning, water management and nature conservation organisations.

Climate change mitigation and adaptation	• Usage of green spaces for cooling as a joint effort of urban planning, climate protection, and nature conservation. • Contribution to both climate change mitigation and adaptation.
Natural hazard prevention	• Green spaces help prevent floods and surface water runoff caused by heavy rainfall. • Support of natural water absorption and storage in urban areas.
Economy	• Multi-functional use of green spaces saves precious urban space and reduces public budget costs. • Water retention in green areas is often more cost effective than technical storage solutions. • Temperature regulation through green spaces, trees, green roofs, and facades lowers air conditioning costs and improves recreational quality.
Human health	• Temperature regulation of open spaces and buildings reduces health risks in heat periods and contribute to human well-being • Natural hazard prevention, such as floods and flash floods safe human lifes and health

Scale for the implementation of Nature-based Solutions

NbS implementation in cities and towns could be encouraged at different levels:

Pan-Alpine	The exchange about best practice of NbS in cities and settlements will support these at the lower levels. NbS can also be part of the MAP of the Alpine Convention, particularly for the Alpine Climate Board, Alpine Biodiversity Board, the WG Spatial Development and Sustainable Development.
National	National bodies can offer guidelines for the implementation of NbS in cities and settlements.
Regional	At regional level district and regional administrations can foster NbS in regional planning, spatial development guidelines and in adopting urban development planning at the local level. Particularly the regional level might have an oversight about different NbS at local level and how to interlink such NbS in a geographical framework.
Local	Single municipalities can support NbS in their area through their municipal statutes binding third parties but also in their own acting and contracting.

Stakeholder groups for the implementation of Nature-based Solutions

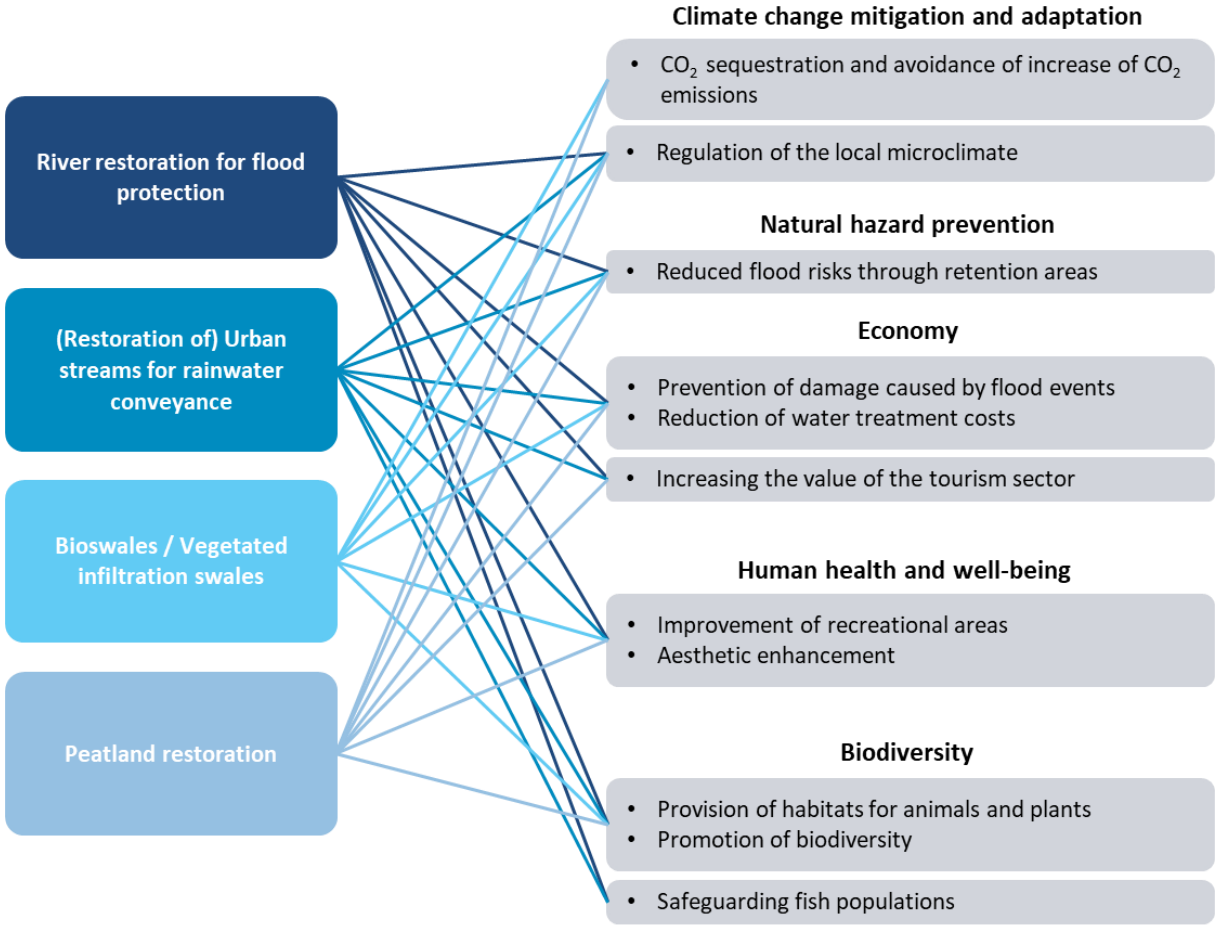
Public administration	Municipal administration is very close to the implementation of NbS in cities and settlements and might have the most effective influence. This refers particularly to departments of urban planning, water management, climate adaptation, nature conservation or waste water management.
Non-Governmental Organisations - NGOs	The implementaion of NbS in cities and settlements may be fostered by NGOs through supporting with their expertise on single solutions and good practices.
Small and Medium Enterprises - SME	SME may use smal scale solutions for NbS on their areas integrating them into a green and blue infrastructure such as biodiversity friendly design of courtyards, parking areas, roofs.
Industry	Industry can contribute to a sustainable urban development while designing their premises with NbS such as green roofs and facades, unsealed surfaces where possible, attractive, green open spaces which are attractive for staff and customers. Enterprises may present themselves as an active partner in their municipalities.
Individuals	The single inhabitants in cities may also contribute indirectly as using their opportunities as citizen but also actively as individuals when designing their own environments such as balconies, green spaces in residential areas or private gardens.

4.1.2 Water management

The management of surface and ground water is of increasing importance to respond to climate change. Handling surface runoff can be supported by NbS (see Figure 11) through designing non-technical solutions for flood management such as renaturing river floodplains or (re-)creating natural retention volumes (such as relocating dams, flood polders). NbS can also be used for handling rainwater in urban areas, with the added benefit of enhanced water quality through their inherent water purification effects.

Groundwater may similarly be positively affected by NbS, as such solutions have no negative effects, improve the status of groundwater infiltration, and filter water entering the groundwater table.

Figure 11: Examples of NbS and their potential water management effects



Source: Author's own illustration, ifuplan.

Water management examples from the project analysis

The opening and restoration of streams in the project *Albisrieder Dorfbach Zurich* is an example of how hydraulic problems in the sewage system were solved, the effectivity of handling rainwater runoff increased, biodiversity in stream habitats improved, and recreation opportunities alongside streams reinstated and improved.

To combat overloading of its sewage system, the City of Grenoble transformed a brownfield site into the *Parc Ouagadougou*, a park with theme gardens, a wetland and water management infrastructure. The park collects and partially purifies surface runoff for irrigation and the creation of wetlands, thereby reducing drinking water consumption and relieving pressure on the wastewater system.

Building on a previous LIFE conservation initiative, the *LIFE Lech – Dynamic River System Lech* project features thirteen river engineering and species protection measures along the Tyrolean Lech and its German border. It aims to stop deepening of the riverbed, stabilise groundwater levels, and improve flood protection, for the benefit of both nature and local communities.

Interlinkages and potential synergies with other sectors

Obviously, water management is interlinked with nature conservation, as watercourses are green corridors important for connecting different habitats. They also serve as migratory corridors over long distances, opening up an entire network throughout the countryside.

Watercourses are often closely linked with urban development and the greening of urban areas (the blue-green infrastructure within towns and cities), while also functioning as ecological corridors to surrounding areas.

Water management is related to the energy sector, particularly to hydropower but also to the use of cooling water. Furthermore, the transport sector is affected by the management of high and low runoff rates.

Climate change mitigation and adaptation	• Climate change will affect precipitation patterns and by this run-off which will require adaptation of water management. This also serves as hazard prevention.
Natural hazard prevention	• Green spaces for recreational purposes and can function as water retention areas (and biodiversity areas) during floods and heavy rainfall. • These multi-functional use of green spaces in urban areas with high real estate prices and low availability of land are an underestimated option for NbS.
Economy	• NbS offer economic benefits in water management, as NbS for flood plains are often cheaper than technical infrastructure like dams, reservoirs, bed slide management or maintenance of these infrastructures. • Natural purification of drinking water from surface or groundwater saves financial resources compared to technical purification methods.

Scale for the implementation of Nature-based Solutions

NbS implementation in water management could be encouraged at different levels:

Pan-Alpine	The exchange about best practice of NbS in water management will support these at the lower levels. NbS can also be part of the MAP of the Alpine Convention and those TWBs which are closely linked to water management such as the Alpine Climate Board, the Alpine Biodiversity Board, and the WG Transport (in terms of waterways).
National	National bodies can offer guidelines for the implementation of NbS in water management and can link this to the implementation of the water framework directive.
Regional	At regional and district level NbS for water management can be fostered in developing inter-municipal mangagement strategies and plans for surface waters.
Local	Single municipalities can implement NbS in water management while managing their local water carriers. There are many options from voluntary actions on municipality properties, dealing with water rights of private owners to raising awareness in the citizenship.

Stakeholder groups for the implementation of Nature-based Solutions

Public administration	Water management has often its own public administration bodies which are responsible for this sector. This administration exist at national and regional level, but also municipalities have to cover water management issues.
Non-Governmental Organisations – NGOs	Water management is a subject of nature conservation and environmental NGOs, sometimes also local initiatives which care for single water bodies. They can support the implmentation of NbS with concrete action on the plot as well through awareness raising, participation in public planning procedures.
Small and Medium Enterprises - SME	SME may use smal scale solutions for water related NbS on their properties in offering rainwater retention and infiltration to the groundwater such as green roofs, unsealed surfaces, rain water storage systems and to integrate such areas into a green and blue infrastructure such as biodiversity friendly design of courtyards, parking areas, roofs.
Industry	Industry can implement water related NbS when developing their properties with NbS such as unsealing surfaces, water infiltration, water retention through green roofs and facades or green water retention areas. Enterprises may present themselves as environmentally aware actors in society.
Individuals	Individuals may contribute in small scale with private initiatives such as rain water collection and use, private water consumption patterns, or support of local actions of NGOs or municipalities.

4.1.3 Energy

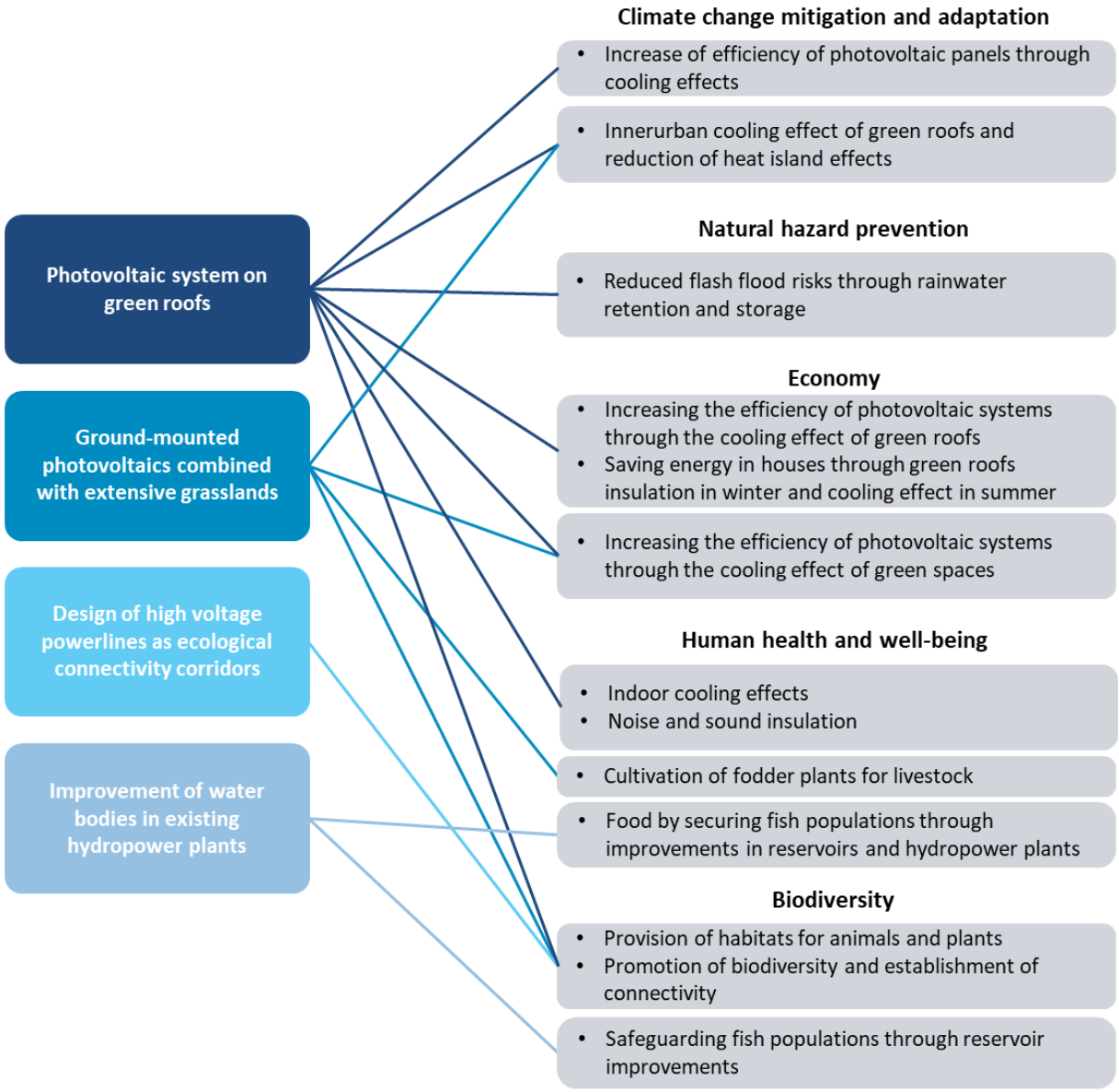
Energy plays an important role in the Alpine area, with its topography offering opportunities for hydropower, pumped storage hydroelectricity and wind power. This also leads to many powerlines across the Alpine area. In all fields NbS may be used to reduce energy impacts on the environment or even to improve habitat conditions (see Figure 12).

Power generation, particularly hydro and solar power, may be enhanced by NbS. Existing hydro power stations may be renatured with the residual flow increased, fish ladders installed and oxbow lakes re-activated. Ground-mounted photovoltaics (PV) produce fewer emissions than the intensive agricultural use of the same land, while PV fields can be designed as elevated constructions allowing extensive grazing opportunities underneath. Large-scale bioenergy plantations or the afforestation of non-forest ecosystems are not considered as NbS as they have negative effects on existing biodiversity (Díaz et al. 2019).

Power storage, particularly in pumped storage reservoirs, impact aquatic environments less when their design features areas for maintaining water levels, floating vegetated islands, and fish habitats.

Power transmission with high voltage powerlines can be designed as ecological corridors interconnecting often remote and undisturbed spaces. They may require specific maintenance measures.

Figure 12: Energy-related examples of NbS and their potential effects



Source: Author's own illustration, ifuplan.

Energy-related examples from the project analysis

No projects were analysed in this sector.

Interlinkages and potential synergies with other sectors

All NbS for the energy sector will have interlinkages to nature conservation as they offer undisturbed spaces.

Climate change mitigation and adaptation	• Renewable energies are an important contribution to climate protection. • The use of NbS can enhance renewable energy implementation.
Natural hazard prevention	• Strong interlinkages exist between water management and hazard prevention. • Hydropower stations and reservoirs can serve multiple purposes, including flood retention, renaturation, and recreation (e.g. fishing, water sports, walking).
Economy	• Renewable energy generation is economically more efficient when considering external costs compared to other energy sources. • Water reservoirs can be used for energy storage, making renewable energies available at all times, and NbS can reduce negative effects of artificial reservoirs. • Energy transmission with powerlines is more cost-effective than underground cables, and NbS can help mitigate their negative impacts

Scale for the implementation of Nature-based Solutions

Energy-related NbS implementation could be encouraged at different levels:

Pan-Alpine	The exchange about best practice of NbS in energy will support these at the lower levels. NbS can also be part of the MAP of the Alpine Convention and those TWBs which are closely linked to energy such as the Alpine Climate Board.
National	National bodies can offer guidelines for the implementation of NbS in energy and can link this to the implementation of national energy strategies and plans. At strategic level there could be an alignment with national ecological connectivity concepts.
Regional	At regional and district level NbS may be more relevant particularly for powerlines which cross larger areas and can interconnect such areas.
Local	Energy generation as hydropower, solar power and wind power at local level exist and can implement NbS driven by private enterprises, individuals and also municipalities.

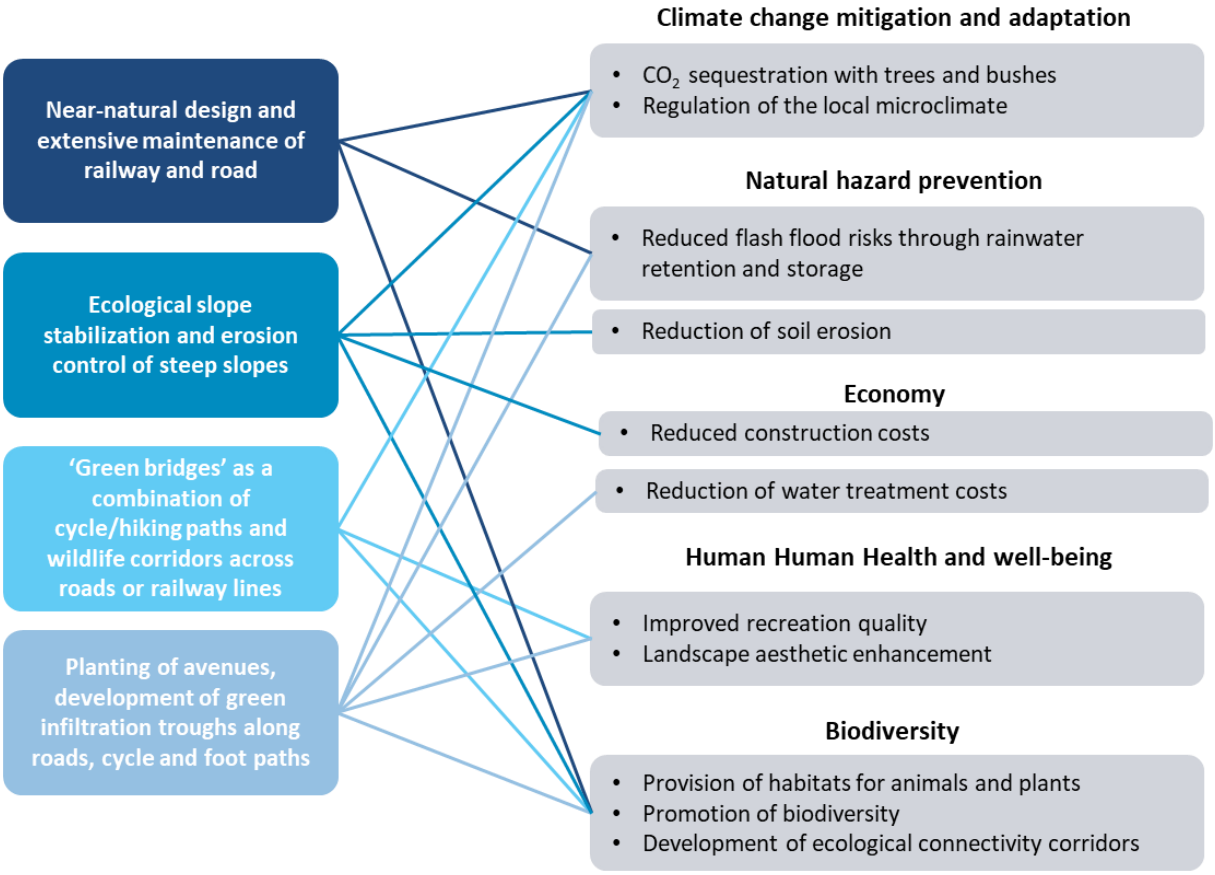
Stakeholder groups for the implementation of Nature-based Solutions

Public administration	Public administration bodies are sometimes public enterprises and are themselves in charge for energy generation, storage and transmission. In this case they can implement feasible NbS in their responsibility. They have also the opportunity via the procurement conditions to request or prefer NbS in services or construction which are carried out under their contracts.
Non Governmental Organisations - NGOs	NGOs often are involved in the authorisation procedures for energy infrastructure and have by this the opportunity to foster NbS in this sector. Some NGOs act themselves as small and medium enterprises and have energy infrastructure installed.
Small and Medium Enterprises - SME	SME may have the opportunity to implement NbS similarly as industrial enterprises (see below) but on a smaller scale.
Industry	Industry will be one key player to implement NbS in the energy sector. industrial enterprises run power plants, power storage systems and also power lines. They will act on basis of legal requirements or on a voluntary basis. A benefit for enterprises is, that they can present themselves as environmentally aware actors in society.
Individuals	Individuals may contribute in small scale if they have access to private properties, which may then often be at a commercial basis, such as farmers.

4.1.4 Transport

Transport infrastructures have manifold impacts on the environment. However, they also are a network of connectivity not only for human transport but in many cases also for ecological connectivity. Strips of land alongside railways, roads and watercourses are often habitats for species. In heavily used agricultural areas, they are indeed sometimes the only semi-natural habitats. Therefore, the nature-based design of such strips of land can provide habitats and connectivity to biodiversity (see Figure 13).

Figure 13: Transport-related examples of NbS and their potential effects



Source: Author's own illustration, ifuplan.

Transport-related examples from of the project analysis

No projects were analysed in this sector.

Interlinkages and potential synergies with other sectors

Water transport is closely linked to water management. The near-natural design of strips of land alongside transport infrastructures can contribute to nature conservation.

Climate change mitigation and adaptation	• The design of surfaces, edges, and other transport areas can use NbS to avoid surface sealing, allowing better infiltration of precipitation and reduces surface water run-off.
Natural hazard prevention	• Waterways can help manage run-off during floods, with NbS supporting this hazard prevention function. • NbS can also be used for slope protection and stabilisation along transport routes, reducing the risk of mudslides and rockfalls.
Economy	• Non-technical or lower-standard technical solutions (e.g. near-natural water retention reservoirs, unsealed agricultural tracks) are often remarkably cheaper than purely technical solutions.

Scale for the implementation of Nature-based Solutions

NbS implementation in transport could be encouraged at different levels:

Pan-Alpine	The pan-alpine level might support the implementation through networking activities between regions and states. It may also work towards an alpine wide network of ecological connectivity also considering transport corridors. NbS can also be part of the MAP of the Alpine Convention and those TWBs which are closely linked to energy such as the Transport Working Group.
National	At national level standards can be defined, how transport infrastructure will be designed and that in suitable cases NbS must be considered.
Regional	The regional level may foster the implementation of NbS in local transport projects through supervision of local projects and in case of connectivity regional authorities may organise a coherent development of local structures.
Local	Most transport projects are implemented at local level, so NbS will mainly be subject of decision at this level.

Stakeholder groups for the implementation of Nature-based Solutions

Public administration	Public administration bodies are sometimes responsible for building and maintaining the transport infrastructure. In these cases, they have all opportunities to implement NbS for their transport infrastructure. They have also the opportunity via procurement conditions to request or prefer NbS in transport infrastructure design and construction which is carried out under their contracts.
Non Governmental Organisations - NGOs	NGOs often are involved in the authorisation procedures for transport infrastructure and have by this the opportunity to foster NbS in this sector.
Small and Medium Enterprises - SME	SME may have sometimes the opportunity to implement NbS similarly as industrial enterprises (see below) but on a far smaller scale. If SME have transport infrastructure on their territory they can apply NbS as well.
Industry	Industry is involved in case of private transport organisations, such as private organised road or railway enterprises. In these cases, they have manifold possibilities to support the implementation of NbS.
Individuals	Besides participation activities individuals will have minor influence on the implementation.

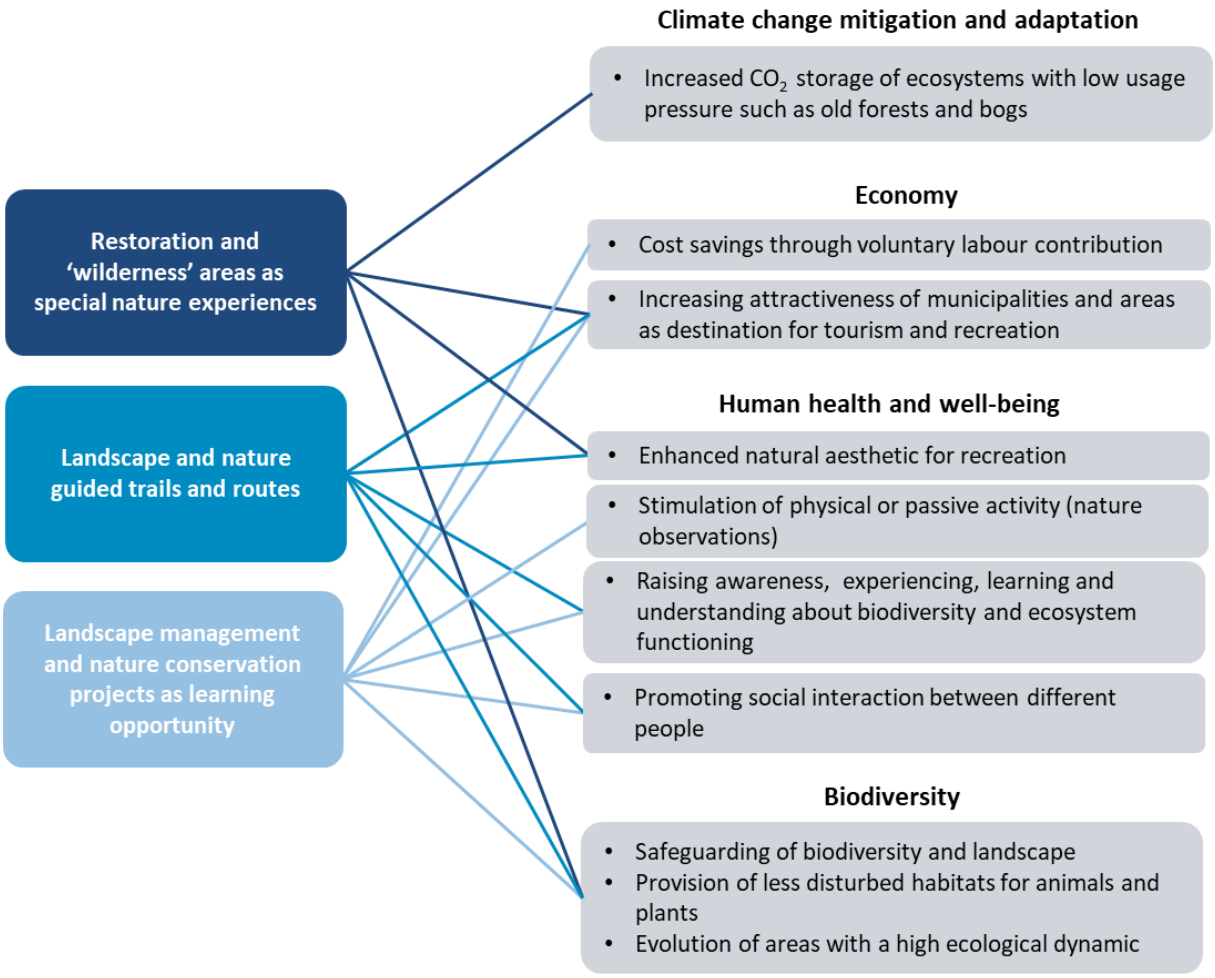
4.1.5 Tourism and recreation

To a large extent, tourism and recreation rely on unpolluted and semi-natural environmental conditions attractive for their customers. The report of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) states that demand for nature-based tourism or ecotourism has increased. Conversely, tourist and recreational travel are causing increased pollution, driving up land demand, and attracting alien species (Díaz et al. 2019).

The tourist sector is of specific importance for the Alpine area, one of Europe's top tourist destinations. NbS in tourism and recreation can be implemented through appropriate infrastructures and activities. For tourist infrastructures such as resorts, hotels and guest houses, hiking and biking trails and car parks, opportunities similar to those described for urban planning and transport exist.

As regards activities, NbS can contribute to near-nature activities such as hiking, bird and wildlife watching and photography, fishing, or just contemplation in nature (see Figure 14).

Figure 14: Examples of NbS and their potential effects in the tourism sector



Source: Author's own illustration, ifuplan.

Tourist and recreational examples from the project analysis

In the *LIFE Lech* project, the River Lech was further developed as a recreational area, in addition to revitalising and restoring river dynamics. The project includes guided visitor tours in the Tyroler Lech Nature Park, raising awareness for bird-breeding areas and enhancing the tourist image of the Lech region.

The opening and restoration of streams in the *Albisrieder Dorfbach* project in Zurich serves as a powerful example of how hydraulic challenges in the sewage system can be effectively addressed. It has significantly improved rainwater runoff efficiency, boosted biodiversity in stream habitats, and revitalised as well as enhanced recreational spaces along the watercourses.

The *Allgäuer Moorallianz* promotes cooperation between conservation, agriculture, regional development and tourism to protect and restore the moorland ecosystems of the Allgäu region. It highlights the importance of moors in biodiversity and climate mitigation while ensuring their resilience and safeguarding ecosystem services. The project integrates moor protection, sustainable land management, education and nature-based tourism.

Interlinkages and potential synergies with other sectors

There are many interlinkages with other sectors, as in many cases NbS supporting tourism have synergies with water management (creation of near-nature environments), energy (functionalities for outdoor recreation) and urban planning (development of environmentally friendly tourist accommodation).

Climate change mitigation and adaptation	• The maintenance or evolution of areas with wilderness character can increase CO_2 sequestration or reduce CO_2 emissions (rewetting of bogs)
Nature conservation	• Developing and maintaining attractive areas for nature-based tourism and recreation often are areas which are of interest for nature conservation. Assumed a mutual understanding this can offer benefits for tourism and nature conservation.
Economy	• Tourism is an economic sector, and NbS measures supporting tourism can have a positive economic impact for regional economy. • The tourism sector can benefit from diversifying its activities and offering environmentally friendly infrastructure and activities, which are increasingly in demand by customers.

Scale for the implementation of Nature-based Solutions

NbS implementation related to tourism and recreation could be encouraged at different levels:

Pan-Alpine	At alpine-wide level an exchange of experiences with NbS and cross-border offers and solutions for nature-based tourism can increase the attractiveness of this kind of tourism. NbS can also be part of the MAP of the Alpine Convention.
National	The national level might give guidelines and standards for the regional and local level of NbS and support through awareness raising initiatives.
Regional	At regional scale a coherent perception of the nature-nearness of tourism will develop. Therefore, the regional level can organise a coherent approach of nature-based tourism and enlarge the offer for tourists, such as long-distance hiking and biking, regional transport offers, etc.
Local	Most tourism and recreation activities take place at local level and are managed and this scale. However, tourist destinations often are perceived at a larger scale.

Stakeholder groups for the implementation of Nature-based Solutions

Public administration	Public administration can define areas for tourism activities, steer tourism infrastructure via the public authorisation procedures and can thus implement NbS in tourism in their area. There is particularly in tourism a mutual partnership between private enterprises and public authorities.
Non Governmental Organisations - NGOs	NGOs can offer themselves NbS for tourism and recreation activities, such as guided wildlife tours, maintenance of visitor centers and awareness raising.
Small and Medium Enterprises - SME	SME in the tourism sector are also a key player as a large amount of tourist offers is made by SMEs. They have the opportunity to implement NbS on a smaller scale similarly as the tourism industry (see below).
Industry	Tourism industry is a key player for the design and implementation of NbS in tourism and many concepts for green or sustainable tourism contain NbS. In the long term the broad implementation of NbS can be an important issue to safeguard the attractiveness of tourism destinations in future.
Individuals	Individuals can contribute by their preferences as customers and their personal behavior in nature. The choice of nature-based tourism offers is in its total an important tool for enforcing the implementation of NbS.

4.2 Barriers to establishing Nature-based Solutions in the Alpine region

This chapter explores the key challenges slowing the establishment of NbS in the Alpine region.

4.2.1 Knowledge and communication

A key challenge impairing NbS implementation is the 'lack of knowledge and data gaps for their sustainable and impactful design within different contexts and across geographical and temporal scales' (El Harrak & Lemaitre 2023). This study goes on to state that existing tools and guidelines for NbS implementation lack visibility, transferability to and usability in a wide range of contexts. Coupled with insufficient knowledge transfer mechanisms, these barriers collectively hinder any effective upscaling of NbS in the region. In fact, NbS benefits and their potential contribution to international policy objectives addressing global crises remain disputed in international fora (El Harrak & Lemaitre 2023).

In addition, the many national and subnational languages in the Alps constitute a further barrier to communication.

4.2.2 Coordination

The United Nations Environment Programme (UNEP 2022a) highlights critical barriers to implementing NbS, including the lack of integrated approaches combining policy, finance, and safeguards. Moreover, there is an urgent need for appropriate standards and guidelines to ensure effective and equitable NbS practices. Finally, the absence of a common understanding of NbS among stakeholders complicates efforts to (up-)scale these solutions effectively. Addressing these challenges is key to maximising the benefits of NbS in tackling climate change and enhancing biodiversity. As outlined by El Harrak & Lemaitre (2023), one of the core hurdles lies in the complexity of integrating diverse stakeholder interests and fostering multi-level collaboration. This challenge is particularly pronounced in the Alpine region, where governance structures often need to bridge transboundary jurisdictions, align with existing regional policies, and accommodate the differing priorities of local communities, policymakers, and the private sector. Furthermore, the high-altitude and often fragile Alpine ecosystems introduce unique biophysical constraints, making it difficult to standardise NbS approaches.

4.2.3 Framework

According to El Harrak & Lemaitre (2023), significant challenges regarding framework conditions for NbS implementation stem from a lack of capacities and incentives, as well as a tendency to focus on a narrow set of values and perspectives during the decision-making process regarding NbS. The authors go on to emphasise that social, financial, political and institutional barriers further complicate the effective deployment of these solutions. The varying governance structures and political frameworks in the Alpine region exacerbate these challenges. Policy Brief #39 of the International Institute for Applied System Analysis (Linnerooth-Bayer & Scolobig 2023) highlights the lack of evidence regarding the efficacy and co-benefits of NbS, creating a substantial barrier for public authorities and private businesses seeking to justify these solutions over conventional infrastructure. The brief states that '[F]or many NbS, this evidence will not be forthcoming in time for their urgent scale up' (Linnerooth-Bayer & Scolobig 2023, p. 1). In addition, entrenched institutional, regulatory and financial factors, referred to as "grey path dependency", often favour conventional infrastructure projects, further complicating NbS adoption. This situation is exacerbated by the public-good character of most NbS which leads to a scarcity of bankable projects compared to more attractive private investments, such as those in renewable energy. (Linnerooth-Bayer & Scolobig 2023)

Addressing these challenges requires strengthened governance frameworks and inclusive participatory processes to ensure equitable and sustainable outcomes (see Chapters 4.3.7, 6.6).

4.2.4 Challenges identified in the analysed model projects

The findings from the model project analysis provide a very similar picture:

- There is a lack of NbS knowledge and awareness among key stakeholders and interest groups.
- There are deficits in cross-sectoral and interdisciplinary cooperation and mutual understanding between those involved.
- There is no clear legal and regulatory framework for planning and implementing NbS.
- The standards and quality level for multi-level governance in NbS projects are often inadequate. There is a high dependency on the motivation of individual actors.
- There is often a lack of opportunities and incentives to get landowners and authorised users on board to participate in NbS projects or to enable NbS projects on their land.
- Approaches following a short-term project logic dominate. Yet NbS need long-term thinking extending beyond individual projects.
- NbS need sufficient space. However, there is and has always been a lack of space in the Alpine valley floors.

Addressing these challenges also requires bold approaches to ensure equitable and sustainable outcomes, outlined in detail in the next Chapter 4.3 and in Chapter 6.

4.3 Framework for the successful and comprehensive establishment of Nature-based Solutions

What important factors for the successful establishment of NbS are to be considered as a priority for promoting human well-being?

Based on the general research on NbS and our analysis of selected projects, general requirements for the successful and comprehensive establishment of NbS in the Alpine region were identified. The hypotheses established were discussed at an international workshop with representatives from administration, academia and the model projects analysed. All participants injected valuable expertise on NbS from different perspectives. The basic considerations on the central aspects and the hypotheses emerging from the workshop are presented below.

> The Lech LIFE project has shown that this is possible: With appropriate land availability and interdisciplinary cooperation, sustainable and cost-effective measures for the re-dynamization of watercourses can be implemented.
>
> *Bernhard Kogelbauer, Office of the Tyrolean Provincial Government, Department of Water Management*

4.3.1 Spatial requirements

Depending on the societal challenge addressed, the specific goal to be reached, and the type of NbS to be implemented, NbS have very different spatial requirements. It should be noted that the terms “large-scale” and “small-scale” can be interpreted very differently without specification. The NbS principles as defined by IUCN (2016) (see Chapter 2.2, Table 2) refer to the spatial scale of NbS explicitly in principle 6 which states that ‘NbS are applied at a landscape scale’.

While consensus can be assumed regarding the importance of considering the landscape scale for ecosystem management, this may also cause practical bottlenecks such as available funds, administrative boundaries and responsibilities, technical dimensions and human work capacity (Cohen-Shacham et al. 2019).

In some cases, small areas are sufficient for realising NbS, e.g. from planting trees along an urban street to provide shade and evapotranspiration, via green roofs or facades, to the use of artificial wetlands to treat surface runoff, or to the restoration and protection of individual habitats, like spawning ponds for endangered amphibians. Beyond their local impact, small-scale NbS present the opportunity to experiment with new solutions, realise pilot projects, and use them as best practice examples to raise public awareness, interest, and motivation for NbS in the public as well as the private sector.

However, certain challenges, like drought adaptation or comprehensive flood protection require large-scale NbS. The restoration of a river flood plain, for instance, is usually associated with significant space requirements reflecting the size of the river and local circumstances, e.g. infiltration capacities, land use, geology, etc. This can harbour high conflict potential, as space is generally limited in Alpine valley floors and many areas are privately owned and/or already heavily built up.

The establishment and widespread implementation of NbS in the Alpine region therefore requires both large-scale approaches and the promotion of small-scale (pilot) projects. Hence, different planning levels should cooperate in the most effective and efficient way possible (see Chapters 6.2 , 6.4.1). The need to promote both approaches is particularly acute in the Alps: On

the one hand, Alpine-specific natural hazards require large-scale solutions (e.g. the creation of retention areas for flood events or extensive protective forest areas); on the other hand, space is limited, especially for settlement areas, due to the topography, meaning that the realisation of many decentralised small-scale NbS is equally important.

Another spatial aspect is notably relevant with respect to flood protection: The most efficient NbS flood protection measures are located in the headwaters and upper reaches of rivers. NbS implemented there, like (semi-)natural retention areas, protect downstream residents and settlements and therefore have effects on areas far away from the implementation site – in cases of transboundary river basins sometimes even in a different state. This emphasises that NbS and their effects must be considered in very broad dimensions (spatial, temporal, financial and social). In this context it becomes obvious that small-scale measures can have large-scale effects. From a negative perspective, this happens when many small-scale surfaces are sealed, leading to the whole catchment area of a river becoming subject to accelerated runoff, in turn generating bigger flood waves. Albert et al. (2021, p. 1450) points out that NbS may have 'multi-directional effects (…) across different scales', meaning that some NbS may have additional effects when upscaled, while others may be effective on small scales but not on large ones.

Relevant instruments for determining NbS spatial requirements are landscape and urban planning, backed by governance mechanisms for the appropriate identification, design and implementation of NbS as outlined by Albert et al. (2019) (see Chapter 6.2.2 and Figure 19).

Based on these considerations, the following hypothesis can be derived:

Hypothesis I

- Regarding space, the successful establishment of NbS requires mechanisms for two approaches: a bottom-up approach, starting from small projects and spreading or upscaling them, and a top-down approach, implementing large-scale solutions at individual project sites or combining many small-scale solutions to form a large one.

4.3.2 Temporal requirements

In general, the temporal scale of NbS is not very clearly addressed in the IUCN (2016) principles (see Chapter 2.2, Table 2) (Cohen-Shacham et al. 2019). In view of their importance for maintaining ecological functions, NbS projects need long-term objectives and long-term maintenance. In many cases, NbS require longer time periods to develop their full functionality and deliver their services (Albert et al. 2021). This may be perceived as a tension between short-term business timescales. Although such economic risks might be covered by society through public funding or legal instruments (Maes et al. 2012; Maes & Jacobs 2017).

Also in practical terms, different types of NbS require different approaches: some, especially small-scale projects, can be realised and show effects within a short space of time (i.e. within several months or a few years), as seen with the decentralised rainwater management system in the *Parc Ouagadougou* in Grenoble (see Chapter 3.2, Appendix A.2).

Other NbS, however, especially those based on complex ecosystem processes, such as the large-scale conversion to climate adapted forests, soil formation, or the colonisation of habitats by certain species, may require long periods of time. As such processes follow different time schedules than human activities, the associated NbS require a long-term approach to be successful. Even if initial measures can be carried out within a short timeframe, the desired effects and ecosystem services may only occur with a significant time lag due to the dynamics of

natural systems. Conversely, this aspect also demonstrates the value of and the time saved by measures protecting existing ecosystems.

To ensure the appropriate management and acceptance of such long-term projects, as well as the monitoring and evaluation of their effects, the additional establishment of long-term, multi-dimensional and cross-sectoral governance mechanisms is necessary (successful examples are the projects *Allgäuer Moorallianz* and *Bergwaldprojekt,* Chapter 3.2, Appendix A.2). Such an approach could overcome the deficits of the currently prevailing logic of short-term visions. Furthermore, it offers long-term perspectives and planning security to the landowners and stakeholders involved in these projects.

The transformation to long-term perspectives may be challenging for existing funding programmes because most of them, such as the Interreg Alpine Space Programme, are not designed for long-term project funding. They would thus require interfaces to long-term funding programmes at national and EU level to ensure follow-up funding after an initial project phase. Long-term funding could also be realised by compensation mechanisms or adapted market mechanisms (see Section 4.3.3).

Hypothesis II:

- The successful establishment of effective and sustainable (in terms of time and function) NbS requires adapted temporal management approaches: While some projects, especially proven and directly effective small-scale NbS, need targeted promotion and funding to spread rapidly, NbS based on complex natural processes require (new) concepts for long-term thinking, long-term management and adaptive governance.

4.3.3 Financial and economical requirements

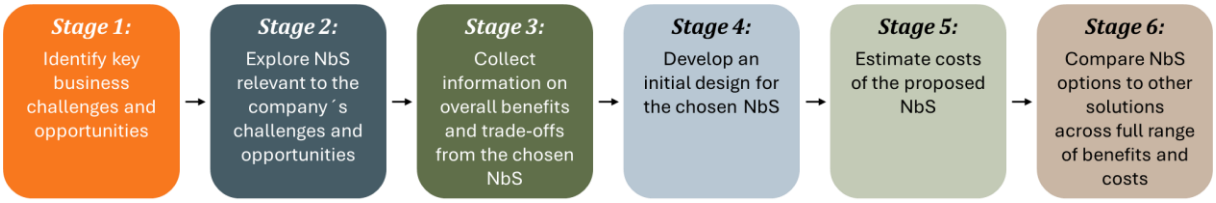
'Any region's economic competitiveness and security depend – in the long run – directly on sustainable use of natural resources' (Maes & Jacobs 2017, p. 121). NbS can offer a transition path from the traditional economic model towards a sustainable economy (ibid).

NbS are usually based on or closely related to public goods often not subject to general market mechanisms. For such non-market or non-use values of NbS, costs and benefits cannot be derived from markets, instead needing to come from a variety of other economic valuation methods. The recognition and incorporation of use and non-use values are important to achieve a comprehensive assessment of NbS costs and benefits (Lozano et al. 2023).

There is political agreement that public goods relevant to services of general interest, i.e. that are essential for the well-being of the population – such as the provision of good-quality drinking water – should not be an economic interest of the private sector. On the one hand, such an integrated approach will bring enterprises and the market into the management of NbS, as they are part of the system. Therefore, it can be double-edged to make the implementation of NbS economically attractive for enterprises or individuals.

However, there is increasing awareness in the corporate world that economic prosperity is based on ecosystem services and that NbS can positively address business challenges. Benefits for enterprises can include reduced supply chain risks, improved business performance, and health benefits for communities and employees (WBCSD 2024). Based on eight case studies, guidelines for developing a business case have been developed by the WBCSD (see Figure 15).

Figure 15: Six development steps for NbS business cases.



Source: Adapted from WBCSD (2024).

For NbS projects that are not economically viable or are too large for single private investors, public funding can be decisive, particularly during their initial phases.

Some types of NbS, on the other hand, offer cost savings and efficiency gains (for instance, higher yields and an additional source of income as in the pilot project *Rotational Pasture Management* (Chapter 3.2, Appendix A.2) and may be economically more profitable than technical solutions. Protective forests as NbS may be far more cost-effective than technical solutions, as seen in an Austrian case study where a ratio of 1/146 for a protective forest versus a technical solution was reported (PLANALP 2022). NbS may also have positive effects on the regional economy and labour market. These NbS, especially small-scale projects, may need promotion but in many cases do not need public funding.

Another resource for implementing NbS are volunteers willing to invest time and financial resources out of personal interest rather than economic considerations. The involvement of volunteers has proven successful in several NbS projects (e.g. the *Bergwaldprojekt*, Chapter 3.2, Appendix A.2).

Under appropriate economic framework conditions, an NbS may benefit from strong public support in terms of funding and its institutional setting (see also Section 4.3.4) as well as from private investments. Notably with respect to companies or associations, the private sector can be fast and dynamic in establishing new approaches, e.g. setting up sponsorship or voluntary programmes, fundraising campaigns, applied research, etc.

When assessing the economic viability of NbS and deciding on the allocation of public funds for their implementation, it should be remembered that (according to their definition) NbS are associated with an increase in social benefits, an often-neglected return on investment (ROI). To assess ROI in economic terms, the 'user-pays' principle (i.e. 'What would an average user pay to benefit from a specific ecosystem service?') can be applied. Similarly, the 'polluter-pays' principle – a core principle of the Alpine Convention (AC 1991, Art. 2 Nr. 1) and European Environmental Law – may be instrumentalised for funding NbS, e.g. by linking an obligation to take compensatory measures to NbS implementation. This approach needs corresponding institutional structures (see Section 4.3.4).

> Nature conservation must be recognised as a permanent government responsibility. It is naive to believe that it can only be achieved through temporary projects. Roads are not built through subsidy programmes but by a state administration with a permanent budget. In the same way, nature conservation and climate protection must be guaranteed by the state in the long term – incentives alone are not enough.
>
> *Ulrich Weiland, Project Manager, special-purpose association Allgäuer Moorallianz*

Hypothesis III:

- A smart combination of public funding and the utilisation of private resources, supported by adapted institutional frameworks, is highly relevant for the successful establishment of NbS. Public funding and business models for enterprises need to be developed, promoted and made easily accessible for project applicants across sectors.

4.3.4 Institutional requirements

Besides financial incentives, NbS need to be fostered by legal requirements, guidelines and institutions and to be integrated into political objectives and strategies from EU to local scales.

To establish a common understanding of NbS characteristics and benefits, standards are needed that define NbS as well as the ecosystem services related to them. Introducing NbS testing and monitoring standards, along with criteria for their economic evaluation, is crucial, as it would enable cost-benefit comparisons with purely technical (i.e., non-NbS) measures, taking specific account of the long-term effects of NbS and external cost factors, such as avoided damage management costs or social benefits. Evaluations should follow a comprehensive approach, while being user-friendly and comprehensible.

Based on such a framework, legal requirements for NbS can be formulated in various ways. For instance, public procurement law, construction law, planning law, or environmental law can mandate that the potential use of NbS be considered for implementing a project, with NbS prioritised unless there are compelling reasons of public interest against it.

Such a set of standards should be defined at a transnational level, for example by the UN, at EU level or within the framework of the Alpine Convention. The definition of NbS by (UNEP 2022b) and the Common International Classification of Ecosystem Services (CICES, Haines-Young & Potschin 2018) can serve as a starting point here.

Moreover, subsidies and funding programmes (e.g. sector policies and cross-sectoral spatial development policies from EU to local scale) to foster NbS as well as further economic considerations can be based on common standards. Technical guidelines and recommendations as well as institutions assisting in NbS planning and implementation, such as specialised authorities, can also significantly support the establishment of NbS.

Research also plays an important role in establishing and mainstreaming NbS: applied and transdisciplinary research (e.g. in Horizon Europe, EU Missions) as well as accompanying research in NbS (e.g. in the context of the LIFE programme) can help expand the knowledge base, provide 'good practice' examples of NbS implementation, and improve instruments and processes.

In summary, the stronger establishment and anchoring of NbS in the Alpine region (compared to conventional solutions) requires a 'policy mix' of legal provisions, technical guidelines, financing mechanisms and standardised planning instruments, linking various affected fields, e.g. agriculture and forestry, hydraulic engineering, natural hazard management, tourism, spatial and landscape planning, nature conservation, etc. Ensuring these aspects also requires customised governance structures (see Section 4.3.7).

Hypothesis IV:

- The widespread establishment of NbS requires efforts to build up a binding legal framework, standardised evaluation criteria, and institutionalised support structures.

4.3.5 Educational requirements

Difficulties in establishing and institutionalising NbS arise, inter alia, because many relevant actors (e.g. landowners, administrators, planners, NGOs, media, etc.) know little about the specific features of NbS or are discouraged by the lack of standards or the uncertainty about the (long-term) impact of NbS projects and may therefore be reluctant to adopt them. Besides, the public may easily underestimate or misjudge the risks associated with the climate crisis and the opportunities provided by NbS to counteract these risks.

NbS often involve specific land use or land management requirements and possible restrictions for landowners. This is a particularly important issue in the Alpine region, where valley floor space is limited and different utilisation interests collide.

Two key measures to overcome these obstacles are knowledge transfer and skills development. Important institutions in this regard are technical colleges and universities, professional associations, the public administration, exchange formats for practitioners, NGOs, and schools. They should offer theoretical inputs as well as practical training and the exchange of knowledge and experience for students, public officials, planning offices, associations, school pupils and interested citizens in general.

Hypothesis V:

- Ensuring the establishment of NbS requires efforts to raise public awareness and build up capacities by offering easily accessible education and training on theoretical NbS approaches.

4.3.6 Communication requirements

During the planning phase, we intensively sought dialogue with associations, particularly in the agricultural sector. In a self-moderated consultation process, the specialised planning and management plan were discussed with stakeholders on several occasions. We used coaching to support the dialogue with the interest groups.

Ulrich Weiland, Project Manager, special-purpose association Allgäuer Moorallianz

When planning and implementing specific NbS projects, special attention must be paid to communicating with landowners and other stakeholders to address their concerns and needs, to build trust, and ensure transparency.

Clear and positive messages and narratives that appeal to the public in a motivating, tangible and emotional way are a basic requirement for the successful establishment and anchoring of NbS. An Alpine-wide communication strategy for NbS featuring objectives, key messages, communication channels and suitable communication events could help ensure that NbS projects are more widely accepted by the various target and dialogue groups, thereby making them easier to implement.

Hypothesis VI:

- The successful introduction and anchoring of NbS requires clear and positive messages that appeal to key stakeholders, especially landowners, in a motivating way.

4.3.7 Governance requirements

The comprehensive consideration of all the above-mentioned aspects and the realisation of successful cross-sectoral and interdisciplinary concepts requires adapted and, if necessary, new governance mechanisms.

Their form and scope may vary greatly depending on the size and complexity of the respective NbS project. For smaller projects with few participants and a short duration, simple agreements between the partners involved are sufficient, whereas large NbS projects with many participants and/or a long duration going far beyond the usual "single-project-logic" require collaborative governance systems with clearly defined organisational structures and processes – up to and including permanent institutionalisation beyond the immediate project duration and long-term financing mechanisms. An additional challenge is when the scope of a project extends across borders. An important prerequisite for successful governance is the presence and involvement of the relevant actors and stakeholders. Those able to significantly influence the success or failure of an NbS project must be part of the collaborative system. In addition, civil society organisations and citizens should be involved in knowledge co-creation and NbS implementation. In most projects, conflicts of interest between those involved are the norm, e.g. between different fields (agriculture - water management - nature conservation) or between project operators on the one side and landowners and land users on the other. Similarly, conflicts within the fields should not be neglected, e.g. between "changers" and "preservers". Dealing with these different interests in an interdisciplinary and cross-sectoral approach and in a constructive and professional manner is a key factor for the success of NbS. There is a wide range of methods and tools for collaboration, conflict negotiation and collaborative decision-making. These methods must be selected carefully, depending on the issue at hand, the number of people involved, the escalation of the conflict and other framework conditions.

Besides the structural aspects mentioned above, "the human factor" plays an important role in managing conflicts of interest. Individual participants must learn to recognise the interests of others and to deal with difficult emotional situations. In particular, mediators between interest groups need facilitation skills and expertise.

Negotiating conflicts of interests and finding joint solutions require a certain room for manoeuvre in the negotiation processes with regards to content, organisation, time, space or financial leeway. This is another key aspect for successful NS governance.

Particular attention must also be paid to careful and professional internal and external communication, especially with landowners, without whose land NbS often cannot be implemented. This is particularly challenging in the Alpine region with its limited land availability leading to increased land use conflicts, especially in Alpine valley floors.

> We have always endeavoured to inform the public. However, direct dialogue with those directly affected is just as important.
>
> *Ulrich Weiland, Project Manager, special-purpose association Allgäuer Moorallianz*

Further important success factors are a high quality of the content of the measures and a professional framework for cooperation between the various actors. This includes the formulation of clear project goals, a good distribution of tasks among the partners involved, clear leadership by the respective responsible institutions, the establishment of steering and decision-making mechanisms, internal and external transparency and communication based on a clear concept (what is communicated to whom, when, how, by whom). Those responsible for communication should also provide interested citizens with regular information about an NbS project to increase acceptance and awareness of the opportunities offered by it. Another key success factor is the direct contact and exchange with those directly affected by the project, especially landowners. It is important to start this exchange at an early project stage to get those people affected on board and take their interests into account right from the outset. Besides, a high quality of implemented measures is important to build up trust, counteract possible concerns or prejudices, and create good-practice examples.

These considerations demonstrate how important and valuable it is to provide sufficient financial and human resources for professional support and management to successfully realise NbS projects.

These points reflect the 12 Principles of Good Governance (CoE 2022) confirmed by the Council of Europe in its "Strategy on Innovation and Good Governance at local level" (COE 2008):

1. Participation, Representation, Fair Conduct of Elections;
2. Responsiveness;
3. Efficiency and Effectiveness;
4. Openness and Transparency;
5. Rule of Law;
6. Ethical Conduct;
7. Competence and Capacity;
8. Innovation and Openness to Change;
9. Sustainability and Long-Term Orientation,
10. Sound Financial Management;
11. Human Rights, Cultural Diversity and Social Cohesion;
12. Accountability.

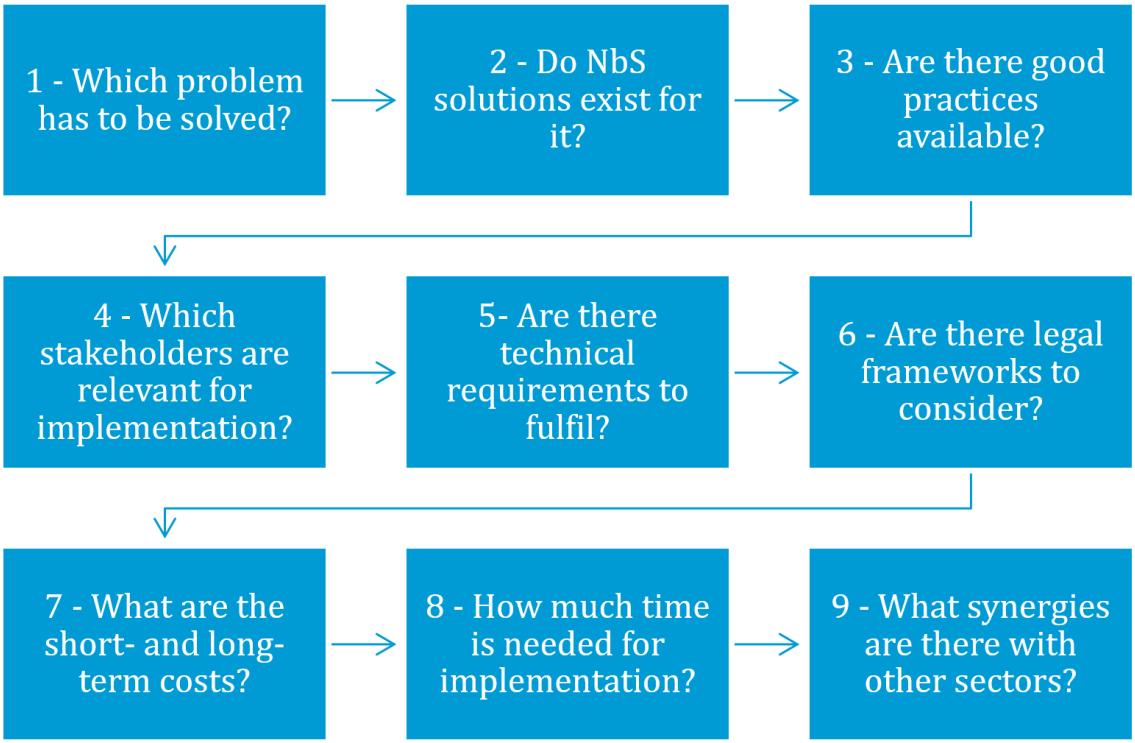
Hypothesis VII:

- The successful establishment of NbS requires good and case-adapted governance mechanisms. This facilitates cross-sectoral and interdisciplinary collaboration with a specific focus on transparency and continuous communication, and increases NbS acceptance among landowners, (private) investors, planners, public administration and policymakers.

4.4 Feasibility checklist to start Nature-based Solutions

Based on the results of the project analysis, contributions from the international workshop conducted as part of this project, a draft checklist for determining the feasibility of NbS in 9 steps is displayed in Figure 16. This checklist can be considered as a detailed "co-define setting" as suggested as a first step by (Albert et al. 2021). The checklist is further explained in the sections below, with examples for each step presented.

Figure 16: Feasibility checklist for NbS



Source: Authors' own illustration, ifuplan.

Step 1 – Which problem has to be solved?

The first step is to identify the problem to be solved and what impact the solutions should have.

- Example: In summer the built environment in cities stores the sun's energy as heat. This is radiated into the urban environment at night, creating an urban heat island. Therefore, in summer nights urban areas do not cool down as much as the urban surroundings, with negative effects on human well-being and health. If solar radiation can be reduced by shading trees and the cooling effect of evaporation on green spaces, energy storage in the built environment and temperatures in urban areas are reduced.

Step 2 – Do Nature-based Solutions exist for the problem?

In many cases we are used to conventional solutions offering easily available, short-term or traditionally used solutions. Therefore, this step is to question whether NbS exist but are not being considered, or whether they can be developed beside commonly known conventional solutions.

- Example: Technical structures shading parking areas can be a solution to reduce the heating effect. Instead of technical structures, trees could be planted or pergolas with climbing plants erected as an NbS.

Step 3 – Are there good practices for this Nature-based Solutions available?

Besides the existence of NbS in general for this problem, good practices for this NbS may help promote project feasibility and stakeholder acceptance.

- Example: The *Parc Ouagadougou* in Grenoble is a multi-functional NbS for inner-urban green infrastructure development combined with water retention to adapt to climate change, support water purification and irrigation, and establish an urban recreation area.

Step 4 – Which stakeholders are relevant for implementation?

Who is affected by the problem and its solution? There may be public administration bodies involved, but also private enterprises, the general public or NGOs. When considering the indirect effects of NbS (synergies), a wider range of stakeholders will often be relevant. A rough grouping of stakeholders – such as public administration bodies, enterprises (SME, industry), NGOs, groups of individuals such as owners, employees – may help.

Who will probably support a NbS? Who might be reluctant to accept the NbS?

- Example: The *Bergwaldprojekt* involves diverse stakeholders forming partnerships with organisations and companies in Germany – forest administrations, municipal administrations, private enterprises and foundations.

Step 5 – Are there technical requirements to fulfil?

Does the NbS require technical solutions for which technical standards or guidelines exist, such as in civil engineering and construction? If such standards exist, how are they defined and measured, and which indicators may be used.

- Example: The renaturation of a channelled stream will need to consider specific runoff in case of floods. Any widening or remodelling of stream banks must take account of the widest possible flood effects.

Step 6 – Are there legal frameworks to consider?

For some NbS, legal frameworks exist and have to be taken into account. On the other hand, legal requirements for traditional technical solutions may be not relevant anymore, thereby facilitating NbS implementation.

- Example: Changes in water management, afforestation, infiltration in groundwater aquifers, green roofs may require public authorisation procedures under national law or municipal statutes.

Step 7 – What are short-term and long-term costs?

When making decisions, not only the short-term but also the long-term costs of the solutions should be calculated. Calculations should include possible funding for NbS. This financial aspect may be of importance as NbS are often economically promising in the long term but not in the short term.

- Example: A flood retention project may need a higher investment in the beginning to finance the initial modelling of the terrain. Once that has been done, all that remains is the maintenance of the floodplain forests. In the long term, the total saved through avoided damage will be much higher than the short-term investment.

- NbS projects may receive funding from different sources, as seen with the *Moorallianz* project which has been funded by the Federal Ministry for the Environment, the Bavarian state government, the district government and the Office for Food, Agriculture and Forestry.

Step 8 – How much time is needed for implementation?

With which timeframe should the effects of a NbS become noticeable? NbS sometimes need quite some time to become fully effective, though afterwards the effects may be long-lasting and only require low maintenance. Therefore, the time schedule for implementing an NbS needs to be explored and compared.

- Example: Protective forests need time to mature to a stable forest cover. Once this status is achieved, the protection function remains effective for decades or even centuries.
- Near-nature flood retention areas in flood plains can be activated almost immediately, if the terrain is modelled according to the foreseen delineation of the retention area.

Step 9 – What synergies are there with other sectors?

One big advantage of NbS are positive synergies with other sectors as they have been introduced in chapter 4.1. Considering such synergies NbS may be more attractive due to their multifunctional advantages and this attraction can be used as an additional reason for implementing NbS.

- Example: The *Parc Ouagadougou* in Grenoble is an example of an NbS where synergies were generated between water management, urban development, recreation and climate change adaptation.

5 Existing institutions and networks for promoting Nature-based Solutions in the Alpine area

5.1 Main institutional players for implementing Nature-based Solutions in the Alpine area

NbS implementation in the Alpine region is supported by key institutional frameworks, including the Alpine Convention and its Thematic Working Bodies (TWBs), the EU Macro-regional Strategy for the Alpine Region (EUSALP) and the Alpine Space Programme. These initiatives facilitate transnational cooperation and promote biodiversity, climate resilience and the sustainable development of the Alpine region.

The following paragraphs provide a brief insight into the existing integration of NbS and the starting points for their further establishment in the respective institutions. For a more detailed description of the main institutional players, their objectives, their way of functioning, and their potential for promoting and implementing NbS, please refer to Appendix B.

The Alpine Convention makes use of TWBs such as the Alpine Biodiversity Board which prioritises restoration, connectivity and conservation through initiatives like the Alpine Biodiversity Action Plan. NbS are also of central importance to the Alpine Climate Board's Climate Action Plan 2.0 (PSAC 2021), addressing climate adaptation across sectors such as ecosystems, forests, and water management. PLANALP, the Natural Hazards Working Group, highlights NbS for risk reduction and spatial planning. Other Working Groups (WGs), such as those focused on soil protection and sustainable agriculture, explore NbS for ecosystem service restoration and carbon sequestration.

Within EUSALP, thematic Action Groups (AGs) align with NbS goals. For example, AG6 promotes multifunctional forests for biodiversity and climate adaptation, while AG7 integrates NbS into green infrastructure to enhance ecological connectivity. AG8 emphasises NbS in risk governance to manage climate-induced hazards.

The Alpine Space Programme (2021–2027) promotes NbS to address climate change, biodiversity loss and resource sensitivity. It advocates ecosystem-based approaches, green infrastructure development, and community-driven NbS projects to achieve regional climate resilience and sustainability (Interreg 2022).

Across all institutional frameworks, NbS offer transformative potential, combining ecological, social and economic benefits. Key opportunities include climate change mitigation, natural hazard prevention, biodiversity restoration, and fostering transnational collaboration.

5.2 Platforms and networks

Since the concept of NbS is not fundamentally new, their potential to address the many societal challenges associated with the climate crisis has already been widely recognised, and there is significant scientific interest in their study and development. Consequently, numerous platforms and networks already explicitly or thematically address NbS. Table 4 provides an overview of these platforms and networks along with a brief description of their objectives and the NbS-related content they offer.

Table 4: Overview of platforms and networks addressing NbS

Short description	NbS-related content
Network Nature: https://networknature.eu/ Resource for the NbS community. Objectives: ▶ Offering opportunities for local, regional and international cooperation to maximise the impact and spread of NbS. ▶ Maintaining and adding to a diverse and scientifically-based collection of knowledge about NbS. ▶ Strengthening partnerships and promoting new relationships on the basis of a clear, strategic framework for action.	▶ Definition of NbS ▶ Event calendar for NbS events ▶ News ▶ NbS resources, databases and case study finder ▶ NbS policy roadmap: core action areas for European research and innovation ▶ Biodiversity enhancement and ecosystem restoration ▶ Sustainable food systems ▶ Climate adaptation, mitigation and resilience ▶ Sustainable finance, investment and transition ▶ Sustainable urban and regional transformation ▶ Zero pollution ▶ Network Nature project groups
European Platform Urban Greening https://platformurbangreening.eu/ Objectives: ▶ Increasing the knowledge and skills required to address climate adaptation, biodiversity and well-being in the urban, green living environment. ▶ Broadening expertise among professionals in Europe.	▶ News ▶ Resources ▶ Urban Greening network map (expert map) ▶ Case studies ▶ Spin-off projects
Interlace Hub https://interlace-hub.com/ Online community for sharing knowledge, ideas and stories about restoring nature in cities.	▶ News ▶ Information about participating cities ▶ Case study finder ▶ Events ▶ Articles and resources
NATURVATION https://naturvation.eu/ Project involving 14 institutions from across Europe in the fields of urban development, geography, innovation studies and economics. Objectives: ▶ Developing understanding of NbS in cities. ▶ Investigating the promotion of innovation in this area. ▶ Helping to realise the potential of NbS to address urban sustainability challenges	▶ Definition of NbS ▶ Project partners and cities ▶ Urban Nature Atlas: database of NbS for cities ▶ Action reports about different NbS topics ▶ Assessment reports ▶ Briefing on assessment of biophysical and ecological services provided by urban NbS ▶ Briefing on Economic valuation of urban NbS ▶ Briefing on financial and economic values database ▶ Briefing on social and cultural values and impacts of NbS

Short description	NbS-related content
through collaboration with communities and stakeholders.	▶ Value and benefit assessment methods database for urban NbS ▶ Assessment maps: Demonstration of the potential of NbS ▶ Urban Nature Explorer: Open-access software tool to support the development and the visualisation of NbS scenarios (costs, benefits, impacts) ▶ NbS podcasts, blogposts and films
ThinkNature https://climate-adapt.eea.europa.eu/en/knowledge/adaptation-information/research-projects/ThinkNature [4] Multi-stakeholder communication platform to support the understanding and promotion of NbS at local, regional, EU and International levels.	▶ ThinkNature Platform: Integrated multi-stakeholder web platform to foster dialogue and interaction on NbS through discussion forums and debates ▶ Nature-based Solutions Handbook: Methodologies from project development to financing and policy making ▶ NbS Case Study Portfolio ▶ Expert Interview videos ▶ ThinkNature Webinars ▶ ThinkNature Summer School ▶ Brainstorming Forums ▶ Greentown Game App: App to demonstrate the impact of choices and the advantages of using NbS solutions ▶ Business Case for NbS: Illustration of a strategic process framework used for identifying the key elements of a project needed to develop an NbS business case ▶ Project partners
LIFE-myBUILDINGisGREEN https://life-mybuildingisgreen.eu/en/home/ Objectives: ▶ Implementation of NbS in public education buildings and social care centres as solutions to adapt to climate change, improving environmental health and well-being.	▶ Definition of NbS ▶ Information about the LIFE-myBUILDINGisGREEN programme ▶ Information about LIFE-myBUILDINGisGREEN partners ▶ Results of different LIFE-myBUILDINGisGREEN projects and news
Connecting Nature Enterprise Platform (CNEP) https://naturebasedenterprise.com/ Platform for nature-based enterprises to connect with their peers, learn about good practices and market trends and to connect nature-based enterprises with potential investors highlighting their expertise. Membership necessary.	▶ Communities of ecosystem restoration, green buildings, landscapes etc. ▶ News & research ▶ Projects

[4] The current project website https://platform.think-nature.eu/ is currently not available.

Short description	NbS-related content
Urban Nature Atlas https://una.city/ The most comprehensive database of urban NbS to date from European cities and beyond.	▶ Analysis tool to filter and compare NbS along their characteristics or impact
Urban by Nature https://urbanbynature.eu/ A facilitated capacity-building programme which provides a platform for collaboration, knowledge sharing, and the implementation of NbS.	▶ Service and training in NbS ▶ Access to expert knowledge and resources ▶ Opportunities for collaboration and networking ▶ Support for implementing NbS projects ▶ A platform for sharing best practices
OPPLA https://oppla.eu/ The EU Repository of NbS. An open platform that is designed for people with diverse needs and interests – from science, policy and practice.	▶ Networking: Connecting professionals and stakeholders to share knowledge and solutions. ▶ Knowledge hub: Providing resources, case studies, and expert advice on NbS and related topics. ▶ Marketplace: Facilitating connections between suppliers and users of NbS. ▶ Community engagement: Encouraging collaboration and idea-sharing among diverse environmental sectors.
NBS Edu World https://nbseduworld.eu/ Overview of NbS-related content, including the websites above.	▶ NBS Edu Directory: Providing a comprehensive list of available resources, including guidance, reports, tools, and service. ▶ NBS Edu Resources: Providing valuable insights and tools to support work on NbS.

6 Recommended actions to foster Nature-based Solutions

6.1 Strategic actions and considerations

With the intention of fostering NbS in the Alpine area from a strategic perspective, such solutions need to be recognised by decision-makers as relevant and feasible. The relevant stakeholders need to be addressed, and further project development and funding need to be generated in the appropriate bodies and institutions.

There are several options available to better integrate NbS into decision-making processes in the Alpine region:

- Their structural integration at different policy levels (see below).
- Their systematic integration in the different sectors.
- Gaining the involvement of decision-makers and stakeholders.
- Incorporating NbS in programmes and plans.
- Developing an Alpine-wide NbS strategy.

6.1.1 Integration at different policy levels

The first requirement for integrating NbS into policy-making processes is to make policy-makers aware of these kinds of solution and their potential benefits. The second is to establish NbS as a standard solution. Decision-making can then take place at several policy levels (see also examples in Chapter 4.1):

- At local level, as part of local development policies and municipal statutes, such as land-use planning, landscape planning and also the revision of outdated development plans[5];
- At regional and national levels within the framework of legislation, guidelines, subsidies, (sectoral and integrated) strategic concepts and planning instruments;
- At the pan-Alpine level within the framework of the Alpine Convention, the EUSALP, and the Interreg Alpine Space Programme; furthermore, at EU level the Alpine Member States could work together on relevant dossiers to ensure that European framework conditions take adequate account of the specific needs of the Alpine area.

Integrating NbS into decision-making processes in the Alpine region requires an appropriate policy mix consisting of legal provisions, technical guidelines, financing instruments and (standardised) planning instruments in the various sectors involved in NbS implementation: agriculture and forestry, hydraulic engineering, natural hazard management, tourism, spatial and landscape planning, nature conservation, etc.

6.1.2 Systematic integration in different sectors

Besides the policy level, the various stakeholders involved in implementing NbS in different sectors need to be empowered to recognise opportunities, deliver their contributions, and fulfil their responsibilities. Though single stakeholders might work on a single project in one sector,

[5]Many NbS come to life on specific plots of land within the remit of local decision-makers. Therefore, local land use planning, landscape planning, and statutes on how land use is designated (as in German local development plans (*Bebauungspläne*)) offer plenty of opportunities to define NbS at local level.

the systematic integration of all relevant stakeholders through their federations and associations will foster cooperation in the concrete projects. Examples how single sectors can contribute to NbS are presented in Chapter 4.1.

6.1.3 Decision-maker and stakeholder involvement

In line with NbS principle 4 (Chapter 2.2, Table 2), NbS planning and implementation involve a wide range of stakeholders, including decision-makers, funders, landowners and others affected by the NbS, local administrations, company managers, NGOs and private persons. This involvement ensures they benefit from the NbS, that opportunities are not lost, that processes are transparent, and that understanding is generated in local politics. These factors are the basis for defining compensation-based mechanisms for the supply and payment of ecosystem services generated by the NbS (Cohen-Shacham et al. 2019). NbS implementation should aim at a "socially inclusive planning process" based on inclusive, organised participation as reflected in the principle of equity (Albert et al. 2021).

To establish such involvement, the long-term education and training of stakeholders should be envisaged as part of environmental and nature education, but also as part of governance processes (see Chapters 6.6, 6.7, 6.8).

6.1.4 Incorporation in programmes and plans

NbS should be incorporated in the relevant programmes and plans in the Alpine area as a project topic and funding subject, in particular in the Multi-Annual Work Programme of the Alpine Conference 2030 (PSAC 2022), the objectives of the individual TWBs in the Alpine Convention, the objectives for the AGs of the EUSALP, the Interreg Alpine Space and Central Europe Programme. In addition, other EU instruments (and their corresponding national transpositions) can list reasons for implementing NbS. Such instruments include the recently adopted EU Nature Restoration Law, the Water Framework Directive or the Habitats and Birds Directive as well as relevant strategies such as the EU Biodiversity Strategy 2030 (Chapter 6.4.3).

6.1.5 Development of an Alpine-wide Nature-based Solutions strategy

As widely discussed in the chapters above, the Alpine region offers great potential for implementing NbS in various sectors and at all levels. The introduction and implementation of NbS as an umbrella concept create the challenge to bring different sectors, levels and stakeholders together. This will not happen automatically, even if clear political intent exists.

Specific political mandates to strategically integrate NbS could be set out in a "Nature-Based Solutions Strategy for the Alps" or an "Action Plan for Nature-based Solutions in the Alps" between the Member States of the Alpine Convention.

The initial content of such an NbS strategy would aim to systematically assess NbS implementation and funding options across all sectors, analyse NbS application and feasibility, collect best practices, and promote NbS. Potential caretakers for such a strategy could be the Alpine Biodiversity Board, the Alpine Climate Board, or a new *ad hoc* Working Group. Funding could come directly from the Alpine Convention or the Alpine Space Programme.

Summary of strategic actions and considerations

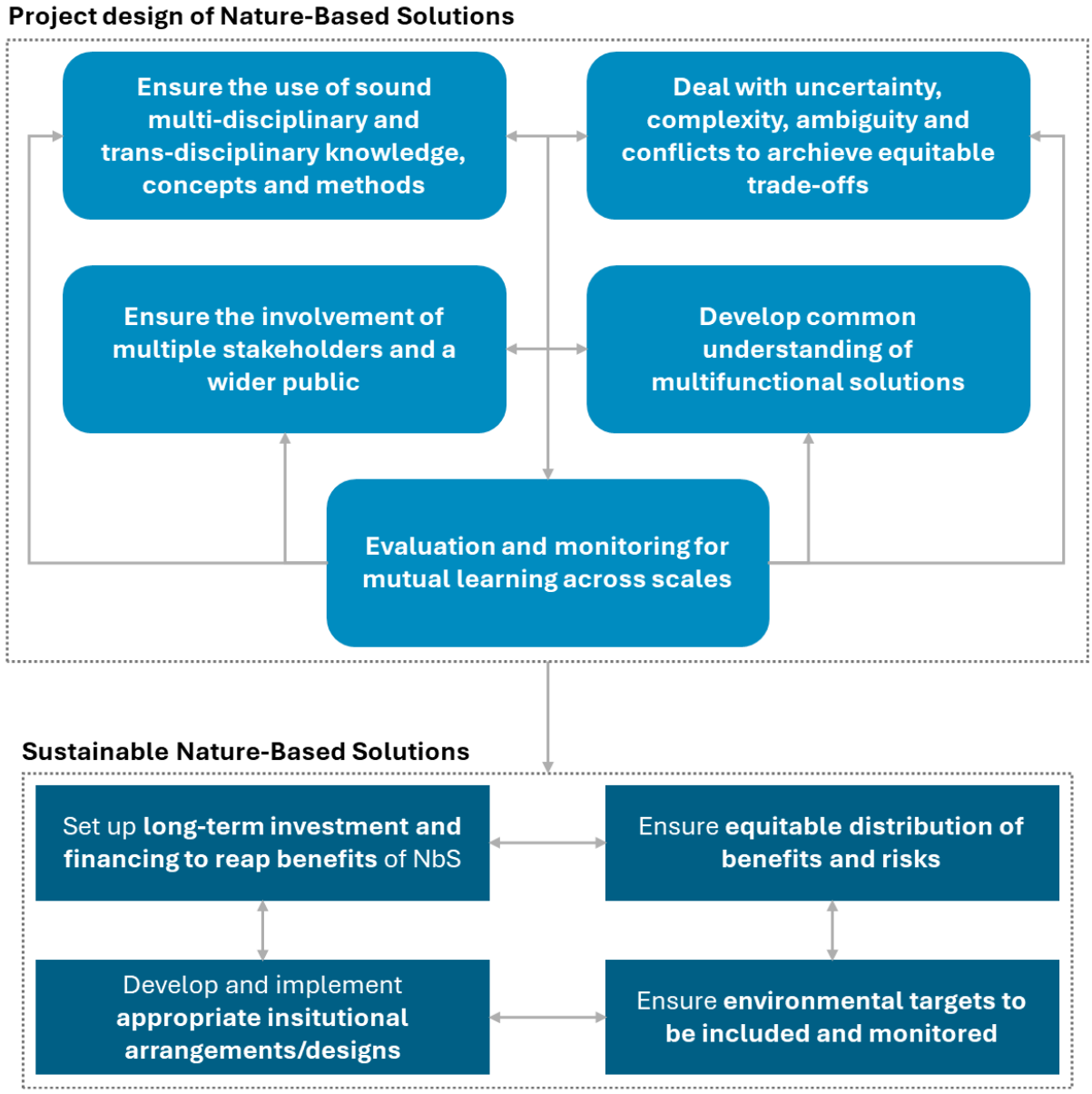
- NbS offer significant potential for addressing environmental and socio-economic challenges in the Alpine region. To realise this potential, they need to be strategically integrated into policy, across different sectors and in the relevant plans and programmes at local, regional, national and pan-alpine level.
- Active collaboration between stakeholders will be essential to ensure transparent and inclusive planning processes and achieve consent on the compensation mechanisms. Stakeholder education and training will also be required.
- Finally, an Alpine-wide strategy or action plan is useful to effectively coordinate efforts across sectors and regions, promote cooperation, and establish NbS as key instruments for sustainable development in the Alpine region.

6.2 Practical implementation

Several measures and aspects are helpful for mainstreaming and fostering the practical implementation of NbS in the Alpine area. Mainstreaming means that NbS have to be integrated into the existing mix of policies and measures such as nature conservation, spatial planning, environmental assessments, landscape planning or economic instruments. This integration process will have to consider a wider number of stakeholders and their traditional problem-solving approaches. It will be necessary to evolve the institutional framework to tackle NbS.

For the design and implementation of NbS, Nesshöver et al. (2017) have identified five key elements to be considered, as presented in Figure 17.

Figure 17: Key elements to be considered for NbS implementation



Source: Nesshöver et al. 2017.

6.2.1 Planning processes and procedures

What is needed for planning NbS in concrete implementation projects? Five key guiding principles, three key criteria (see Chapter 6.3.2) and six steps have been proposed by Albert et al. (2021). Together, they form an adaptive planning cycle (Figure 18). The authors of these six steps point out that planning in real life will have to be iterative, with some steps possibly not used and on-the-ground implementation possibly varying. The steps suggested are as follows:

- Co-define setting: This includes clarifying context, expectations and limitations, stakeholder influence and involvement, funding of the planning process, available informal and formal planning instruments; some detailed steps within this step are suggested in Chapter 4.4.
- Understand challenges: This step is dedicated to a multi-dimensional assessment of societal, legislative, institutional and ecological dimensions.
- Create visions and scenarios: This step identifies spatial options for NbS in the landscape, jointly develops objectives for the future and describes future status of areas and landscape.
- Assess potential impacts: This step evaluate potential costs and benefits in social, ecological and economic terms.
- Develop solution strategies: This step designs feasible governance and business models for NbS implementation, considering place-specific requirements and potential barriers.
- Realise and monitor: This includes the implementation of first NbS actions and the set-up of a monitoring concept. It is recommended to start with easy implementable, funded NbS actions.

Figure 18: Framework of principles, steps and criteria for NbS planning

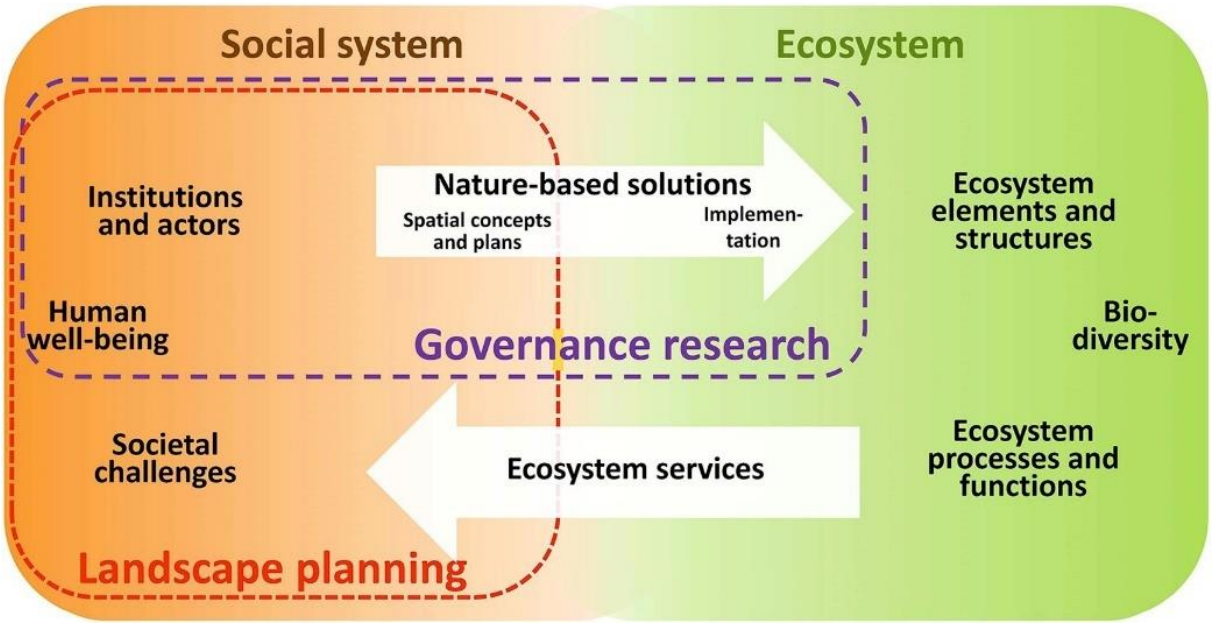
Source: Albert et al. 2019.

6.2.2 Spatial development and landscape planning

Sustainable spatial development involves intertwining overarching, large-scale considerations from a top-down perspective with local, site-specific designs and developments as bottom-up approaches. Both will require constant iterative reflections and revisions while at the same time being an effective planning process.

For considering NbS spatial requirements, relevant instruments are landscape and urban planning, backed by adapted governance mechanisms for the appropriate identification, design and implementation of NbS as outlined by Albert et al. (2019), see Figure 19.

Figure 19: Interlinkages between governance and landscape and spatial planning



Source: Albert et al. 2014; Albert et al. 2019.

National and regional level – top-down approach

Delineating relevant and sufficient areas for NbS at a strategic Alpine-wide level and integrating these areas into existing regional and national spatial planning instruments could support their implementation (top-down approach). In addition, areas suitable for implementing NbS and specific NbS themselves can be included in existing or envisaged biodiversity strategies. Such an approach may, inter alia, effectively support the practical implementation of the recently adopted EU Nature Restoration Law (EU 2024) and the EU Biodiversity Strategy for 2030 (EC 2020).

Local level – bottom-up approach

Besides the strategic level, the local level is crucial for any bottom-up approach. NbS should address challenges identified at local level and also perceived as such by local stakeholders. Such an approach should take precedence over declaring pre-planned projects as an NbS. At local level, in particular, benefits can be demonstrated via small-scale, low-cost and direct-effect projects (quick wins).

Multi-level planning

Implementation via a top-down (strategic level) and bottom-up (local level) approach means that NbS should be planned at the local, regional, national and alpine-wide level and that the

different levels be integrated. Large-scale strategies at national or Alpine-wide level may be implemented through projects for large geographic areas. These are then supplemented by small, site-specific projects proposed and implemented at regional to local level, possibly with support from staff from experienced public or private institutions.

Land use, landscape and sectoral planning

Basically, NbS implementation involves the re-adjustment of land use and a corresponding planning procedure. Dependent on the challenge, site-specific planning techniques and knowledge may be used, such as hydraulic planning, road and railway planning, forestry plans or urban planning and architecture.

Landscape design, landscape planning and stakeholder involvement with good governance are considered as relevant for NbS implementation (Albert et al. 2019). Landscape planning has traditionally been designed to carry out an assessment of landscape and environmental issues, and to develop and plan solutions on ways of dealing with an area's natural assets. Therefore, landscape planning tools and experiences might be of use for NbS planning (Albert et al. 2019).

6.2.3 Supporting bodies and institutional support

Many institutions are responsible for actually implementing NbS projects (such as municipalities, planning offices, private investors, NGOs, etc.). However, these institutions often lack sufficient personnel and financial resources or may even lack an overview of suitable NbS measures. In general, better knowledge and understanding are needed about how different policy instruments (e.g. strategies, programmes, planning instruments) support or hinder NbS implementation.

Therefore, the realisation of NbS through entrepreneurs in the Alpine region may be supported by public or private institutions. The following aspects should be considered:

- Specialised institutions: Ensuring that already existing or new institutions at regional, national and transnational levels are able to support cross-sectoral and interdisciplinary approaches. Such specialised institutions should assist in planning and implementation processes, particularly for small communities or organisations with limited personnel and financial resources. Landscape management associations (*Landschaftspflegeverbände*) in Germany serve as an example for such specialised institutions. They offer knowledge support in maintaining cultural landscapes, offer machinery for landscape management, and carry out services on their own. To support those municipalities without sufficient resources, specialist departments can also be established at regional government level to assist with NbS planning and implementation.
- Networking opportunities: Facilitate networking among practitioners, scientists and administrators to enhance collaboration.
- Governance support: Provide support, such as consultancy, moderation, external mediators or assistance, to realise potentially complex communication and participation formats and to develop new forms of governance.

6.2.4 Tools

Easy-to-use practical application tools can facilitate NbS implementation regardless of the spatial level. Some helpful tools and some processes are listed below.

Assessment, mapping and data

Every kind of implementation needs to be based on transparent, site-specific information about the physical dimensions in a NbS project – the basis for any cost-benefit analysis. Geographical extent and differentiation are relevant for developing a site-specific solution as well for stakeholder communication.

Transparent information indicators and data relevant for the challenges, objectives and solutions of the project have to be defined at the start of a project. They are the basis for a clear assessment of the NbS and its alternatives, provide common ground for stakeholder involvement and the joint development of solutions.

Mapping environmental assets, biodiversity components such as habitats and species, ecosystem service supply and demand, and the spatial extent of NbS will help recognise effects for stakeholders and the area. Mapping may also help recognise large-scale interlinkages and needs. One example is the Strategic Alpine Connectivity Areas concept for ecological connectivity in the Alps (Plassmann et al. 2016) which can guide where NbS should be implemented in the geographical context to support ecological connectivity.

Monitoring

Monitoring NbS implementation is relevant to provide proof of project outcomes. As NbS often need a certain time to achieve their full effect, it is interesting and relevant to monitor the relationship between investment in the solution and the delivery of benefits.

For a substantial and validated monitoring, clear performance indicators referring to the objectives of the solution need to be defined early in the project. This allows the situation before the NbS is implemented to be documented and for it to be compared with the status after implementation.

Furthermore, to assess NbS as a solution type, monitoring results have to be evaluated according to various criteria and offer the opportunity for further learning, development and adaptive governance (Albert et al. 2021).

Planning processes

NbS are spatially relevant and therefore their implementation needs to be planned. This planning process involves decision-making and support, while allowing NbS to be transferred to different thematic and spatial contexts. Steps for NbS planning processes are suggested in Chapter 6.2.1.

Assessment of Nature-based solutions feasibility and effects

How can the suitability of an NbS be systematically checked vis-à-vis a conventional solution? A new and effective instrument at project and programme level would be an assessment of the feasibility of the NbS.

- Such an assessment could be carried out first on a qualitative and voluntary basis to remind decision-makers of NbS options.

- In a second and mandatory step, an NbS feasibility check could be designated as a pre-condition for financing the project, with results to be cross-checked in the concrete project implementation.
- In a third step, based on existing tools, procedures and processes, a standardised NbS assessment template for the Alpine area could be developed to assess the effects of NbS in terms of the ecological, social and economic effects. Such a standardised assessment would also enable a quality evaluation – even without its legally binding application.

The development of a tool for the assessment of NbS is also suggested by the WG on natural hazards (PLANALP 2022). Such an assessment might also serve in the long term as a way of benchmarking NbS against conventional solutions.

Nature-based Solutions glossary

A comprehensive and easy-to-use glossary of NbS terms, explaining various related concepts, such as the ecosystem services concept or green and blue infrastructure, will help to better and faster understand the concept of NbS. Such a glossary may be offered on an NbS platform as suggested below.

Good practice collection

Good practices are often the best way to explain innovative approaches to stakeholders in a non-scientific way. Therefore, the systematic collection and dissemination of good practice Alpine NbS examples would be a supportive tool. Such a good practice database could systematically offer information structured by geographical areas, sectors, languages or administrative levels. A first draft of how such a "good practice documentation" could be structured is to be found in the project factsheet in Appendix A.2 of this report.

Nature-based Solutions exchange platform

One of the greatest challenges in today's world is information overload and, closely related to this, the selection of information sources.

The centralised provision of as much relevant information on NbS in the Alpine region as possible may therefore be a decisive lever to address and connect relevant stakeholders as well as to prevent parallel (and thus redundant) developments and efforts with the same objective.

Although there are already various platforms covering different NbS aspects available (see Chapter 5.2), there is no centralised platform. Such a platform could provide a very comprehensive overview in one place, linking existing platforms and networks and briefly indicating for which use they are suitable. The NBS Edu World is starting to realise this centralisation but is still not sufficiently comprehensive.

The authors of this paper hence suggest the development of an open-access interactive platform for the Alpine region, aggregating all relevant information on NbS and facilitating all the aspects mentioned in the previous sections. This platform would include, for example, definitions and standards, legal guidance, governance guidelines, case studies and educational material. The platform might include a Web-GIS service showing implemented NbS locations and providing a feature that allows citizens to propose potential NbS sites.

Summary of practical NbS implementation

- The practical implementation of NbS in the Alpine region requires their integration into existing policies and measures such as nature conservation, environmental, landscape and spatial planning. Different stakeholders and their traditional methods need to be taken into account.
- Five key elements are crucial: dealing with uncertainty, involving multiple stakeholders, using multi- and transdisciplinary knowledge, developing a common understanding, and evaluating mutual learning.
- The planning of NbS requires an adaptive planning cycle, the definition of the project scope and the consideration of social, legal, institutional and ecological dimensions and challenges, as well as the development of visions and scenarios.
- NbS implementation should take place at local, regional, national and Alpine-wide levels, integrating both top-down and bottom-up approaches.
- NbS projects can be fostered by specialised institutions able to support those NbS projects lacking in human resources, skills, and support (consultancy, facilitation, communication) from governmental bodies.
- Successful NbS implementation depends on tools supporting transparency, stakeholder engagement and evidence-based decision-making. Data management and analysis, mapping, monitoring and assessments are key to ensuring that NbS are effectively integrated into planning processes and comparable with conventional alternatives.
- The stepwise introduction of a feasibility check for NbS and their effects could boost NbS implementation, especially when ultimately made mandatory.
- Knowledge sharing through collections of best practices, glossaries and central platforms can improve understanding and collaboration while reducing redundant efforts. To maximise impact, the development of standardised tools and a freely accessible, interactive platform is recommended, allowing stakeholders across the Alpine region to access information related to NbS (e.g. definitions, legal notices, educational material, etc.), view implemented NbS projects and suggest new sites for potential NbS implementation.

6.3 NbS standards and evaluation

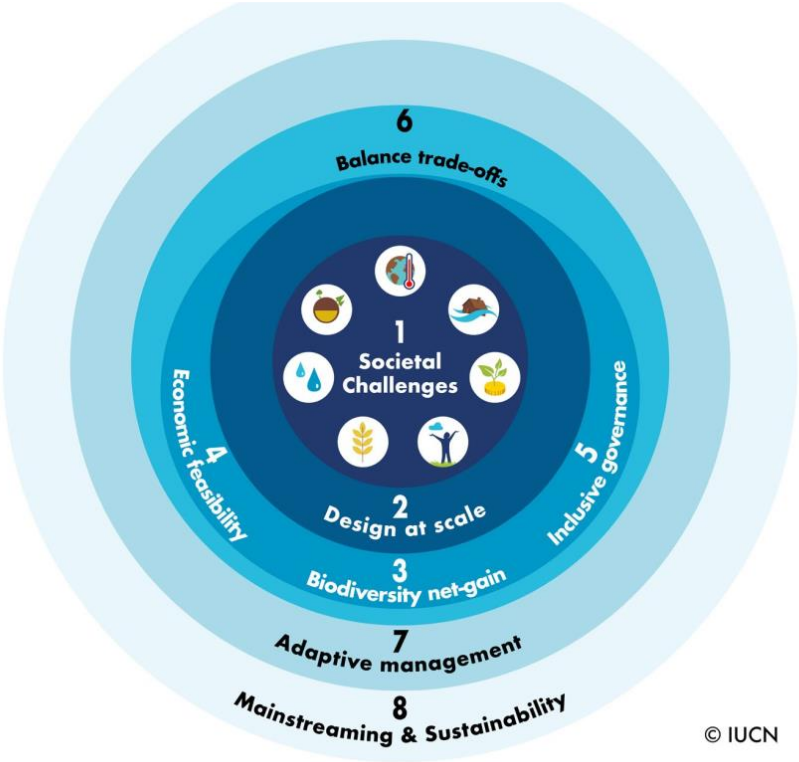
In the long run, a standardisation of NbS and evaluations of their effects will be needed to demonstrate and proof NbS effects to support further implementation. Standardisation means that NbS will consider comparable project components such as benefits for biodiversity and human well-being, or certainty for the maintenance of the measures. Evaluations will provide evidence on effects achieved.

6.3.1 IUCN Standard for Nature-based Solutions

In 2020, the IUCN published its global standard for NbS (IUCN 2020b), based on the eight NbS principles (Chapter 2.2, Table 2) adopted in IUCN Resolution 6.069 in 2016 (IUCN 2016). The standard defines eight criteria (Figure 20) and 28 indicators, giving users a framework for verifying NbS (see also Chapter 2.2).

The intention of the IUCN standard is to offer a simple tool making the NbS concept accessible for implementation actions, for reinforcing best practices, and addressing and correcting shortcomings (IUCN 2020b).

Figure 20: Eight criteria of the IUCN standard



Source: IUCN (2020b).

The IUCN standard starts out from the societal challenges to be dealt with and develops other criteria around this starting point. IUCN has published guidelines on how to apply the criteria and indicators (IUCN 2020a). These can be used for an NbS self-assessment. The IUCN has since drafted a certification process in collaboration with the International Social and Environmental Accreditation and Labelling Alliance, the Forest Stewardship Council, the Gold Standard, the Initiative for Responsible Mining Assurance, FairTrade International, and the Global Sustainable Tourism Council. This process allows NbS to be internationally certified.

Furthermore, on its *Contributions for Nature Platform* (IUCN 2025a) IUCN offers its members the opportunity to showcase projects contributing to biodiversity and climate mitigation. The platform offers a global, spatially explicit summary on potential conservation and restoration benefits saving biodiversity and reducing climate change. Project contributions reducing the extinction risk of species are assessed via the *Species Threat Abatement and Restoration metric*[6] (STAR) (IUCN 2025b). As yet, the platform lists just few contributions for the Alpine area.

Another IUCN tool, the *Restoration Barometer* (IUCN 2025c), is designed to track ecosystem restoration progress by measuring eight indicators relevant for restoration effects, including area size, biodiversity and socio-economic benefits. Project data is used to feed the indicators and provide a comprehensive view of restoration progress and outputs. The restoration barometer is currently only accessible for governments, though access for the private sector is planned. Development of the restoration barometer is supported *inter alia* by the German Federal Ministry for the Environment.

Covering conditions in a very general way, the IUCN standard is designed for global application. When applying it to the Alpine area, some indicators appeared difficult to apply or at least would need translation to reflect Alpine conditions.

6.3.2 Criteria and principles for planning Nature-based Solutions

Based on the IUCN definition, planning criteria and principles for NbS implementation have been defined by (Albert et al. 2021). Considered obligatory, the criteria define NbS as a focus in the planning process:

- **Challenge orientation**: refers to a clearly defined societal challenge (which should go beyond general terms) to give a clear indication of the problem to be solved.
- **Ecosystem process utilisation**: means that NbS are based on ecological interaction with habitats and species and that ecosystem processes and resources are at least maintained and not affected negatively by the NbS.
- **Practical viability**: expresses that NbS have to be nested in governance and business models for their implementation.

Successful NbS planning then follows five key guiding principles (Albert et al. 2021):

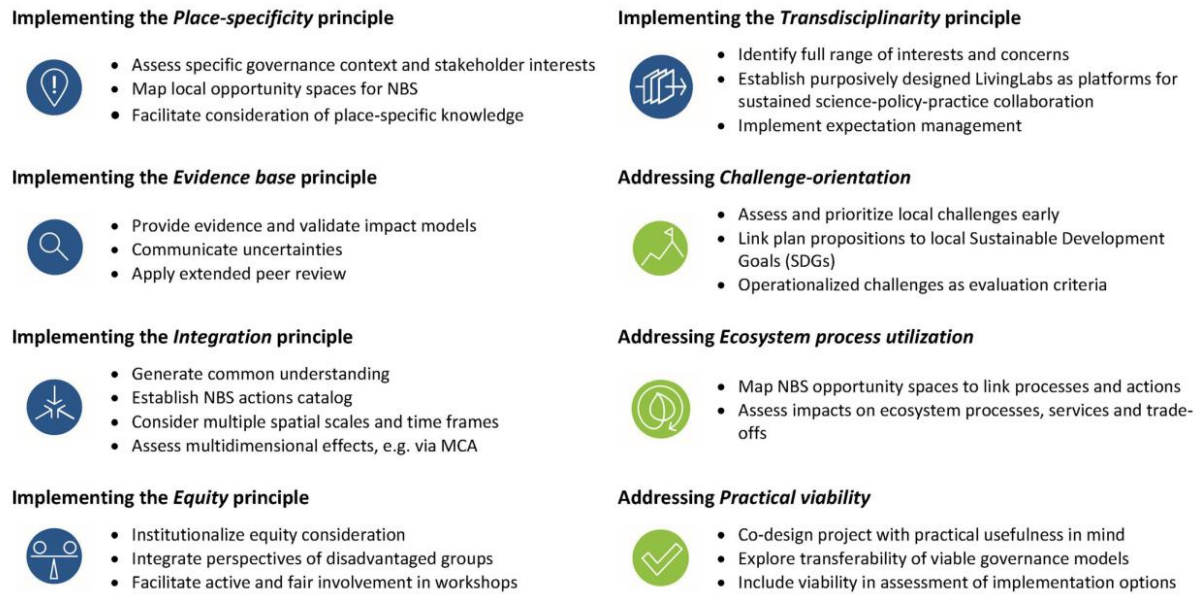
- **Place-specificity**: requires means a clear adaptation of general solutions to local conditions.
- **Evidence base:** should be sought as far as possible. However, empirical evidence of multi-dimensional effects, benefits and co-benefits is rare and may be supplemented with expert judgements.
- **Integration:** comprises the integration of different thematical approaches as well as of different sectors and temporal and spatial scales.
- **Equity**: is a principle equally considering the rights, values and interests of actors, allowing their inclusive and fair participation.
- **Transdisciplinarity:** includes cooperation between different scientific disciplines and practitioners to merge knowledge from various stakeholders in a cooperative planning

[6] The STAR methodology assesses the potential contribution to reducing the extinction risk of endangered species, considering this risk in terms of threat abatement and habitat restoration (IUCN 2025b).

process. This kind of process is interwoven with the terms “co-design”, “co-production” and “co-creation”.

The criteria and principles used for NbS planning can also be used for checking NbS implementation quality (Figure 21), while the feasibility checklist suggested in Chapter 4.4 adds further details to the beginning of the quality check.

Figure 21: Checklist for the planning of NbS



Source: Albert et al. (2019).

6.3.3 Sectoral standards

For many sectors standardised approaches for implementing measures already exist. These might be considered for or adapted to NbS. Such standards are defined at national or regional, in some cases even at local level.

Examples for such standards are (technical) guidelines for river restoration measures, land readjustment, green roofs or facades, or land management. Also, legal definitions for spatial and urban development and land use can play a role in defining and safeguarding NbS. One concrete example is the Set of Rules by the German Association for Water, Wastewater and Waste (DWA 2025). The screening, documentation and need for adaption of such sectoral standards is beyond the scope of this report. Suitable existing standards for a standardised approach could be made available via an open access platform as suggested in Chapter 6.2.4.

6.3.4 Limiting factors for Nature-based Solutions

- Uncertainty: due to the dynamic, self-organising nature and limited predictability of ecosystems, uncertainty will always remain when implementing NbS (Cohen-Shacham et al. 2019). This holds true both for the values and benefits generated by NbS for stakeholders and for how these benefits are perceived (Raymond et al. 2017). However, uncertainty is part and parcel of many technical solutions and economic forecasts.
- The temporal scale of NbS is considered as a relevant issue. It requires long-term objectives and long-term maintenance to be established in NbS projects, with the aim of avoiding any

NbS failure or too early termination possibly leading to a dysfunctionality of ecosystem functions (Cohen-Shacham et al. 2019).

- There is some questioning by (Albert et al. 2021) whether co-benefit generation and cost-effectiveness are really common characteristics to be fulfilled by NbS or whether they instead limit NbS application as an accepted alternative.

Summary of NbS standards and evaluation

- A standardisation of NbS and the assessment of their impact are essential to demonstrate their effectiveness. IUCN has developed a global standard that provides a framework for assessing and certifying NbS, although adaptations may be necessary for specific contexts such as the Alpine region.
- Effective NbS planning should address societal challenges, harness ecosystem processes and ensure practical viability through governance and business models. Principles for NbS planning such as place specificity, evidence-based approaches, integration, equity and transdisciplinarity are essential for successfully implementing NbS.
- In addition, existing sectoral standards, such as river restoration or land management guidelines, can be used for NbS

6.4 Selected legal instruments

Legal instruments play a crucial role in establishing NbS in the Alpine region. Both the modification or supplementation of existing regulations and the application of current legal norms targeting NbS can contribute to an increase of respective measures. At the same time, NbS can be utilised to fulfil legal objectives and obligations. Well-designed legal instruments provide binding frameworks for achieving desired goals while allowing sufficient flexibility to account for individual circumstances. The following sections illustrate how policymakers and administrative bodies in Alpine countries and under the Alpine Convention can strategically design or employ legal instruments to promote NbS, using selected key legal areas as examples. This report does not aim to provide an exhaustive analysis of legal details; rather, it serves as encouragement to take a closer look at the aspects mentioned and the associated references.

6.4.1 Spatial planning instruments

Spatial planning instruments serve as a key starting point for the large-scale implementation of NbS. By their very nature, NbS integrate various existing planning principles addressing conservation, social and economic challenges, thereby acting as tools for environmental mainstreaming in policy and practice. The primary legal spatial planning instrument of the Alpine Convention is the 1994 *Spatial Planning and Sustainable Development Protocol* (AC 1994). Signed by all contracting parties and ratified by all but Switzerland and the EU, it is legally binding for most Alpine states and offers numerous connections to NbS. These include:

- Goals such as harmonising land use with ecological objectives (Art. 1 b), c), h)), ensuring resource-efficient and environmentally sustainable land use, and considering natural constraints, public interest services, resource use limitations, and pricing that reflects true value;
- Integration of environmental protection criteria into spatial planning policies (Art. 3);
- Consideration of spatial planning goals in other policies (Art. 5) and
- Coordination of sectoral policies (Art. 6).

As repeatedly emphasised, successful NbS projects require interdisciplinary and cross-sectoral collaboration. Promoting NbS through targeted spatial planning measures directly supports these provisions. Furthermore, NbS generally align with the subsidiarity principle (Art. 2), which advocates decision-making at the lowest effective level, typically at the local level with participation from various stakeholders within local or municipal communities. This approach upholds the principles of proximity to citizens and local responsibility inherent in subsidiarity. However, despite its significant legal binding force in Alpine states, the Protocol has a notable shortcoming regarding NbS promotion: it lacks specific planning guidelines or enforcement mechanisms. These responsibilities are left to individual states within their national spatial planning laws. In all Alpine states, municipalities are responsible for local land-use planning, though broader spatial planning competences vary widely, as illustrated in Table 5.

Table 5: Spatial planning competences (administrative levels) in the Alpine states

Relevant legal spatial planning competence (administrative levels)	AT	CH	DE	FR	IT	LI	SI
National Level		X	(X)	(X)	(X)	X	X
Federal State / Kanton	X	X	X				
Region / Province	X		X	X	X		(X)
Agglomeration / Metropolitan area		(X)		X	X		
Municipality (association)	X	X	x	X	X	X	X

X: Direct / strong spatial planning competence (X): Indirect / limited spatial planning competence.
Source: Adapted from Meyer et al. (2022).

Across all levels of spatial planning, from supranational to municipal, examples exist of effective instruments highlighting NbS and targeting their widespread implementation. These examples should be subject to deeper exchange of experiences and knowledge-sharing. Recommendations developed within this project are directly in line with findings from initiatives such as *OpenSpace* and *CLISP – Climate Change Adaptation through Spatial Planning in Alpine Space*:

According to the results of the *OpenSpace* Programme, three aspects are essential to institutionalise standards for cross-border cooperation in spatial planning in the Alpine region (Meyer et al. 2022):

- Exchange of planning documents.
- Participation in planning procedures in border regions.
- International cooperation framework for spatial planning.

The Alpine Convention provides a significant advantage by offering an established platform for regular cross-border exchanges between countries and administrative levels. Institutional frameworks like the *AlpPlan Network* explicitly foster collaboration between academia and practice to achieve the Alpine Convention's goals.

The following examples may inspire a stronger integration of NbS into spatial planning. They represent different types of spatial planning instruments – voluntary and legally binding –, providing ideas for further discussion on suitable frameworks to promote NbS in the Alpine area:

- **Voluntary frameworks**: the EU Urban Agenda (Urban Agenda for the EU 2025) and Austria's Spatial Development Concept 2030 (ÖROK 2025);
- **Legally binding instruments**: Bavaria's State Development Programme (StMWi 2023) and France's Territorial Coherence Scheme and Local Town Planning Scheme;
- **Proposals for enhancing binding instruments**: Additions to the Bavarian Alpine Plan as defined by Meyer & Job (2024) or the Spatial Climate Plan for Lienz, Austria (Janesch 2024).

Voluntary frameworks

EU Urban Agenda

The EU Urban Agenda (Urban Agenda for the EU 2016, 2025) is a voluntary framework promoting sustainable urban development by fostering partnerships between EU institutions, national governments, local authorities, stakeholders and NGOs. Its scope focuses on 'better regulation, better funding, and better knowledge' (Naumann et al. 2020). The Urban Agenda explicitly mentions NbS within the *Sustainable Land Use and Nature-based Solutions* partnership which has defined nine specific actions on this topic.

Austrian Spatial Development Concept 2030

At a national level, the *Österreichisches Raumentwicklungskonzept 2030* (Austrian Spatial Development Concept, ÖREK 2030) (ÖROK 2025) is a modern spatial planning instrument emphasising 'Space for Change' as its guiding principle. It aims for equitable, climate-compatible, sustainable development aligned with public welfare goals — implicitly promoting NbS as they align with its principles and action programme. Although it does not have legal binding force, the ÖREK 2030 was jointly developed and adopted within the framework of the Austrian Spatial Planning Conference by the federal government, the Austrian federal states and municipalities, as well as economic and social partners. Its content is intended to be taken into consideration by federal states and municipalities, with the 10-point action programme providing a solid foundation for concrete implementation.

Legally binding frameworks

Bavarian State Development Programme

The *Landesentwicklungsprogramm Bayern* (Bavarian State Development Program, LEP) (StMWi 2023) is the central, legally binding spatial planning instrument influencing the German Alpine region. As a cross-sectoral future-oriented concept, it establishes state-wide objectives and principles for spatial development in Bavaria. All public authorities are required to observe its goals, and municipalities must adapt their land-use planning accordingly. The principles outlined in the LEP must also be considered in spatially significant plans and measures. First adopted in 1976, the LEP is regularly updated, with the most recent revision in 2023.

Sustainability is an overarching criterion for balancing various interests and land-use demands. The latest LEP version places particular emphasis on achieving climate goals and addressing ecological concerns. For instance, in cases of conflict between land-use demands, ecological considerations are now prioritised if there is a risk of significant and long-term harm to natural resources. In addition, spatially significant plans are required to target climate neutrality, preserve or restore the climate functions of natural resources, and keep green and water areas in urban spaces free from sealing.

New spatial planning tools introduced include priority areas reserved for climate protection (e.g., areas serving as natural carbon sinks) and climate change adaptation (e.g., areas for generating and transporting fresh and cold air). In the field of water management, specific provisions aim to reduce flood risks through measures such as landscape preservation and retention areas — both examples of NbS.

These provisions implicitly provide a framework for implementing NbS, as they not only focus on ecological design and climate change mitigation or adaptation but also consider the social and economic dimensions of sustainability. However, they still need specific criteria and procedures for their implementation.

Local Town Planning Scheme

The *Plan Local d'Urbanisme* (Local Urban Planning Scheme, PLU) is a key urban planning instrument in France, developed at local level by individual municipalities or intercommunal associations. It regulates land use and permissible construction projects within a municipality. Legally binding, it must align with the overarching *Schéma de Cohérence Territoriale* (Territorial Coherence Scheme).

The PLU offers various opportunities to promote NbS, particularly through urban green-blue infrastructure. It can set strategic guidelines for developing and integrating green-blue infrastructure into urban planning. In addition, it allows for the designation of zones for preserving or restoring ecological areas and allocating spaces for creating or adapting green spaces and ecological corridors. Finally, the PLU includes provisions to limit soil sealing and promote areas that contribute to ecological connectivity.

Proposals for enhancing binding instruments

Bavarian Alpine Plan with additions by Meyer & Job (2024)

Adopted in 1972, the Bavarian Alpine Plan (*Bayerischer Alpenplan*) is widely regarded as an exemplary spatial planning instrument for protecting the Bavarian Alps. Integrated into Bavaria's LEP (StMWi 2023), it is legally binding. The plan divides the Bavarian Alpine perimeter into three zones: a development zone covering 35% of the area (Zone A where development projects are generally permitted), a buffer zone covering 22% (Zone B where development projects are allowed only after thorough review), and a quiet zone covering 43% (Zone C where only landscape-related, non-motorised recreational activities are permitted).

This zoning has had tangible impacts on specific projects; for example, 19 proposed ski tourism projects were not realised due to conflicts with Alpine Plan regulations. While the Alpine Plan is already an effective and forward-looking tool, it holds significant potential for further promoting NbS and providing positive planning impulses.

Meyer & Job (2024) highlighted this potential by analysing six criteria related to climate risks within the Alpine Plan perimeter: soil-based water retention potential, extreme flood risk, protective forests against soil erosion and avalanches, avalanche risk, landslide susceptibility, and climate compensation areas. Their analysis identifies areas in the Bavarian Alps with high exposure to climate risks but also high potential for multifunctional green infrastructure. They propose integrating these areas into Zone C (the quiet zone) of the Alpine Plan and fostering NbS implementation, particularly green infrastructure, to enhance regional climate resilience.

Key features of both the existing Alpine Plan and the proposed additions (Meyer & Job 2024) include clear land-use regulations while maintaining sufficient flexibility to respect municipal planning autonomy as well as clearly delineated zones.

Climate Spatial Plan Lienz (Austria)

One example of a proposed spatial planning instrument at municipal level is the draft Climate Spatial Plan (*Klimaraumplan*) for Lienz (Janesch 2024). Based on an analysis of how the Alpine region is particularly affected by climate change, a review of selected climate plans and tools regarding their sensitivity to climate issues and contribution to transformative planning, as well as a characterisation of Lienz's local conditions, the author envisions a climate-friendly future for Lienz. This vision includes 60 specific urban planning measures with precise spatial allocations.

This vision stands out as both innovative and forward-looking: not only does it provide spatially precise measures, but it also adopts an integrated, cross-sectoral approach to developing spatial

structures that enable climate-friendly behaviour. Moreover, it outlines a bold vision for transforming Lienz into a climate-friendly city.

These examples demonstrate how diverse approaches, ranging from legally binding frameworks to voluntary initiatives, can contribute to integrating NbS into spatial planning practices effectively.

6.4.2 Public procurement law

Considering the number and economic value of projects being realised under the responsibility of public authorities, public procurement law is one of the most powerful tools for actively promoting NbS.

As outlined below, the existing legal framework can primarily be leveraged, supported by administrative guidelines, regulations, and advisory institutions. In addition, adjustments to legal provisions may be considered; not solely targeting NbS but fostering sustainable procurement in general, encompassing ecological, economic, social and temporal dimensions.

Procurement officials face several obstacles that hinder the effective integration of NbS into procurement processes, including the following key challenges:

- **Complexity of public procurement processes per se**: Public tenders are always case-specific, and there are no standard templates for many procurement measures. This in turn necessitates an in-depth engagement with the subject matter, including technical details. At the same time, legal nuances may be relevant to ensure that the procurement process is legally compliant. In particular, the principles of transparency and equal treatment must always be upheld. Consequently, both technical and legal expertise are required. For individual administrative staff, especially in small municipalities that are financially and personnel-wise under-resourced, it is extremely challenging to meet all these requirements while also acquiring detailed expertise on sustainable procurement.
- **Knowledge and expertise gaps**: Many procurement officials have limited familiarity with NbS typologies and methods, impeding the specification of requirements and the evaluation of their value and impact. They often lack the “common language” and technical expertise facilitating communication with suppliers and evaluating relevant ecosystem services.
- **Risk aversion**: In view of the fact that procurement officials manage taxpayers’ money, they tend to avoid risks in their economic decisions. Due to the long-term implementation needed for NbS and the sometimes challenging task of assessing their effects, a certain reluctance towards their targeted procurement exists. Hence, traditional paradigms favour conventional engineering solutions.

Nonetheless, procurement regulations, particularly at the EU level and thus applicable to all procurement measures exceeding EU thresholds, offer numerous opportunities for the preferential procurement of sustainable products or services and for the specific implementation of NbS. Sustainability criteria or NbS-specific considerations can be integrated into procurement processes through various mechanisms as long as they relate directly to performance requirements of the procured product or service and ensure transparency:

- **Product specifications**: Specifications can include functional requirements (e.g., energy consumption, natural infiltration of water) and may also relate to production processes and supply chains. These encourage innovative solutions rather than standard practices.

- **Environmental management systems**: Suppliers may be required to demonstrate an environmental management system if justified by contract execution.
- **Award criteria**: Offers that incorporate ecological aspects can receive additional points in the evaluation process. While not mandatory, this incentivises sustainable solutions. For cost assessments – often the ultimately decisive criterion –, lifecycle costs should be considered. This is already partially mandatory, for example, in § 67(3) of the German Procurement Regulation. A lifecycle cost analysis ensures alignment with principles of economic efficiency by focusing on long-term cost-effectiveness rather than upfront costs. Externalised costs (e.g., environmental impacts) can also be factored in.
- **Execution requirements**: Contracts may stipulate the use of NbS or environmentally sensitive practices in general, such as treating runoff through soil filters.
- **Challenge-based approaches**: Challenge-based approaches are designed to foster innovative solutions by allowing public authorities to specify desired outcomes rather than detailed solutions, inviting suppliers to propose creative solutions like the realisation of NbS. Considering the objectives and results of the suppliers' submissions, the product specifications and award criteria can be defined accordingly.

To unlock the potential of these procurement law opportunities and promote the increased inclusion of sustainability criteria in general and NbS in particular within public procurement processes, the following aspects should be considered:

- **Capacity building and specialised support**: There should be increased (and mandatory) training opportunities for both administrative staff in procurement offices and bidders to facilitate the integration of sustainability criteria into public procurement. Furthermore, specialised agencies offering free assistance and advice should be expanded, particularly for public contracting authorities with limited administrative capacity. These authorities should have the option to have their tenders easily reviewed to ensure the adequate, effective, and legally compliant inclusion of sustainability criteria. Table 6 contains a list of examples in this regard.
- **Collaboration**: Cross-sectoral cooperation and multidisciplinary teams for procurement planning should be encouraged. In this context, exchange between persons with expertise in the technical implementation of sustainable (or nature-based) solutions and those with legal knowledge should be promoted. Compiling best practice examples of successful tenders with applied sustainability criteria or procured NbS and exchanging corresponding product specifications or award criteria could also help reduce reluctance towards innovative procurement instruments. Apart from that, joint procurement initiatives or framework agreements could facilitate access to NbS solutions by pooling resources across municipalities.
- **Mandatory consideration of lifecycle costs**: For cost evaluations, mandatory lifecycle cost assessments might support sustainable procurement. They could clarify and facilitate the demonstration of possibly significant long-term monetary benefits of NbS or sustainable products and services in general over traditional engineering solutions.
- **Developing key performance indicators**: Specific indicators to be applied in tender evaluations could help measure the environmental, social and economic success of NbS projects, making their holistic value more tangible for practitioners.

- **Establishing role models**: The administrative bodies of the Alpine Convention could elaborate specific recommendations for public authorities in the Alpine area on how to procure NbS effectively and present successful examples with a view to establishing role models.

Table 6: Examples of institutions fostering sustainable procurement processes

Name	Offer
Network *Auftragsberatungsstellen Deutschland* (Procurement Advisory Offices Network Germany), a self-governing institution of the German economy https://auftragsberatungsstellen.de Including i.a. ***Auftragsberatungszentrum Bayern*** (Procurement Advisory Centre Bavaria) www.abz-bayern.de	▶ Free consulting on public procurement processes ▶ Training courses for public authorities and bidders
Enterprise Europe Network (EEN) https://een-deutschland.de	▶ Support for companies aiming to participate as bidders in sustainability-oriented tenders
KOINNO – Competence Centre for Innovative Public Procurement, hosted by the German Federal Ministry for Economic Affairs and Climate Action https://www.koinno-bmwk.de/en/koinno/	▶ Free consulting on public procurement ▶ Comprehensive information on innovative procurement ▶ Tools (currently only available in German) ▶ Corresponding events and training offers (including E-Learning courses) ▶ Certification for public clients as innovative procurement institution
Platform *Umweltfreundliche Beschaffung* (Green public procurement platform), provided by the German Environment Agency www.beschaffung-info.de	▶ Detailed information on sustainability-oriented procurement processes ▶ Tender recommendations ▶ Tools for life cycle cost analyses ▶ Database with ecological award criteria ▶ Seminars ▶ Best practice examples

To enhance NbS implementation within public procurement frameworks, particularly in regions like the Alpine area, several measures are recommended. These include targeted training programmes, advisory services for smaller entities, fostering collaboration between technical and legal experts, and exploring legal reforms where appropriate. By addressing knowledge gaps and systemic barriers while leveraging existing frameworks effectively, public procurement can become a key element for advancing sustainable and innovative solutions, particularly NbS.

6.4.3 Environmental law

Key environmental legal requirements affecting the Alpine region are contained in the Alpine Convention and various EU legal acts. The Alpine Convention (AC 1991) prominently clarifies in Article 2 that the conservation and protection of the Alps, along with the prudent and sustainable use of resources, are the key goals of the contracting parties. Accordingly, they commit to taking appropriate measures in environmental law areas such as air quality, soil

conservation, water management, nature conservation and landscape management, mountain agriculture and mountain forests. Although neither these general objectives nor the related protocols and declarations of the Alpine Convention explicitly mention NbS, they implicitly call for such solutions. This is highlighted, for example, in a policy brief by the Natural Hazards Working Group (PLANALP 2022).

More specific requirements are found in certain legal acts of the EU which has made extensive use of its competence in environmental law, as witnessed by the many regulations, strategies and directives adopted in recent years. These have a significant impact on the Alpine region, although Monaco and Switzerland are not formally subject to them. A comprehensive presentation of the significance of EU law for establishing NbS exceeds the scope of this report; for this, reference is made to Naumann et al. (2020) and Corgo (2024, Appendix S4). (Naumann et al. 2020) stress that the EU Floods Directive promotes NbS by requiring natural water retention measures and that the Climate Adaptation Strategy and the Strategic Environmental Assessment Directive have a significant influence on local governance instruments and plans.

In addition, the EU Nature Restoration Law (EU 2024) should be mentioned explicitly. Coming into force in August 2024, it is a significant legislative milestone aimed at reversing biodiversity loss and promoting sustainable ecosystems across Europe. This law is part of the EU's Biodiversity Strategy for 2030 (EC 2020) and the European Green Deal's (EC 2019) environmental goals. It sets legally binding restoration targets to restore at least 20% of the EU's land and sea areas by 2030, with the aim of addressing all ecosystems requiring restoration by 2050.

While it has direct legal effects in EU member states, its successful implementation requires each country to develop detailed National Restoration Plans by September 2026. These plans must outline how member states intend to meet the law's targets, including specific measures for restoring degraded ecosystems. The flexibility allowed in these plans enables countries to tailor their strategies to local conditions while adhering to the binding requirements of the law. Here, NbS can play a crucial role in achieving the objectives set out by the Nature Restoration Law (EU 2024), *inter alia* with respect to the following aspects:

- **Restoration targets**: NbS are pivotal in restoring habitats such as forests, grasslands, rivers and wetlands. By implementing NbS, member states can effectively meet restoration targets to improve at least 30% of habitats currently in poor condition by 2030.
- **Ecosystem services**: NbS enhance ecosystem services such as water purification, flood protection and carbon sequestration. These services are vital for building resilience to climate change and securing food and water resources.
- **Socio-economic benefits**: Implementing NbS can also lead to socio-economic benefits by creating green jobs and promoting sustainable agricultural practices. Projects like *LIFE Lech* demonstrate how NbS can be applied to realise large-scale nature conservation objectives, while supporting local economies and providing natural hazard prevention.

Summary of selected legal instruments

- Legal instruments, notably from the fields of spatial planning law, public procurement law and environmental law, play an important role in implementing NbS in the Alpine region, creating a binding framework while allowing case-specific flexibility.
- Spatial planning frameworks such as the Alpine Convention's *Spatial Planning and Sustainable Development* Protocol offer the opportunity to harmonise environmental and land-use objectives. However, specific guidelines and enforcement mechanisms for promoting NbS are not available at that level.
- Promising examples are legally binding instruments, such as the Bavarian State Development Programme with its Bavarian Alpine Plan, or the French Local Urban Planning Scheme. They can be supplemented by voluntary frameworks such as the EU Urban Agenda or the Austrian Spatial Development Concept 2030.
- Proposed visionary instruments, like additions to the Bavarian Alpine Plan (Meyer & Job 2024) or the draft Climate Spatial Plan for Lienz (Janesch 2024) demonstrate how spatial planning at different spatial levels can designate areas for NbS implementation through clear, data-driven zoning, climate resilient measures and cross-sectoral approaches.
- Public procurement rules offer great potential to promote the integration of NbS through mechanisms such as product specifications, lifecycle cost analyses and challenge-based approaches. There is, however, a lack of binding rules for the prioritised consideration of NbS as well as a lack of knowledge and confidence in the application of the corresponding instruments.
- Environmental legislation in the Alpine region, characterised by the Alpine Convention and key EU legal acts, supports the sustainable use of resources and the protection of ecosystems, thus implicitly promoting NbS. The recent EU Nature Restoration Law further emphasises this by setting binding restoration targets, for which NbS may play a crucial role in restoring habitats, improving ecosystem services and achieving socio-economic benefits.

6.5 Some considerations on the economic dimension

As the economic dimension of NbS is an important factor for NbS acceptance and implementation, in this chapter we outline some general considerations about the economic dimensions of NbS and their applicability to the Alpine area. However, a comprehensive discussion and recommendations on this dimension is outside the scope of this report.

The economic dimension of NbS is discussed under main five topics:

- Benefits of NbS and their economic value,
- Costs of NbS,
- Economic assessments of NbS,
- Funding for NbS, and
- Some preliminary recommendations from an economic perspective.

6.5.1 Benefits of Nature-based Solutions and their economic value

NbS generate multiple benefits addressing the societal challenges which are the starting points for NbS. One key challenge when assessing the economic value of NbS benefits is the mix of use and non-use values. This makes a clear calculation of monetary benefits difficult. However, NbS are dependent on the acknowledgement and calculation of economic benefits. NbS benefits are basically derived from the provision of four kinds of goods (Figure 22):

- Public goods accessible for all members of society and without any usage restrictions, such as good-quality air or access to beautiful mountain scenery.
- Private goods with access limited to their owners and benefits solely accruing to these owners, such as fruit, crops or dairy products.
- Common goods providing benefits accessible for all members of society but the use of which is subject to competition, such as fishing, hunting deer or collecting wild mushrooms in the Alps.
- Club goods (or toll goods) with access limited to selected members of society (the “club”), albeit with no or limited competition as access is limited, Examples are golf clubs or private nature protection areas.

Several conflicts over natural goods in the Alpine area can be traced back to these kinds of goods, particularly if a good is shifted from one category to another. Examples are the privatisation of drinking water provision (public to private good), the public use of trails on private ground (private to public good), collecting mushrooms for commercial purposes (common to private goods).

Figure 22: Economic characterisation of goods

		SUBTRACTABILITY OF USE	
		LOW	HIGH
CONTROL OF ACCESS TO BENEFITS	HIGH	CLUB (OR TOLL) GOODS	PRIVATE GOODS
	LOW	PUBLIC GOODS	COMMON GOODS

Source: Breil et al. (2023).

These different categories of goods are relevant for understanding NbS funding options. The kind of good determines which investor can generate revenues from it or, if not, what nevertheless makes an NbS an interesting investment. One example of an NbS value calculation (even if not from the Alpine area) gives a first impression of the economic dimension: A study of the benefits of 85 NbS for urban residents in Europe calculated the "total social value to urban residents". Based on a value-transfer function, an aggregated social value of 800 Mio US$ per year was delivered. Per hectare of urban space, the urban NbS delivered on average benefits worth 96,286 US$ per year (Bockarjova et al. 2022). Looking at the cost side, a cost-benefit analysis found that 65% of the NbS delivered a positive return on investment based on the social value (ibid). NbS benefits are grouped by (Lozano et al. 2023) in categories which also include socio-economic benefits (see Table 7).

Table 7: Generic and specific benefits of NbS

Generic benefits	Specific benefits
Adaptation to climate change	Reduced flood risks (rivers, wetlands, sea-level) Heat mitigation (Urban Heat Island) Alleviation of storm impacts Reduced incidents of droughts and water scarcity
Climate change mitigation	Reducing impacts of climate change
Disaster risk reduction	Reduced damage from avalanches, landslides
Improved environmental quality	Reduced erosion Improved air quality Improved water quality Enhanced biodiversity Reduced noise pollution
Socio-economic benefits	Improved economic possibilities and jobs Reduced economic challenges Improved health and well-being Improved equality, integration, environmental justice, social inclusion, including improved security and lower crime rates Increased awareness and education Lower energy-related challenges, sustainable transport patterns

Source: Lozano et al. (2023).

6.5.2 Costs of Nature-based Solutions

NbS implementation generates costs which need to be realistically considered when planning NbS. Such costs are grouped by Lozano et al. (2023) in six generic categories (see Table 8).

Table 8: Cost categories of NbS

Generic cost categories	Specific cost categories
I. Costs of establishment	a) Fundraising b) Feasibility and planning studies c) Architectural and engineering design d) Research and development (R&D) e) Site and/or land acquisition f) Construction and installation g) Allowance for contingencies h) Relocation and/or removal of existing land-use infrastructure i) Labour and training j) Stakeholder involvement k) Capital (equipment, facilities, machinery, and office supplies) l) Utilities
II. Maintenance, administrative and operation costs	a) Labour and training b) Insurance and taxes c) Ongoing research and development (R&D) d) (Continued) Stakeholder involvement e) Land rent f) Capital (equipment, facilities, machinery, and physical endowments) g) Capital depreciation h) Utilities i) Transport and travel expenses j) Legal counselling, audit and supporting staff
III. Monitoring costs	*[Costs of tracking and observation ex-ante and ex-post]*
IV. Financing costs	a) Interest b) Fees, transactions costs and commissions c) Lease payments
V. Opportunity costs	*[Foregone benefits associated with other land uses such as housing developments, industrial activities, sports, recreation, and other competing land uses]*
VI. Indirect costs	a) Residual damage b) Agricultural loss c) Reduced air / water / soil quality

Source: Lozano et al. (2023).

6.5.3 Economic assessment of Nature-based Solutions

Economic assessments are used to analyse the relationship between benefits delivered and costs necessary to produce the benefits, as well as comparing NbS with other solutions, e.g. conventional solutions as described in Chapter 2.3.

In such economic assessments it is crucial to include short- and long-term benefits and monetary and non-monetary (social value) benefits. For an NbS to be feasible, the cost-benefit analysis should deliver benefits exceeding the costs.

Monetarising non-monetary benefits (and sometimes external costs) remains a challenge, as different valuation methods are available, a common valuation standard is missing, and valuations are often dependent on site-specific factors, which might differ between NbS.

How results are interpreted will also depend on the kind of investor. For private investors, non-monetary values generate no revenue, except when payment schemes for such values are in place. For public investors non-monetary benefits may be of major interest, as public bodies may be obliged to maintain non-monetary benefits while NbS projects may replace other public investments which deliver the same benefits (Breil et al. 2023), such as clean air, pleasing urban green spaces or a rich biodiversity. In such an assessment, the cost of inaction should also be considered when establishing a comparable framework for NbS.

In the evaluation handbook (Dumitru & Wendling 2021), a variety of indicators for identifying benefits are to be found. Economic assessments of NbS projects should be documented by data collection of costs and benefits in the Alpine area. Alternatively Alpine NbS projects could be marked in existing collections of economic assessments. Such data collections facilitate economic comparisons and can increase the acceptance of NbS projects.

6.5.4 Funding of Nature-based Solutions

The previous subchapters have introduced NbS benefits, costs and the role of economic assessments of NbS. We need to understand where funding can come from to start and maintain NbS projects. Main funding hurdles specific to NbS are mentioned by (Hudson et al. 2023): information failure (difficulty to collect and provide relevant information), knowledge gaps of practitioners and decision-makers, missing positive public perception, the challenge of handling multiple stakeholders and land users and high transaction costs for NbS project development.

Despite some emphasis on NbS by the European Biodiversity Strategy and the EU Nature Restoration Law, private funding for NbS remains low (Hudson et al. 2023). They conclude that NbS projects are funded mainly by the public sector. It is estimated that investments in NbS need to be tripled by 2030 and increased fourfold by 2050 for climate change, biodiversity and land degradation targets to be met. This equates to an annual investment rate of US$ 536 billion (UNEP 2021).

A review of databases and online information carried out by (Hudson et al. 2023) analysed 1364 projects with on-the-ground implementation in the EU and UK. At present only 3% of them have private-sector funding for more than 50% of total project costs. Financial data of NbS projects shows that 81% of projects with documented financial data have investment costs of less than €10 million and 44% of less than €1 million. However, 56% of the projects analysed have no financial data documented in the databases.

It will be a challenge to achieve the above-mentioned investment levels needed according to UNEP (2021) solely via public funding. An increase in private NbS funding is thus needed. However, private investments are faced with the challenges described above. Based on the

findings of (Hudson et al. 2023) this can be summarised as an economic dilemma linked to the public good character of NbS (see Chapter 6.5.1):

- NbS require investments to cover implementation costs. NbS projects provide public and private benefits. For private benefits or goods (such as timber, fruit), markets exist from which income can be generated. But the total investment costs of NbS have to be covered by such income. This means that private investors will probably only invest in NbS to the extent they can cover their costs.
- Even when NbS implementation is cost-effective or less costly than conventional solutions in the long term and the preservation of ecosystem services generates a higher total social (i.e. non-monetary) value for society, there will be no greater investment from private investors as long as project costs exceed private economic benefits.

Increasing the size and number of NbS projects, as demanded by UNEP (2021), will depend also on the kind of ecosystem. The potential for such upscaling in relation to the kind of ecosystems is displayed in Figure 23.

Figure 23: Potential for upscaling NbS by ecosystem

	Urban	Forestry	Agriculture
High opportunity for NbS growth	• Many policy instruments are readily available for urban NbS (e.g. use of building codes to encourage/require green roofs) • High population density results in greater number of people deriving benefits from NbS, which in turn can enhance demand for urban NbS • Examples: urban heat and flood mitigation, aesthetic greening	• Strong potential for revenue streams through carbon credits and ecotourism revenues • Poorly managed commercial forests have significant opportunities for NbS deployment, through potential for enhanced carbon sequestration and for NbS actions to achieve policy goals (such as the EU Nature Restoration Law targets) • Key challenge: risk profile of long-term maturity rates linked to the slow growth rates of plantings	• Significant potential for NbS funding through the Common Agricultural Policy (CAP) • Such funding could be directed toward current NbS instruments under the CAP which are under-utilised, or additional NbS through CAP reform • CAP reform could also reduce perverse incentives

	Rivers and lakes	Wetlands
Medium opportunity for NbS growth	• Lack of incentive for private investment due to the public good-nature of benefits derived from these ecosystems (e.g. biodiversity improvements are difficult to finance privately) • However, the water sector could invest in NbS to meet regulatory requirements and recoup costs from customers	• Peatland and wetland areas have significant carbon storage potential • Such ecosystems often overlap with agricultural landscapes, and their absolute area is relatively small due to historic land take actions

	Marine and coastal
Low opportunity for NbS growth	• Low private ownership of sites hinders the opportunity and incentive for private investment • Significant knowledge gaps mean that identifying areas in poor condition (a proxy for NbS demand) is challenging • Key driver for future NbS is public investment in risk reduction measures • Restoring seagrass, kelp forest, coastal wetland areas for carbon and biodiversity is a potential area of growth

Source: Hudson et al. (2023).

Financing instruments

Based on a survey and interviews, financial instruments used in the EU for funding NbS were analysed by (Hudson et al. 2023). It turns out that the market for NbS is considered to be underdeveloped at present, meaning that it is difficult for financial investors to find a 'proven track record and sources of financial viability' (Hudson et al. 2023, p. 74). Financial investors thus prefer public-sector risk / research capital rather than market-based loans for project development. Therefore, few financing instruments are frequently used.

The results of the analysis are divided into two groups by (Hudson et al. 2023): financial instruments frequently used, and those underused but promising further financing options. For both groups an overview is provided in Table 9 and Table 10 using criteria such as standardisation capacity, ease of implementation, complexity, forward- or backward-looking, frequency, and effects on the market.

Frequently used financial instruments for NbS

Financial instruments commonly used in the EU are:

- Grant funding: i.e., funding does not have to be repaid. Grants are the most frequently used financial instrument for NbS in the EU, with most financed by the public.
- Market loans: a party borrows capital from a bank or other financial institution, repaying the money over a period of time at a certain interest rate. Market loans are the second most frequently used financing instrument in the EU.
- Concessional loans: these offer a discount on interest rates or a longer repayment period. Financial institutions may express their interest in developing a certain project when offering a concessional loan.
- Equity instruments: these are investments of venture or private capital in NbS projects, whereby the investor in general expects a short-term profit. This limits uptake, as NbS timescales often do not match the short-term investment horizon of investors.

Table 9: Overview of financial instruments frequently used for NbS

Financial instruments	Grant instruments	Market loans	Concessional loans	Equity instruments
Standardisation capacity	High	High	High	Low
Ease of implementation	Intermediate	High	High	Intermediate
Complexity	Low	Low	Low	Low
Frequency of use	Very high	Intermediate	Intermediate	Very low
Forward- or backward-looking	Backward-looking	Backward-looking	Backward-looking	Backward-looking
Effects on the nature-based solutions market	► Supporting early development stage nature-based projects	► Currently used very little for lack of sufficiently large loan opportunities	► Mostly offered by development finance institutions and states, not	► Potential to help upscale small NbS ventures (early-stage-equity),

Financial instruments	Grant instruments	Market loans	Concessional loans	Equity instruments
	► Fostering innovation ► Limiting the potential growth of the NbS market due to "grant addiction"	► Not embraced by most nature-based projects due to their high interest rates and the associated burden ► Market entities claim they are crowded out by too many grants	by the private sector ► Seen by many as an intermediate solution between market-rate loans and equity	especially if concessional ► Potential to accelerate the growth of mid-sized NbS, especially if supported by additional technical guidance by the equity investor ► Highly unlikely to expand due to scale, low returns and excess risk

Source: Hudson et al. (2023).

Underused financial instruments for NbS

- Guarantees: A (public) institution assumes responsibility if an NbS project loan cannot be repaid. This means that the risk for private funding is reduced by the amount of the guarantee.
- Thematic bonds: Bonds for NbS project can be developed for different themes such as Sustainable Development Goals, resilience development, blue-green infrastructure. Bonds would be an instrument for corporate or public issuers.
- Sustainability-linked bonds and loans: Different to thematic bonds, sustainability-linked bonds are linked to key performance indicators. This instrument is used by the World Bank and the European Investment Bank.

Table 10: Overview of promising but underused financial instruments for NbS

Financial instruments	Guarantees	Thematic bonds	Sustainability-linked bonds and loans (SLBs and SLLs)
Standard capacity	High	High	High
Ease of implementation	High	Low	Intermediate
Complexity	Low	Low	Intermediate
Frequency	Intermediate	Intermediate	Intermediate
Forward- or backward-looking	Backward-looking	Backward-looking	Forward-looking
Effects on the NbS market	► Potential effect of boosting private	► Can boost the growth of NbS in	► Offer more flexibility on how

Financial instruments	Guarantees	Thematic bonds	Sustainability-linked bonds and loans (SLBs and SLLs)
	investment in NbS by de-risking them in a nascent phase of the market ► Risk of putting too much responsibility and pressure on public institutions to develop a single market ► Appreciated by NbS project managers for their potential to bring in private capital on top of sources such as grants	their mid-to-late development stage ► Enable investors to verify the claims and tie the issued debt to the exclusive use for projects ► Issuing costs are high and are best tailored for large projects	the money is employed and are cheaper than thematic bonds ► May lead issuers to set less ambitious key performance indicators and offer less rigorous accountability measures

Source: Hudson et al. (2023).

As outlined in Chapter 4.3.2, NbS projects often have a longer duration than conventional projects. Public project funding should consider this by extended funding periods, otherwise the risk of a disruption of financing may lead to the loss of NbS maintenance and ultimately to the non-achievement of targets.

NbS project tenders could be given higher priority in funding decisions and/or NbS elements could be declared as mandatory in funding applications. Moreover, considering NbS as a criterion for public procurement would help foster such projects.

Further funding measures for private and public investors

Private and public investments in NbS may be reimbursed by direct payments but also by indirect financial advantages. Some examples for compensating private and public investments are listed below based on Breil et al. (2023) and Hudson et al. (2023):

- Sale of products and commodities from NbS areas, such as timber, fruit or dairy products as direct revenue from the NbS project.
- Tax or fee breaks for private NbS investments such as lower sewage fees for green roof retention capacities.
- Benefits generated by public funded NbS but also accruing to private properties (such as an increase of real estate values) could be repaid to the public in the form of real estate taxes.
- Credits are considered one of the most promising financial tools. They could experience significant growth rates up to 3000% between 2023 and 2029 if the regulation scheme is tightened (Bloomberg 2022). Credits may be offered as carbon credits, biodiversity credits (with additional premiums per credit for biodiversity effects), carbon farming credits or wetland mitigation credits (for restoring wetland areas).

- Cost reduction models benchmarked against the costs avoided by NbS, particularly in high-risk environments. A percentage of the cost reduction could be calculated as revenue for institutions benefiting from lower risks such as insurance companies.
- Ecosystem service taxes or payment for ecosystem services covering undervalued goods and services through direct public or private payments, tax incentives, cap-and-trade markets and certification programmes.
- Insurance payments for asset protection, liability reduction or the facilitation of capital inflow markets.

A generally interesting concept in this field is the "nature-positive" economy, an economy which ensures and contributes to stopping biodiversity loss by 2030 and improving biodiversity to full recovery by 2050 on a 2020 baseline (WWF 2024). There is an ongoing debate on the extent to which NbS can contribute to such a broad concept (McQuaid et al. 2022).

6.5.5 Recommendations for the economic dimension

Based on the above considerations regarding the economic dimension of NbS, some preliminary recommendations can be made on ways of fostering the development of NbS from an economic perspective:

Encouraging funding and promoting benefits

- Increasing public and / or private funding is identified as a key challenge for upscaling NbS projects. As public funding will not be able to finance the total number of NbS needed, private investment in NbS needs to become attractive (Breil et al. 2023; UNEP 2021).
- One main challenge for NbS financing is how to combine private and public finance sources (Breil et al. 2023), i.e., encouraging public-private-partnerships.
- Economic assessments of NbS should focus on sharing benefits between public and private actors to identify financing mechanisms (Breil et al. 2023).
- A nature-positive economy has the potential to support benefit delivery from NbS while at the same time delivering economic benefits such as jobs, skills, innovation and new enterprises (El Harrak & Lemaitre 2023).

Research and training

- Research on the transaction costs for NbS planning and implementation is needed, as a broader range of stakeholders and governance requires greater planning and implementation effort which needs to be reflected in the costs and benefits of NbS (El Harrak & Lemaitre 2023).
- Though various economic valuation methods exist, regional and municipal administrations often lack the capacity and skills to perform economic assessments (El Harrak & Lemaitre 2023).

Summary of considerations on the economic dimension

- Benefits generated by NbS may be characterised as relating to public goods, private goods, common goods and club goods. Each type requires different handling in terms of NbS financing and revenues.
- NbS implementation causes costs in different categories. These need to be considered in economic assessments together with the benefits generated by NbS. In such assessments, the challenge is to include short- and long-term effects as well as monetary and non-monetary benefits. How economic assessments are interpreted depends on the kind of investor, as private and public investors have diverging interests.
- The EU Biodiversity Strategy puts a focus on the further dissemination and implementation of NbS with a view to slowing down or stopping impacts on biodiversity and climate change. This will require substantial budgets possibly exceeding public funding capacities.
- However, NbS funding faces various challenges limiting private funding and needing to be resolved. In particular, public goods generated by NbS often do not produce short-term revenues, making NbS a difficult investment for private investors.
- Commonly used financing instruments are as yet limited mainly to grants, market loans and concessional loans. Additional, conceptually promising instruments are equity instruments, guarantees, thematic bonds and sustainability-linked bonds and loans.
- Besides these financing instruments, other funding measures exist such as tax breaks, credits, cost reduction percentages or lower insurance premiums.
- Recommendations for NbS from the economic perspective include encouraging private investments, private-public partnerships, and benefit-sharing. Research and training will be needed to better explore transaction costs for larger stakeholder groups and to develop stakeholders' skills in dealing with the economic dimension of NbS.

6.6 Successful governance mechanisms for establishing Nature-based Solutions in the Alpine region

The stronger establishment of NbS in the Alpine region can be supported by several key governance mechanisms essential for integrating NbS into existing frameworks and ensuring their effectiveness.

Cross-sectoral approaches

Stronger anchoring of cross-sectoral approaches is crucial in designing a cohesive policy mix within the Alpine region. Traditional sectoral perspectives often hinder comprehensive NbS implementation. Instead, integrated mechanisms should be established, encompassing legislation, funding, strategies and planning instruments across various sectors. This includes forming regional, national and transnational cooperation and coordination bodies facilitating integrated strategies and programmes with a spatial reference. Such an approach promotes cross-sectoral thinking and fosters stronger horizontal and vertical cooperation among diverse actors within the political-administrative system.

Cooperative projects and initiatives

To strengthen horizontal and vertical cooperation in the Alpine region, cooperative approaches should be more strongly emphasised in calls for tenders. This concerns both the composition of project teams and the description of governance mechanisms and participatory methods in the individual projects. Another possibility would be incentive systems: projects that choose collaborative approaches could be rewarded with bonus points and thus increase their chances of being awarded a contract.

Transdisciplinary research

Interdisciplinary and transdisciplinary approaches should also be more firmly anchored in the field of research. Inter- and transdisciplinary projects in which researchers from different disciplines work together with non-researchers should be promoted in separate calls. Incentive systems for strengthening inter- and trans-disciplinary projects could also be introduced for research calls.

Skills development and training

Skills development and training in multilevel governance is another critical aspect. Training opportunities should be made available for staff in administration, research, planning offices, NGOs, landowners and other stakeholders involved in NbS initiatives. Training can take various forms, including webinars, workshops and field excursions. By enhancing the NbS knowledge base, stakeholders will gain more confidence in navigating complex systems and processes specific to the Alpine region.

The Policy Brief of PLANALP, Mandate 2021-2022 (PLANALP 2022) emphasises that monitoring and evaluating policy implementation and governance mechanisms is crucial for increasing accountability. Regular training can help ensure that stakeholders are equipped to adapt to changing environmental conditions and governance structures.

Monitoring and evaluation

Assessing impact through monitoring and evaluation is essential for determining the effectiveness of NbS initiatives. This includes gathering feedback from stakeholders on their perceptions of these initiatives and adjusting strategies and measures accordingly. Continuous

refinement of these strategies based on stakeholder input can significantly enhance the overall effectiveness of NbS governance.

The governance framework must include mechanisms for evaluating not only the implementation of NbS but also their socio-economic impacts. As noted in the *Manifesto for the governance of glaciers and related natural resources* (Legambiente 2023), successful governance requires a dynamic engagement process bringing diverse groups together to foster collaborative decision-making.

Summary of successful governance mechanisms for establishing Nature-based Solutions in the Alpine region

Establishing effective governance mechanisms for Nature-based Solutions in the Alpine region necessitates a multifaceted approach involving

- Cross-sectoral collaboration.
- Skills development.
- Rigorous monitoring and evaluation processes.

6.7 Communication mechanisms for establishing Nature-based Solutions

Effective communication is essential for successfully establishing NbS in the Alpine region. To foster greater acceptance and understanding of NbS, several key communication mechanisms should be implemented:

Promoting success stories

It is crucial to collect and share successful examples of NbS implemented in the Alpine region. By making these positive narratives publicly available, stakeholders get to see tangible results able to motivate and inspire action**.** These narratives should be communicated in a motivating, tangible and emotional way, addressing a community's sentiments and reducing scepticism towards NbS. As highlighted in a discussion paper on *Strengthening synergies for biodiversity and climate* by the German Federal Agency for Nature Conservation (Kozban et al. 2023), to scale-up NbS, 'generating widespread and common understanding and knowledge on NbS and their governance, social, and financial dimensions will be critical' (Kozban et al. 2023, p. 6).

Using sensitive communication practices

Communication on NbS-related plans and measures should be transparent from the outset. Stakeholder concerns, in particular those of landowners, must be taken seriously and addressed promptly. This sensitivity in communication will not only enhance understanding but also prevent fears regarding the potential misuse of NbS concepts. The discussion paper further emphasises that 'any kind of biodiversity and climate interventions should always integrate a social perspective' (Kozban et al. 2023, p. 6). By fostering an environment where stakeholders feel heard, it becomes easier to build trust and collaboration among all involved.

> Before the first culverts were installed, local residents were concerned about mosquitoes and safety. After the first examples were implemented, these fears were dispelled in no time because it was possible to show that the concept worked. In addition, people were very proud of 'their' streams because they significantly improved the quality of life in the neighbourhood.
>
> *Stefan Hasler, Association of Swiss Wastewater and Water Protection Experts (VSA)*

Addressing stakeholder concerns

Continuous engagement with stakeholders is crucial. Feedback mechanisms should be established to ensure that community concerns are integrated into NbS planning and implementation processes. This two-way communication fosters a sense of ownership among stakeholders, encouraging them to support NbS initiatives.

Raising awareness

Communication campaigns illustrating to a public audience how NbS can address local environmental challenges while providing socio-economic benefits can significantly enhance community engagement.

Utilising various communication channels

To reach a broader audience, it is recommended to utilise various communication platforms and channels. Each platform and channel can serve different demographics, ensuring increased NbS information outreach.

Summary of communication mechanisms for establishing Nature-based Solutions

- Establishing effective communication mechanisms is fundamental for promoting NbS in the Alpine region.
- By developing positive narratives, engaging transparently with stakeholders, addressing concerns sensitively, raising awareness through educational campaigns, utilising diverse platforms, and continuously evaluating efforts, NbS acceptance and implementation can be significantly enhanced.

6.8 Education and training for Nature-based Solutions

Since NbS projects involve complex interrelationships in several aspects (interaction of ecological and technical processes, involvement of various stakeholders, indirect social or economic impacts, etc.), knowledge transfer and skills development are very important for the establishment of NbS. As outlined in the European Roadmap 2030 (EC 2011), integrating research with practical demonstration is crucial for bridging the gap between theory and implementation. This integration promotes transdisciplinary dialogues enhancing stakeholder engagement and ownership of NbS initiatives. Effective NbS education can cultivate a better understanding among various stakeholders, thereby facilitating the mutual comprehension and collaboration essential for addressing the complexities inherent in ecological management.

Training opportunities

Various training opportunities can enhance the learning aspect and increase networking amongst actors or would-be-actors in the field of NbS.

- **Workshops and webinars**
  These can provide theoretical insights and practical skills to government officials, planners, NGOs, researchers and interested citizens. Such sessions can cover topics ranging from ecological principles to specific NbS applications.
- **Field excursions**
  Hands-on experiences in natural settings allow participants to observe NbS in action, fostering a deeper appreciation of their benefits and challenges.
- **Knowledge exchange platforms**
  Creating forums for practitioners, administrative staff and scientists to share experiences enhances collective learning and innovation in NbS practices. (See for example the project *Zürcher Bachkonzept,* Chapter 3.2, Appendix A.2.)

Innovative approaches – Research and practical examples

The authors of the European Roadmap 2030 (EC 2011) emphasise the need for innovative methods to integrate research with demonstration projects effectively**.** This includes systematic approaches to project design that include demonstrations and the involvement of non-academic partners (trans-disciplinary research).

Curriculum integration

The integration of NbS topics into educational curricula affects universities of applied sciences, but also secondary schools and, in particular, agricultural and forestry colleges. Content could be delivered by supporting materials, like those provided by the *I-SWAMP* project (see Chapter 3.2,

Appendix A.2). Furthermore, NbS topics should also be integrated into in-service training programmes for administrators, planners, NGOs and similar stakeholders.

Summary of education and training for Nature-based Solutions

- Education and training for NbS will foster acceptance, confidence, mutual understanding among different stakeholders, and help those involved gain more self-confidence in dealing with complex systems and processes in the Alpine region.

6.9 Participation and utilisation of social engagement

Engaging local communities and harnessing social participation are crucial to anchoring NbS, setting the right conditions for good governance and helping implement effective NbS.

Innovative concepts

Competitions between communities can significantly boost participation in NbS projects. A prime example is the Dutch *Tegelwippen* (tile-flipping) contest (NK Tegelwippen 2025) where municipalities compete in removing the most paving slabs and replacing them with green spaces. This national championship, supported by the Dutch Ministry of Infrastructure and Water Management, has led to the removal of over 11 million slabs since 2021, creating hundreds of acres of new green space. Such an approach could be adapted to Alpine communities, encouraging them to compete in restoring natural habitats or implementing NbS.

Youth engagement

Involving young people is particularly important in the Alpine region. As an example, the GaYA (Governance and Youth in the Alps, Interreg Alpine Space 2014-2020) project focused on youth participation and governance in the Alps, demonstrating the potential for involving the younger generation in decision-making, especially in rural and protected areas. As stated in the project's press release, the project aim is to 'Actively promote a political culture of participation, anchor the participation of young people in decision-making processes, and make youth participation a must, not just a nice extra!' Young people often bring fresh perspectives and innovative ideas to tackle challenges, while their participation strengthens innovative and participatory democracy in the region, increasing the quality of democratic processes and national and transnational governance.

Experiential learning

Experiential learning is a transformative approach integrating hands-on, real-world experiences to enhance learning and personal development.

The following three exemplary projects are part of the selected model projects in this report (see Chapter 3).

- ***I-SWAMP***: This initiative focuses on sustainable management and agroecology, fostering interdisciplinary learning and community engagement. It provides participants with opportunities to apply theoretical knowledge in practical settings, promoting environmental stewardship and sustainable practices.
- ***Zürcher Bachkonzept***: NbS benefits can be made tangible by integrating them into community spaces, e.g. restored streams crossing playgrounds or recreation areas.
- ***Bergwaldprojekt***: Active in Austria, Germany, Switzerland and Liechtenstein, this international nature conservation organisation involves volunteers in forest preservation

activities. Participants gain experiential learning by working directly in forest ecosystems, understanding ecological interconnections, and contributing to biodiversity conservation.

Volunteer involvement

Involving volunteer is a critical component of these projects, offering participants meaningful opportunities to contribute to societal and environmental well-being, while at the same time generating understanding for the need to apply NbS:

- **I-SWAMP Project**: Volunteers play a vital role in implementing sustainable practices, supporting local communities, and conducting research on agroecological systems. Their contributions help bridge the gap between academia and real-world applications.
- **Bergwaldprojekt**: This project relies to a large extent on volunteers who actively participate in forest conservation tasks such as planting trees, maintaining trails and restoring habitats. Their involvement not only supports ecological goals but also fosters a sense of environmental responsibility.

  These projects are part of the selected model projects in this report (see Chapter 3.2, Appendix A.2).

Summary of participation and utilisation of social engagement

Social engagement and community participation are key to implementing NbS, with innovative approaches such as competitions, youth and volunteer involvement, and experiential learning driving environmental stewardship and sustainable practices in the Alpine region.

7 References

AC (Alpine Convention) [ed.] (1991): Alpine Convention - Framework Convention. https://www.alpconv.org/fileadmin/user_upload/Convention/EN/Framework_Convention_EN.pdf (14.02.2025).

AC (Alpine Convention) [ed.] (1994): "Spatial Planning and Sustainable Development" Protocol - Protocol on the implementation of the Alpine Convention of 1991 relating to spatial planning and sustainable development. https://www.alpconv.org/fileadmin/user_upload/Convention/EN/Protocol_Spatial_Planning_EN.pdf (10.03.2025).

AC (Alpine Convention) [ed.] (2022): Some insights in the current work of the Alpine Climate Board (ACB). https://alpineclimate2050.org/2023/07/25/working-across-borders-across-functions-across-sectors/ (24.01.2025).

AC (Alpine Convention) [ed.] (2024): Biodiversity in the Alps - Policy Brief. https://www.alpconv.org/fileadmin/user_upload/Organisation/SL/Biodiversity_in_the_Alps_Policy_Brief.pdf (18.02.2025).

Albert, C.; Brillinger, M.; Guerrero, P.; Gottwald, S.; Henze, J.; Schmidt, S., et al. (2021): Planning nature-based solutions - Principles, steps, and insights. In: Ambio 50 (8), p. 1446 - 1461. DOI: 10.1007/s13280-020-01365-1.

Albert, C.; Schröter, B.; Haase, D.; Brillinger, M.; Henze, J.; Herrmann, S., et al. (2019): Addressing societal challenges through nature-based solutions - How can landscape planning and governance research contribute? In: Landscape and Urban Planning 182 (7645), p. 12 - 21. DOI: 10.1016/j.landurbplan.2018.10.003.

BCA (Biodiversity Credit Alliance) [ed.] (2024): High Level Principles to Guide the Biodiversity Credit Market - Working Paper. https://www.biodiversitycreditalliance.org/wp-content/uploads/2024/11/BCA_High-level-Principles-to-Guide-the-Biodiversity-Market-working-paper-EN_ES_FR.pdf (10.03.2025).

Bloomberg [ed.] (2022): Carbon offsets price may rise 3,000% by 2029 under tighter rules. https://www.bloomberg.com/professional/insights/commodities/carbon-offsets-price-may-rise-3000-by-2029-under-tighter-rules/, zuletzt aktualisiert am 2025 (17.02.2025).

Bockarjova, M.; Botzen, W. J. W.; Bulkeley, H. A. & Toxopeus, H. (2022): Estimating the social value of nature-based solutions in European cities. In: Scientific reports 12 (1), p. 19833. DOI: 10.1038/s41598-022-23983-3.

Breil, M.; Castellani, C.; Keesstra, S.; Zimmer, D.; Nieminen, H.; Trozzo, C. & Galluccio, G. (2023): Economic enabling conditions for scaling of Nature Based Solutions - ETC-CA Technical Paper. European Environment Agency (EEA), ETC CA - European Topic Centre on Climate change adaptation and LULUCF. DOI: 10.25424/cmcc-g4t5-4h87.

CoE (Centre of Expertise for Good Governance, Council of Europe) [ed.] (2022): 12 Principles of Good Democratic Governance. https://rm.coe.int/12-principles-of-governance-poster-a2/1680787986; https://www.coe.int/en/web/centre-of-expertise-for-multilevel-governance/12-principles#{%2225565951%22:[0]} (20.01.2025).

COE (Council of Europe) [ed.] (2008): 15th session of the Conference of European Ministers responsible for local and regional government - (Valencia, 15-16 October 2007) – Report by the Secretary General. https://search.coe.int/cm?i=09000016805d3dc8 (20.01.2025).

Corgo, J. (2024): Nature-based solutions in spatial planning and policies for climate change adaptation: a literature review - Supplementary information (Appendix). In: Ambio 53 (11). DOI: 10.1007/s13280-024-02052-1.

Costanza, R.; d'Arge, R.; Groot, R. d.; Farber, S.; Grasso, M.; Hannon, B., et al. (1998): The value of ecosystem services - Putting the issues in perspective. In: Ecological Economics 25 (1), p. 67 - 72. DOI: 10.1016/S0921-8009(98)00019-6.

Costanza, R. & Daly, H. E. (1992): Natural Capital and Sustainable Development. In: Conservation Biology 6 (1), p. 37 - 46. DOI: 10.1046/j.1523-1739.1992.610037.x.

Daily, G. C. (2013): Nature's Services - Societal Dependence on Natural Ecosystems (1997). In: Robin, L.; Sörlin, S. & Warde, P. (Hg.): The Future of Nature : Documents of Global Change, New Haven: Yale University Press, p. 454 - 464.

Daly, H. E. & Farley, J. (2011): Ecological economics - Principles and applications, 2. Edition, Island Press, Washington, DC.

Deppisch, S.; Heitmann, A.; Savaşçı, G. & Lezuo, D. (2022): Ökosystemleistungen in Instrumenten der Stadt- und Regionalplanung. In: Raumforschung und Raumordnung | Spatial Research and Planning 80 (1), p. 58 - 79. DOI: 10.14512/rur.122.

Díaz, S.; Settele, J.; Brondízio, E. S.; Ngo, H. T.; Guèze, M.; Agard, J., et al. (2019): IPBES - Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. IPBES secretariat, Bonn. DOI: 10.5281/zenodo.3553579.

Dumitru, A. & Wendling, L. (2021): Evaluating the Impact of Nature-based Solutions - A Handbook for Practitioners. European Commission (EC), Luxembourg. DOI: 10.2777/244577.

DWA (Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall e. V.) [ed.] (2025): DWA - the network of experts for water, wastewater and waste. https://en.dwa.de/en/ (18.02.2025).

EC (European Commission) (2011): Roadmap to a Resource Efficient Europe. http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52011DC0571 (10.12.2015).

EC (European Commission) (2019): The European Green Deal, Brüssel. https://eur-lex.europa.eu/resource.html?uri=cellar:b828d165-1c22-11ea-8c1f-01aa75ed71a1.0002.02/DOC_1&format=PDF (10.03.2025).

EC (European Commission) [ed.] (2020): EU Biodiversity strategy for 2030 - Bringing nature back into our lives. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:52020DC0380 (20.01.2025).

EC (European Commission) [ed.] (2024): One Health - Overview. https://health.ec.europa.eu/one-health/overview_en, zuletzt aktualisiert am 2024 (17.02.2025).

EC (European Commission Directorate-General for Research and Innovation) [ed.] (2021): Evaluating the impact of nature-based solutions – A summary for policy makers. DOI: 10.2777/521937.

El Harrak, M. & Lemaitre, F. (2023): European Roadmap to 2030 for Research and Innovation on Nature-based Solutions. With contribution of Kris Decleer, Robert McDonald, Siobhan McQuaid, Ignacio Palomo, Christopher M. Raymond und Laura Wendling. NetworkNature. https://networknature.eu/sites/default/files/uploads/eu-ri-roadmapweb.pdf (10.03.2025).

ESPON (European Spatial Planning Observation Network) [ed.] (2022): Updating and Integrating CLIMATE Datasets and Maps. - Final report. https://archive.espon.eu/sites/default/files/attachments/ESPON_CLIMATE_update_Final_Report_0.pdf (10.03.2025).

EU (European Union) [ed.] (2024): REGULATION (EU) 2024/1991 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 24 June 2024 on nature restoration and amending Regulation (EU) 2022/869. https://eur-

lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32024R1991&qid=1722240349976, zuletzt aktualisiert am 7/29/2024 (10.02.2024).

EUSALP [ed.] (2021): Work plan 2023-2025 - Action Group 1 “Research and innovation”, Interreg. https://alpine-region.eu/fileadmin/user_upload/EUSALP_Work_plans_23-25_ALL.pdf (10.03.2025).

Gobiet, A.; Kotlarski, S.; Beniston, M.; Heinrich, G.; Rajczak, J. & Stoffel, M. (2014): 21st century climate change in the European Alps—a review. In: The Science of the total environment 493, p. 1138 - 1151. DOI: 10.1016/j.scitotenv.2013.07.050.

Gómez-Baggethun, E.; Groot, R. d.; Lomas, P. L. & Montes, C. (2010): The history of ecosystem services in economic theory and practice - From early notions to markets and payment schemes. In: Ecological Economics 69 (6), p. 1209 - 1218. DOI: 10.1016/j.ecolecon.2009.11.007.

Haines-Young, R. & Potschin, M. (2018): CICES - Towards a common classification of ecosystem services. European Environment Agency (EEA). http://cices.eu/ (10.03.2025).

Hänel, K. & Reck, H. (2010): Netzwerk für Wald bewohnende, größere Säugetiere - Prioritäten zur Vernetzung von Lebensraumkorridoren im überregionalen Straßennetz. Forschungs- und Entwicklungsvorhaben „Prioritätensetzung zur Vernetzung von Lebensraumkorridoren im überregionalen Straßennetz“ (FKZ 3507 82 090), Bonn, Bundesamt für Naturschutz (BfN). https://www.bfn.de/daten-und-fakten/netzwerk-fuer-wald-bewohnende-groessere-saeugetiere-prioritaeten-zur-vernetzung (10.03.2025).

Henger, R.; Daniel, S.; Schier, M.; Blecken, L.; Fahrenkrug, K.; Melzer, M., et al. (2019): Modellversuch Flächenzertifikatehandel - Realitätsnahes Planspiel zur Erprobung eines überregionalen Handelssystems mit Flächenausweisungszertifikaten für eine begrenzte Anzahl ausgewählter Kommunen. Abschlussbericht. Umweltbundesamt (UBA), Dessau-Roßlau. https://www.umweltbundesamt.de/sites/default/files/medien/1410/publikationen/2019-10-02_texte_116-2019_modellversuch-flaechenzertifikatehandel.pdf (10.03.2025).

Hudson, G.; Hart, S. & Verbeek, A. (2023): Investing in nature-based solutions - State-of-play and way forward for public and private financial measures in Europe. European Investment Bank, Luxembourg. https://www.eib.org/attachments/lucalli/20230095_investing_in_nature_based_solutions_en.pdf (10.03.2025).

Interreg [ed.] (2022): Interreg Alpine Space Programme 2021-2027, 1.1. Edition. https://www.alpine-space.eu/wp-content/uploads/2024/02/Interreg_Alpine_Space_programme_2021-2027-1.pdf (10.03.2025).

Interreg Alpine Space [ed.] (2014-2020): GaYa - Governance and Youth in the Alps. https://www.alpine-space.eu/project/gaya/ (10.03.2025).

IUCN (International Union for Conservation of Nature) [ed.] (2016): WCC-2016-Res-069-EN: Defining Nature-based solutions. https://portals.iucn.org/library/sites/library/files/resrecfiles/WCC_2016_RES_069_EN.pdf (10.03.2025).

IUCN (International Union for Conservation of Nature) [ed.] (2020a): Guidance for using the IUCN Global Standard for Nature-based Solutions - A user-friendly framework for the verification, design and scaling up of Nature-based Solutions, Gland, Switzerland. https://portals.iucn.org/library/sites/library/files/documents/2020-021-En.pdf (10.03.2025).

IUCN (International Union for Conservation of Nature) [ed.] (2020b): IUCN Global Standard for Nature-based Solutions - A user-friendly framework for the verification, design and scaling up of NbS, Gland, Switzerland. https://portals.iucn.org/library/sites/library/files/documents/2020-020-En.pdf (10.03.2025).

IUCN (International Union for Conservation of Nature) [ed.] (2025a): Contributions for Nature Platform. https://www.iucncontributionsfornature.org/ (18.02.2025).

IUCN (International Union for Conservation of Nature) [ed.] (2025b): How STAR works. https://iucn.org/resources/conservation-tool/species-threat-abatement-and-restoration-star-metric#3289 (18.02.2025).

IUCN (International Union for Conservation of Nature) [ed.] (2025c): The Restoration Barometer. https://iucn.org/resources/conservation-tool/restoration-barometer (18.02.2025).

Janesch, T. L. (2024): Hilfe, die Alpen glühen! Überlegungen zu einem Klimaraumplan für die Stadt Lienz. DOI: 10.34726/hss.2024.109630.

Jansson, Å.; Hammer, M.; Folke, C.; Costanza, R.; Koskoff, S.; Johansson, O. C. & Jansson, A. (1994): Investing in natural capital - The ecological economics approach to sustainability, 1. Edition, Island Press, Washington, DC.

Kozban, I.; Kopsieker, L.; Wulf, S. & Hedden-Dunkhorst, B. (2023): Strengthening synergier for biodiversity and climate - Discussion paper. Bundesamt für Naturschutz (BfN), Bonn. https://bfn.bsz-bw.de/frontdoor/deliver/index/docId/1603/file/hgr232en.pdf (10.03.2025).

Legambiente [ed.] (2023): Manifesto for a governance of glaciers and related naturale resources, Salecina. https://www.legambiente.it/wp-content/uploads/2023/09/Manifesto-for-a-governance-of-glaciers-EN-0921.pdf (18.02.2025).

Lezuo, D.; Marzelli, S.; Savaşçı, G. & Neumann, C. (2020): Der Ökosystemleistungsansatz als Vermittler in Planungsprozessen? - Zum Status quo in der Stadtumlandentwicklung. Auswertung grauer Literatur. landmetamorphosis. https://www.ifuplan.de/wp-content/uploads/2024/01/landmetamorphosis_04_A1_b_Oekosystemleistungen_Planungsprozesse-ifuplan.pdf (10.03.2025).

Linnerooth-Bayer, J. & Scolobig, A. (2023): Tackling policy barriers to nature-based solutions. International Institue for Applied System Analysis (IIASA) (IIASA Policy Brief #39). https://iiasa.ac.at/policy-briefs/sep-2023/tackling-policy-barriers-to-nature-based-solutions (10.03.2025).

Lozano, J. E.; Nainggolan, D.; Zandersen, M.; Kofler, V.; Kernitzkiy, M.; Staccione, A., et al. (2023): Value categories and approaches to assess NBS economic and financial performance, Deliverable 2.1, V.3. Invest4Nature, Horizon Europe Grant (no.101061083). DOI: 10.5281/zenodo.10834731.

Maes, J.; Egoh, B.; Willemen, L.; Liquete, C.; Vihervaara, P.; Schägner, J. P., et al. (2012): Mapping ecosystem services for policy support and decision making in the European Union. In: Ecosystem Services (1), p. 31 - 39. DOI: 10.1016/j.ecoser.2012.06.004.

Maes, J. & Jacobs, S. (2017): Nature-Based Solutions for Europe's Sustainable Development. In: Conservation Letters 10 (1), p. 121 - 124. DOI: 10.1111/conl.12216.

Marot, N.; Bevk, T.; Debevec, M.; Klepej, D.; Stubicar, N. & Klara, P. (2025): Quality of Life - 10th Report on the State of the Alps. Permanent Secretariat of the Alpine Convention (PSAC). https://www.alpconv.org/fileadmin/user_upload/Publications/RSA/RSA_10_EN_web.pdf (10.03.2025).

McQuaid, S.; Kooijman, E.; Rizzi, D.; Andersson, T. & Schanté, J. (2022): The vital role of Nature-Based Solutions in a Nature Positive Economy - Independent Expert Report. European Commission (EC), Brussels. DOI: 10.2777/307761.

MEA (Millennium Ecosystem Assessment) (2005): Ecosystems and human well-being - Synthesis. With contribution of Walter V. Reid, Harold A. Mooney, Angela Cropper, Doris Capistrano, Stephen R. Carpenter, Kanchan Chopra, 1. Edition, Island Press, Washington, DC.

Mehryar, S.; Sasson, I. & Surminski, S. (2022): Supporting urban adaptation to climate change - What role can resilience measurement tools play? In: Urban Climate 41, p. 101047. DOI: 10.1016/j.uclim.2021.101047.

Meyer, C. & Job, H. (2024): Developing a data-driven approach to climate-proof a regional spatial planning instrument - The Bavarian Alpenplan. In: eco.mont (Journal on Protected Mountain Areas Research) 16 (2), p. 16 - 29. DOI: 10.1553/eco.mont-16-2s16.

Meyer, C.; Job, H.; Laner, P.; Omizzolo, A.; Kollmann, N.; Clare, J., et al. (2022): OpenSpaceAlps Planungshandbuch - Perspektiven für eine konsistente Freiraumsicherung im Alpenraum. DOI: 10.25972/OPUS-27307.

Naumann, S.; Burgos Cuevas, N.; Davies, C.; Bradley, S.; Mahmoud, I. H. & Arlati, A. (2020): Harnessing the power of collaboration for nature based solutions - New ideas and insights for local decision-makers. Publications Office of the European Union. https://data.europa.eu/doi/10.2777/954370 (10.03.2025).

Nesshöver, C.; Assmuth, T.; Irvine, K. N.; Rusch, G. M.; Waylen, K. A.; Delbaere, B., et al. (2017): The science, policy and practice of nature-based solutions - An interdisciplinary perspective. In: The Science of the total environment 579, p. 1215 - 1227. DOI: 10.1016/j.scitotenv.2016.11.106.

NK Tegelwippen [ed.] (2025): NK Tegelwippen. https://www.nk-tegelwippen.nl/ (18.02.2025).

ÖROK (Geschäftsstelle der Österreichische Raumordnungskonferenz) [ed.] (2025): Das österreichische Raumentwicklungskonzept 2030 (ÖREK2030) - Raum für Wandel. https://www.oerek2030.at/ (17.02.2025).

PLANALP (Plattform Naturgefahren der Alpenkonvention) (2022): Nature-based solutions in the context of natural hazards. Permanent Secretariat of the Alpine Convention. https://www.alpconv.org/fileadmin/user_upload/Organisation/TWB/PLANALP/PLANALP_NbS_policybrief_fin.pdf (10.03.2025).

Plassmann, G.; Kohler, Y.; Badura, M. & Walzer, C. (2016): Alpine Nature 2030 - Creating [ecological] connectivity for generations to come, BMUB - Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety, Berlin. https://www.bmuv.de/fileadmin/Daten_BMU/Pools/Broschueren/alpine_nature_2030_broschuere_en_bf.pdf (10.03.2025).

PSAC (Permanent Secretariat of the Alpine Convention) [ed.] (2019): Climate-neutral and Climate-resilient Alps 2050 - Declaration of Innsbruck Alpine Climate Target System 2050 7th Report on the state of the Alps “Natural Hazard Risk Governance”, Innsbruck, Bolzano. https://www.alpconv.org/fileadmin/user_upload/Organisation/TWB/ACB/AlpineConvention_ClimateActionPlan2.0_EN.pdf (10.03.2025).

PSAC (Permanent Secretariat of the Alpine Convention) [ed.] (2021): Climate Action Plan 2.0. https://alpineclimate2050.org/wp-content/uploads/2021/04/ClimateActionPlan2.0_en_fullversion_FINAL.pdf (24.01.2025).

PSAC (Permanent Secretariat of the Alpine Convention) [ed.] (2022): Multi-Annual Work Programme of the Alpine Conference 2023 - 2030, Innsbruck, Bozen. https://www.alpconv.org/fileadmin/user_upload/Organisation/AC/XVII/AC_MAP_2023-2030_en_web.pdf (10.03.2025).

Rao, R.; Choi, E. & Czebiniak, R. P. (2024): Can ‘Biodiversity Credits’ Boost Conservation? World Resources Institute (WRI). https://www.wri.org/insights/biodiversity-credits-explained (20.01.2025).

Raymond, C. M.; Frantzeskaki, N.; Kabisch, N.; Berry, P.; Breil, M.; Nita, M. R., et al. (2017): A framework for assessing and implementing the co-benefits of nature-based solutions in urban areas. In: Environmental Science & Policy 77, p. 15 - 24. DOI: 10.1016/j.envsci.2017.07.008.

Roveri, G.; Crespi, A.; Eisendle, F.; Rauch, S.; Corradini, P.; Steger, S., et al. (2024): Climate change and human health in Alpine environments - An interdisciplinary impact chain approach understanding today’s risks to address tomorrow’s challenges. In: BMJ global health 8 (Suppl 3). DOI: 10.1136/bmjgh-2023-014431.

Schumacher, E. F. (1973): Small is beautiful - Economics as if People Mattered, 1. Edition, Blond & Briggs, London.

Siedentop, S.; Marschall, J.; Henger, R.; Fleischer, J. J.; Schmitz, J.; Sprenger, J., et al. (2024): Die NRW-Flächenampel - Konzeption eines Planungs- und Informationsinstruments zur Reduktion der Flächeninanspruchnahme in nordrhein-westfälischen Städten und Gemeinden. Institut für Landes- und stadtentwicklungsforschung gGmbh (ILS), Dortmund. DOI: 10.58122/c5s2-wy74.

Steiner, C.; Peham, T.; Spanischberger, A.; Berger, F.; Le Loarer-Guezbar, M.; Glante, F., et al. (2022): Long-Term Action Plan - For the implementation of provisions and declarations on soil protection in the specific context of the Alpine region. Permanent Secretariat of the Alpine Convention, Soil Protection Working Group of the Alpine Convention Mandate 2021-2022, Innsbruck, Bozen. https://www.alpconv.org/fileadmin/user_upload/Organisation/TWB/Soil/Long-term-action-plan_soil-protection.pdf (10.03.2025).

StMWi (Bayerisches Staatsministerium für Wirtschaft, Landesentwicklung und Energie) [ed.] (2023): Zusammenfassende Erklärung sowie Zusammenstellung der Maßnahmen, die für eine Überwachung erheblicher Umweltauswirkungen bei der Verwirklichung des Raumordnungsplans durchgeführt werden sollen - Landesentwicklungsprogramm Bayern Anlage 1 (Teil 3). https://www.stmwi.bayern.de/fileadmin/user_upload/stmwi/Landesentwicklung/Dokumente/Instrumente/Landesentwicklungsprogramm/LEP_2023/F_230516_Zusammenfassende_Erkl%C3%A4rung.pdf (10.03.2025).

Takacs, D. (1996): The Idea of Biodiversity - Philosophies of Paradise, 1. Edition, Johns Hopkins University Press, Baltimore.

UBA (Umweltbundesamt) [ed.] (2022): Die Risiken des Klimawandels für Deutschland - Ergebnisse der Klimawirkungs- und Risikoanalyse 2021 sowie Schlussfolgerungen der Interministeriellen Arbeitsgruppe „Anpassung an den Klimawandel“, Dessau-Roßlau. https://www.umweltbundesamt.de/sites/default/files/medien/376/publikationen/2022_fachbroschure_die_risiken_des_klimawandels_fur_deutschland_220218.pdf (10.03.2025).

UNEP (United Nations Environment Programme) [ed.] (2021): State of Finance for Nature, Nairobi. https://www.unep.org/resources/state-finance-nature-2021 (10.03.2025).

UNEP (United Nations Environment Programme) [ed.] (2022a): Nature-based Solutions: Opportunities and Challenges for Scaling Up - Summary, Nairobi. https://wedocs.unep.org/handle/20.500.11822/40822 (10.03.2025).

UNEP (United Nations Environment Programme) [ed.] (2022b): Resolution adopted by the United Nations Environment Assembly on 2 March 2022 - Nature-based solutions for supporting sustainable development. https://wedocs.unep.org/bitstream/handle/20.500.11822/39864/NATURE-BASED%20SOLUTIONS%20FOR%20SUPPORTING%20SUSTAINABLE%20DEVELOPMENT.%20English.pdf?sequence=1&isAllowed=y (10.03.2025).

UN (United Nations) [ed.] (1987): Our Common Future - Report of the World Commission on Environment and Development (‘Brundtland Report’). https://www.are.admin.ch/are/en/home/media/publications/sustainable-development/brundtland-report.html (10.03.2025).

UN (United Nations) [ed.] (2015): Transforming our world: the 2030 Agenda for Sustainable Development - Resolution adopted by the General Assembly on 25 September 2015 (RES/70/1). https://documents.un.org/doc/undoc/gen/n15/291/89/pdf/n1529189.pdf (20.01.2025).

Urban Agenda for the EU (2016): Pact of Amsterdam. Urban Agenda for the EU, Amsterdam. https://futurium.ec.europa.eu/en/urban-agenda/library/pact-amsterdam (17.02.2025).

Urban Agenda for the EU (2025): The Urban Agenda for the EU - Better Regulation - Better Funding - Better Knowledge. https://www.urbanagenda.urban-initiative.eu/urban-agenda-eu (10.03.2025).

WBCSD (World Business Council for Sustainable Development) [ed.] (2024): The NbS Blueprint - Building business cases for Nature-based Solutions. https://www.wbcsd.org/wp-content/uploads/2024/06/WBCSD-NbS-Blueprint-5June2024-.pdf (10.03.2025).

WHO (World Health Organization) [ed.] (2017): One Health - Q&A. https://www.who.int/news-room/questions-and-answers/item/one-health (17.02.2025).

Wilson, E. O. [ed.] (1988): Biodiversity. With contribution of Frances M. Peter, National Academies Press, 1. Edition, Washington, DC.

WWF [ed.] (2024): Global Roadmap for a Nature-Positive Economy - An economic and financial reform agenda to meet nature and climate goals. https://wwfint.awsassets.panda.org/downloads/global-roadmap-for-a-nature-positive-economy---october-2024.pdf (10.03.2025).

Zahn, A. (2014): Beweidung mit Wisenten - In: Burkart-Aicher, B. et al., Online-Handbuch “Beweidung im Naturschutz”. Akademie für Naturschutz und Landschaftspflege (ANL). www.anl.bayern.de/fachinformationen/beweidung/handbuchinhalt.htm (20.01.2025).

A Appendix – Nature-based Solutions Model Projects

A.1 Pre-selected Nature-based Solutions model projects

Figure 24: Overview of pre-selected NbS model projects and their evaluation

Project Title	Alpine Climate Target System						Alpine Countries							NbS Criteria				Climate Change	
	Natural Hazard	Forest	Agri-culture	Water	Soil	Tourism	AT	DE	CH	FR	IT	LI	SI	Fostering Biodiversity	Fostering Human Well-being	Implementation	Governance Potential	Climate Change Adaption	Climate Change Mitigation
Moorallianz Bayern			x	x	x	x		x						x	x	x	x	x	x
Alternative rainwater management in the Ouagadougou Park of Grenoble	x			x	x					x				x	x	x	x	x	
LIFE Lech	x			x		x	x	x						x	x	x		x	
Albisrieder Dorfbach Zürich	x			x		x			x					x	x	x	x	x	
Bergwaldprojekt e.V.	x	x		x	x	x		x	x					x	x	x	x	x	x
I-SWAMP Integrated small wetlands of the Alps monitoring and protection			x	x	x		x				x		x	x	x	x	x	x	x
LIFE PASTORALP			x							x	x				x	(x)		x	
Rotational pasture management to increase the sustainability of mountain livestock farms in the Alpine region			x		x						x				x	x	?	x	x
REGREEN: Nature based solutions The Gorla Maggiore water park: A nature-based solution to treat Combined Sewer Overflows				x							x			x	x	x	?	x	
Living Lab in Invest4Nature Project: Climate change adaptation and resilience through natural capital and forest management	x	x		(x)			x							x	x	x		x	
Umgang mit invasiven Pflanzen: Herstellung von Ziegeln, Pflanzgefäßen etc. (Krater); Bildungsmaßnahmen und Begleitaktivitäten (Projekt APPLAUSE)													x			x	x	(x)	
Bergbauernmodell Sachrang			x					x						x	x	x	?	(x)	
Erosionsschutz im Kaunertal	x				(x)		x							x	x	x	?	x	
SylvACCTES		x								x				x	x			x	
Slovenia Forest Service																			
Anpassung von Schutzwäldern an Klimawandel entlang der Bahnlinie des Lutschbergs	x	x							x					x	x	x	?	x	
GreenRisk4Alps - Pilot DE Bergwaldoffensive Oberammergau (die übrigen Pilotprojekte sind keine Umsetzungen)	x	x						x						x	x	x	x	x	
Hochwasserschutz Obere Iller	x			x				x						x	x	x		x	
Sicherung der zukünftigen Wasserversorgung auf regionaler und lokaler Ebene im Lavanttal, Kärnten		x		x			x								x	x		x	
Bio Method: Naturbasierte Maßnahmen gegen Steinschläge über Wälder in der Region Engadin, Schweiz	x	x							x						x			x	
FRENE Network			x							x				x	x	?		x	
Sentinel Mountain Pastures Program			x							x					x	(x)		x	
Vermarktung ökologischer Landwirtschaft unter lokalem Label in Murau			x				x							x	x	x			
SEMLES ALPES					(x)					x				x	x	x			
LIFE - Help Soils			x		x						x			x	x	x			
der.inn - lebendig und sicher	x			x			x							x	x	x	x	x	x
INNsieme				x			x	x	x					x		x	x		x
Renaturierung Naßköhrmoos				x			x							x	x	x			x

Source: Authors' own illustration, ifuplan.

A.2 Factsheets

The factsheets document the results of an in-depth analysis of the eight selected NbS model projects. They are available under the following DOI: https://doi.org/10.53197/0006-NBSMPFS

B Appendix – Main institutional players for implementing Nature-based Solutions in the Alpine area

This appendix.2 provides a detailed overview of the main institutional players in the Alpine area and their potential for promoting and implementing NbS. They include the Alpine Convention and its TWBs, the EUSALP and its AGs, as well as the Alpine Space Programme and its different funding priorities.

B.1 Alpine Convention

Against the background of the selected model projects in this report, the Alpine Convention's TWBs and their potential for driving NbS are explored here. The TWBs directly connected to the focus of the selected model projects are analysed with regard to their respective NbS options. The other TWBs with no direct connection are only dealt with very briefly. Nevertheless, they also offer some points of reference for NbS, as mentioned in the respective description.

B.1.1 Alpine Biodiversity Board

Founded in 2019, the goal of the Alpine Biodiversity Board is to take stock of relevant biodiversity and landscape strategies, guidelines and policy recommendations for Alpine countries and international bodies. The Board intends to develop a system for joint action in the Alpine area, also with a focus on ecological connectivity. It also emphasises the need to use indicators for mountain biodiversity to address specific features in biodiversity strategies.

The Alpine Biodiversity Conference has identified four thematic clusters for future action: conservation, connectivity, restoration and monitoring (AC 2024). Implementing the EU Nature Restoration Law, launched in 2024, is identified as a focus area for the Board's ongoing work. In the policy brief on Biodiversity in the Alps of the Alpine Convention, one recommendation is to 'elaborate an Alpine Restoration Plan identifying strategic action to restore priority habitats and areas at Alpine level' (AC 2024, p. 10). The Board dedicated an international workshop in November 2024 to nature restoration in the Alpine region, with a view to implementing the EU Nature Restoration Law, whereby the use of NbS for ecosystem restoration and connectivity and transboundary measures were identified as key actions.

The policy brief also confirms the need to elaborate an *Alpine Biodiversity Action Plan* at pan-Alpine level, stating that multi-functional benefits from nature protection measures such as NbS are key. The Alpine Biodiversity Action Plan aims to create synergies between biodiversity, land use, climate action and quality for life.

Implementing green infrastructure in the Alps is the core objective of Alpine Nature 2030 (Plassmann et al. 2016), a study recommending that ecosystem service-based approaches (such as NbS) are used as a new impetus for trans-sectoral collaboration, and that ecological connectivity is protected and improved via the assessment and valuation of ecosystem services.

Options for NbS:
NbS may be an important tool to safeguard and support mountain biodiversity through the different kind of solutions, with synergies developed in the fields of natural hazard prevention and implementation of the EU Nature Restoration Law (EU 2024).

Numerous projects in the Alpine area bear witness to the feasibility of NbS, as well as identifying areas and measures for biodiversity improvement and ecological connectivity. Projects such as *PlanToConnect*, *OpenSpaceAlps*, *LUIGI* or *ALPBIONET2030* can provide reference areas for implementing NbS directly supporting mountain biodiversity.

B.1.2 Alpine Climate Board

The Alpine Climate Board (ACB) steers and bundles climate action within the framework of the Alpine Convention. The Board has developed two main tools, the Alpine Climate Target System 2050 (PSAC 2019), and the Climate Action Plan (CAP) 2.0 (PSAC 2021), both of which have been adopted by the Alpine Conference. One core focus of the CAP 2.0 are the "implementation pathways" – short- and medium-term measures in ten different sectors identified by the ACB in close cooperation with the other TWBs of the Alpine Convention.

CAP 2.0 features 16 priority pathways (out of a total of 30 pathways) (see Figure 25).

Options for NbS:

- The pathways identified and elaborated by the ACB are of exemplary nature. NbS can certainly support implementation of these pathways, particularly *Ecosystems & biodiversity*, *Mountain forests*, *Alpine soils*, *Water*, *Natural hazards* and *Tourism*. Close collaboration with the ABB can further support the mutual benefits deriving from the activities and objectives.
- Further actions for the ACB could include collecting best practices in climate mitigation and adaptation, NbS in the Alpine area, and encouraging further NbS projects in this field.

Figure 25: Sixteen priority pathways in the Climate Action Plan 2.0

Source: PSAC (2021).

B.1.3 Natural Hazards Working Group – PLANALP

The objective of the Alpine Convention's Natural Hazards Working Group (PLANALP) is to elaborate strategies designed to prevent natural hazards in the Alps as well as to foster exchange on adaptation strategies. Driven by climate changes and increasing urban, infrastructure and tourism development in the Alpine area, the damage caused by such hazards materialising is constantly increasing.

NbS are particularly relevant in this field and the WG has already published a paper on NbS for natural hazard management (PLANALP 2022) which refers also to the CAP 2.0. In this paper the WG outlines many NbS examples in different fields which, when combined, have the potential to

reduce the dimension of natural hazards. NbS advantages but also potential disadvantages are addressed.

Options for NbS:

- Based on a broad perception of NbS potential, PLANALP pointed out the relevance of spatial planning and funding for NbS implementation at an early stage (PLANALP 2022). This potential could be strengthened through a collaboration with the Spatial Planning and Sustainable Development Working Group in the Alpine Convention and funding from national and European sources. As an NbS frontrunner, the PLANALP also could give advice on how to design a tool for assessing NbS.

B.1.4 Ad hoc Working Group for drafting the Report on the State of the Alps

The State of the Alps reports (RSAs) are prepared by ad hoc WGs composed of experts from the Alpine countries. Led by the Slovenian Presidency, the Ad hoc Working Group for the elaboration of the 10th Report on the State of the Alps (Marot et al. 2025) focuses on "Quality of life in the Alps", an important cross-cutting issue with many links to NbS. The Working Group identified five topics as crucial for the quality of life in the Alps: 1) the environment, 2) infrastructure and services, 3) work and financial security, 4) social relations, and 5) governance, with NbS able to make valuable contributions especially to the following topics:

- **Environment**: RSA 10 identified climate change and natural hazards as major challenges, with NbS able to play an important role for climate change mitigation and adaption as well as in the wider field of natural hazards. As shown in this study, NbS are already contributing significantly to protection against natural hazards. Examples include river restoration reducing the risk of flooding and protecting groundwater, and protective forests stabilising slopes. Broader application of these NbS also contributes to improving the quality of life.
- **Social relations**: RSA 10 identifies deficits in social interaction among older and younger age cohorts, particularly in sparsely populated regions. One recommendation is to provide venues where people can become involved and community life supported. Here too, NbS offer various opportunities for participation, from the planning to the implementation of measures. It is also desirable to involve the local population.
- **Governance**: RSA 10 identified governance as 'the quality of life aspect that consistently receives the lowest score and the least amount of public trust' (Marot et al. 2025, p. 68). NbS could help enhance trust, especially when NbS projects are organised in a participatory way.

RSA 11 will be dedicated to glaciers and permafrost in times of global warming. Adaption to the increasing natural risks connected with the withdrawal of glaciers and permafrost offer a wide field for NbS. For example, NbS related to water retention can improve the future summer water balance, while other NbS can contribute to stabilising slopes.

B.1.5 Other Thematic Working Bodies

Other existing TWBs within the Alpine Convention may also have the opportunity to implement NbS in their thematic fields::

- **Large Carnivores, Wild Ungulates and Society Working Group** – WISO: This WG deals with the management of large carnivores and wild ungulates, with a view to aligning their

abundance harmoniously with society. The WG also considers economic and social aspects in a balanced manner.
Large carnivores and ungulates represent a specific kind of NbS as large carnivores can help keep deer populations in balance, particularly in remote Alpine areas where hunting is difficult. Different species of large ungulates can act as landscape designers for natural and semi-natural landscapes, keeping landscapes open. They are also tourist attractions. Various projects using large ungulates for landscape management exist[7]. Depending on the species they will require specific management (Zahn 2014). First considerations at national level in Germany exist on how a network for large mammals could be maintained, with the Alpine area being considered a functional area of national importance (Hänel & Reck 2010). Remote Alpine areas might offer good opportunities for implementing such concepts, although public involvement would be a crucial issue.

- **Mountain Agriculture and Mountain Forestry Working Group**: The WG is aligned with priorities of the Alpine Convention's Multi-Annual Work Programme 2023-2030 (PSAC 2022). Many designated activities are linked to NbS, such as *Conserving and valuing Alpine biodiversity and ecosystems*" or *Taking ambitious climate action*. Also contributing to the ACTS 2050, the WG is focused on promoting climate-friendly agriculture. Moreover, the development of sustainable value chains in forestry and agriculture present potential linkages to NbS.

  The WG is already involved in the concept of circular economy and green economy, for which NbS may be another entry point. NbS could be fostered by the WG in the field of soil management (conservation of organic matter for CO_2 sequestration) and water management (cutting back artificial drainage systems, increasing groundwater infiltration, developing riparian strips) in mountain agriculture. Moreover, mountain forestry NbS can be encouraged, including site-specific afforestation, reducing numbers of forest roads, or preventing natural hazards (see section above).

- **Soil Protection Working Group**: The WG contributes to protecting and improving Alpine soil conditions. Its current focus is on the economical and prudent use of soil in the Alps, peatland protection, comparable soil data, soil literacy, awareness-raising, and knowledge exchange. In its long-term action plan (Steiner et al. 2022) the WG explicitly refers to NbS as a way to mitigate and prevent risks, defining them as long-term actions for the WG.

  The WG can foster NbS implementation in the fields of avoiding soil loss through land use changes, erosion or natural hazards, through maintaining and even increasing organic matter in soils, particularly in peatlands and wetlands, as well as through fostering NbS projects in urban and commercial areas as soil-friendly measures.

- **Spatial Planning and Sustainable Development Working Group:** The WG has drafted an assessment study on cross-border spatial development and contributed to the RSA 9 on Alpine Towns and the implementation of the pathways to achieve the Alpine climate targets by 2050. The WG is working on further contributions to the ACTS 2050 and on a draft for an Alpine Spatial Planning Perspective.
  As regards NbS implementation, WG actions are not directly. However, they are possible in many indirect ways, for example through limiting land conversion through smart spatial development using NbS – a major lever to reduce soil and biodiversity loss and mitigate climate impacts. Examples such as flood retention areas, river revitalisation and flood

[7] https://www.nabu-station-oste-region.com/auerochsen/ ; https://kunst-und-natur.de/massnahmen/ganzjahresbeweidung ; https://www.naturpark-altmuehltal.org/auerochsen/

retention are mentioned in (PLANALP 2022) and are part of the long-term action plan of the Soils Protection Working Group. The WG can develop and provide tools for NbS implementation which allow for recognition, delineation and compensation mechanisms between landowners and NbS beneficiaries. Concepts including financial transfer tools are needed to compensate spatial disparities in terms of NbS implementation. Various concepts are already being developed such as a planning permit trading system (Henger et al. 2019; Siedentop et al. 2024), biodiversity credits (BCA 2024; Rao et al. 2024), or CO_2 credits, all of which require space and are set to be a relevant topic for trans-border cooperation. As NbS are closely linked to ecosystem services, concepts for the spatial consideration of such services represent a future-oriented approach and may be taken into account via informal instruments or to some extent formal planning instruments (Deppisch et al. 2022; Lezuo et al. 2020).

- **Transport Working Group**: This WG focuses on evaluating the potential of new technologies for promoting sustainable transport and for sustainable mobility policies in the Alps. The WG is in contact with various bodies working on transport in the Alps, such as EUSALP AG4 and the Zurich Process and the Spatial Planning and Sustainable Development Working Group.
  Opportunities for NbS implementation exist through the national and trans-national encouragement of NbS on road and rail side strips and adjacent areas but also in cooperation with the Spatial Planning and Sustainable Development Working Group on reducing land conversion for transport purposes.

B.2 Macro-regional Strategy for the Alpine Region – EUSALP

The EUSALP is the second of three important transnational cooperation frameworks through which NbS should be fostered and established. Being the EU's fourth macro-regional strategy, it was adopted by the European Commission in 2015. Its establishment addressed the need to tackle common challenges in the region, with the overarching goal of achieving greater economic, social and territorial cohesion.

Its organisational structure features 9 thematic AGs working on different topics. Furthermore, the AGs cooperate with each other when it comes to synergies and forming specific task forces to tackle broader challenges.

B.2.1 Action Group 1: Research and Innovation

AG1's overall goal is 'to develop an effective Research & Innovation ecosystem for the Alpine Region' (EUSALP 2021, p. 3). It established two key topics for the period 2023-2025: the green transition and the digital and energy transition. Climate change adaptation and innovation are two of the main activities here, with the AG setting itself the goal of compiling a portfolio of NbS and best practices for Alpine mountain regions. (EUSALP 2021)

As universities and research institutions play a key role in fostering sustainable development, strengthening, and leveraging networks of universities and bringing together actors can be a strategic asset for the Alpine region. AG1 also seeks to establish joint teaching and research on topics and challenges of particular relevance to the Alpine region and possibly requiring specialised skills. (EUSALP 2021)

NbS can significantly benefit from AG1's work in promoting sustainable research and development, as they provide a framework for innovative, ecosystem-centred approaches to address environmental, social and economic challenges, in line with the goal of fostering research tailored to the special conditions of the region. Clearly, NbS are also helpful when it comes to climate change adaptation. Nonetheless, researching them requires input from multiple disciplines. Here, AG1 could encourage interdisciplinary collaboration for Alpine-specific solutions.

B.2.2 Action Group 2: Economic Development

AG2 focuses on enhancing the economic potential of strategic sectors and improving the economic and social conditions across the Alpine macro-region. Its key aim is to better utilise the region's unique resources and support SMEs by improving framework conditions and opportunities. AG2 seeks to advance a balanced and sustainable development model, emphasising innovative approaches to ensure the region's long-term resilience and prosperity (EUSALP 2021).

NbS can play a major role here by boosting sustainable tourism through promoting restored ecosystems and protected natural areas, thereby attracting visitors and providing long-term economic benefits while preserving the environment. In addition, by integrating NbS into agricultural practices, for example, AG2 can create new value chains, while NbS implementation can benefit the labour market in related sectors. By adopting NbS, AG2 can thus achieve a balance between economic growth and environmental preservation, fostering a sustainable and resilient economy in the Alpine region.

B.2.3 Action Group 3: Labour Market, Education and Training

AG3 aligns education and training with Alpine labour market needs, focusing on green and digital transitions. It supports students in vocational education and training (VET) as well as workers through lifelong learning, aiming to upskill and reskill them for new job opportunities.

It also aims to raise awareness of job opportunities, particularly for youth, and enhance training programmes that combine technical and soft skills. Key sectors like forestry, agri-food and tourism are prioritised, supporting a shift toward a circular economy. Through these initiatives, the AG is working to create a macro-regional educational space meeting the evolving needs of the Alpine economy. (EUSALP 2021)

By incorporating NbS into VET curricula and evolving professional profiles, AG3 can align education with the growing demand for green jobs and sustainable practices in the Alpine region. Moreover, NbS projects, such as reforestation or wetland restoration, can boost employment in rural areas, thus contributing to retaining local talents and reducing depopulation.

B.2.4 Action Group 6: Resources

The Alpine region holds exceptional natural and cultural resources, historically utilised in ways that have impacted both the environment and the resources themselves. Conflicts often arise between conserving these resources and exploiting them economically. AG6 works to sustainably preserve and enhance them, contributing to a framework that ensures their future viability. Guided by the motto, 'With Alpine heritage today for a sustainable, resilient and innovative tomorrow' (EUSALP 2021, p. 4), AG6 aims to maintain the Alps as a unique and liveable space for future generations.

In line with this mission statement, AG6 identified key priorities for the period 2023-2025: water, forestry and agriculture, soil and biodiversity as well as cultural heritage (EUSALP 2021). The AG agreed upon the need to further enhance and pursue the work of the Task Force on Multifunctional Forests and Sustainable Use of Timber (TF-MFSUT) as their Strategic Flagship Initiative which was established in cooperation with other AGs of the Programme in 2019.

'One of the main issues addressed by the TF-MFSUT are the governance mechanisms needed to increase the resilience of mountain forests, in particular regarding the impacts of climate change' (EUSALP 2021, p. 10). To tackle this, the cross-sectoral and interdisciplinary approach chosen by the TF is of great importance. In addition, 'the TF-MFSUT continues to promote the implementation of nature-based solutions as an effective way to address challenges of preserving biodiversity, protecting against natural hazards, and maintaining the multifunctionality of EUSALP forests. For instance, nature-based solutions can be used to promote the renewable material wood capable of replacing artificial raw materials or fossil energy sources, whereby further emissions of greenhouse gas could be captured and reduced. In this perspective, multifunctional forests, as nature-based solutions, are further explored as a tool for territorial resilience to be promoted and combined with existing technical solutions' (EUSALP 2021, p. 10).

Likewise, during the current working period, the establishment of a Task Force on Water Transition was proposed and implemented, as this aligns well with one of the four defined cross-cutting priorities. As in the TF-MFSUT, this Task Force is formed across several AGs and benefits from the exchanges among them to reach its objectives, including the capitalisation of results on the political level.

It becomes evident that AG6 has large room for manoeuvre when it comes to NbS implementation and has already integrated them directly into its programme. For future programmes, NbS need to be further analysed, explored and promoted.

B.2.5 Action Group 7: Green Infrastructure

Within the EUSALP Working Programme 2023 – 2025, Green Infrastructure (GI) has been defined as a 'strategically planned network of natural and semi-natural areas with other environmental features, designed and managed to deliver a wide range of ecosystem services, while also enhancing biodiversity' (EUSALP 2021, p. 3). This definition is closely linked to the character of NbS. NbS should thus constitute a crucial part of AG7's strategies, whose focus lies on enhancing biodiversity and ecosystem services by fostering ecological connectivity within a multifunctional GI network. Such a network – if functionally interconnected – can offer a wide range of advantages for nature and humans. Through collaboration with diverse Alpine stakeholders, it promotes sustainable regional planning based on EU GI strategies. AG7's initiatives aim to identify and connect transnational ecological elements, improve governance and planning tools, and secure funding. By advocating GI as a complement to Grey Infrastructure, AG7 addresses climate resilience, transboundary collaboration and economic opportunities, bridging the gap between nature and development to support a green, circular economy in the Alpine region. (EUSALP 2021)

Similar to NbS, Green Infrastructure can have an important impact on large areas which serve as living environments for different ecosystems (e.g. wetlands, forests, urban areas etc.) and are related to one or more sectors (e.g. agriculture, forestry, water etc.). Moving forward, AG7 will adopt a broader landscape approach, viewing ecosystems and sectors as distinct yet interconnected components of multifunctional landscapes. This approach facilitates identifying links, synergies, and conflicts among these elements. (EUSALP 2021)

The EU's Nature Restoration Law, part of the Biodiversity Strategy and the European Green Deal, seeks to restore degraded ecosystems, focusing on carbon capture, disaster prevention and biodiversity. Following the approval of the Nature Restoration Law in 2024 by the European Parliament and the Council of the EU, all member states must draft National Restoration Plans within a two-year period. The Alps are one of the largest mountainous regions in Europe and therefore vital for unique species. Besides that, they offer benefits like clean air, water resources, and numerous recreation areas. AG7 aims to integrate GI and connectivity into these efforts, collaborating with experts and initiatives to promote cross-border cooperation. Using NbS as a tool 'to better understand what Green Infrastructure is and how it can be used to maintain or increase the quality of life. […] A set of NbS will be selected and used to support activities in awareness rising of the general public and capacity building of the experts' (EUSALP 2021, p. 10). Through this, AG7 highlights sustainable practices like reforestation and wetland restoration to enhance ecological resilience and human well-being. As the importance of NbS is growing in the face of current global challenges like the climate crisis and biodiversity loss, they provide possibilities to tackle these crises while at the same time protecting the natural systems on which humanity depends.

Launched by the AG, the GI Goes Business Award is an initiative which 'supports innovative ideas, products and services for Green Economy and promotes sustainable development in the EUSALP' (EUSALP 2021, p. 9). In 2024 the award was successfully held for the third time consecutively. Among its aims were: secure financing of the initiative itself, improve visibility and scale it up towards becoming a real green business incubator.

Here too, NbS are already being put forward in the strategy, as they inter alia

- can restore and enhance ecosystems and thus strengthen ecological connectivity and improve ecosystem services;
- can support climate adaptation and mitigation by enhancing carbon sequestration (e.g. wetland restoration);
- often require cross-sectoral collaboration and therefore promote this once they are implemented.

B.2.6 Action Group 8: Risk Governance

'Action Group 8 aims at improving and enhancing policies and management strategies in the areas of risk management and climate change adaptation. The overall objective is to contribute to the strategic, sustainable and climate-resilient development of the Alpine macro-region' (EUSALP 2021, p. 3). In order to attain this overarching goal, the AG is a focal point for knowledge as well as experience transfer. The strategic flagship initiative set up by the AG is the Climate Adaptation Platform for the Alps (CAPA). This serves as a facilitator towards reaching the aforementioned goal and promoting cooperation between various stakeholders and networks in the field (local, regional and national public authorities, universities and research institutions, NGO's, international organisations and networks).

Emphasising NbS, AG8 will explore the role of green spaces, protective forests and ecosystem services in adaptation and hazard prevention, while collaborating with the Interreg Alpine Space project MOSAIC to harmonise data and raise awareness among stakeholders. To drive action, AG8 will also develop policy recommendations on climate adaptation and hazard management. All results of these efforts will be published through the CAPA platform, thereby sharing the knowledge among all relevant stakeholders and the general public.

It thus becomes very clear that NbS can play a major role in the work field of AG8, as many of the developed and already implemented concepts and projects within this framework target the prevention of extreme weather events caused by the climate crisis. At the same time, they do no further harm or damage to the ecosystems and environments in which they are implemented and make use of on-site present ecosystem services and natural conditions. Hence, AG8 should consider integrating all NbS suitable for preventive risk management and adaptation to climate change – for instance restoring wetlands to shield local communities from flood waters or revitalising floodplains to reduce the risk of flood water in lower reaches – as standardised instruments for future programmes.

B.3 Alpine Space Programme

The Alpine region is highly diverse, featuring a wide range of landscapes, from mountains to lowlands, and urban centres to remote rural areas. Its cultural and economic variety makes both the region as a whole and its individual areas unique. However, crises such as climate change, biodiversity loss, pandemics and financial instability, along with future challenges like digitalisation, remoteness and climate neutrality, require tailored solutions to ensure a stable and equitable future.

The Alpine Space Programme 2021-2027 (Interreg 2022) addresses these challenges through supporting projects that tackle them effectively. It emphasises that transnational cooperation at

various governance levels can offer comprehensive, place-based solutions to environmental, economic and social issues. The programme views environmental and climate-related challenges as opportunities to transition toward sustainable economies and societies. Organised around four priorities for the entire region, the programme outlines Specific Objectives under each priority. The following sections summarise these priorities and explore how NbS can contribute to achieving the overall goals. (Interreg 2022)

B.3.1 Priority 1: Climate resilient and green Alpine region

The Alpine region's unique topography makes it especially vulnerable to climate change, with rising temperatures, shifting precipitation patterns and a higher snow line leading to water shortages, heatwaves and warmer winters. These changes will heighten natural risks, affecting sectors such as tourism, agriculture, forestry, water management and infrastructure. To address these challenges, experts and policymakers must adopt NbS to climate adaptation and disaster risk prevention. Experience shows that the costs of inaction far outweigh the investments needed now.

Furthermore, protecting nature and biodiversity which have been severely threatened by rapid lifestyle changes and resource exploitation since the mid-20th century is crucial. Landscape fragmentation and ecosystem degradation have worsened, with the climate crisis and some countermeasures (e.g., wind parks affecting bird populations) exacerbating the situation. Enhancing biodiversity, improving ecosystem connectivity, and developing multifunctional green and blue infrastructures are critical for protecting biodiversity, sustaining ecosystem services, preserving cultural landscapes, and supporting local economies like tourism and agriculture (Interreg 2022).

Activities related to this priority should prioritise NbS wherever possible, as they enhance climate resilience, support biodiversity, manage water sustainably, mitigate climate change, empower communities, develop green infrastructure, and offer cost-effective solutions.

B.3.2 Priority 2: Carbon-neutral and resource-sensitive Alpine region

The Alpine region, a global leader yet significant contributor to greenhouse gas emissions, must reduce energy consumption to combat climate change. Despite progress in energy efficiency, more effort is needed in key sectors like transport, buildings and tourism. Local, regional and transnational measures are essential, but achieving carbon neutrality requires innovative, integrated approaches promoting post-carbon lifestyles. The Alpine region's unique features make it ideal for testing these solutions.

The linear economy's high resource consumption and waste generation highlight the need for a shift to circular, green and bio-economy models. These approaches minimise resource use, energy consumption and environmental impacts while fostering social inclusion. Rich in natural resources like wood and renewables, the Alpine region presents opportunities for sustainable circular economies but faces challenges in key sectors like tourism and mobility. Balancing resource use with protection is crucial. Circular economy strategies can drive innovation, value chain development and sustainable growth, decoupling economic progress from resource depletion. Leveraging its environmental sensitivity and innovation, the Alpine region can lead in adopting circular, green, and bio-economy solutions through transnational collaboration with diverse stakeholders (Interreg 2022).

NbS must be considered as an important pillar towards meeting this priority, as they can inter alia restore damaged ecosystem services, reduce carbon emissions, promote resource efficiency and foster behavioural change by involving communities in sustainable practices. These solutions provide cost-effective, multi-functional benefits in line with goals for carbon neutrality and resource sustainability in the Alpine region.

B.3.3 Priority 3: Innovation and digitalisation supporting a green Alpine region

Transnational cooperation on innovation and digitalisation can advance a climate-resilient, green and resource-sensitive Alpine region by addressing territorial imbalances and fostering equitable development. The region's innovation performance is uneven, especially in rural areas. Strengthened collaboration among diverse actors and improved access to innovation and digitalisation can boost competitiveness and inclusivity. Future efforts should focus on green innovation, testing, and transnational implementation to address pressing needs while promoting carbon-neutral and sustainable solutions (Interreg 2022).

Through establishing more refined cooperation frameworks among all kinds of actors in one field and integrating them into relevant policies, their individual capacity is strengthened. This is particularly important when it comes to territorial imbalances. NbS projects often pursue bottom-up approaches and offer a wide range of innovative possibilities, through which actors on a local level are empowered to greatly contribute to a Green Alpine Region. For example, by encouraging green entrepreneurship and thus fostering green innovations or driving digitalisation by using tools like GIS to monitor and optimise NbS or using virtual platforms to engage communities.

B.3.4 Priority 4: Cooperatively managed and developed Alpine region

Promoting transnational cooperation and cross-border exchanges is central to all transnational programmes. Strengthening the institutional capacity of public authorities and stakeholders is essential for effective collaboration. The Alpine region boasts a strong tradition of high-quality public administrations and cooperation across various governance levels, from local to macro-regional, especially within initiatives like EUSALP. These efforts take place in diverse formats, including EU-funded programmes, bilateral agreements and frameworks like the Alpine Convention. Current challenges, such as climate change and digital transformation, highlight the need for public administrations to evolve beyond isolated approaches and embrace modern, multilevel governance. Priority areas for support include improving communication between governance levels, capacity-building and fostering cross-sectoral cooperation (Interreg 2022).

Here, NbS require and promote cross-sectoral collaboration. Once implemented, they build resilience in terms of climate change adaptation and can promote sustainable economic development. Hence, they help the Alpine region collaborate effectively on environmental challenges, enhancing local economies and fostering a sustainable, resilient future.