Federal Agency for Nature Conservation

The Social Dimension of Nature-based Solutions

Guidance Report

Vanessa Haines-Matos, Irina Kozban, Nour Bassil, Sunita Chaudhary, Carine Ghassibe, Nicole Hynek, N'Golo Abdoulaye Koné, José Ernesto Mancera Pineda, André Mascarenhas, Günther Schreder, Kolotchèlèma Simon Silué, Salma N. Talhouk and Lisa Biber-Freudenberger

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André Mascarenhas
Günther Schreder
Kolotchèlèma Simon Silué
Salma N. Talhouk
Lisa Biber-Freudenberger

Contributions:
Marcelo Inácio da Cunha
Mohamed T. Kamar
Jairo Humberto Medina-Calderón
Adriana Santos-Martínez

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Authors' contact details:

Vanessa Haines-Matos	Center for Development Research, Bonn University, Germany E-mail: vhainesm@uni-bonn.de
Irina Kozban	Federal Agency for Nature Conservation, Germany
Nour Bassil	American University of Beirut, Lebanon
Dr. Sunita Chaudhary	International Center for Integrated Mountain Development, Nepal
Carine Ghassibe	American University of Beirut, Lebanon
Mag. Nicole Hynek	University for Continuing Education Krems, Austria
Prof. N'Golo Abdoulaye Koné	Université Félix Houphouët-Boigny, Côte d'Ivoire
Prof. José Ernesto Mancera Pineda	Universidad Nacional de Colombia
Dr. André Mascarenhas	Institute of Landscape Planning and Ecology (ILPÖ), University of Stuttgart, Germany
Mag. Günther Schreder	University for Continuing Education Krems, Austria
Kolotchèlèma Simon Silué	Uiversité Félix Houphouët-Boigny, Côte d'Ivoire
Prof. Salma N. Talhouk	American University of Beirut, Lebanon
Jun-Prof. Lisa Biber-Freudenberger	Center for Development Research, Bonn University, Germany E-mail: lfreuden@uni-bonn.de

Contributing Authors' contact details:

Dr. Marcelo Inácio da Cunha	Center for International Forestry Research and World Agroforestry (CIFOR-ICRAF)
Mohamed T. Kamar	Center for Development Research, Bonn University, Germany
Prof. Jairo Humberto Medina-Calderón	Universidad Nacional de Colombia
Prof. Adriana Santos-Martínez	Universidad Nacional de Colombia

BfN specialist support:

Irina Kozban Division I 2.4 "International nature conservation", E-mail: Irina.kozban@bfn.de

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Summary

Nature-based Solutions (NbS) encompass ecosystem protection, restoration, and sustainable management to address various societal challenges such as climate change, disaster risk, and biodiversity loss while aiming to enhance human well-being. However, despite their cost-effective multifunctional benefits, NbS face various operational hurdles. The social dimension of NbS remains overlooked, posing challenges for inclusive and equitable implementation. This Guidance Report distils the lessons learnt from research and practice, aiming to inspire and equip all those working towards a sustainable and socially just future through NbS. It offers a theoretical and practical framework to define and better understand the social dimension of NbS, support social safeguarding and specifically promote transdisciplinary, participatory NbS design and implementation, and enhance the societal benefits of NbS.

In the BioClimSocial project, **the social dimension** of NbS is understood as: The process and principles of integrating social dynamics throughout the NbS intervention cycle, as well as the social impacts or outcomes that result from these interventions.

The main lessons learned are:

- **Considering the social dimension throughout the full NbS** cycle is essential for identifying and addressing all stakeholder needs and priorities and ensuring equitable distribution of benefits; neglecting this dimension risks undermining both social outcomes of NbS and long-term sustainability.
- **Processes and fundamental principles to guide NbS** include acknowledging diversity of perspectives and stakeholders; following rights-based approaches; ensuring justice, equity, and access; integrating various knowledge systems; understanding the cultural context and social networks; aiming at establishing collaborative governance and effective, eye-level communication.
- **Social co-benefits** that can be achieved when NbS are designed and implemented in line with the above principles include, among others, contribution to individual and societal well-being, improved quality of life, promotion of equality and the strengthening of community resilience, provision of economic and financial opportunities, improved land tenure security, the promotion of the value of traditional and local knowledge, fostered human-nature connections, and enhanced local decision-making processes.
- **Negative social consequences or trade-offs** can occur at any of the NbS stages when the social context of NbS is not understood or core social principles are neglected. This includes reinforcing social inequalities, land-use conflicts, and temporary or localised economic losses, putting a strain on social dynamics.
- Positive social outcomes are more likely when NbS are implemented through **inclusive, participatory and context-sensitive approaches**. A **transdisciplinary** perspective on NbS implies acknowledging and integrating diverse interests, perceptions, values and knowledge systems through collaborative processes that engage a wide range of actors and stakeholders across all the project stages.
- **Practises leading to positive social outcomes** in NbS require appropriate guidance: frameworks, tools and methodologies grounded in robust socio-ecological research, real-world observations, lessons from case studies, and insights from actors and stakeholders. Some aspects of the NbS social dimension are discussed in scientific and especially grey

literature, yet significant knowledge and implementation gaps remain.

- **Engagement processes in NbS** rely on stakeholder mapping; establishing transparent and ethical project frameworks that integrate safeguarding principles; assessing the underlying factors that influence meaningful participation such as, for example, the political situation; identifying and applying suitable methods (e.g. focus group interviews or participatory workshops) to foster knowledge braiding and to move towards co-production of knowledge. Establishing transparent and adaptive communication and reflective monitoring help to navigate and steer the process.
- **Enablers of transdisciplinarity in NbS** include inclusive and culturally sensitive project design, trust-building, recognition of land rights, use of Indigenous and local language, ethical engagement, and appropriate financial and logistical support that lowers participation barriers. **Challenges** include land tenure insecurity, power asymmetries, political instability, institutional rigidities (for example, specific procedures), and seasonal or cultural constraints.
- **Planning and implementing** NbS with proper consideration of the social dimension can create **a self-reinforcing feedback loop** where socially sound processes and approaches ensure greater relevance, acceptance, effectiveness, and overall impact of interventions, and positive outcomes in turn help strengthen trust and engagement, enhancing both sustainability and resilience in the face of intensifying biodiversity loss and climate change.

Zusammenfassung

Naturbasierte Lösungen (NbS) umfassen den Schutz, die Wiederherstellung und die nachhaltige Bewirtschaftung von Ökosystemen, um verschiedenen gesellschaftlichen Herausforderungen wie dem Klimawandel, Katastrophenrisiken und dem Verlust der biologischen Vielfalt zu begegnen und gleichzeitig das menschliche Wohlergehen zu fördern. Trotz ihrer kosteneffizienten und multifunktionalen Vorteile stehen NbS jedoch vor Herausforderungen. Die soziale Dimension von NbS bleibt häufig unberücksichtigt, was ihre inklusive und gerechte Umsetzung erschwert.

Dieser Leitfaden fasst aus Forschung und Praxis gewonnenen Erkenntnisse zusammen und soll all jene inspirieren und befähigen, die mithilfe von NbS auf eine nachhaltige und sozial gerechte Zukunft hinarbeiten. Er bietet einen theoretischen und praktischen Rahmen, um die soziale Dimension von NbS besser zu definieren und zu verstehen, soziale Schutzmechanismen zu stärken sowie insbesondere eine transdisziplinäre und partizipative Gestaltung und Umsetzung von NbS zu fördern und so ihre gesellschaftlichen Vorteile zu steigern.

Im BioClimSocial-Projekt wird die **soziale Dimension von NbS** folgendermaßen verstanden: Sie umfasst den Prozess und die Prinzipien der Integration sozialer Dynamiken während des gesamten NbS Interventionszyklus sowie die sozialen Auswirkungen oder Ergebnisse, die aus diesen Interventionen resultieren.

Die wichtigsten Erkenntnisse sind:

- **Die Berücksichtigung der sozialen Dimension im gesamten NbS-Zyklus** ist entscheidend, um die Bedürfnisse und Prioritäten aller Interessengruppen zu identifizieren und zu berücksichtigen sowie eine gerechte Vorteilsverteilung sicherzustellen. Wird diese Dimension vernachlässigt, gefährdet dies sowohl die sozialen Ergebnisse von NbS als auch die langfristige Nachhaltigkeit.
- **Prozesse und grundlegende Prinzipien** zur Unterstützung von NbS umfassen die Anerkennung der Diversität verschiedener Perspektiven und Stakeholder; die Wahrung der Rechte aller Beteiligten durch rechtsbasierte Ansätze; die Gewährleistung von Gerechtigkeit, Gleichberechtigung und Zugänglichkeit; die Integration verschiedener Wissenssysteme; das Verstehen des kulturellen Kontexts und der sozialen Netzwerke; sowie das Ziel, kollaborative Governance und effektive Kommunikation auf Augenhöhe zu etablieren.
- **Soziale Vorteile**, die durch die Umsetzung von NbS im Einklang mit diesen Prinzipien erreicht werden können, umfassen Beiträge zum individuellen und gesellschaftlichen Wohlergehen, eine verbesserte Lebensqualität, die Förderung von Gleichstellung und eine stärkere Resilienz der Gemeinschaft, die Schaffung finanzieller und wirtschaftlicher Möglichkeiten, verbesserte Landnutzungssicherheit, gesteigerte Wertschätzung von traditionellem und lokalen Wissen, die Stärkung von Mensch-Natur-Beziehungen sowie verbesserte lokale Entscheidungsprozesse.
- **Negative soziale Folgen oder Zielkonflikte** können in jeder Phase von NbS auftreten, wenn der soziale Kontext nicht verstanden oder grundlegende soziale Prinzipien vernachlässigt werden. Dazu zählen die Verstärkung sozialer Ungleichheiten, Landnutzungskonflikte sowie temporäre oder lokal begrenzte wirtschaftliche Verluste, was soziale Dynamiken belastet.

- Positive soziale Auswirkungen sind wahrscheinlicher, wenn NbS durch **inklusive, partizipative und kontextsensible Ansätze** umgesetzt werden. Eine **transdisziplinäre** Perspektive auf NbS bedeutet, unterschiedliche Interessen, Wahrnehmungen, Werte und Wissenssysteme anzuerkennen und durch kollaborative Prozesse zu integrieren, die eine breite Palette von Akteuren und Interessengruppen in allen Projektphasen einbeziehen.
- Praktiken, die zu positiven sozialen Ergebnissen bei NbS führen, erfordern **geeignete Leitlinien**: Rahmenwerke, Instrumente und Methoden, die auf solider sozioökologischer Forschung, realen Beobachtungen, Fallstudien sowie Erkenntnissen von Akteuren und Interessengruppen basieren. Einige Aspekte der sozialen Dimension von NbS werden in der wissenschaftlichen und insbesondere in der grauen Literatur diskutiert, dennoch bestehen erhebliche Wissens- und Umsetzungslücken.
- **Beteiligungsprozesse bei NbS** basieren auf einer Kartierung der Stakeholder; der Schaffung transparenter und ethischer Projektstrukturen, welche soziale Kriterien berücksichtigen; der Berücksichtigung zugrunde liegender Faktoren für eine sinnvolle Teilhabe, wie beispielsweise der politischen Lage; sowie der Identifizierung und Anwendung geeigneter Methoden (z. B. Fokusgruppeninterviews oder partizipative Workshops), um Wissensverflechtung zu fördern und auf eine Koproduktion von Wissen hinzuarbeiten. Transparente und adaptive Kommunikation sowie reflektives Monitoring helfen, den Prozess zu steuern.
- **Faktoren für Transdisziplinarität** in NbS sind inklusive und kultursensible Projektgestaltung, Vertrauensaufbau, Anerkennung von Landrechten, die Verwendung Indigener und lokaler Sprachen, ethisches Engagement sowie geeignete finanzielle und logistische Unterstützung, um Teilhabebarrieren zu reduzieren. **Herausforderungen** ergeben sich aus unsicherem Landbesitz, Machtasymmetrien, politischer Instabilität, starren institutionellen Strukturen und inflexiblen Verfahren sowie saisonalen oder kulturellen Einschränkungen.
- **Die Planung und Umsetzung von NbS** unter angemessener Berücksichtigung der sozialen Dimension kann eine sich selbst verstärkende **Rückkopplungsschleife** schaffen, in der sozial fundierte Prozesse und Ansätze zu größerer Relevanz, Akzeptanz, Wirksamkeit und Wirkung der Interventionen führen. Positive Ergebnisse wiederum stärken Vertrauen und Engagement und fördern sowohl Nachhaltigkeit als auch Resilienz angesichts des zunehmenden Biodiversitätsverlustes und des Klimawandels.

1 Introduction: Why this Guidance Report?

The twin crises of biodiversity loss and climate change - largely driven by human activity - threaten not only ecological systems but also the social fabric that underpins human well-being, security, and cohesion. **Nature-based Solutions (NbS)** have emerged as a powerful concept to address these interlinked challenges, leveraging natural processes and functions to deliver ecological, social, and economic benefits.

Nature-based Solutions feature growing attention, recognition and application in policy, science and practice. Multiple policy arenas including the United National Framework Convention on Climate Change (UNFCCC) and the Convention on Biological Diversity (CBD) formally acknowledge this approach. One of the recent Conferences of the Parties (COP) to the UNFCCC, COP28 (Dubai, UAE, 2023) witnessed commitments to increase investments in NbS, while COP30 (Belém, Brazil, 2025) is expected to further promote NbS as integrated climate-biodiversity action. "At the nature end", NbS is appearing and will likely further feature in many national biodiversity strategies and action plans, as one of the outcomes of the CBD COP16 in Cali (Colombia) in 2024. The Resolution on Nature-based Solutions for supporting sustainable development, adopted at the 5th United Nations Environment Assembly (UNEA-5) in 2022, marked a significant step in encouraging the use of NbS across various sectors including agricultural, urban, forestry, water, coastal and marine planning and governance. The growing body of dedicated scientific and grey literature and developed frameworks, platforms, and partnerships – like the IUCN Global Standard, updated at the end of 2025, NetworkNature[1] or ENACT Partnership[2], to name a few – have further strengthened the uptake in both research and real-world deployment.

Despite their recognised potential to generate synergistic climate and biodiversity gains as well as numerous co-benefits, the **social dimension of NbS remains underexplored**. It lacks a standardized definition and appears in the global discourse in a fragmented way; recommendations for the consideration of the social dimension in practice are limited and actual social safeguarding is not well established.

The social dimension itself is a multifaceted term which refers to the complex interplay of human relationships, cultural norms, institutions, and collective behaviours that shape societal outcomes and influence human well-being. This is directly linked to the ways that interventions like NbS are conceptualised, planned, designed, implemented, managed, and monitored – meaning what approaches are applied and what principles are followed at every stage. Furthermore, the social dimension includes the social benefits NbS can generate, such as job creation, supporting cultural values, community cohesion, and contributions to health and education.

Understanding this complexity is essential to identify the needs, priorities, and knowledge of diverse actors and stakeholders in NbS processes and to respond appropriately. Without such understanding and action, projects risk unequal benefit distribution and compromised long-term sustainability. To explore open questions on the social dimension of NbS, the BioClimSocial project was launched, resulting in the given publication (see Box 1).

[1] https://networknature.eu/

[2] https://enactpartnership.org/

Box 1: The BioClimSocial project at a glance

The **BioClimSocial** project – formally titled "The social dimension of research and implementation of Nature-based Solutions: utilising synergies for biodiversity and climate" (05/2023-11/2025) – was commissioned by the German Federal Agency for Nature Conservation (BfN) and implemented by the Center for Development Research (ZEF) at the University of Bonn, with funding from the Federal Ministry for the Environment, Climate Action, Nature Conservation and Nuclear Safety (BMUKN).

The project built on the outcomes of the international expert workshop "Fostering applied research on the synergies between biodiversity and climate", conducted by BfN in June 2022. Following the workshop's recommendations, the BioClimSocial project was set out to investigate how the social dimension's complexity of dynamics among actors and stakeholders, governance structures, Indigenous and local knowledge, and power relations affects the success and sustainability of Nature-based Solutions (NbS), which address both climate change and biodiversity loss. The project also looked at how participatory and transdisciplinary approaches can unlock and enhance the societal benefits of NbS.

The BioClimSocial methodology combined literature reviews, a global questionnaire, in-depth interviews, and participatory workshops with NbS experts. Furthermore, the project selected four diverse NbS case studies from agricultural, coastal, mountainous, and urban contexts. These case studies constituted ongoing research projects and were respectively located in Côte d'Ivoire, Colombia, Austria, and Lebanon. Thus, the project covered experiences and perspectives in high-, low-, and middle-income countries. In each case, local partner institutions worked closely with stakeholders and supplied the BioClimSocial team with valuable observations, examples of applied methods, tools, and lessons learnt. The collaboration with the case study representatives not only enriched the BioClimSocial research but also facilitated peer exchange and strengthened local capacities for ongoing NbS research and implementation.

The main outcome of the BioClimSocial project is this Guidance Report, which is intended for everyone engaged in Nature-based Solutions. This publication aims at providing a comprehensive overview of what constitutes the social dimension of NbS and at presenting examples and experiences highlighting how this dimension can be addressed in NbS projects.

Target audience and structure of the report

The BioClimSocial Guidance Report responds to the urgent need for flexible, context-sensitive resources for the topic of the social dimension in NbS that can be applied across scales and sectors, bridging the gap between theory and practice. It is designed for anyone involved in NbS – from academic researchers, especially in applied sciences, and field practitioners to policymakers and funders, offering a framework for integrating social considerations into NbS, referring to concrete methods and tools for strengthening stakeholder engagement, and presenting lessons learned from good practice. Thanks to the presented examples, the report illustrates how social outcomes can be enhanced in diverse contexts – ensuring that NbS projects are not only environmentally effective, but also socially inclusive, responsive and sustainable. The report specifically emphasises transdisciplinarity as a means to reconcile diverse knowledge systems and perspectives and shares considerations on enhancing transdisciplinary approaches.

This report begins with an introduction to the concept of Nature-based Solutions in Chapter 2: the definition, links to related concepts and approaches, and concrete evidence of how NbS deliver tangible environmental, social, and economic benefits. The chapter also outlines the main criticism of the concept and its implementation, as well as current constraints in NbS practice. Additionally, it explains the BioClimSocial project methodology for generating and synthesizing knowledge on NbS and presents the four case studies.

Chapter 3 explains how the social dimension of NbS is understood in the context of the BioClimSocial project, including the terms and aspects it encompasses. Specifically, this chapter describes the social and societal perspectives regarding how NbS should be designed and implemented – emphasising the fundamental principles that need to be observed in the respective processes. It also explores how NbS affect society, illustrating both positive outcomes (with examples from concrete contexts) and potential trade-offs.

Moving from theory to practice, Chapter 4 provides a comprehensive, though not exhaustive, overview of existing NbS guidance materials and assesses how these address certain social aspects, while identifying gaps that require further attention.

The following part of the report is designed to assist NbS researchers and practitioners in integration of social considerations into their work through adopting transdisciplinary and participatory approaches. Drawing inter alia on the experiences of the BioClimSocial partners, Chapter 5 provides recommendations, practical insights, and examples of how to engage stakeholders throughout the entire NbS process. Chapter 6 examines the key enabling and constraining factors that shape meaningful transdisciplinary participation in NbS research and practice, with specific focus on the engagement of Indigenous Peoples and local communities[3] (IPLCs). The final reflections summarize the analysis and highlight areas requiring closer attention.

The authors hope that this publication can serve to provide relevant, accessible, and practice-oriented guidance for all parties involved in the research, application, and advancement of NbS, ensuring that the social dimension is appropriately considered alongside the safeguarding of climate and biodiversity.

[3] Based on UNGA resolution A/77/460, this report applies the UN Editorial Manual to capitalize the term "Indigenous Peoples". This is without predetermination to the continued use of “indigenous peoples and local communities” under the Convention on Biological Diversity and its agreed terminology contained in CBD COP Decision XII/12, pending negotiations on this issue.

2 The concept of Nature-based Solutions

2.1 What are Nature-based Solutions?

The concept of Nature-based Solutions (NbS) has emerged to define actions that are inspired and supported by nature (EC 2015). They aim to address societal challenges – such as climate change, risk of natural disasters, threats to food and water security – while simultaneously providing benefits to human well-being and biodiversity (Cohen-Shacham et al. 2016). NbS enhance cities, landscapes, and seascapes by integrating natural features and processes as a means to derive environmental, social, and economic benefits and help build resilience (EC 2024).

Historically, the concept has evolved in nature conservation circles, building on the ecosystem approach endorsed by the Convention on Biological Diversity a few decades back, but essentially it looks beyond biodiversity conservation and sustainable use which underline this approach (Cohen-Shacham et al. 2019; Roe 2021). NbS leverage ecosystem services in a purposeful, solution-oriented way (IPBES 2019) and focus on **how to use natural assets and processes strategically** to help resolve problems in diverse thematic areas. The mechanism resembles some earlier conservation approaches. For example, Integrated Landscape Management and Forest Landscape Restoration, though differing in focus, share the goal of conserving ecosystems while also delivering societal benefits like disaster risk reduction, health, jobs, and land productivity (Marzelli et al. 2025). Climate-focused nature-based Solutions, for instance, resemble ecosystem-based approaches to climate change mitigation and adaptation (BfN 2023). Through sharing a common foundation of **using ecosystem functions to deliver multiple benefits**, Nature-based Solutions are interconnected with other integrated conservation and management approaches. While the nature of these relationships is complex and may still be debated, frequent references to NbS as an "umbrella" concept or term can be observed (Cohen-Shacham et al. 2019; Pauleit et al. 2017). An overview of some of the mentioned related concepts and approaches is presented in Box 2.

The BioClimSocial project acknowledges and follows the NbS definition provided by the UNEA-5 Resolution on Nature-based Solutions for supporting sustainable development with the caveat that such a concept, and therefore its definition, is evolving. The Resolution refers to Nature-based Solutions as "actions to protect, conserve, restore, sustainably use and manage natural or modified terrestrial, freshwater, coastal and marine ecosystems, which address social, economic and environmental challenges effectively and adaptively, while simultaneously providing human well-being, ecosystem services and resilience and biodiversity benefits" (UNEP/EA.5/Res.5, UNEP 2022).

In line with this definition, NbS can encompass a wide range of practical measures, from protection of land and sea (for example, in the form of protected areas) to the sustainable use of natural resources (sustainable fisheries, community forest management, crop rotation in agriculture etc.). They may involve restoration of degraded ecosystems (for example, restoration of eroded coastal dunes), but also establishment of new and development of existing ecosystems at different scales (like road verges, city parks and natural ponds in urban contexts – linking such types of NbS to the green and blue infrastructure concept).

Climate-focused NbS address primarily the need to mitigate climate change and adapt to climate change impacts. Restoration of native forests, reconnecting floodplains and rewetting

peatlands are implemented to store and sequester carbon, secure water supplies, and protect adjacent communities from floods, erosion and landslides (Cook-Patton et al. 2021; BfN 2023; Tanneberger et al. 2021). Green roofs, walls, and urban trees moderate heatwaves, capture storm water, and additionally abate pollution (Monteiro et al. 2023). Restoring, protecting, or managing coastal ecosystems like mangroves, reefs, and salt marshes protect against storm surges and erosion (Jordan & Fröhle 2022) and secure blue carbon sinks (Zhong et al. 2023). Furthermore, even when NbS are designed for other purposes, their inherent multifunctionality often enables them to address climate-related challenges as a co-benefit.

It is crucial to underline that for an ecosystem intervention to qualify as a Nature-based Solution, it must provide benefits beyond human needs, resulting also in positive outcomes for biodiversity (IUCN 2020a; UNEA 2020; EC 2024). Furthermore, NbS should respect social safeguards, including such for IPLCs (UNEP 2022).

Finally, it is important to acknowledge that many forms of NbS are deeply rooted in the traditional ways that IPLCs have managed land and natural resources for generations. (Jang 2024). These approaches draw upon long-standing ancestral knowledge, spiritual relationships with nature, and time-tested practices that promote balance, resilience, and sustainability. In many cases, what is now being recognized as innovative NbS is, in fact, a continuation or adaptation of Indigenous and local practices that have safeguarded ecosystems for centuries.

Box 2: Selected concepts and approaches linked to NbS

The **ecosystem approach** is a strategy for the integrated management of land, water, and living resources that promotes conservation and sustainable use in an equitable way. One of its key principles is aiming at the conservation of ecosystem structure and functioning in order to maintain ecosystem services (CBD 2004).

Ecosystem services are defined as “flows of value to human societies as a result of the state and quantity of natural capital” (TEEB 2010, p.7) and “the direct and indirect contributions of ecosystems to human well-being” (TEEB 2010, p.33). They are categorized into provisioning (e.g. food, water), regulating (e.g. climate regulation, water purification), supporting (e.g. soil formation, nutrient cycling), and cultural (e.g. recreation, inspiration) services. **Natural capital** encompasses the stock of natural resources that provide these services, like forests and oceans (ibid.).

Ecosystem-based mitigation (EBM) involves utilizing ecosystems for carbon sequestration and storage to aid climate change mitigation. **Ecosystem-based adaptation** (EbA) implies using biodiversity and ecosystem services as part of an overall strategy to adapt to the adverse effects of climate change (Doswald & Osti 2011). Both of these **ecosystem-based approaches** can be applied in various contexts and sectors such as agriculture, forestry, tourism, etc. and usually result not only in positive outcomes for biodiversity and climate, but also provide benefits for human well-being, in which case they can be placed under the umbrella of NbS (BfN 2023).

Green infrastructure refers to a planned network of natural and semi-natural areas – such as urban parks and green roofs (EC 2013) – that is designed to provide ecosystem services and enhance biodiversity. Meanwhile, **blue infrastructure** focuses on natural water features that support biodiversity, like wetlands and rivers (UNEP 2014).

Natural Climate Solutions (NCS) may be defined as deliberate human interventions aimed at protecting, restoring, and sustainably managing forests, wetlands, grasslands, agricultural lands, and oceans with the explicit goal of mitigating climate change. However, the concept of NCS is specific in ensuring that these natural-system-based actions deliver genuine, measurable, and additional climate mitigation benefits while also avoiding negative impacts on biodiversity, food and fibre supplies, and local communities (Ellis et al. 2024).

Successful NbS implementation establishes “place-based partnerships between people and nature" (Seddon et al. 2021). A growing bulk of research provides evidence that such partnership delivers concrete positive results. For example, NbS can lower urban temperatures by an average of 1.1°C, retain 58% of excess rainfall, and potentially reduce carbon emissions by 25% (Ferrario et al. 2024; Pan et al. 2023). A recent study shows that health co-benefits of citywide green corridors in Barcelona could potentially prevent 13 deaths per 100,000 inhabitants annually (Iungman et al. 2025). Up to 71% of NbS are found to be a consistently cost-effective approach for disaster risk reduction, being at least as beneficial as engineering-based solutions (Vicarelli et al. 2024). Furthermore, NbS interventions investigated by Key et al. (2022) show a 67% average increase in species richness, with 88% of the interventions that improved climate change adaptation also demonstrating benefits for ecosystem health. A further analysis shows that 64% of the investigated NbS produce environmental benefits (e.g. carbon storage and improved biodiversity) and 36% socio-economic co-benefits (e.g. social cohesion, economic development), while the majority contribute to Sustainable Development Goals (SDGs) 6, 13, and 15 (Debele et al. 2023). These findings underscore the multifaceted value of NbS, highlighting their effectiveness as a sustainable, cost-efficient strategy that delivers tangible environmental, social, and economic benefits while advancing global development goals.

At the same time, NbS remain a contentious issue, as countries (and, eventually, institutions, businesses, civil society, and other actors) interpret the concept and its implementation in diverse ways. The concept of NbS has faced criticism for its predominantly utilitarian framing, which can hinder the transformative change needed to tackle the very root causes of ecological degradation (Hafferty et al. 2025; Melanidis & Hagerman 2022; Welden et al. 2021). A key concern is that NbS initiatives may cater to vested interests and be implemented through top-down processes, neglecting local rights, values, and traditional knowledge systems (Hafferty et al. 2025; Kill 2024; BfN 2023). Critics also highlight the marginalisation of alternative perspectives which can reinforce existing patterns of injustice and inequality within communities (Hafferty et al. 2025). The risk of greenwashing, where NbS are promoted as ecologically beneficial but in practice amount to superficial or cosmetic measures, is also alarming. This issue has been raised in cases where developers advertise environmental value without delivering meaningful ecological outcomes (Gałecka-Drozda et al. 2021).

To help address these major concerns and achieve solutions that garner widespread backing, it is essential to build and respectively strengthen a **shared understanding of NbS that prioritize social safeguards**, ensuring justice, transparency, inclusion, and equity. Additionally, there is a need to bridge the gap between scientific epistemologies as well as traditional and local knowledge (TLK) and practices when it comes to the development and implementation of NbS (Woroniecki et al. 2020). The further challenge lies in converting this ideal vision of action into concrete practical steps and measures.

2.2 Current constraints in NbS practice

Several interconnected dimensions can be distinguished within the concept of NbS: ecological, political, social, economic, and even technological. While the ecological dimension focuses on ecosystem resilience and biodiversity enhancement, political and governance frameworks ensure that NbS are effectively implemented and supported at the policy level. Economic factors, such as cost-effectiveness and financial viability, relate to the sustainability of NbS and their maintenance over the long term.

Within this multidimensional framework, various constraints remain in the NbS practice. According to the conducted literature review, these are, for instance, often insufficient or absent long-term monitoring, evaluation, and adaptive management approaches, which limits our ability to understand the sustained performance and resilience of NbS longitudinally, under changing conditions (Dumitru et al. 2020). Policy, governance and institutional barriers, such as conflicting policies, lack of incentives, and a path dependency on grey infrastructure, can significantly limit the widespread adoption of NbS (Seddon et al. 2020). The complexity of NbS interventions means that they can pose a less attractive short-term political and financial proposition, due to timeframes that are subject to change in the long term, for example, with each electoral cycle. It is only through strengthening social, technical, economic, and policy interfaces that NbS can be reinforced as a politically viable investment (Wellmann et al. 2023).

In summary, while the potential benefits of NbS are becoming established among policymakers, researchers, and practitioners, there are still knowledge gaps where the challenges related to NbS quantification, long-term performance, governance, and financing need to be addressed so that NbS can be planned, implemented, and evaluated effectively.

Yet, the social constituent is arguably one of the most important and least considered dimensions in NbS practice, given its far-reaching implications for society at large, specific groups or individuals – encompassing inclusion, equity, well-being, among many other elements.

2.3 Overview of NbS projects around the world

With the development of the scientific and political discourse on NbS, their application has expanded significantly, now encompassing multiple sectors and ecological settings spanning across the globe.

For an overview of recent NbS projects around the world and their further analysis in line with the set socio-ecological research objectives, the BioClimSocial team has compiled its own NbS database from secondary sources. This database constitutes a non-exhaustive but diverse selection of NbS cases collected through convenience sampling from a range of sources, including the following websites: UNEP Equator Initiative[4], Nature-based Solutions Evidence Platform[5], and WOCAT SLM Database[6].

Additional NbS case studies and corresponding contacts were also compiled following an online search of university departments and institutions with keyword prompts such as “Nature-based Solutions (NbS)”, “stakeholder engagement”, “social dimension”, “social benefits”, “transdisciplinary research”, “Global South”, and “Global North”.

[4] https://www.equatorinitiative.org/knowledge-center/nature-based-solutions-database/
[5] https://www.naturebasedsolutionsevidence.info/
[6] https://wocat.net/en/global-slm-database/

Inclusion criteria for the selected NbS cases were as follows:

- These cases represent NbS aligned with the UNEA-5 Resolution's definition – that is, these are interventions (protection, conservation, restoration, sustainable use or management) across a range of natural or modified ecosystems to address various societal challenges. For the purpose of the BioClimSocial project research, they show relevance for climate mitigation and/or adaptation, while simultaneously supporting human well-being and benefitting biodiversity.
- To a lesser or greater extent, these cases indicate significant stakeholder engagement in designing and implementing interventions.
- The projects were, or are, officially affiliated with research institutions – either a university or an established NGO and an individual researcher's or practitioner's name and contact were available.

At the time of the database compilation, the selected NbS projects were either completed less than five years ago or still ongoing, finding themselves in the planning, implementation, or evaluation phases.

The BioClimSocial team collated and stratified the NbS case study database by identifying commonalities of good practice, particularly cases that explicitly incorporate participatory practices and transdisciplinarity, especially within research projects. Transdisciplinary research is defined for the purpose of the BioClimSocial project as the **inclusion of non-academic stakeholders in the process of knowledge production (co-production)**. In other words, transdisciplinary research engages stakeholders significantly throughout the research process, including decision-making. To this end, it often also requires an interdisciplinary approach where scientists from different disciplines collaborate to inform stakeholders or valorise knowledge afterwards.

The compiled database included 423 projects. Figure 1 indicates that the database had a geographical bias towards Europe and Asia, which the BioClimSocial team attributes as a secondary effect to the convenience sampling. This geographical bias needs to be considered when interpreting the results.

Each NbS entry from the database was contacted during 2024 and invited to complete a semi-structured questionnaire (see Box 3). The aim was to gather insights from NbS researchers and practitioners regarding the process of stakeholder and community engagement in transdisciplinary processes related to NbS initiatives, as well as to learn about social impacts of these initiatives. The data derived from the questionnaire serves as a complementary source for qualitative analyses of the social impact of NbS and of the stakeholder engagement processes in NbS projects, with more detailed results presented in Chapters 4 and 5.

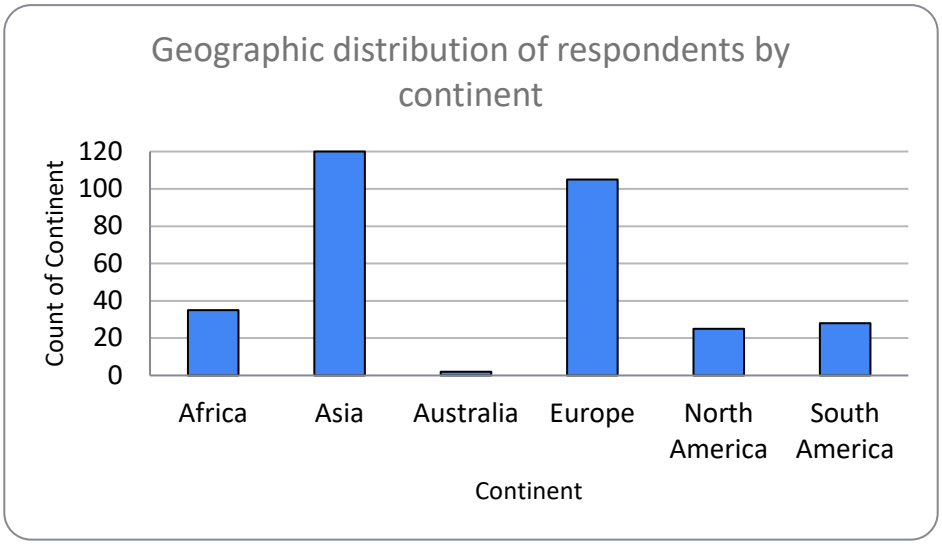

Fig. 1: Distribution of project contacts across different continents within the BioClimSocial database, illustrating the geographic scope of Nature-based Solutions (NbS).

Box 3: BioClimSocial online survey

All 423 contacts from the BioClimSocial database were invited to participate in the tailored online survey that addressed the following topics:

- **Matters of stakeholder identification, selection, and meaningful engagement* in NbS projects** (approaches to stakeholder mapping and engagement, their effectiveness; diversity of representation; participation throughout the project cycle)
- **Factors that motivate stakeholder engagement in the transdisciplinary process** (motivating conditions and incentives, including financial compensation and perceived importance for own livelihood; role of knowledge/awareness raising on NbS; ways to sustain stakeholder engagement beyond the project period)
- **NbS implications** (observations regarding potential trade-offs and opportunity costs compared to other land uses; stakeholders' perception of benefits from NbS)
- **Influences in the decision-making process** (e.g. role of land tenure/ownership; gender; educational levels; socio-economic status; trust in the process)
- **Aspects of the social outcomes of NbS** (social impacts: observations regarding improvements of individual well-being, community cohesion, enhanced guardianship of nature, strengthening of decision-making structures etc.)

*It is important that the term "meaningful engagement" of stakeholders is defined. In the context of the questionnaire, this means that stakeholders have significant power in the deliberation and decision-making over the design and implementation of the NbS and therefore it ensures that NbS outcomes are relevant to a given – often diverse – group of stakeholders.

In total, 31 responses to the questionnaire were received. The majority of respondents represented the research community (universities and research institutes), followed by non-governmental organisations to a lesser extent, and, in a few instances, other types of

organisations. Most respondents reported having over five years of experience in transdisciplinary research and practice related to NbS (see Fig. 2 and 3).

The collected responses do not provide a comprehensive global representation of NbS, but yet feature a fairly balanced distribution between high- middle- and low-income countries (Fig. 4).

The responses also refer to NbS projects implemented across a variety of ecosystems and land-use types. Urban environments emerged as the most frequently cited setting (slightly over one-third of responses). Other cases referred to the work in montane forests and other mountain ecosystems, agricultural landscapes (associated with agroforestry), freshwater and coastal ecosystems, tropical forests, and savannahs. In contrast, marine ecosystems, temperate forests and meadows, boreal forests, semi-arid regions, and global-scale studies were mentioned only occasionally.

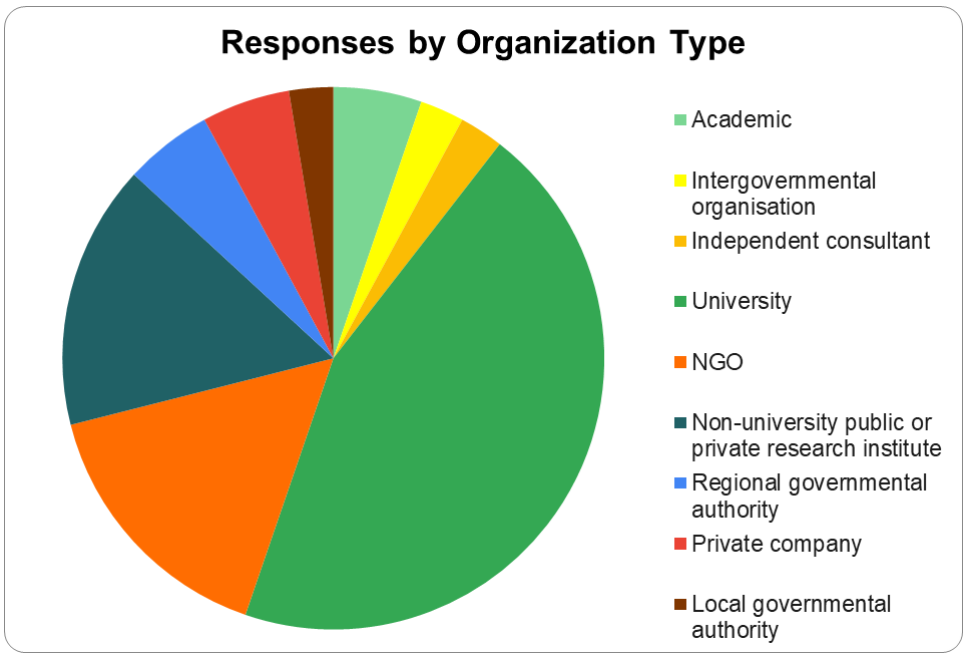

Fig. 2: Identified NbS researcher/practitioner affiliated organisations

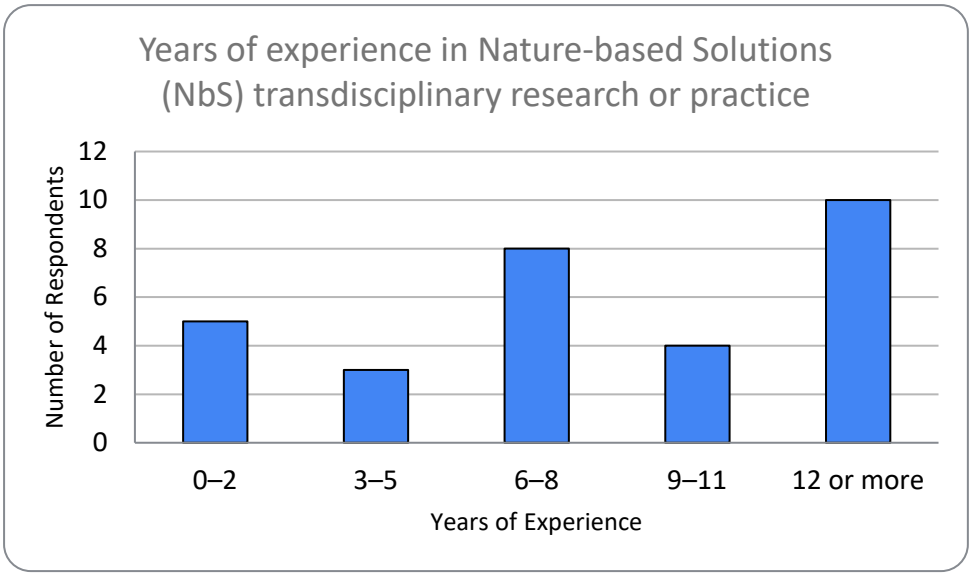

Fig. 3: Years of respondents' experience in transdisciplinary research and/or practice related to Nature-based Solutions

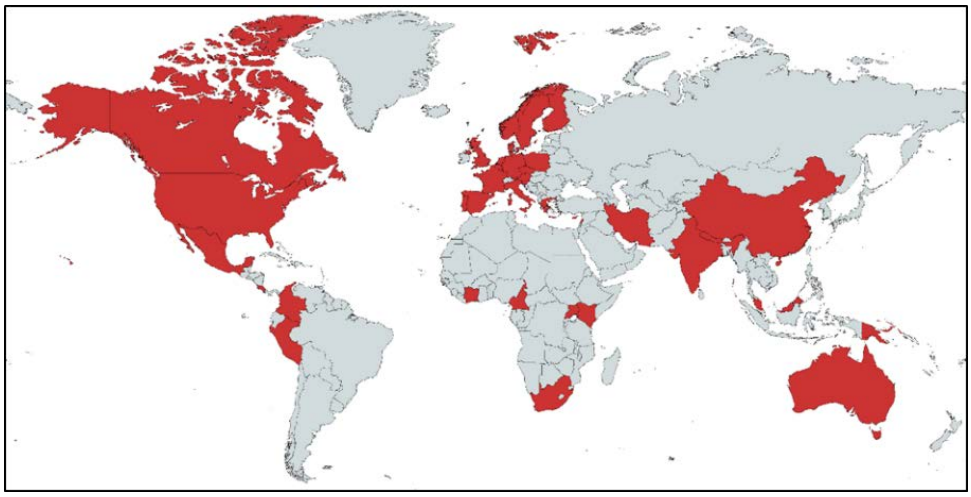

Fig. 4: Map reflecting the data from the questionnaire where respondents indicated that the following countries were the focus for researchers/practitioners to implement NbS (prepared based on https://www.mapchart.net/)

2.4 Taking a closer look: Four BioClimSocial NbS case studies

To gain a deeper understanding of the complex nature of NbS in real-world contexts, particularly regarding their social dimension, the BioClimSocial team explored four NbS projects in greater detail. These case studies, with a diverse geographical reach from Côte d'Ivoire, Colombia, Austria and Lebanon (see Fig. 5), involve university-affiliated researchers who work in various settings (urban and rural, coastal and mountainous) to address locally significant societal challenges through the NbS concept. In the case of Côte d'Ivoire, for example, the focus is set on agricultural systems, with special attention to agroforestry. In Colombia, the project tackles the erosion of seagrass meadows and the associated challenges for fishery, tourism, and climate change mitigation through community-based restoration. The two projects in Lebanon showcase approaches to NbS that provide opportunities for education, a healthier environment, and human well-being in a metropolitan city. The Austrian case looks at the issues

related to land use and land cover change in the Alps driven by demographic and socio-economic shifts and facilitates search for most suitable and locally acceptable NbS to address these. Even when climate or biodiversity are not in focus, all studies imply actual or potential synergies with climate mitigation, adaptation, and biodiversity enhancement.

Fig. 5: Location of the BioClimSocial NbS case studies

The selected cases differ from the standpoint of project type and design. In some cases, the applied research deals with concrete NbS on the ground (Colombia, Lebanon). In Austria, the project develops a participatory framework for NbS planning, while the research in Côte d'Ivoire constitutes a country-wide "inventory" of NbS with subsequent biogeographic and semantic analysis.

Although the selected cases are grounded in scientific research, non-academic actors and stakeholders including local communities are engaged throughout the respective projects in various forms, ranging from surveys to workshops. As a result, the case studies also meet the criteria of transdisciplinarity. This engagement – its goals, scope, methods, and outcomes – constitutes one of the key focus areas of the BioClimSocial analysis.

The BioClimSocial project anticipates that the NbS case studies featured throughout this Guidance Report covering diverse ecosystems and communities will be of relevance to a wide audience working in NbS and related fields. A closer look at these case studies enables practical insights into the **actual application of principles of NbS design and implementation**, as well as into the **social impacts** of NbS, which are discussed throughout the report as the NbS "social dimension". The following boxes (Box 4 to Box 7) provide summary information on these four case studies.

Box 4: Case study 1 – Seagrass restoration, Colombia

Title: Community-based seagrass restoration on the islands of San Andrés, Colombia, as a nature-based solution for erosion and climate change mitigation

Implementing institution: Universidad Nacional de Colombia, Bogotá, Colombia

Macro-context: The landscape of political, economic, and social processes as well as the prioritization of mainland policies has resulted in increasingly vulnerable coast and island areas. Since San Andrés, among other regions in Colombia, is expected to be affected severely from climate change, NbS are hoped to be able to contribute to damage mitigation.

Geography and sector context: Due to their size and location oceanic islands are especially affected by climate change consequences, such as beach erosion. At the same time, these islands contribute significantly to the national economy by offering highly frequented tourist destinations and fishing grounds.

Natural capital: The Archipelago of San Andrés harbours a rich network of diverse coastal and marine ecosystems, among which seagrass beds (predominantly *Thalassia testudinum*) are prominent. Seagrasses are recognized for the multiple ecosystem services they provide, such as storing organic carbon and serving as habitat and food source to multiple ecologically and commercially important marine species.

The specific problem: Erosion has led to a gradual decrease of seagrass cover along the coast and the rise of correlated problems, such as the loss of biodiversity and decline of ecosystem services available to the local community.

Aim of the NbS project: The project focused on developing a restoration technique to combat the loss of seagrasses and to increase carbon storage in San Andrés.

Fig. 6: View of Haynes Cay, with the seagrass meadow in the foreground. On the upper left is the natural aquarium, a site for easy marine life observation due to the shallow and calm waters. (Photo: José Ernesto Mancera Pineda)

Box 5: Case study 2 – Agroforestry, Côte d'Ivoire

Title: Nature-based Solutions through agroforestry in Côte d'Ivoire: Insights from the country's phytogeographic and climatic gradients

Implementing institution: University Félix Houphouet-Boigny, Abidjan, Côte d'Ivoire

Macro-context: Côte d'Ivoire's pursuit of its National Adaptation Plan (NAP) and its Nationally Determined Contributions (NDCs) targets has driven strong national engagement,

notably from the Ministry the of the Environment, Sustainable Development and Ecological Transition, and the Ministry of Agriculture and Rural Development. These bodies lead efforts to tackle climate change, strengthen ecosystems, and foster sustainable land use. While agriculture remains central to the economy, with the country leading global production of cocoa and cashew, decades of growth have contributed to severe ecosystem degradation, now exacerbated by increasing climate impacts that threaten the sector's future viability.

Geography and sector context: Côte d'Ivoire spans a range of diverse phytogeographic zones, from humid dense forests in the south to wooded savannahs in the north. These zones form nine distinct agricultural hubs, each shaped by specific environmental conditions that determine the region's agricultural focus and requirements for successful cultivation.

Natural capital: The country's ecosystems provide essential services such as carbon sequestration, water purification, and soil fertility maintenance. However, they have been subjected to intense anthropogenic pressure for several decades, mainly due to the continued expansion of agriculture and the overexploitation of natural resources.

The specific problem: NbS for agriculture have not been adequately tailored to the country's heterogenous climatic and landscape conditions, resulting in inefficiencies and underperformance. This hinders the successful implementation of generally highly suitable NbS, specifically agroforestry. Alongside a lack of financial resources, technical expertise and weak enforcement mechanisms further hamper the implementation of NbS nationally.

Aim of the NbS project: Key objectives were to document and categorize NbS types and techniques in Côte d'Ivoire, evaluate constraints and struggles in their implementation as well as map socio-linguistic patterns related to NbS usage across the country. This aimed at providing a helpful overview and recommendations for NbS implementation in the agricultural sector.

Fig. 7: Agroforestry systems in Côte d'Ivoire including a cotton farm (a); maize farm (b) rice farm (c) and okra farm (d) (Photos: N'Golo Abdoulaye Koné & Kolotchèlèma Simon Silué)

Box 6: Case study 3 – Urban green infrastructure (2 projects), Lebanon

Title: Urban balcony gardens: Exploring a residence-led Nature-based Solution

Implementing institution: American University of Beirut, Lebanon

Macro-context: Greening has proven difficult in densely populated urban areas, which is why vertical urban green spaces can help reach environmental targets proclaimed during the UNFCCC COP28 (role of cities to mitigate climate change), and the UN SDG 11 (making cities and human settlements inclusive, safe, resilient, and sustainable).

Geography and sector context: The project is set in an urban environment in Beirut, Lebanon. The city of approximately 1.3 million inhabitants is the largest and densest in Lebanon, with only 23% open spaces and 77% built spaces (UN-Habitat Lebanon 2021). The narrowness of streets is the outcome of initial urban plans which did not account for vehicular traffic.

Natural capital: Well established balcony gardens can provide important services to urban residents such as heat mitigation, aesthetic value, and a space for socializing and privacy. The provision of wildlife habitats through balcony gardens is possible when residents use ecologically adapted, ideally native species.

The specific problem: Greening dense neighbourhoods, which is only possible through vertical greening, is challenging. Residents in these areas often lack the resources, skills, and supportive social and governance systems to implement complex vertical systems. Balcony gardens offer a simple and popular alternative. However, little is known of the impact of balcony gardens on urban nature and the environment. Their value as NbS may become clearer when collective resident greening actions are combined and assessed.

Aim of the NbS project: The project aimed to find out whether balcony gardens qualify as NbS contributing to improving human well-being and the overall environmental condition of the city. The project is grounded in three core NbS principles that guide the analysis: environmental benefits, biodiversity contribution, and social well-being. It examines residents' perceptions of balcony gardens, the suitability of plant species for local biodiversity, and the potential value of balcony canopies, assessed as Small Urban Tree Equivalent (SUTE) in enhancing urban environments.

Title: Ancillary Botanic Gardens (ABGs)

Implementing institution: American University of Beirut, Lebanon

Macro-context: Growing urbanization poses the issue of fading awareness and connection to nature. This can be counteracted in numerous ways, among which botanic gardens are an important option for fostering education, interaction with nature, and environmental activism. While contributing to international environmental agreements, such as the CBD, they support plant conservation efforts.

Geography and sector context: The lack of formal botanic gardens can be compensated by offering opportunities for informal education and engagement with plant life in institutional urban green spaces, which serve as ancillary (supplementary) botanical learning

environments. The concept of Ancillary Botanic Gardens – that is, existing urban green spaces adjusted and used for environmental education such as botanical tours – is designed to be applicable worldwide. This first study was conducted on institutional green spaces in Lebanon.

Natural capital: Using institutional green spaces as botanic gardens primarily enhances informal botanical learning opportunities in cities. Additionally, curating such spaces offers important co-benefits, such as supporting and increasing local biodiversity – especially when native vegetation is prioritized.

The specific problem: While guidelines to implement the ABG concept have been developed (see Melhem et al. 2023), there is a need to elaborate the application of this concept with potential host institutions and visitors through the engagement of stakeholders and co-creation of implementation approaches.

Aim of the NbS project: Explore institutions' opinions about the ABG concept and youth's perceptions following visits to an ABG.

Fig. 8: Example of residential balcony gardens in Beirut. (Photo: American University of Beirut).

Fig. 9: Excursion through an Ancillary Botanic Garden, Lebanon. (Photo: American University of Beirut)

Box 7: Case study 4 – NbS in mountainous regions, Austria

Title: Addressing the problem of spruce monoculture forests in the Ötscher Region

Implementing institution: University for Continuing Education, Krems, and Ötscher-Tormäuer Nature Park, Austria

Macro-context: The socio-economic situation (aging population, shift away from farming activities) in some parts of the Alps leads to significant changes in landscapes, for example, the extent of forest cover. Recognising this as an issue, the Alpine Convention calls for maintaining traditional management of the landscapes in an ecologically and economically feasible way. However, local-level action may not always align with these objectives.

Geography and sector context: The study was conducted in the Ötscher-Tormäuer Nature Park located in Lesser Austria. Historically, this area is characterized by traditional land use such as pastoralism, however, a significant amount of the land is nowadays covered by forests, mainly spruce monocultures, with tree cover reaching in places 80-90%.

Natural capital: The region's traditionally managed grasslands represent a valuable component of natural capital, with high structural diversity and ecological richness. These extensively used meadows support a wide range of plant and animal species. Besides maintaining biodiversity, grasslands provide other essential ecosystem services like forage quality for livestock and open habitats on which deer rely. However, the abandonment of traditional land use has led to a gradual increase in forest cover which fundamentally alters these ecosystems and contributes to the decline of species dependent on open landscapes.

The specific problem: The "overforestation", with the extensive presence of spruce, is a twofold issue. The current approach to forest management has led to domination of monoculture stands. Meanwhile, ecosystems linked to traditional agricultural practices are gradually lost due to natural succession. Spruce monoculture forests negatively impact both local biodiversity and the region's appeal to tourists. Yet, the conventional mental models of "good" forests might hinder the local communities' willingness to pursue change.

Aim of the NbS project: By combining actor mapping with insights into participation dynamics, the study aimed to address local needs and priorities, foster mutual learning, and

encourage active engagement with the issue – ultimately leading to a stakeholder-driven identification of a suitable Nature-based Solution for the region.

Fig. 10: Patches of traditional pastures in the Ötscher-Tormäuer Nature Park, next to the forests claiming land (Photo: Günther Schreder)

3 Conceptualising the social dimension of NbS

The social dimension of NbS remains a conceptually ambiguous area, lacking a standardized or universal definition. Nonetheless, the importance of adequately considering social aspects is increasingly emphasized in NbS-related discussions (Frantzeskaki 2019). The social dimension encompasses a broad range of factors that are context-specific, complex, and often difficult to quantify. Issues forming it, like rights, relationships and power dynamics, social norms, cultural values and local knowledge, equity and justice, social cohesion and participation (Bennett et al. 2017; Redhead & Power 2022) – the list is not exhaustive – can vary significantly across regions and communities. These issues are deeply intertwined and their impacts may not be immediately visible or easily measured, making it challenging to define and apply a standardized approach to the social dimension of NbS.

Despite its complexity, acknowledging and considering the social dimension in conceptualising, designing, planning, implementing, managing, and monitoring NbS is crucial for ensuring that these solutions are adherent to social safeguards and deliver beyond environmental and economic benefits also human (and societal) well-being (Kabisch et al. 2016). A clear understanding of the social aspects braided into the full cycle of NbS helps to identify the needs, priorities, and existing knowledge of diverse actors and stakeholders at different levels, including IPLCs, landowners and land users, governments and various vulnerable groups. Without such understanding, there is a risk of overlooking important implications of NbS, which can lead to unequal access to benefits and undermine the long-term sustainability of projects (IUCN 2020b; Seddon et al. 2021).

The current chapter explains how the social dimension of NbS is interpreted by the experts collaborating in the BioClimSocial project: the meaning of the “social dimension”, its role and importance, and which aspects of the social dimension are showcased in the relevant literature.

To this end the social dimension of NbS is conceptualised in two interconnected ways: as the **process and principles** of considering and implementing social dynamics through the full cycle of NbS interventions, and as the **social impacts or outcomes** resulting from these interventions.

Firstly, the **process and principles** of considering and implementing social dynamics involves understanding and engaging with the complex social matters that in the end shape the success of NbS projects. This is based on recognizing the diversity of actors and stakeholders involved and ensuring that their perspectives, needs, and knowledge are incorporated into decision-making processes.

It is worth noting that actors and stakeholders are related but distinct terms: actors, in the NbS literature, and for the purposes of the BioClimSocial Guidance Report, refer to all individuals, organizations, or entities who play an active role in enabling, planning, designing, implementing, or monitoring NbS projects. Stakeholders are specifically those parties who are affected by or can affect a particular NbS intervention. Stakeholders encompass a broader spectrum, including both those who influence decision-making (e.g., funders, authorities, implementers) and those impacted by the outcomes (e.g., local residents, advocacy groups, businesses). Stakeholders are often categorised by their relationship to the issue or solution (e.g., directly affected, indirectly affected, influencing actors) and by their roles (e.g., decision-

makers, knowledge providers, lobbyists) (Zingraff-Hamed et al. 2020). All actors in NbS can be considered stakeholders, but not all stakeholders are actors (Mitincu et al. 2023).

Engaging with the social dynamics around NbS also involves navigating interactions between individuals, social groups, and institutions, aiming at trust building, dialogue, collaboration, and – if necessary – conflict resolution. Furthermore, this implies an application of approaches that empower actors and stakeholders and foster ownership and shared responsibility over decisions (solutions). The process and principles should ensure that NbS are initiated and implemented in a way that is appropriate, transparent, inclusive, and responsive to the specific contexts of the society these solutions aim to support. The respective issues are further elaborated in section 3.1.

Secondly, the **social outcomes** of NbS refer to the tangible and intangible effects these solutions have on the society. These outcomes can include improved community resilience, enhanced social equity, increased social capital, as well as more direct benefits like job creation, improved livelihoods, and strengthened community cohesion. Social outcomes also encompass the long-term impacts of NbS on human well-being, particularly for vulnerable or marginalized groups. These outcomes are not only crucial for measuring the success of NbS, but also for ensuring that these NbS contribute to sustainable development by promoting social justice and addressing environmental challenges in a way that benefits all members of society. These outcomes are discussed in section 3.2.

In simple terms, these two facets explore and describe social and societal perspectives on 1) how Nature-based Solutions should be designed and implemented, and 2) how they affect society.

3.1 Process and principles

The essence of this chapter can be best understood by shifting the analytical lens, moving away from the conventional perspectives of scientists, policy makers or NbS experts and instead adopting the perspective of individuals or communities directly involved in or affected by NbS initiatives. This shift prompts several important questions: What must be considered to ensure that NbS projects genuinely reflect the needs and expectations of various actors and stakeholders, e.g. the local community? How can we ensure that NbS generate added value without producing unintended negative trade-offs? How can participation throughout the NbS project cycle be made both meaningful and effective? What constitutes context-appropriate action that contributes to just and equitable socio-ecological outcomes?

In the global discourse on NbS, these questions relate closely to the notion of **social safeguards** – that is, the policies, measures, procedures and rules, designed to prevent unintended negative consequences and to ensure equitable outcomes in NbS implementations (Qi & Terton 2025; Reise et al. 2021). In the BioClimSocial framework, it is proposed to look beyond safeguards by embracing the **fundamental values and guiding principles** that shape socially responsible NbS.

Some of the key, often interconnected, components of the processes and principles to guide NbS are outlined below, drawing primarily on scientific and grey literature within the nature conservation sector as well as BioClimSocial case studies.

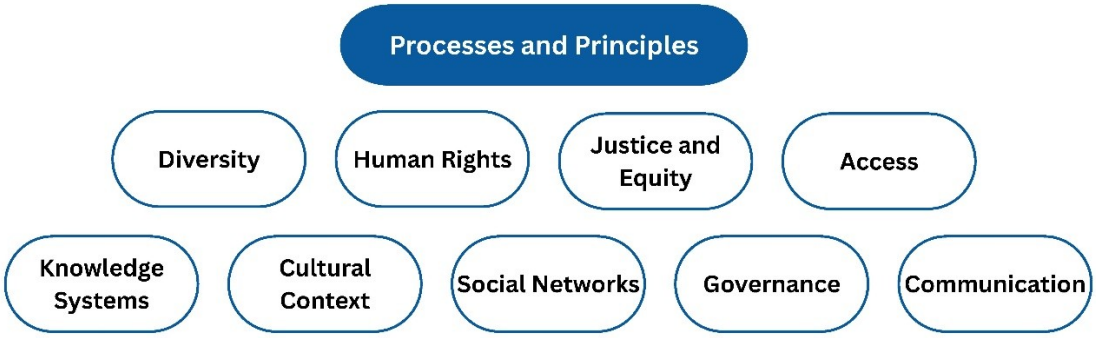

Fig. 11: Processes and principles in planning and implementing NbS projects explored in the framework of the BioClimSocial research

Diversity: Diversity across individuals, groups, and institutions is expressed through a range of demographic, cultural, and socio-economic characteristics such as gender, age, race, ethnicity, caste, Indigeneity, religion, and many other identity markers (Caswell & Jang 2024). At the group and institutional levels, diversity refers not only to the types of actors and stakeholders – such as local communities, landowners, local governments, etc. – but also to the ways in which their positions may reflect a varying degree of power, vulnerability, or marginalization (Zingraff-Hamed et al. 2020; Megyesi et al. 2024). NbS initiatives can benefit from acknowledging and reflecting this diversity, recognizing the intersecting identities, social layers, and structures that shape how people experience and prefer to address environmental and social challenges (World Bank 2023). Yet, achieving success requires a high degree of **sensitivity and responsiveness** to social dynamics. (Shackleton et al. 2023). When existing power imbalances that hinder inclusive engagement are addressed, a range of perspectives and lesser recognized knowledge systems (e.g. Indigenous knowledge) can contribute meaningfully to NbS (Hicks Peterson 2018; Masood 2018).

Human rights: The Kunming-Montreal Global Biodiversity Framework of the CBD calls for adopting a human rights-based approach, including the right to **Free, Prior and Informed Consent** (FPIC) of IPLCs – as fundamental principle in implementing measures to halt biodiversity loss, conserve ecosystems, and ensure equal sharing of benefits (CBD 2022). Applied to the context of NbS, such approach requires that policies, governance and management respect, protect and promote human rights at every stage of NbS projects. States are recognized as duty-bearers with legal obligations to uphold human rights, while non-state actors such as NGOs, corporations, and development agencies are increasingly acknowledged as having a responsibility to respect, protect, and support the fulfilment of human rights (Martin et al. 2025). Rights-holders include individuals with both procedural (e.g., participation, access to information, justice) and substantive rights (e.g., land, health, water), as well as collective rights including customary tenure, FPIC, and self-determination. The human rights-based approach reframes equitable governance in NbS not as an optional safeguard, but as a core condition for achieving just, inclusive, and effective socio-ecological outcomes (OHCHR 2021). It emphasizes the importance of placing people and their rights at the centre of any NbS intervention – enhancing local capacities, improving livelihoods, fostering inclusive and sustainable action that allows both nature and society to thrive.

Justice and equity: Justice and equity are important concepts in social and political science, particularly for understanding the [unequal] distribution of “goods and bads” among divided populations, with a specific attention to marginalised groups (Brulle & Pellow 2006; Fisher et

al. 2013; Lehmann et al. 2025). In the context of NbS, this refers to understanding who benefits and who bears the costs and possible trade-offs associated with these initiatives (Chaudhary et al. 2018; Daw et al. 2011) and encourages fair outcomes for both people and nature (Sikor 2013). Integrating principles of justice into NbS is a significant societal challenge. This includes striving for the fair distribution of benefits, ensuring meaningful participation in decision-making, and addressing inequalities related to opportunities, wealth, and power (Anguelovski & Corbera 2023). Justice in NbS involves three interconnected dimensions: Distributive justice focuses on the fair sharing of benefits and burdens, especially for marginalized groups, considering factors like gender, age, and ethnicity (Kato-Huerta & Geneletti 2022; Sikor et al. 2014; Wijsman & Berbés-Blázquez 2022). Procedural justice ensures inclusive, transparent decision-making where all affected groups can meaningfully participate (Cousins 2021; Martin et al. 2016). Recognitional justice highlights the importance of acknowledging diverse values, knowledge systems, and cultural identities, addressing injustices rooted in social exclusion (Chaudhary et al. 2018; Martin et al. 2016). Together, these three dimensions form the foundation of transformative justice in the context of NbS, ensuring that interventions do not simply deliver ecological benefits, but also address systemic inequalities. In this regard, historical injustices – such as towards IPLCs – and power imbalances need to be confronted.

Access: The concept of "access" is equally significant for the work on NbS aligning with the principles described above. The theory of access by Ribot & Peluso (2003), defines it as the ability to derive benefits from things (material objects, people, institutions) and describes the various mechanisms through which different individuals or groups are able to gain, control, and maintain access. This approach shifts the focus from formal ownership to the social, economic, and political processes and mechanisms that may shape the use of resources with consequences for social exclusion and marginalisation (Hansen et al. 2020). In application to NbS, this means that diverse social characteristics such as gender, ethnicity, etc., and related formal and informal mechanisms like customary practices, use rights, access to information, knowledge, technology, and markets etc. play a crucial role in defining how various actors and stakeholders may benefit from NbS and how power dynamics influence the effectiveness and fairness of such solutions.

Knowledge systems: The CBD explicitly calls for the preservation and maintenance of knowledge and practices of IPLCs relevant to the conservation and sustainable use of biodiversity (Tengö et al. 2017; The Nature Conservancy 2021). This is echoed in the IUCN Global Standard for NbS (IUCN 2020a) which encourages integration of different knowledge systems - i.e. traditional, local, and scientific. Traditional and local knowledge (TLK)[7], defined as the collective body of knowledge, innovations and practices of IPLCs (United Nations 1992), forms an essential part of human-nature relationships at the local scale. Understanding the values that IPLCs assign to ecosystems and recognizing local biodiversity stewards is key to enhancing sustainability (Badola & Hussain 2005) and, furthermore, can be crucial for reducing inequity (Woldie & Tadesse 2019; Woroniecki et al. 2023).

[7] In this report, the authors use the terms "Traditional and local knowledge (TLK)" and "Indigenous and local knowledge (ILK)" to refer to knowledge systems developed and maintained by Indigenous peoples and local communities over generations. While TLK emphasizes traditional practices and cultural transmission, ILK highlights the broader contributions of Indigenous and local communities to understanding and managing the environment. Througout the report, these terms are used interchangeably, where appropriate, with ILK providing a more inclusive framing that encompasses both traditional and contemporary knowledge.

To meaningfully integrate, validate, and protect this knowledge within NbS, Cottrell (2022) advocates for co-production approaches that respect and braid diverse knowledge systems for climate action and ecosystem management. Research shows that such braiding requires intentional processes to foster mutual learning and integrate multiple perspectives. Therefore, it should be based on ensuring equitable participation from all actors and stakeholders, especially for historically marginalized groups (Bogatinoska et al. 2024; Fonseca et al. 2024; Reyes et al. 2024). Recognising TLK and land rights builds trust, fosters local ownership of NbS and raises the chances for long-term success (Mguni et al. 2025). Moreover, exploring TLK can result in innovative solutions and tangible sustainability outcomes that might otherwise be overlooked (Contor 2025).

Ideally, interweaving scientific research and TLK creates a robust foundation for NbS implementation by leveraging the diverse skills and perspectives. For instance, communities all around the world applying Indigenous and local knowledge to address climate variability have significantly enhanced resilience (Galappaththi & Schlingmann 2023). A similar positive example appears in the BioClimSocial NbS case study on community-based seagrass restoration in Columbia, where stakeholders contributed vital capacities such as knowledge, networks, and funding to ensure successful NbS implementation. The case study on agroforestry in Côte d'Ivoire underscored another critical theme: bridging the knowing-doing gap and how much this gap is influenced by individual capacities.

Cultural context: A literature review conducted by da Rocha et al. (2017) highlights the complex and multidimensional value of nature in NbS. This value extends beyond the concept of natural capital to include place-based appreciation and connections, natural heritage, and local meanings. For instance, sacred forests or culturally significant landscapes may hold spiritual meaning for IPLCs. In some cases, NbS reinforce cultural traditions – such as community-led mangrove restoration that aligns with longstanding stewardship practices (Infield et al. 2018). In others, NbS may challenge traditional norms, for example, by introducing new land management approaches that conflict with established or customary methods (Sangha et al. 2025). Recognizing and integrating these cultural dimensions in the design and implementation of NbS helps ensure they are not only more effective, but also more socially accepted.

Social networks: Social networks are another important social aspect for the design and implementation of NbS, particularly when diverse actors and stakeholders are involved. They provide a valuable framework for understanding the structural properties of relationships among individuals and groups (Bodin & Crona 2009). By focusing on the characteristic patterns of these relationships, social network analysis helps reveal how social structures shape behaviour and attitudes within a community or system (Hall & Wellman 1985). Importantly, social networks shape the flow of resources, thereby influencing access to opportunities and imposing constraints (Valente & Pitts 2017). The concept of social networks could play an important role in improving the design, planning, implementation, and governance of NbS by exploring and explaining actors' and stakeholders' relationships. It may help to identify key influences and communication gaps to strengthen collaboration on NbS. Despite its potential, there remains a limited body of empirical research exploring how social structures affect NbS planning, implementation, and related policy effectiveness.

Governance: The complexity of NbS governance lies in its engagement across multi-layered interfaces: geo-politically (local, regional, national, transnational) and sectorally (agriculture, forestry, water management, urban planning, nature conservation, etc.). Addressing this scale and complexity requires effective coordination and integration of existing policy frameworks

and planning instruments (Marzelli et al. 2025). Equally important for successful NbS implementation is highly collaborative governance, that engages actors from politics, administration, business, research, and civil society (Battisti et al. 2024). Successful NbS governance depends on clear institutional arrangements, transparent communication, sustained stakeholder engagement (especially landowners), and the establishment of inclusive steering and decision-making mechanisms. However, significant barriers persist, including insufficient legal and financial frameworks, a lack of standardized evaluation criteria, and conflicting interests among stakeholders (Marzelli et al. 2025). Much of the literature on NbS governance emphasizes the critical role of justice and equity, particularly given the risk of NbS to inadvertently reproduce or exacerbate existing environmental inequities and vulnerabilities. Achieving just and equitable outcomes requires broad participation and a deliberate effort to address contestations arising during problem identification, design, and implementation (Sekulova et. al 2021).

Communication: Finally, another widely recognized critical enabler for the successful planning and implementation of NbS is effective communication. Ensuring that goals and plans are conveyed in accessible and context-sensitive ways is essential for enabling all stakeholders to engage meaningfully and contribute to co-production processes (Brown & Everard 2015; Seddon et al. 2020). The need for multi-level, inclusive communication was strongly emphasized by a respondent to the BioClimSocial questionnaire, who noted the importance of tailoring engagement strategies to context-specific social dynamics: “Communication on the multiple layers is important — for example, local government, community/village level — including analysing the power relations of the major castes/ethnic groups. And then design/apply the community meeting accordingly (mixed, separate, or key informant interview). Equally important is to communicate clearly the purpose/objectives and the process of the project to build mutual trust with the different stakeholders.” This highlights the importance of addressing local power relations and customizing communication strategies to build trust and inclusivity.

Another important dimension within communication is the role of knowledge brokerage in bridging the gap between research scientists, NbS practitioners, policymakers, urban planners, and community stakeholders. As Frantzeskaki et al. (2019) argue, trusted knowledge brokers are crucial for facilitating two-way communication, overcoming barriers of culture, language, and education, and fostering shared understanding across stakeholder groups. This function was underscored in the BioClimSocial interviews on co-design processes for montane NbS in Nepal, where the respondent described the value of “a common voice from the community to communicate ideas.” Often, this role was informally assumed by local actors. However, in the absence of a designated broker, tensions were more likely to arise. As one NbS scientist observed, “…at the individual level you can discuss with them; at the community level, sometimes you have some conflicts with the engagement.” These insights suggest that strategic facilitation of communication — especially in diverse and multi-scalar governance contexts — is essential to mitigate conflict and enhance collaborative outcomes. This need for effective communication is further illustrated in a BioClimSocial case study of community-based seagrass restoration for erosion control and climate resilience in San Andrés, Colombia (see Chapter 5). Reflections on the project emphasized that facilitated communication among actors and stakeholders was key to its success.

3.2 Social outcomes

In contrast to the previous section, the focus of this part lies on the potential social outcomes of NbS rather than the principles that should be applied in designing and implementing them.

3.2.1 Positive social outcomes of NbS

NbS have the potential to deliver multiple benefits which include but are not limited to climate change mitigation, adaptation, resilience, improved water and air quality, recreational opportunities, and sustaining livelihoods (Seddon et al. 2020). Quantifying these benefits can help build a compelling economic case for the NbS implementation, as demonstrated by cost-benefit analyses in various contexts (see e.g. van Zanten et al. 2023). Moreover, NbS can deliver significant co-benefits – contribute to individual and societal well-being, quality of life, greater equity, community resilience and yield other forms of positive outcomes in the social sphere (Raymond et al. 2017). Expanding this list, an overview of possible positive social outcomes was gathered from the BioClimSocial questionnaire. Figure 12 presents the results of the questionnaire showing how respondents rated the social impacts observed within their NbS interventions.

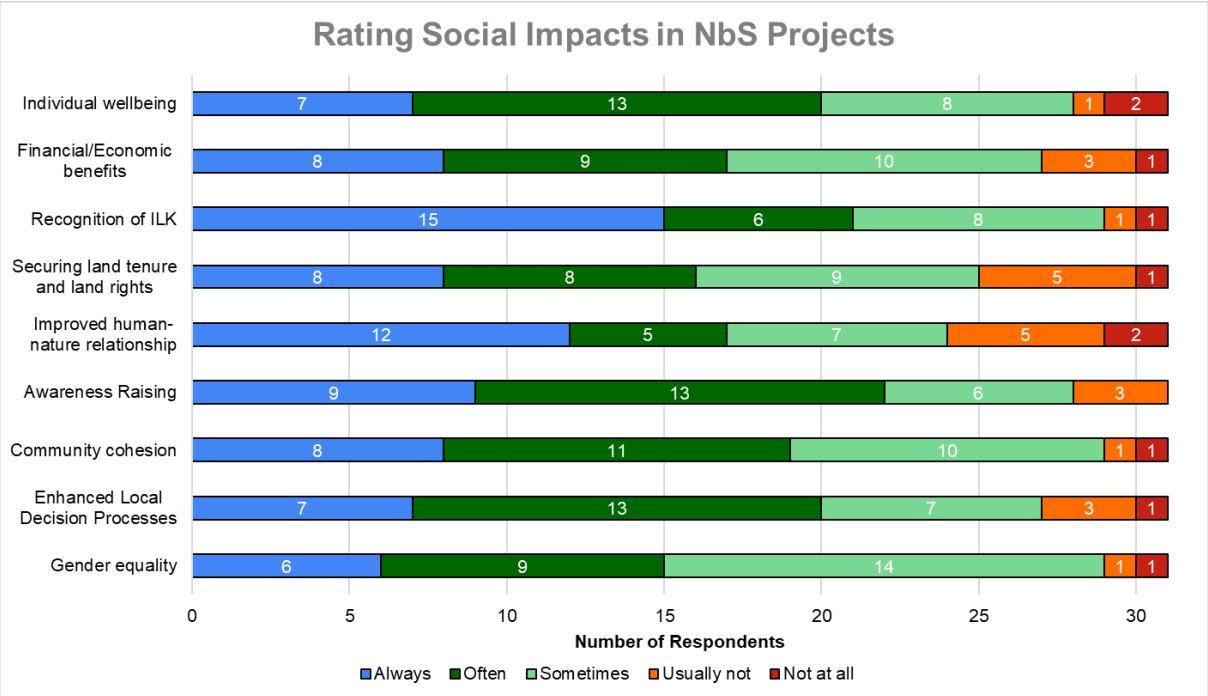

Fig. 12: Responses to the BioClimSocial questionnaire regarding perceived social impacts related to NbS (31 responses in total).

It is important to note that the responses do not clarify how these stated social impacts are measured, whether they endure over time or occur at certain phases of the NbS intervention cycle, or whether they are based on primary research or second-hand stakeholder accounts. Despite these uncertainties, the questionnaire reveals some noteworthy patterns.

The most consistently achieved impact is considered to be the integration of Indigenous and local knowledge, rated as “always” in 50% of responses (15 out of 30). Other frequently achieved impacts include interaction with nature (40%) and awareness (30%). In contrast, outcomes such as financial benefits to the community and gender equality are less consistent,

with only 17% and 20% of respondents respectively rating them as “always” achieved. This suggests that cultural and environmental outcomes are more reliably realized in NbS projects than social equity or economic benefits.

Below we describe the different aspects of positive social outcomes of NbS in more detail.

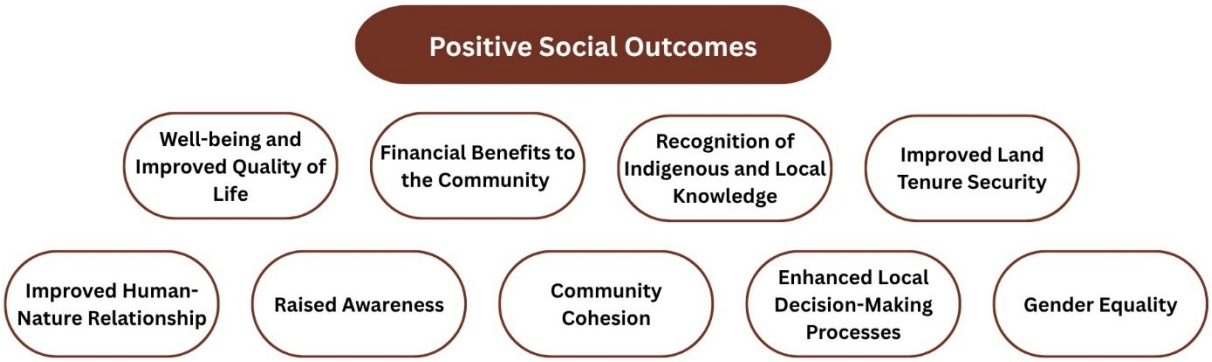

Fig. 13: Positive social outcomes of NbS explored in the framework of the BioClimSocial research

Well-being and improved quality of life: A growing body of evidence from studies and projects shows several pathways in which NbS support well-being through enhanced provision of ecosystem services. First of all, emotional well-being and mental health are positively influenced. Engaging with nature – particularly through urban green and blue spaces – has been associated with reduced stress levels (as indicated by cortical activity), improved mood, and lower rates of anxiety and depression, contributing to better overall psychological well-being (Kolokotsa et al. 2020). In addition to mental health benefits, NbS play a significant role in supporting physical health. This connection is evident in NbS capacity to enhance air and water quality, reduce urban heat stress, and expand space for recreation (van den Bosch & Ode Sang 2017; Kopsieker et al. 2021). Access to green spaces, for instance, encourages active lifestyles without significant financial barriers. Regular physical activity supported by these spaces reduces the prevalence of conditions such as cardiovascular disease and obesity-related illnesses (Shanahan et al. 2019). Moreover, NbS contribute to social well-being. Studies have demonstrated that shared green spaces elicit a sense of social connection and foster community cohesion, substantially reducing social isolation (Lemos et al. 2024).

These insights from literature can be further complemented by responses to the BioClimSocial questionnaire on perceived well-being outcomes most associated with NbS. Respondents often described the benefits in general terms (such as resilience, availability of natural resources), occasionally also emphasising the recovery of past environmental and well-being conditions. The exemplary statements include: “Respect and preservation of the environment; sustainability; back to ancestral practices and health and well-being in general”, “Quality of life, sustainability, inclusiveness, trust and social capital”, “In urban settings, enhanced quality of life and more attractive neighbourhoods”, and “The main benefit that I have perceived, especially for the local community, is recovered environmental and well-being conditions that we had in the past”.

Among the BioClimSocial experts, there is consensus that, NbS enhance quality of life by improving environmental conditions, while also supporting mental and physical health through access to nature. These outcomes are explicitly reflected in a number of existing NbS standards (e.g. IUCN 2020a; IUCN 2023; WHO 2025).

Financial/Economic benefits to the community: Beyond the general and restorative benefits, respondents to the BioClimSocial questionnaire also identified more tangible, economically focused advantages that NbS can bring. These are broadly associated with improving the livelihood opportunities of local communities and enhancing their financial resilience. As one respondent noted, NbS provide "benefits that can easily be monetarized," pointing to the potential for direct economic gains. Others emphasized "financial benefits and capacity building" and "linking natural systems to economic opportunity." For example, NbS can create income-generating opportunities for various stakeholder groups through the sustainable use of natural resources, such as eco-tourism, agroforestry, or sustainable fisheries (see also section 3.2.2). In many cases, NbS also offer a cost-effective solution to a societal challenge that would have otherwise required financial investments in grey infrastructure, e.g. for water management, disaster risk reduction or coastal protection.

Beyond direct livelihood benefits, NbS often generate valuable ecosystem services that serve the wider society as common goods (e.g. carbon sequestration, improved air and water quality, regulation of floods and droughts etc.). Several policy and financial mechanisms aim to incentivize these outcomes. Two noteworthy instruments in this context are Payments for Ecosystem Services (PES) and Reducing Emissions from Deforestation and Forest Degradation (REDD+). REDD+ is an international mechanism under the UNFCCC that provides payments or incentives to developing countries to promote conservation and sustainable management practices and incentivise actions that enhance forest carbon stocks and reduce emissions from deforestation (Thompson et al. 2023). PES schemes involve direct, conditional payments from beneficiaries of ecosystem services (e.g. biodiversity, water purification, carbon sequestration) to land managers or NbS providers who are commissioned to implement conservation or restoration actions that deliver these services (ibid.). Together, these mechanisms illustrate how NbS can generate ecological, social and economic value while aligning with broader sustainable development goals. However, the effectiveness of instruments like PES and REDD+ depends on equitable benefit-sharing, robust governance, and the meaningful inclusion of local communities. Without these elements, such mechanisms risk reinforcing existing inequalities or delivering only short-term gains at the expense of long-term resilience.

Recognition of Indigenous and local knowledge and practices: The consideration and recognition of Indigenous and local knowledge (ILK) emerged as the most frequently cited social impact in the BioClimSocial survey, with 48% of respondents reporting it as "always occurring" in NbS projects. This social outcome closely aligns with the section on diverse knowledge systems outlined before, highlighting the recognition of ILK as both a guiding principle and a key outcome of effective NbS implementation. A stronger consideration of alternative knowledge systems within NbS processes — such as ILK — creates a self-reinforcing cycle in which inclusion fosters legitimacy, and legitimacy further strengthens knowledge holders' role in shaping effective, context-specific solutions. This finding reflects a growing recognition among researchers and practitioners of the critical role IPLCs play in effective ecosystem stewardship. Indigenous Peoples and local communities manage approximately 50% or more of the world's remaining biodiversity, and their ancestral lands are often in significantly better ecological condition than those governed by other groups (Reytar et al. 2024). This stewardship is grounded in centuries of place-based ecological knowledge, sustainable practices, and deep cultural and spiritual connections to nature. As such, drawing upon Indigenous expertise is increasingly seen as a vital pathway to ensuring the effectiveness, resilience, and long-term sustainability of NbS (WEF 2023). However, this recognition also invites a critical reflection. As

Reed et al. (2022) highlight, NbS initiatives can act as a double-edged sword for Indigenous communities. While they have the potential to support the preservation of ancestral knowledge and practices, they can also inadvertently undermine them when implemented without genuine collaboration, respect for rights, or consideration of cultural contexts. This underscores the importance of moving beyond tokenistic engagement towards equitable partnerships that place Indigenous Peoples and local communities at the centre of decision-making processes and respect their sovereignty over traditional knowledge systems.

Improved land tenure security: Land tenure rights refer to the recognition and formalisation of legitimate land and resource claims, particularly for IPLCs. These rights are increasingly understood as essential for climate resilience and sustainable management of ecosystems. Communities with secure tenure are significantly better positioned to protect, restore, and manage natural ecosystems sustainably (Rakotonarivo et al. 2023). In this regard, the recognition of land rights functions as both a matter of social justice and a strategic climate and biodiversity intervention. Where tenure rights are insecure, the risks of land-grabbing, forced displacement, and the marginalization of traditional stewardship practices increase. In contrast, secure land tenure is consistently associated with lower deforestation rates, greater carbon storage, and higher levels of biodiversity, as shown in global assessments (Garnett et al. 2018). Within the context of NbS, improved land tenure security has been identified as a critical social outcome of well-designed interventions. Secure land tenure gives communities confidence that their access to and control over land will not be arbitrarily removed. This positive outcome can be achieved through participatory mapping, legal recognition of customary rights, and co-management agreements that empower Indigenous and local communities as stewards of ecosystems.

Improved human-nature relationship: Another key finding of the BioClimSocial questionnaire is that nearly 39% of respondents identified improved human-nature relationship as a social benefit that “always” occurs in NbS. This suggests a widely perceived role of NbS in fostering deeper connections between people and their surrounding ecosystems. This theme is further supported by respondents’ reflections on the aesthetic and experiential dimensions of NbS outcomes: NbS are perceived to enhance the physical environment and people’s emotional and cultural relationships with it. These reflections underscore how NbS not only deliver ecological and practical benefits, but also actively shape the emotional, cultural, and symbolic relationships between people and nature — relationships that are further illuminated in specific case studies. The culture-nature theme is, for example, highlighted in the BioClimSocial agroforestry case study in Côte d'Ivoire. Researchers noted that to address the issue of the interface between culture and nature, local farmers and indigenous groups are those most directly involved in shaping and sustaining landscapes, as they are responsible for implementation and maintenance of any new practices. This also aligns with findings from the Assessment on Transformative Change made by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). The Assessment results emphasize the need to shift from exploitative relationships to those based on care, respect, solidarity, responsibility, and stewardship (IPBES 2024).

Raised awareness: Another (co-)benefit of NbS is the heightened awareness such solutions foster among policymakers, communities, and other actors and stakeholders regarding the importance of nature, for example, of specific ecosystems. NbS projects often serve as tangible examples of how healthy, functioning ecosystems can address environmental challenges such as climate change and biodiversity loss and increase urban resilience (Cohen-Shacham et

al. 2016). Furthermore, when the tangible successes of NbS and their social benefits are effectively communicated, this can raise public awareness of the NbS themselves and inspire broader political and policy support. The positive feedback loop can be observed, when increased visibility and understanding of NbS outcomes reinforce public engagement, which in turn puts pressure on decision-makers to invest further in these approaches (Nesshöver et al. 2017).

Community cohesion: Among the perhaps less obvious potential social benefits of NbS is the fostering of social cohesion, collective action, and progressive participatory democracy at a local level. These social dynamics not only strengthen community ties but also empower residents to take active roles in shaping their environment. A related benefit is that a well-designed NbS can lead to social equity and inclusion. Within the broad spectrum of NbS, urban greening provides particularly tangible opportunities for enhancing social connections. A review of 51 empirical studies, conducted by Wan et al. (2021), found that urban green spaces positively influence social cohesion through a combination of physical characteristics, users' perceptions, and usage patterns. Community gardens, for example, have proved helpful in strengthening civic engagement by providing shared spaces where individuals from different backgrounds come together for a common purpose (Kabisch et al. 2016). These interpersonal and community benefits are echoed in the BioClimSocial NbS research work in Beirut, Lebanon. In both explored cases – of greening urban balconies and Ancillary Botanic Gardens (ABG) – various participatory methods, including activity-oriented focus group discussions with ABG youth visitors, in-depth semi-structured interviews with potential ABG owners, and specifically, in-depth interviews with individuals identified as green balcony champions helped draw this conclusion: even small-scale urban greening initiatives can generate broader social impacts by nurturing shared identity, local ownership, and inclusive forms of engagement.

Enhanced local decision-making processes: NbS can lead to improved local decision-making by fostering inclusive, participatory, and evidence-based approaches to managing natural resources and addressing environmental challenges. Because NbS rely on the integration of ecological knowledge with social and economic considerations, they encourage collaboration among diverse actors and stakeholders, including local communities, government agencies, scientists, and private sector (Raymond et al. 2017). The benefit of this collaborative approach is that it engenders a more locally relevant and culturally attuned set of interventions, increases stakeholder buy-in, and increases capacity for sustainability of NbS (Seddon et al. 2020). However, the involvement of stakeholders can be uneven. According to the Colombian case study partners, a clear and well-understood regulatory framework is essential for successful decision-making and compliance in NbS implementation. Although Colombia has numerous environmental laws, public understanding and appropriation of these regulations remain limited. Building literacy around legal frameworks is critical to strengthening governance, as is ensuring compliance for the sustainability of NbS initiatives. Moreover, establishing long-term mechanisms for stakeholder collaboration can help overcome the short-term focus of governments driven by electoral cycles. Such mechanisms also offer opportunities to build trust and foster relationships among stakeholders from different sectors with diverse interests, thereby enhancing the effectiveness and resilience of NbS governance.

Gender equality: As recognised by the United Nations (Caswell & Jang 2024) and European Commission (Gaspers et. al. 2022), women are the primary stewards of natural resources in many contexts around the world and with that, contribute their unique perspectives and knowledge that are crucial for the effective implementation of NbS. Conversely, increased

gender equality and equity can also emerge as a positive outcome of NbS. By actively involving women in decision-making processes and recognizing their contributions, NbS projects can empower women socially and economically, challenging traditional gender roles and promoting more equitable community dynamics. Recognising the intersectionality of gender with other social identities – such as age, ethnicity, socioeconomic status, or disability – can further ensure that NbS initiatives address the needs and priorities of a wider range of marginalised groups. This broader inclusivity not only enhances social equity but also brings diverse perspectives that strengthen the design, implementation, and long-term success of NbS. This empowerment not only strengthens the effectiveness and sustainability of environmental initiatives but also contributes to broader social progress by fostering inclusive governance and reducing inequalities (Delbaere et al. 2024).

The overview of potential positive social outcomes of NbS presented above is not exhaustive. Additional outcomes — identified by the BioClimSocial team as particularly meaningful to those directly or indirectly affected by NbS interventions — include fostering experience-based learning; building trust in research; facilitating communication among stakeholders; and promoting intersectoral collaboration. Together, all these examples underscore the diverse and far-reaching social dimension of NbS and simultaneously point to the need for carefully tailored and enabling approaches in NbS design and implementation – approaches that are transdisciplinary, inclusive, and context-sensitive. The following chapters of this report will explore these approaches in greater detail, as well as conditions necessary for their successful application.

3.2.2 Exploring positive social outcomes in selected types of NbS

Drawing on findings from desk-based research as well as insights from original case studies, this section takes a closer look at the social outcomes associated with concrete NbS implemented in diverse settings. The positive social outcomes discussed are not intended as exhaustive or definitive scenarios for NbS impacts on the social sphere, but rather as illustrative examples of the potential improvements.

Agroforestry

Agroforestry, meaning the integration of trees with crops and/or livestock, delivers significant social benefits across diverse ecological and geographic contexts (Satish et al. 2024). As a NbS, it enhances livelihood diversification, food security, community empowerment, and climate resilience.

Empirical cases from Sierra Leone, Brazil, and India show that agroforestry increases income through the sale of diverse products such as timber, fruits, and honey, while lowering production costs and boosting market value (Malan et al. 2024; Shennan-Farpón et al. 2022; Telwala 2022). Intercropping improves soil fertility and stabilizes yields, reducing vulnerability to environmental shocks (Garrity et al. 2010). Furthermore, incorporating apiculture and native species can help to boost ecological resilience and economic returns (Willmott et al. 2023; Garrity et al. 2006). In the BioClimSocial case study in Côte d'Ivoire, agroecological practices such as mulching and cover cropping have strengthened food security, especially in savannah and transition zones.

Community participation enhances the sustainability of agroforestry systems. In the Côte d'Ivoire case study, IPLCs co-designed agroforestry interventions. Other reviewed studies have shown that such participatory approaches reinforce traditional knowledge, build social capital,

and promote collective resource governance (Mbow et al. 2014; Willmott et al. 2023). Key enabling factors include secure land tenure, financial mechanisms such as carbon payments, and institutional recognition of traditional knowledge systems (Telwala 2022; Satish et al. 2024). When these conditions are met, agroforestry demonstrates strong potential to deliver inclusive, sustainable, and resilient outcomes.

Coastal and marine restoration

Examples of coastal and marine NbS include the conservation and restoration of coral reefs, mangroves, and seaweeds, which help mitigate the impacts of climate change, coastal erosion, storm surges, and flooding by dissipating oceanic energy (Wedding et al. 2022). Such interventions are increasingly recognised by both science and policy as valuable approaches to climate change mitigation as well. Yet, those countries most vulnerable to climate and ecological crises, particularly the Pacific Small Island Developing States (PSIDS), face significant financial, technical, and institutional barriers in implementing marine and coastal NbS (Châles et al. 2022).

Despite all these challenges, research highlights the substantial social benefits coastal and marine NbS can offer, especially in PSIDS. They include improving local livelihoods, reducing vulnerability, and fostering community engagement. NbS act as a catalyst for resilience-building and offer viable pathways towards more sustainable futures by enabling opportunities in sustainable fisheries, agroecological practices, and eco-compatible tourism (Hilmi et al. 2025). These, in turn, generate conditions for improved socioeconomic stability. For instance, sustainable fisheries management has been shown to buffer against fluctuations in external markets and support livelihood security (Costello et al. 2016).

The BioClimSocial NbS case study on seagrass restoration off the Caribbean coast of Colombia highlights multiple ecosystem services that were enhanced, along with achieved positive social outcomes. Seagrasses provide crucial provisioning services such as fisheries, biochemical products, and medicinal resources. They also play a key regulatory role by capturing carbon, mitigating erosion and stabilizing coastlines, as well as regulating the hydrological and nutrient cycles. Additionally, seagrasses support biodiversity by offering breeding habitats and contributing to soil formation. On the cultural side, seagrasses indirectly enhance recreation and tourism and hold symbolic and aesthetic value. From a participatory perspective, through community workshops, the seagrass restoration project in San Andrés, Colombia, has strengthened local knowledge, fostered a sense of social ownership over the marine-coastal ecosystem, and helped consolidate community networks. These outcomes support the long-term environmental sustainability of the archipelago while providing tangible social benefits such as access to seafood, medicinal resources, and opportunities for recreation and tourism.

NbS in mountainous regions

Diverse NbS implemented in mountainous regions play a vital role in improving local quality of life by addressing both environmental and socio-economic challenges. One of their key benefits is disaster risk reduction, particularly in mitigating hazards such as floods and landslides. Furthermore, NbS support water management in critical watersheds, where they help preserve aquatic ecosystems while securing resources for drinking water, irrigation, and different industries. For instance, water conservation efforts in the Andean micro-basins in Peru have improved water availability during dry seasons, supporting agriculture, livestock, and food security (Mori-Clement & Zapata 2023). Other examples from the mountainous regions of Peru indicate that NbS such as agroforestry and ecosystem restoration implemented here have

stimulated local economies by creating jobs and diversifying income. These benefits were particularly valuable in strengthening household resilience during the COVID-19 pandemic (ibid.). Economic benefits can also be observed in the Alpine region, where NbS are reported to reduce costs related to ecosystem management, infrastructure, and insurance while supporting regional employment and local economies (Marzelli et al. 2025).

Beyond tangible ecological and economic impacts, well-managed montane NbS can foster social change. Research highlights their potential to reinforce local governance, encourage stakeholder-led decision-making, promote gender equality, and safeguard cultural heritage and ancestral lands (Marzelli et al. 2025; Palomo et al. 2021). In their report on Nature-Based Solutions and their governance structures in the Alpine region, Marzelli et al. (2025) further underscore the broad social value of NbS in mountainous areas, specifically in the Alps. These include enhanced recreational and aesthetic values, platforms for scientific research and environmental education, and increased community engagement. By involving local populations in the co-design and implementation of NbS, such initiatives strengthen social cohesion, empower citizens, and raise environmental awareness. Furthermore, they contribute to preserving cultural identity by sustaining local traditions embedded in the Alpine landscapes. Importantly, NbS help maintain the unique character of the Alpine socio-ecological systems by supporting multifunctional land use, traditional practices such as alpine pastoralism, and the biodiversity that depends on these dynamic cultural landscapes.

The BioClimSocial case study in the Austrian Alps addresses the complex issue of overforestation, which — unlike deforestation — is difficult to detect and understand due to long-term socio-ecological interactions and uncertain impacts on biodiversity. This problem challenges traditional views of "good" forests versus alternative land uses like grazing. The project revealed positive social outcomes from promoting traditional agricultural land-use practices and pastoralism, including mutual learning, trust-building, and enhanced collaboration. Workshops that visualized diverse stakeholder perspectives facilitated inclusive dialogue, reduced initial scepticism, and fostered respectful communication among participants. Scientists were highly engaged and maintained solidarity beyond formal sessions. Local farmers, initially cautious due to concerns over criticism, eventually acknowledged the issue's relevance and strengthened cooperation with the local protected area (Nature Park). While full stakeholder ownership remains a goal, the committed Nature Park partner offers strong potential for ongoing progress. The initiative established a foundation for sustained cooperation, though bridging the gap between farmers' practical knowledge and scientists' theoretical views will be important in future phases.

Urban NbS

Urban NbS have received considerable global attention, especially compared to rural, coastal, and mountainous settings where implementation remains uneven. This heightened interest is particularly evident in high-income countries, where many urban NbS initiatives are well-funded and supported by policy. The trend reflects a growing recognition of cities' roles in addressing climate change, improving environmental quality, and delivering a range of public health and social co-benefits (Bockarjova et al. 2022). With approximately 57% of the global population now living in cities (Ritchie et al. 2023), and the urban–rural divide continuing to widen, urban NbS have become focal points for investment. Urban NbS also show considerable potential to enhance community well-being, equity, and environmental justice. Well-designed urban NbS can reduce climate risks — such as urban heat and flooding — particularly for vulnerable populations, while improving access to green spaces and supporting inclusive

governance processes. In doing so, they address structural inequalities and enhance the resilience of urban poor communities (Reid 2020).

The BioClimSocial case study in Lebanon provides two strong examples of urban NbS: green balconies and Ancillary Botanic Gardens (ABGs). Green balconies demonstrate how vertical greening strategies can promote biodiversity, reduce urban heat, trap dust, and function as small-scale carbon sinks. They represent an innovative, space-efficient method of integrating greenery in densely populated urban areas, while enhancing the urban aesthetic and ecological balance.

The ABG initiative exemplifies how climate change adaptation and biodiversity conservation can be community-driven. These gardens, established on redundant or underused urban sites, provide platforms for climate research, ecological monitoring, and informal environmental education across altitudinal gradients. The involvement of local communities in ABG creation makes these projects socially impactful: the benefits are not only environmental, but also educational, emotional, and cultural. In Beirut, for instance, schoolchildren visiting an ABG reported heightened interest in plants, improved ecological awareness, and enhanced mood and well-being. These gardens also triggered personal reflections, reconnecting youth with nature and reinforcing botanical learning. ABGs thus emerge as powerful tools for democratizing botanical knowledge through strategies like storytelling and active exploration. Institutional stakeholders further recognized the role of ABGs in promoting mental well-being, providing refuge from urban stress, and fostering environmental responsibility. By transforming closed green spaces into accessible and sensory-rich experiences, ABGs position institutions as key agents of inclusive learning and urban wellness.

Similarly, the case study on green balconies highlights notable social outcomes. Residents described their balcony gardens as spaces of beauty and comfort — venues for both solitary reflection and social gatherings. The gardens improved mental well-being, evoked memories of rural traditions, and offered therapeutic value after stressful days. Particularly among older adults, gardening provided a purposeful, engaging activity. Green balconies also enhanced privacy and reduced noise, creating a peaceful buffer within crowded urban environments. In parallel, plant nursery owners noted the long-term value of balcony gardens in strengthening community ties, promoting native ornamentals, and expanding public understanding of urban greening practices.

Both ABGs and green balconies reveal how urban NbS can deepen people's emotional and cultural connections with nature while enhancing health, education, and overall quality of life. In densely populated and climate-vulnerable cities, these small-scale interventions are not only environmentally beneficial — they serve as catalysts for social transformation.

3.2.3 Possible trade-offs related to NbS

NbS do not always guarantee positive social outcomes. Potential risks and trade-offs can be subtle and experienced differently by various actors and stakeholders, influenced by underlying assumptions, knowledge, and prevailing narratives (BfN 2023). Therefore, recognising and addressing these possible downsides is crucial to ensure that NbS interventions achieve their full potential across all dimensions of sustainability, including the social one.

Research and expert insights, including those from the BioClimSocial project, reveal that neglecting core principles throughout the NbS project cycle or failing to adequately understand the social context can lead to negative social consequences (e.g. Aronson et al. 2017;

Frantzeskaki et al. 2019; Seddon et al. 2021; Anguelovski et al. 2022). For example, Walker et al. (2024) warn that without careful attention to social equity and power dynamics, NbS can have significant adverse impacts on vulnerable populations. They found that a flood buyout programme in rural Catskills, New York – intended as a NbS to enhance flood resilience – had unintended negative effects on vulnerable populations by exacerbating social inequities and power imbalances, leading to the loss of services, housing, and community cohesion.

One of the most documented risks in urban NbS projects is **green gentrification**, where the introduction of green amenities such as parks and restored wetlands raises property values, attracting wealthier residents and displacing lower-income communities (Anguelovski et al. 2022). This process can lead to **reinforcing social inequalities**, especially since access to green spaces often favours higher socioeconomic groups while marginalized communities receive fewer benefits (Kiss et al. 2022). Another example of how improperly planned and implemented NbS can cause distributional inequities between different stakeholder groups has been observed in the context of wetland restoration: if it improves flood regulation but restricts traditional land uses, this can increase social disparities in the community. In general, NbS interventions can trigger **land-use conflicts**, particularly when customary land tenure systems are overlooked. Restricting access to traditional grazing lands, forests, or wetlands may marginalize IPLCs, undermining their rights and livelihoods (Seddon et al. 2021). Additionally, NbS can cause **temporary or localized economic losses**, especially during transition phases. These costs often disproportionately affect resource-dependent communities unless compensation mechanisms and inclusive planning are in place (Castaldo et al. 2025). Social trust is also at risk when NbS projects are implemented in a top-down manner with limited community participation. This can **strain social dynamics**: erode legitimacy, exclude local knowledge, and weaken governance, ultimately reducing social cohesion (Kiss et al. 2022).

One of the most prominent concerns documented in the responses to the BioClimSocial questionnaire is that NbS may become inappropriate, financially unsustainable, or ineffective if land use decisions are poorly planned. In the worst-case scenario, where NbS are portrayed and in some cases, implemented, as environmentally and socially beneficial without proper verification or effect, there is a risk of greenwashing (Gałecka-Drozda et al. 2021).

Respondents to the BioClimSocial questionnaire identified several root causes of negative trade-offs, including conflicting stakeholder expectations, especially when global NbS goals overlook local community needs, high implementation costs, lack of necessary knowledge and skills, and the need for advanced social organization as well as time for “bearing fruits”.

From a practical standpoint, guidance for practitioners recommends early detection of potential NbS trade-offs by actively engaging stakeholders to identify differences in benefit perceptions, balancing competing priorities through inclusive and transparent decision-making frameworks, and monitoring outcomes using adaptive, long-term strategies that incorporate diverse ecological and social indicators, all to minimize unintended consequences and enhance overall project acceptability (Giordano et al. 2020).

3.3 Linking the process and principles with social outcomes

In conclusion, the social dimension of NbS is inherently complex, shaped by a multitude of contextual factors such as stakeholder identities, knowledge systems, power dynamics, and socio-political conditions. While NbS have the potential to generate multiple social benefits — improving well-being, fostering social cohesion, and enhancing equity, to name a few —

these outcomes are not guaranteed. A closer look at the explored social outcomes of NbS reveals that positive impacts (as described in section 3.2.1) are enabled by processes that are inclusive, equitable, respectful of human rights and rooted in local contexts. Therefore, to increase the likelihood of achieving positive social outcomes, NbS must be implemented considering and applying the principles outlined in section 3.1 of this report. At the same time, positive social outcomes lay ground for enhancing the processes and principles of how NbS are designed and implemented as well as for scaling NbS by building trust, legitimacy, and long-term engagement capacity.

Fig. 14 illustrates the **interconnected relationship between processes and principles** in NbS project planning and implementation (left side), and the **social outcomes** they can produce (right side), with equity & justice at the core as both a guiding value and a strong reinforcing mechanism.

Achieving such a system in practice requires appropriate guidance: frameworks, tools, and methodologies grounded in robust socio-ecological research, real-world observations, lessons from case studies, and insights from actors and stakeholders. Only with such informed approaches can NbS truly contribute to just, resilient, and sustainable transformations.

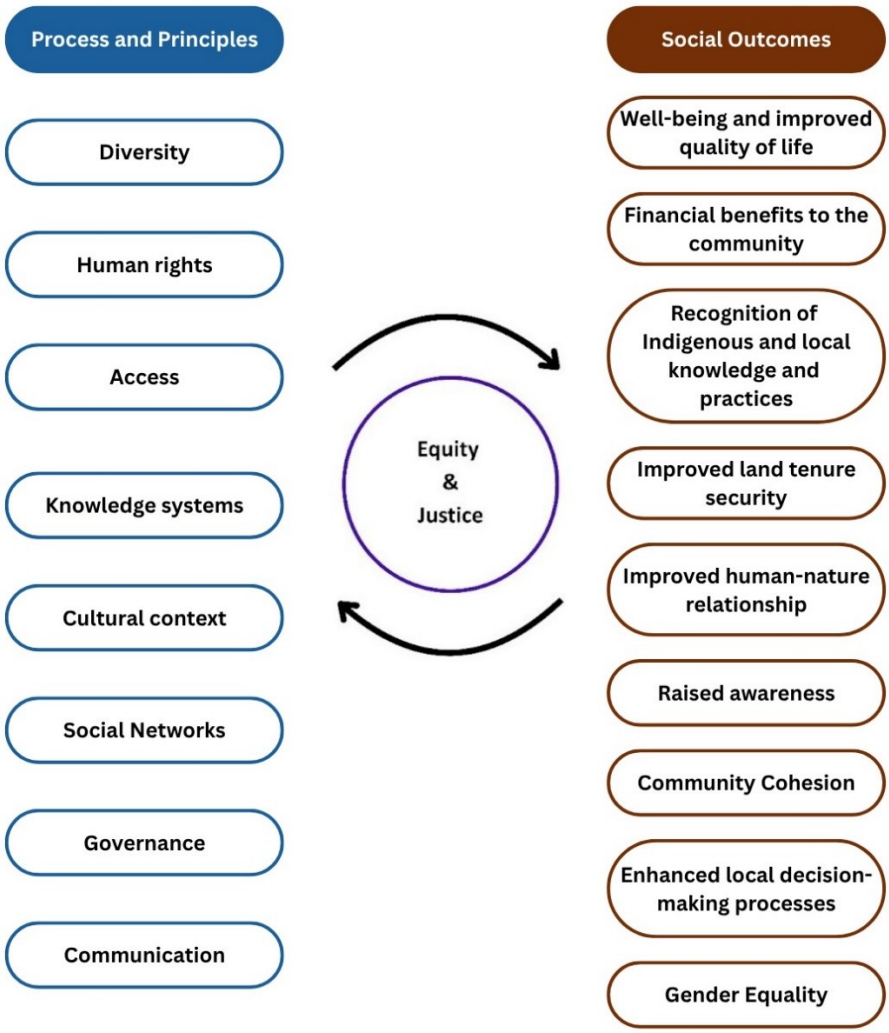

Fig. 14: Schematic diagram illustrating the central principles of “Equity and Justice” that need to underpin all aspects of the social dimension in NbS

A word on complex systems thinking in NbS

Complex systems thinking can guide reflections about the different impacts of NbS including ecological and economic, as well as social outcomes. Complex systems are dynamic, interconnected, and adaptive. Outcomes within such systems rarely follow simple cause–effect relationships; instead, they emerge from feedback loops, nonlinearity, and interdependencies among ecological processes, institutions, and human behaviours (Meadows 2008). Small changes in one part of the system can cascade through other components, sometimes producing effects that are surprising, counterintuitive, or delayed in time. This perspective is critical for sustainability challenges, where interventions often interact with multiple sectors and scales simultaneously. When applied to NbS, systems thinking provides a powerful framework for anticipating both unintended negative impacts and unanticipated co-benefits (Gómez et al. 2020). Complex systems thinking highlights that these "side effects" are not anomalies but inherent features of interventions in complex systems. To account for these dynamics in research, systems' approaches emphasize several strategies. Mapping interactions through tools such as causal loop diagrams, system maps, or network analysis can reveal possible feedback pathways before implementation.

4 The social dimension in the existing NbS guidance material

This chapter delves into the social dimension within the existing NbS guidance material. The IPBES Transformative Change Assessment (IPBES 2024) provides scientific insights into the underlying causes of biodiversity loss and the mechanisms of transformative change, thereby offering a foundational understanding for the systemic shifts required for effective NbS implementation. Complementing this, the publication by Lehmann et al. (2025) underscores the critical importance of adopting a long-term perspective in NbS policies and practices. This work highlights that both ecological and social processes inherent in NbS require adequate time to deliver their intended benefits, while also mitigating potential unintended consequences.

To ensure that the BioClimSocial Guidance Report effectively addresses knowledge and methodological gaps concerning the social dimension of NbS, it is important to first review the existing frameworks and recommended approaches. This provides the necessary background for the BioClimSocial input that explains how stakeholder engagement can be optimised to generate meaningful local social benefits in synergy with biodiversity and climate action, and how the positive social impacts can be better sustained.

A diverse range of NbS guidelines, handbooks, scientific papers, and other forms of literature exist, varying in scope, ambition, purpose, and tone. The intended audiences range from NbS researchers to practitioners focused on implementing such solutions, typically at the local level. This chapter provides an overview of the relevant literature identified through a systematic search on Google Scholar, using targeted keywords such as “Nature-based Solutions”, “Social outcomes”, “Stakeholder engagement”, “Guideline(s)” and “Handbooks”. The search yielded various forms of guidance material related to NbS, which are analysed and categorized in this review. Whilst trying to capture the global outlook, this chapter also highlights the gaps in both the thematic coverage and practical application of NbS guidance.

The state-of-the-art assessment is summarised in the following matrix (Tab. 1), where the reviewed NbS guidance documents are listed. Yet, it is important to note that this compilation is non-exhaustive, as the body of NbS literature is vast and continues to grow and evolve. The produced matrix is intended to help navigate the content, focus, and trajectory of the various NbS guidance materials, as the assigned criteria (“categories of concern”) assess whether the guidelines address the outcomes and limitations of NbS (a-d), the inclusive and practical mechanisms needed for their implementation (e-j), and the systemic challenges that influence their long-term sustainability (k-n). Each guideline was examined for each criterion, and the report’s authors recorded a simple “Y” for “yes” if the guideline addressed that aspect or “N” for “No” if it did not. This way, the list and matrix provide orientation to which aspects are considered by which guidelines and which gaps persist:

a. **Environmental management and ecological restoration:** The document may consider ecological restoration, revitalization, or improvement of a given area through natural elements and ecological processes. This may include the transformation of spaces using green infrastructures such as parks, green roofs, community gardens, and green corridors, which collectively enhance biodiversity, climate resilience, social cohesion, and well-being. Environmental management and restoration through NbS shift from "grey" infrastructure (e.g. concrete, asphalt) to "green" living systems that provide multifunctional benefits like cooling, flood mitigation, and habitat creation while respecting and involving local communities in the process of such regeneration.

b. **Impact on health and well-being:** The document may address how NbS can enhance human health and well-being through interventions such as urban greening, agroforestry, forestry, coastal NbS (blue infrastructure), and mountainous biodiversity. Specific factors might include improved air quality, increased physical activity, reduced heat stress, stress reduction, mood improvement, and enhanced cognitive function.

c. **Socio-economic outcomes:** The document may consider the main socio-economic factors associated with NbS that include job creation, economic growth, reduced public costs, financial implications of improved health and well-being, social equity, and resilience to climate-related and socio-economic shocks. This is, for example, the case for initiatives that lower energy costs through natural cooling and insulation, as well as projects that transform abandoned or underused spaces into green and blue infrastructure.

d. **Limitations of NbS:** The document may include clear statements that dismiss NbS as substitutes for the urgent need to phase out fossil fuels and other actions necessary to minimize biodiversity loss, ensuring transparency and preventing their misuse as a form of greenwashing.

e. **Transdisciplinary co-creation of NbS:** The document may provide guidance on the co-creation, design, planning, and implementation of NbS through transdisciplinary approaches that engage different stakeholders across sectors.

f. **Indigenous Peoples and local communities:** The document may consider how IPLCs play an essential role in NbS due to their traditional knowledge, long-standing stewardship of natural ecosystems, and cultural ties to their ancestral lands, thus promoting meaningful integration of their knowledge -based practice into NbS design and research.

g. **Rights-based approach and community rights:** The document may address issues such as e.g. property rights and land tenure challenges when it comes to the implementation of NbS and may promote rights-based approaches, including secure land tenure and the recognition of land ownership.

h. **Gender issues:** The document may include gender-responsive approaches in NbS research and practice, inter alia ensuring equitable participation in NbS design and implementation.

i. **Financial stakeholder compensation mechanisms:** The document may address mechanisms for financial remuneration and compensation to acknowledge and support the contributions of stakeholders in NbS projects.

j. **Step-by-step guidance for project development:** Here, the BioClimSocial team assesses if the document offers step-by-step support for developing NbS projects, covering all phases from planning and design to implementation, monitoring, and evaluation.

k. **Institutional and political context:** The document may address the role of institutional and political frameworks in shaping the efficacy of NbS.

l. **Governance challenges:** The document may delve into governance challenges affecting the sustainability of NbS, including coordination across different scales and sectors, and address motivational factors such as outcome measures of measurable social benefits, including financial returns and time constraints.

m. **Land use conflicts:** The document may specifically address conflicts regarding land use that negatively affect the local communities and, furthermore, may outline strategies for addressing and resolving these conflicts.

n. **Long-term sustainability of NbS:** The document may provide guidance in terms of principles and practicalities ensuring that NbS can be sustained long-term which include the need for ensuring that NbS are effective, resilient, equitable, and capable of delivering sustained ecological and social benefits over time.

Tab. 1: An overview of existing NbS guidance, according to specific criteria (see list above)

No.	NbS Guiding document	a	b	c	d	e	f	g	h	i	j	k	l	m	n
1	Guidelines on the Implementation of Nature-based Solutions (NbS) to Combat the Negative Impact of Climate Change on Forestry (Başsüllü et al. 2023) Initiated by: FAO	Y	Y	N	N	Y	Y	Y	N	N	Y	N	Y	Y	Y
2	Stakeholder Engagement Guide for Nature-based Solutions (Brill et al. 2022) Initiated by: UN Global Compact CEO Water Mandate and Pacific Institute	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y	N	N	Y
3	The BiodivERsA Stakeholder Engagement Handbook (Durham et al. 2014) Initiated by: Biodiversa	N	N	N	N	Y	Y	N	Y	Y	Y	Y	Y	N	N
4	Evaluating the impact of nature-based solutions: a handbook for practitioners (EC 2021) Initiated by: European Union	Y	Y	Y	N	Y	Y	Y	N	N	Y	Y	Y	Y	Y
5	Guidelines for Co-Creation and Co-Governance of Nature-based Solutions. Insights form EU-funded projects. (Andersson et al. 2023) Initiated by: European Union	N	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	N	Y
6	How to support a rights-based approach to nature-based solutions: Recommendations for Danish development cooperation (Funder & Gravesen 2022) Initiated by: DIIS	N	N	Y	N	Y	Y	Y	Y	N	N	Y	Y	N	Y
7	Green Cities Framework Handbook: Guidance for developing and implementing Nature-based solutions strategies towards water and climate resilience (Garcia-Blanko et al. 2022). Initiated by: European Union Horizon 2020	Y	Y	Y	N	Y	Y	N	N	Y	Y	Y	Y	Y	Y
8	Beyond Carbon Credits: A Blueprint for High-Quality Interventions that Work for People, Nature and Climate (Hacking et al. 2021) Initiated by: WWF	Y	N	N	N	Y	Y	Y	Y	N	N	Y	Y	Y	Y
9	Nature-based Solutions in Action: Lessons from the Frontline (Hou-Jones et al. 2021) Initiated by: Bond; compiled by: IIED	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	N	Y
10	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 (IUCN 2020b)	Y	Y	Y	N	Y	Y	Y	Y	Y	N	Y	Y	Y	Y

No.	NbS Guiding document	a	b	c	d	e	f	g	h	i	j	k	l	m	n
11	Natural Climate Solutions Handbook: A Technical Guide for Assessing Nature-Based Mitigation Opportunities in Countries (Leavitt et al. 2021) Initiated by: The Nature Conservancy	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N
12	A Sphere Unpacked Guide. Nature-based Solutions for Climate Resilience in Humanitarian Action (Hoffman & Henly-Shepard 2023) Initiated by: Sphere	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	N	N
13	Harnessing the power of collaboration for nature-based solutions: New ideas and insights for local decision-makers (Naumann et al. 2023) Initiated by: European Union	Y	N	Y	N	N	Y	Y	N	Y	N	Y	Y	N	Y
14	Voluntary guidelines for the design and effective implementation of ecosystem-based approaches to climate change adaptation and disaster risk reduction and supplementary information (SCBD 2019)	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
15	Handbook on implementation and adoption barriers of Urban Living Labs developing Nature Based Solutions (Sarabi et al. 2021) Initiated by: European Union Horizon 2020 (UNALAB)	N	N	Y	N	Y	Y	N	N	Y	N	Y	Y	N	N
16	Guidelines for Successful, Sustainable, Nature-Based Solutions. (Seddon et al. 2021).	Y	Y	N	Y	Y	Y	Y	N	N	N	N	N	Y	Y
17	ThinkNature Nature-Based Solutions Handbook (Somarakis et al. 2019). Initiated by: European Union Horizon 2020	Y	Y	Y	N	Y	N	N	N	Y	Y	Y	Y	Y	Y
18	Guidance on engagement with Indigenous Peoples, Local Communities and affected stakeholders (TNFD 2024)	N	Y	Y	N	Y	Y	Y	Y	Y	N	Y	Y	Y	N
19	Nature-Based Solutions in Humanitarian Settlements - Guidelines for integrating nature-based solutions in settlement planning (Ullal & Manoli 2024) Initiated by: UNHCR	Y	Y	Y	N	N	Y	N	N	N	N	N	Y	Y	N
20	Nature-based Solutions for disaster risk management (World Bank 2018)	Y	Y	Y	N	Y	Y	N	N	Y	Y	Y	N	Y	Y
21	Integrating Gender and Social Inclusion in Nature-Based Solutions. Guidance Note. (World Bank 2023)	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	N	N	N
22	The NbS Blueprint. Building business cases for Nature-based Solutions. (WBCSD 2024)	Y	Y	Y	N	Y	Y	N	N	Y	Y	Y	Y	N	N
23	A Recipe for Engagement in Nature-based Solutions and Nature Recovery (Hafferty et al. 2023)	Y	Y	Y	N	Y	Y	N	N	N	Y	Y	Y	N	Y

Synthesis of Guidelines on Nature-based Solutions

The reviewed guidelines provide comprehensive and practical insights into the design, implementation, governance, and evaluation of Nature-based Solutions across diverse contexts, including forestry, urban planning, humanitarian response, and corporate sustainability. In forestry and ecosystem management, the Food and Agriculture Organisation (FAO) (1), the Worldwide Fund for Nature (WWF) (8), and the International Union for Nature Conservation (IUCN) (10) outline strategies focussed on restoration, protection, and climate adaptation, grounded in global standards and biodiversity frameworks. Urban and climate resilience approaches are detailed by guidelines developed in the EU-context (5, 7, 15) and by the World Bank (20, 21), offering tools for planning, financing, and integrating NbS into infrastructure and city systems. Humanitarian-focused guidance (12, 19) highlights the potential of NbS to reduce risks and support displaced populations, with an emphasis on participatory design and long-term sustainability. While Sphere (12) integrates rights-based and inclusive approaches, the United Nations High Commissioner for Refugees (UNHCR) (19) primarily focuses on technical integration and spatial planning rather than explicit rights-based frameworks.

Stakeholder engagement is a central pillar across most publications. Guidelines from Durham et al. (3), EU co-creation frameworks (5, 13), the Taskforce on Nature-related Financial Disclosure (TNFD) (18) and Hafferty et al. (23) stress the importance of participatory planning, trust-building, and equitable governance. Several documents, including the ones developed by the network of British Overseas NGOs for Development (Bond) (9) and the Danish Institute for International Studies (DIIS) (6), focus on locally led approaches, advocating for the recognition of Indigenous and local knowledge and equitable access to decision-making and finance. Rights-based principles and Free, Prior and Informed Consent (FPIC) are strongly emphasized (8, 10, 18), with practical tools provided for power mapping, participatory monitoring, and benefit-sharing. Key components of engagement and concrete methodologies – though applied specifically to the European context – are presented and discussed in the Recipe for Engagement (23).

Evaluation and impact assessment frameworks or suggestions for indicators are provided by the European Commission (4) and others (17, 23), offering methodologies for measuring environmental, social, and economic outcomes. Business-oriented guidance from the UN Global Compact CEO Water Mandate (2), The Nature Conservancy (11), World Business Council for Sustainable Development (WBCSD) (22), and WWF (8) offers structured approaches for aligning NbS with climate, nature, and equity goals in the private sector, including tools for building investment cases and assessing co-benefits.

Across these sources, several positive learnings emerge. Locally led and inclusive approaches enhance the relevance, sustainability, and acceptance of NbS. Co-benefits such as improved biodiversity, water security, social equity, and climate resilience are consistently documented. The use of standard frameworks like the IUCN Global Standard (10) and WWF's principles (8) promotes quality and accountability. Indeed, the IUCN Global Standard for NbS (IUCN 2020a) and Guidance for using it (IUCN 2020b) constitute an authoritative guide to NbS principles, theory and practice and should be recognised accordingly. The theme of gender issues shows that gender equality remains insufficiently embedded across NbS planning, implementation, and governance. This aligns with IUCN Criterion 5, which requires participation to be based on mutual respect and equality, irrespective of gender (IUCN 2020a, IUCN 2020b). Similarly, the IUCN places emphasis on an equity, equality, and rights-based approach that reflects distributive, procedural, and recognitional justice. This operationalises Criterion 6, which calls for

established safeguards and the recognition of rights, as well as access to and use of land and resources (ibid.). Moreover, the analysis of trade-off balancing highlights that social and ecological trade-offs require transparent governance to prevent inequitable outcomes. This is consistent with Criterion 7, which stresses that NbS must be managed adaptively and evidence-based, with costs, benefits, and risks monitored and adjusted through iterative learning (ibid.).

Overall, the guidelines affirm that successful NbS depend on equity, collaboration, and long-term, adaptive implementation embedded in strong governance systems and tailored to local contexts.

Overview of limitations in the existing guidance materials

The existing NbS guidelines demonstrate strong attention to several important areas. They effectively address transdisciplinary co-creation of NbS (criterion **e** from the list on pages 45-47), ensuring that collaboration across multiple disciplines and stakeholder groups is central to the approach. The guidelines also thoroughly consider the institutional and political context (criterion **k**) as well as governance challenges (criterion **l**), reflecting an understanding of the complex environments in which NbS projects operate. Socio-economic outcomes (criterion **c**) receive solid focus, highlighting the importance of integrating economic and social benefits alongside ecological goals.

On the other hand, there are notable gaps where the guidelines fall short. The limitations of NbS (criterion **d**) are clearly insufficiently acknowledged, which risks creating unrealistic expectations and reduces preparedness for potential challenges. Rights-based approaches (criterion **g**) and especially gender issues (criterion **h**) are not consistently addressed, limiting the guidelines' effectiveness in promoting equity and inclusion. Land use conflicts (criterion **m**) are underrepresented, despite their critical role in shaping NbS feasibility and community acceptance. Furthermore, practical implementation of NbS may be hindered if the existing step-by-step guidance for project development (criterion **j**) does not match the specific context or is too general. Finally, long-term sustainability of NbS (criterion **n**) is also poorly covered, indicating a need for stronger frameworks to ensure that benefits persist well beyond the project lifecycle.

In summary, while the guidelines are supporting interdisciplinary collaboration and consideration of political and governance contexts (criteria **e**, **k**, and **l**) and socio-economic impacts (criterion **c**), they require significant improvements in addressing the limitations of NbS, gender equity issues, land use conflicts, the provision of practical guidance, and the support of long-term sustainability (criteria **d**, **h**, **j**, **m**, and **n**) for more effective and equitable NbS outcomes.

Additionally, effective operationalization of NbS requires a structured approach to indicators and measurement, capturing social, ecological, and economic outcomes (Wendling et al. 2021). Methodologically, evaluating NbS involves both quantitative and qualitative approaches, such as remote sensing, household surveys, and participatory workshops (Sowińska-Świerkosz & García 2021). Yet, only a few of the above presented guidance materials (for example, 4, 10, 23) suggest approaches to assessing social outcomes, including well-being, participation, equity, and governance.

Specific identified gaps

Chapter 3 emphasizes the critical role of social dimension in NbS, including principles, processes and outcomes. Principles and processes include, among others, the direct involvement of individuals and communities throughout the entire NbS process. The BioClimSocial analysis of existing guidance material revealed certain gaps regarding the facets of such involvement. Guidelines often adopt expert-driven approaches that insufficiently address aspects of inclusivity, participatory governance, contextual knowledge, and equitable outcomes. Moreover, existing frameworks tend to underrecognize how cross-scalar actor networks influence local governance, tenure rights, and NbS outcomes, thereby limiting the capacity to understand trade-offs and enable just, equitable transformative change.

This is also supported by other studies, that have shown that there are still major knowledge gaps when it comes to measuring the non-tangible benefits of Nature-based Solutions (NbS), for example, improvements in people's well-being and opportunities for recreation. These benefits are difficult to quantify because many projects assess them separately, without connecting their findings to others. As a result, most studies use a case-by-case approach rather than a more comprehensive or unified method. This lack of a holistic approach in scientific research may slow down the broader adoption of NbS in both the so-called Global South and the Global North (Viti et al. 2022).

Many of the reviewed documents touch on aspects of the social dimension of NbS, including, for example, the roles and involvement of IPLCs or the importance of rights-based approaches and inclusive practices in NbS planning and implementation. However, comprehensive definitions of the social dimension remain rare within NbS guidelines or handbooks. Consequently, there is a need for recommendations to support researchers and practitioners in integrating the full breadth of social considerations throughout all phases of project implementation.

Based on the conducted review (matrix) and inputs from the BioClimSocial project partners during interviews, key gaps in current NbS guidance – particularly concerning how to effectively integrate the diverse facets of the social dimension while staying grounded in practical and operational contexts – have been identified. It is important to note that the presence of a criteria in the guidelines (being indicated by a "Y") does not necessarily imply that all related gaps are addressed; additional shortcomings may still exist. Major gaps identified in the guidelines are listed below, starting with the ones that appeared most often. The authors of this report pay special attention to issues that are not sufficiently addressed. From this review, they identified five main gaps that stand out as priorities for further work:

Limitations of NbS (Criterion d): Beyond the gap as identified in existing guidelines, literature highlights a shortfall regarding the limitations of NbS. There is a risk of greenwashing, misuse, and misrepresentation of NbS as substitutes for fossil fuel phase-out or as guaranteed climate "fixes". Such risks can occur when NbS are poorly designed or promoted without sufficient safeguards, potentially being exploited to justify continued fossil fuel emissions. This contributes to greenwashing on climate action, ultimately failing to address the fundamental challenge of fossil fuel dependence and the urgent need to pursue carbon net zero. Furthermore, the multiple, often inconsistent definitions of NbS introduced by various experts or organisations, still leave the concept open to interpretation and potential misuse, including co-optation by vested interests, including corporations. This ambiguity can obscure accountability and mask who truly benefits, enabling greenwashing by shifting responsibility away from major polluters such as fossil fuel companies onto vulnerable groups like IPLCs or small farmers.

Land use conflicts (Criterion m): Conflicts arising from competing land uses — such as agriculture, forestry, urban development, and conservation — are not adequately emphasized in many NbS guidelines. These competing demands can create significant challenges that require careful navigation to balance ecological, social, and economic objectives. However, current guidelines often lack clear, systematic frameworks to manage these trade-offs in a transparent and equitable manner. This shortfall can lead to unresolved tensions among stakeholders, undermining the legitimacy and effectiveness of NbS initiatives. Moreover, the integration of NbS within national policy frameworks remains limited, which hampers coordinated land use planning and increases the risk of unintended negative consequences, such as land use conflicts and threats to the long-term sustainability of NbS projects. Recognizing and addressing these gaps is vital to reconcile competing land demands and to promote NbS approaches that are both socially just and ecologically resilient over time.

Gender issues (Criterion h): Key gaps in NbS guidelines concerning gender issues primarily involve insufficient integration of gender equality considerations throughout NbS planning, implementation, and monitoring. This lack of mainstreaming gender-responsive approaches limits not only the fairness of NbS interventions but also their overall effectiveness and long-term impact. Many guidelines tend to treat gender as an add-on consideration rather than as a fundamental component of equitable and sustainable NbS design. Additionally, there is a notable underemphasis on the engagement of women in decision-making, planning, and governance, missing opportunities for inclusivity and local knowledge incorporation.

Step-by-step guidance for project development (Criterion j): NbS guideline gaps are apparent on issues such as practical implementation challenges, insufficient operational guidance and limited adaptive management frameworks throughout NbS project cycles. These gaps can hinder the delivery of NbS benefits in addressing environmental and social challenges. Indeed, NbS guidelines, whilst providing overarching principles, fall short on specifying concrete methods for planning, designing, implementing, and monitoring NbS projects tailored to local contexts. This limits practitioners' ability to translate concepts into effective, context-relevant interventions (Qi & Terton 2025)

Long-term sustainability of NbS (Criterion n): The main gaps in NbS guidelines related to sustainability lie in the difficulty of turning broad sustainability principles into practical, operational actions. This makes it challenging to ensure that NbS provide long-term environmental, social, and economic benefits while managing inevitable trade-offs and uncertainties. NbS guidelines often simplify ecosystem functions, neglecting the complexity, temporal changes, and uncertainty in ecosystem responses to interventions and climate change impacts. This affects predicting and sustaining NbS benefits over time (Cook et al. 2025).

While almost all reviewed guidelines addressed the aspects of **transdisciplinarity** to a certain extent and acknowledge the importance of collaboration with non-academic stakeholders, there is need for deeper exploration of how such approaches can be effectively implemented to bring together diverse actors and stakeholders, together with NbS practitioners and researchers from different disciplines. Specific methods and procedures for facilitating transdisciplinarity often remain rather general (Martin et al. 2025). In Chapter 5, the BioClimSocial Guidance Report therefore delves into detail on practical examples and toolkits for participatory and transdisciplinary approaches and sets a focus on facilitative communication. Furthermore, the chapter provides NbS case study examples of participatory processes employed and the lessons learnt.

5 Participatory approaches and tools to support NbS development

5.1 Purpose of transdisciplinary approaches in NbS

The purpose of this chapter is to assist NbS researchers and practitioners interested in enhancing their work through adopting transdisciplinary and participatory approaches. Drawing on the experiences of the BioClimSocial partners and own complementary research, the chapter provides practical insights and examples on how to engage stakeholders throughout the entire NbS process.

Nature-based Solutions are grounded in complex local socio-ecological contexts and, as discussed in Chapter 3, should embrace diverse knowledge, worldviews, values, perceptions, needs, and interests. Effective NbS require a transdisciplinary perspective that fosters collaboration between academic and non-academic actors and stakeholders, including local communities, policymakers, and practitioners. This approach integrates scientific and experiential knowledge through co-created processes that span all stages from problem identification to implementation and long-term sustainability (Zyoud & Zyoud 2025). Addressing the intertwined social, ecological, and climatic dimensions of NbS cannot rely on technical or disciplinary expertise alone; it requires inclusive, collaborative processes that ensure credibility and social legitimacy. One of the key strengths of transdisciplinarity lies in its ability to facilitate the co-production of knowledge by engaging diverse knowledge holders in joint problem framing, interpretation, and co-design (Jacobi et al. 2022). These approaches help create shared, consensus-based visions and actionable roadmaps. However, despite the growing acceptance of the described approach in mainstream science, challenges remain. Epistemological differences can, for example, lead to conflicting assumptions and values, hindering mutual understanding and knowledge integration (Lawrence et al. 2022). Additionally, transferable methods often struggle to incorporate context-specific ILK.

NbS researchers and practitioners who lack expertise in engagement practices may feel overwhelmed by the task of involving diverse participants in a project. Yet, ensuring inclusive participatory processes during all NbS stages including planning, implementation, and management, is critical to enable long-term success and sustainability.

When social engagement fails to be exercised meaningfully, where it is merely symbolic or constrained in NbS projects, it leads to consistent barriers to social learning and a weakening of trust. According to peer-reviewed research, this, in turn, leads to unintended negative consequences such as gentrification or exclusion and the risk that the transformative power of NbS is diminished, yielding only shallow social outcomes as technocratic or market interests take precedence (Kiss et al. 2022).

As outlined above, the BioClimSocial project refers to transdisciplinarity as co-production of knowledge with non-academic stakeholders. Participation is a way of “effectively and ethically engaging people in processes, structures, spaces, and decisions that affect their lives, working with them to achieve equitable and sustainable outcomes on their own terms” (Kindon 2010, p. 518). The extent of participation in the transdisciplinary process should follow principles of openness, inclusivity, and legitimacy (Kiss et al. 2022).

Transdisciplinary participation fosters deliberation, which in turn promotes learning at every stage of a NbS project (Collier et al. 2023). The more inclusive the process, the more opportunities there are for learning among participants with diverse knowledge backgrounds, who contribute by sharing, integrating, and co-producing knowledge (Nancarrow et al. 2013).

However, because NbS actors and stakeholders often differ in their expertise, skills, and interests, this exchange can be influenced by disciplinary divides, communication barriers, stereotypes, and power hierarchies (Bark et al. 2016; Cummings & Kiesler 2014).

Successful transdisciplinary participation results in co-creation – the collaborative generation of ideas, visions, and innovations by actors and stakeholders who bring different interests, perspectives, and expertise to the process (McCormick et al. 2024; Reed et al. 2024). Co-creation in NbS is key to achieving greater social justice in its three dimensions: recognitional, procedural, and distributive, as described in Chapter 3. Procedural justice of NbS, such as promoting participation in the early development stages of the project, critically influences outcomes, as it can, for example, lead to a higher sense of project ownership which contributes to its sustainability (McCormick et al. 2024). Often, the success of NbS is measured primarily in terms of their outcomes related to the targeted challenge (e.g. climate mitigation), while potential co-benefits, in particular social outcomes defined in Chapter 3 are overlooked, and insufficient attention is given to the inclusiveness of the NbS cycle.

The degree of engagement of actors and stakeholders varies during the process of transdisciplinary participation. As outlined earlier, actors are individuals, groups, or organizations that act or have the capacity to influence a process, decision, or outcome. In contrast, stakeholders are those who are affected by or have an interest in a process, regardless of whether they act or directly influence outcomes. Some actors are closely involved throughout the entire project process, helping to shape goals, methods, and implementation. Others may participate only at specific points — typically by providing feedback or input into activities led by project teas. In such cases, these actors are not co-leading the process but rather responding to externally led (e.g. academic-led) initiatives.

In a research process, the degree of involvement of multiple actors influences the level of integration, and such research becomes more complex — but also more robust — when diverse perspectives are included (Mobjörk 2010). Because many stakeholders have relevant knowledge or interests, it is important to identify them early in the process even if they are not yet actively involved. Through meaningful engagement, some of these stakeholders may become actors, contributing directly to planning and decision-making. This was also pointed out during one of the BioClimSocial workshops as indicated by the quotes shown in Fig. 15.

Fig. 15: Selected results from a World Café session with BioClimSocial partners asked to define what constitutes meaningful engagement in the NbS processes

Reflecting on the engagement and the evolving participatory process is crucial for building expertise in transdisciplinary approaches to NbS, as these processes are inherently context-specific and depend on interaction with a diverse range of stakeholders and actors (Sieber et al. 2024). Such reflection should include a critical assessment of the process's strengths, weaknesses, barriers, and enabling factors. This continuous evaluation supports adaptive management. Reflection after implementation can help identify lessons learned from the perspectives of different actors and stakeholders, addressing key process dimensions such as why, what, who, how, and when (Mascarenhas et al. 2021). The reflection not only supports the monitoring phase but also informs future iterations of the NbS process.

5.2 Snapshot of participatory methods and tools for NbS projects

This section introduces the concept of participation which can take many forms, ranging from one-way consultation to genuine co-design and shared governance. Recognizing these different levels of involvement helps clarify the degree to which NbS initiatives can be considered inclusive and collaborative.

To exemplify how participatory principles can be translated into practice, this section first focuses on stakeholder mapping. Stakeholder mapping is often the first step in participatory planning, helping to identify relevant actors, understand their interests and influence, and reveal potential areas of conflict or collaboration. By using stakeholder mapping as an example, the authors aim to demonstrate how participatory approaches can be integrated into NbS development to strengthen inclusiveness, transparency, and long-term sustainability.

Stakeholder mapping, typically initiated through online research and preliminary consultations, is a critical step in identifying who is relevant for the NbS process, who is or may be affected, and what interests, capacities, and knowledge and can be mobilized. These initial contacts may evolve into broader engagement via formal meetings, often hosted across different locations to promote equity and accessibility.

To support the initiation of meaningful engagement, several tools are available for stakeholder identification and analysis. According to the typology developed by Reed et al. (2009), these tools can be grouped according to different goals of stakeholder engagement (Fig. 16).

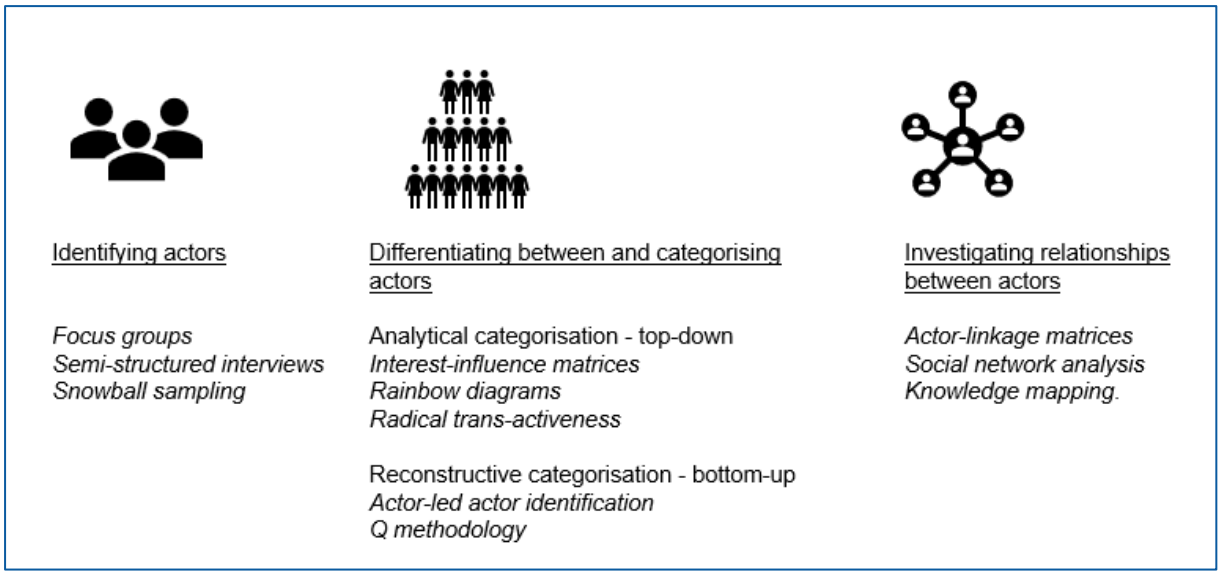

Fig. 16: Tools and methods for identifying actors, differentiating between them and investigating their relationships (adapted from Reed et al. (2009))

A commonly used tool is the Interest-influence matrix, which maps stakeholders based on their level of influence and interest in a project (Reed et al. 2009). Variations of this tool can incorporate other dimensions depending on context. Stakeholder analysis is especially relevant during the planning phase of NbS.

Insights from the BioClimSocial questionnaire highlighted several methods used in practice:

- ALM Matrix: Categorizes stakeholders by their alignment with project goals and interest in outcomes, supporting tailored engagement strategies (Mendizabal 2010).
- 2x2 Matrix System: Plots stakeholders into four quadrants based on high/low power and interest, guiding engagement strategies accordingly (Zhu et al. 2024).
- Actor-Mapping Approach: Visually identifies influential actors and organizations through a process of preparation, facilitation, and revision (Campailla et al. 2020).
- Living Lab Stakeholder Mapping: A co-diagnostic approach involving cultural mapping, motivational interviewing, critical proximity, and participatory design, structured over six participatory steps.
- Other methods include social network analysis and expert consultation to connect policy and science communities.

NbS researchers and practitioners can draw on a wide range of participatory methods and tools that support different stages of the NbS process. While it is beyond the scope of this chapter to list all the existing options, or to explain each one in detail, Tab. 2 provides an overview of selected practical guidelines and toolkits for transdisciplinary and participatory approaches, where readers can find more information. Those guidelines were selected by the BioClimSocial team as best-practice examples reflecting a clear link to NbS development processes, and/or a focus on citizen participation and transdisciplinary research, according to the team's best knowledge.

Tab. 2: Practical guidelines and toolkits for participatory and transdisciplinary approaches

Resource	Target audience	Context	Suggested methods and tools	Stages of the process
Connecting Nature's "Co-production guidebook" (Hölscher et al. 2022), "A practical guide to using co-production for nature-based solutions: a Connecting Nature Guidebook" (van der Have et al. 2022).	Urban actors and stakeholders (local decision-makers, local communities)	NbS co-production (theory and practice)	Co-production design principles Five iterative steps for co-production- i.e. co-defining the context and problem; co-designing options; co-implementing solutions; co-monitoring and evaluating together; co-reflecting and scaling/embedding practices.	NbS planning, implementation and follow-up/stewardship. i.e. ongoing management to ensure NbS sustainability
Biodiversa "Stakeholder engagement handbook" (Durham et al. 2014)	Researchers	Biodiversity and ecosystem services research	Stakeholder identification and mapping Four types of engagement techniques: 1. Opening out (e.g. brainstorming); 2. Exploring (e.g. mind-mapping); 3. Deciding (e.g. voting); 4. Integrating (combining different techniques for different project stages)	All stages of a research project
EKLIPSE report "Building Resilient Coastal Communities through Nature-based Solutions and Empowerment Tools" (Sieber et al. 2024)	Policy- and decision-makers, researchers and practitioners, exploring the nexus between coastal resilience, NbS and empowerment.	Supporting resilience in coastal communities	Community empowerment tools, clustered around: - Education - Knowledge - Platform/Dialogue - Governance - Co-creation tools - Community-led NbS	NbS planning, implementation and stewardship
OECD Guidelines for Citizen Participation Processes (OECD 2022)	Public officials or public institutions interested in carrying out a citizen participation process	Citizen participation processes	Ten steps for designing, planning, implementing, and evaluating a citizen participation process	Designing, planning, implementing, and evaluating a citizen participation process

Resource	Target audience	Context	Suggested methods and tools	Stages of the process
			Eight participation methods: Information and data, open meetings, public consultations, open innovation, citizen science, civic monitoring, participatory budgeting, and representative deliberative processes.	
td-net Methods and tools for co-producing knowledge (SCNAT Knowledge)	Researchers	Co-production of knowledge (transdisciplinary research)	A wide catalogue of methods and tools for collaboration between experts and stakeholders from science and practice, structured by typical process phases and key issues such as integrating knowledge across fields of expertise	All stages of a transdisciplinary research process
BfN PraxisInfo "Meaningful engagement in nature restoration at the local level" (Kozban et al. 2024)	Practitioners and researchers (applied research)	Stakeholder engagement throughout the cycle of nature restoration projects	Questions for self-reflection and methodological examples from practice	All stages of a project

The table presents resources that vary in scope, focus and target audience — from decision-makers to researchers. They reflect a spectrum of participatory methods tailored to different phases of the research or implementation project cycle, with tools ranging from theoretical frameworks to specific engagement techniques, underscoring the flexibility and adaptability of participation in transdisciplinary contexts. Hölscher et al. (2022) and van der Have et al. (2022) target city decision-makers and offer a comprehensive toolkit for urban planning with a focus on integrating NbS through co-production frameworks. The "Biodiversa Stakeholder Engagement Handbook" (Durham et al. 2014) is aimed at researchers, providing insights into stakeholder engagement with an emphasis on translating scientific findings into actionable strategies for NbS. Sieber et al. (2024) focuses on the nexus between coastal resilience, NbS and empowerment (seen as the highest level of engagement). The report presents a catalogue of empowerment tools, clustered around six categories, based on a rapid evidence assessment of published literature. The tools can be applied for contexts other than coastal communities. The "OECD Guidelines" (OECD 2022) guide decision makers on citizen participation processes such as public consultations, open meetings, and participatory budgeting. The "td-net

Methods and Tools for Co-Producing Knowledge" offer researchers a catalogue of transdisciplinary knowledge production across disciplines. The concise PraxisInfo focusing on nature restoration projects (Kozban et al. 2024), published by the German Federal Agency for Nature Conservation (BfN), highlights important considerations, presents good practice examples and offers questions for self-reflection that can aid stakeholder engagement processes at the local level.

Chapter 3.1 "Processes and principles" identified and discussed criteria that ensure best practice, to optimise both meaningful stakeholder engagement in NbS and to facilitate social benefits. In the following section, the selected best-practice sources are examined in relation to these principles. This step aims to assess the extent to which these sources incorporate and operationalize the identified principles for Nature-based Solutions (NbS).

Hölscher et al. (2022), van der Have et al. (2022) and Durham et al. (2014) provide recommendations for establishing transparent and ethical frameworks, which include upholding confidentiality and maintaining respect to all contributors and setting clear roles and expectations. These guidelines also advise on identifying and mitigating problems that can arise, such as power imbalances and stakeholder fatigue. Robust dialogue and ongoing reflection are key. In Hölscher et al. (2022) and van der Have et al. (2022), emphasis is placed on the integration of ongoing evaluation, ensuring ethical safeguards are maintained throughout the entire NbS process. Furthermore, these guidelines address how to engage and empower local organisations and their representatives in order to ensure ongoing access and long-term legacy beyond the project's life.

Diversity: Regarding diversity and inclusiveness, Hölscher et al. (2022), van der Have et al. (2022), Durham et al. (2014) and Sieber (2024) recommend systematically identifying diverse stakeholders – e.g. through stakeholder mapping – thus, ensuring the inclusion of marginalised and minority groups. Furthermore, Hölscher et al. (2022), van der Have et al. (2022), and OECD (2022) discuss a tailored approach to ensure inclusivity, i.e. adapting processes and methods to accommodate different stakeholder culture, experience, and needs. Questions suggested for reflection by restoration leaders in the BfN PraxisInfo (Kozban et al. 2024) can help embrace the various aspects and attributes of stakeholders' diversity (like relationships to the land, power structures, values and interests, etc.) and design most suitable engagement approaches.

Human rights: Empowerment through agency is explored in Hölscher et al. (2022), van der Have et al. (2022), and Durham et al. (2014) and is based on the meaningful involvement of all participants in the planning, delivery, and evaluation of NbS. This includes recognising their rights to information, decision-making, and influence over outcomes. Crucially, participation is voluntary, with individuals fully informed of their rights, roles, and the implications of their involvement – ensuring no coercive action.

Justice and equity: The redress of representation and power gaps is outlined in Hölscher et al. (2022), van der Have et al. (2022), and Sieber et al. (2024) by design to facilitate power imbalances and give voice to those who have been historically marginalised or affected by existing inequities. In Sieber et al. (2024) and OECD (2022), legitimacy is achieved by promoting fairness, transparency, and inclusivity, thus enhancing legitimacy, particularly where there is historic or ongoing conflict.

Access: Consideration is given as to how one removes barriers – both physically and cognitively in Hölscher et al. (2022), van der Have et al. (2022), and Durham et al. (2014). These

include examples such as providing accessible venues, plain language resources, suitable formats for all literacy levels, and timing that is compatible with local contexts.

Knowledge systems: All guiding documents, except OECD (2022), emphasise the integration of multiple knowledge systems – valuing and incorporating local, traditional, and practitioner knowledge alongside scientific research on equal footing. This approach fosters knowledge exchange and supports the co-production of actionable outcomes.

Cultural context: The role of contextualised engagement is discussed Hölscher et al. (2022), van der Have et al. (2022), Durham (2014), and Kozban et al. (2024). It includes adapting engagement to local customs, cultural norms, language, and idioms; using local facilitators or intermediaries when necessary. This is further reinforced by the deployment of community-driven approaches which allow communities to help shape how engagement is structured, including culturally appropriate decision-making and communication formats, as raised in Hölscher et al. (2022), van der Have et al. (2022), and Sieber et al. (2024). Furthermore, in Kozban et al. (2024) cultural background, traditions, and art are highlighted as important means for recognising and enhancing connections between people and their natural environment, which in turn helps to raise awareness and acceptance of nature restoration measures.

Social networks: Building relationships and trust through social networks is crucial to supporting long-term collaboration, learning, and shared initiatives is discussed in Hölscher et al. (2022), van der Have et al. (2022), and Sieber et al. (2024). Additionally, Durham et al. (2014) emphasizes the role of leveraging trusted intermediaries: i.e. the use of local "knowledge brokers" or facilitators trusted by communities to improve outreach and relationship-building.

Governance: All guidelines stress the importance of participatory and transparent governance, engaging stakeholders in advisory, decision-making, and leadership roles, while clarifying structures, responsibilities, and reporting mechanisms. Hölscher et al. (2022), van der Have et al. (2022), and OECD (2022) further emphasize adaptive management supporting continuous adjustment of processes and policies based on feedback, reflexive monitoring, and evolving stakeholder needs.

Communication: According to Hölscher et al. (2022), van der Have et al. (2022), and Durham (2014) effective communication requires plain language, avoiding jargon, and tailoring content to audience needs to ensure inclusivity. Hölscher et al. (2022), van der Have et al. (2022), and Sieber et al. (2024) further stress the importance of ongoing, multi-channel communication (digital, face-to-face, and print formats) to provide continuous updates across all project phases. Additionally, BfN PraxisInfo (Kozban et al. 2024) recommends diversifying communication through more informal approaches, such as landscape walks, that simultaneously help link stakeholders to the area of potential NbS. The mentioned guidelines also emphasize the value of facilitated dialogue among equals, where all perspectives are respected and knowledge is shared openly and transparently among all participants.

It is important to tailor engagement processes to the specific contexts and challenges of each project, taking into account its stage, scope, goals, and the type and number of participants (McCormick et al. 2024). Four main underlying factors influence the process of transdisciplinary participation as identified by McCormick et al. (2024):

- political and legal factors (e.g. power imbalances, weak legal frameworks for participatory processes in decision-making);
- economic and financial factors (e.g. lack of funding or restrictive funding conditions);

- social and cognitive factors (e.g. limited recognition of participants efforts, mismatched expectations, lack of engagement expertise, insufficient time, bureaucratic complexity, and misaligned timescales); and
- (4) the local ecological context in which NbS are implemented.

Responses to the BioClimSocial questionnaire illustrate how these factors manifest in practice. Regarding political and legal challenges, land tenure, and trust in the process were perceived as key barriers to consensus in NbS decision-making. In terms of social and cognitive factors, many respondents linked increased stakeholder engagement to the time invested by the project team in raising awareness and understanding of NbS concepts and practices. Respondents also offered practical recommendations for fostering effective social networking among diverse stakeholders, including providing learning opportunities, hands-on case studies, field visits, peer exchanges with other NbS groups, informal spaces for interaction, integration of art and culture, and celebrating collective achievements to build ownership and sustained motivation. One participant stressed the importance of participatory and reflexive approaches — advocating for inclusive methods that foster knowledge dialogue, consider power dynamics, and support intercultural, intergenerational, and gender-sensitive engagement. They also recommended participatory monitoring of communication quality and involving trained facilitators to ensure processes remain adaptive, inclusive, and responsive throughout the project lifecycle.

Adopting a transdisciplinary approach ensures that NbS research remains grounded, relevant, and contributes to societal renewal. Participation acts as decentralized research, with project success depending on the relationships between people, communities, and institutions. Ultimately, the driver for researchers' engagements in participatory research and development may be the pursuit of social justice and the intellectual interest to reconcile the human and ecological dimensions of NbS (Gastrow et al. 2016).

5.3 From theory to practice: working with stakeholders in various NbS projects

Transdisciplinarity requires researchers and practitioners to draw not only on their professional expertise but also on lived experience – particularly in relation to the specific context in which the project is implemented. In NbS projects, the involvement of local actors and stakeholders is often the most appropriate solution, particularly when the community's well-being is directly affected by the intervention, and when positive social outcomes are a goal. This Guidance Report benefits from the lived experience of the BioClimSocial partners and their knowledge about what is important when it comes to transdisciplinarity in a NbS context.

Fig. 17: Word cloud based on quotes from BioClimSocial partners when asked what is important in transdisciplinary NbS projects

The word cloud (Fig. 17) highlights the central role of communication with stakeholders and the community in effective stakeholder engagement for NbS. It reflects partners' emphasis on inclusive, respectful dialogue, tailored methods, and participatory processes that bridge policy and local levels — all crucial for building ownership and lasting collaboration.

Based on multiple meetings and workshops, the BioClimSocial team identified key aspects critical to transdisciplinary NbS research and practice. These were grouped into five core themes: stakeholder structures, communication principles, engagement methods, cultural and social awareness, and building trust and ownership. For each theme, a few bullet points are suggested to guide the design of transdisciplinary NbS projects (Fig. 18).

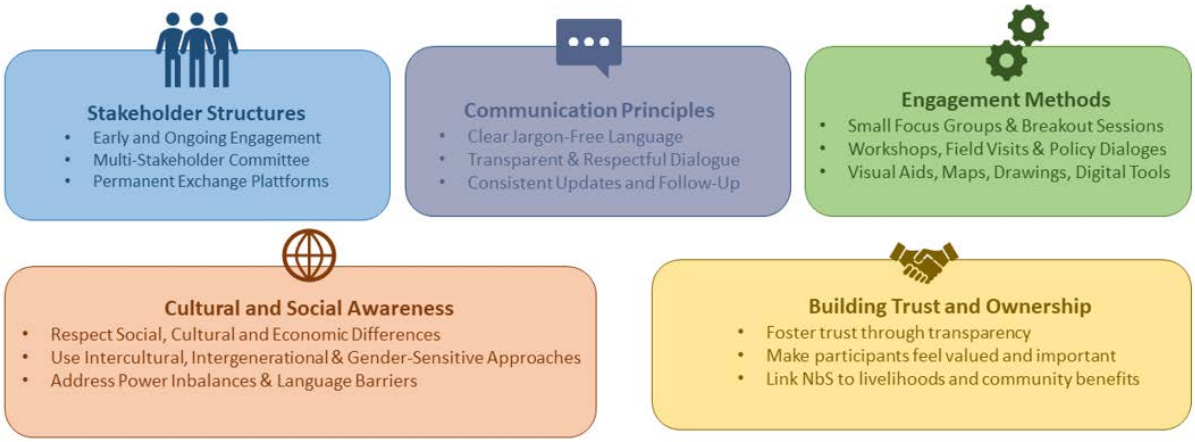

Fig. 18: Core themes and relevant aspects to consider in transdisciplinary research and practice (based on experiences of BioClimSocial partners).

Additionally, this publication provides practical reflections from the BioClimSocial NbS case study partners on their lived experiences facilitating stakeholder engagement. Box 8 shares the reflective insights from the research project in Colombia, emphasizing collaboration with local stakeholders and practical lessons learned. Box 9 presents key learnings from the two urban NbS projects in Lebanon focusing on participatory approaches that engage and empower diverse stakeholders to ensure socially legitimate, equitable, and culturally sensitive outcomes. The BioClimSocial case study in Austria addresses a unique challenge involving

monoculture forest plantations, illustrating the varied contexts and complexities transdisciplinary NbS projects can encounter (Box 10). In the case study on agroforestry in Côte d'Ivoire, specific attention is paid to the aspect of stakeholder mapping and the geographic distribution of activities across the country (Box 11).

Box 8: Insights from the lived experience working with actors and stakeholders in the Community-based seagrass restoration project in San Andrés, Colombia

Acknowledging the diversity: The stakeholder landscape in the project is notably diverse, encompassing governmental authorities, academic institutions, local schools, community members (including the Raizal ethnic group with its own language and customs, building up more than 1/3 of the island population), the private sector, and NGOs. Thus, it combines formal and informal powers, academic expertise and deeply rooted traditional knowledge, with civil society as well as private sector interests and perspectives on the issues related to seagrasses. The importance of language and adaptive communication in the context of diversity was raised as necessary for facilitating dialogue that respects and integrates the culture-nature relationship. A specific example was the collaboration with the Raizal community, where efforts were made to include Creole speakers in the NbS process and ensure their meaningful participation in decision-making.

Raising awareness and building trust: The first step in the co-creation process is engaging each actor and stakeholder in a dialogue about the problem to be addressed. Unlike more familiar or visible ecosystems, seagrasses are typically overlooked and poorly understood by the general public, and social perceptions of seagrass ecosystems are often shaped by imagination rather than experience. To address this challenge, visual materials such as videos and photographs proved essential in making the ecosystem more tangible. Equally important were the stories and testimonies of older community members and local tourism operators.

Stimulating community: The project supported an initiative called “social cartography” which entailed creating community maps that displayed beaches, mangroves, and seagrasses of San Andrés Island. This activity was designed for high school students and their families, encouraging intergenerational learning and community engagement. The initiative not only promoted awareness of local coastal ecosystems but also sparked interest among young participants in applying emerging technologies such as drones and artificial intelligence for environmental conservation efforts (Fig. 19). In parallel, the project found that there is the need to **strengthen assertive communication skills** within the community. Communication plays a fundamental role in building social relationships and fostering collective action, particularly when addressing complex environmental challenges. Assertive communication, implying the capacity to express ideas, beliefs, feelings, and proposals in a clear, respectful, and non-confrontational manner, is key to empowering individuals to participate effectively and constructively.

Fig. 19: Images of the social cartography report, San Andrès island (Photos: Jairo Humberto Medina Calderón)

Strengthening governance: To strengthen the governance of seagrass restoration in the region, the project team prioritised comprehensive capacity development through collective training. This implied knowledge exchange on the different technical-scientific aspects such as what seagrasses are, what characterizes them and differentiates them from species like algae, what changes seagrasses have undergone on the island territory in recent years, why they are important, and why their conservation is critical. Importantly, such collective training must be continuous to remain effective. Another governance-related learning from the project is that importing foreign development models might be inappropriate, while by involving local thinking and knowledge to address global problems, the governance of a territory is fostered and reinforced. This is well illustrated in the open access book on climate risk management that was published with Springer Nature[8], following the occurrence of Hurricane Iota that caused devastation to the archipelago and its community (https://cemarin.org/es/a).

Drivers for engagement: In this project, actors' and stakeholders' motivation to get familiar with the concept of NbS and engage in its implementation has been driven by a growing awareness of environmental challenges. This was shaped by events like Hurricane Iota in 2020 (Fig. 20), which underscored the urgency of climate change, and the widely covered CBD COP16, which broadened public understanding of biodiversity's importance. Given that NbS based on marine ecosystem restoration can take several years to deliver visible outcomes and involves significant uncertainty, securing both medium- and long-term funding is essential — not only for ensuring ecological results, but also for sustaining stakeholder engagement and commitment throughout the process.

[8] https://library.oapen.org/handle/20.500.12657/96117

Fig. 20: Images of the effect of the hurricane Iota in November 2020. (Photos: Adriana Santos-Martinez)

Box 9: Reflections on stakeholder engagement in resident-led, urban green initiatives in Lebanon: Ancillary Botanic Gardens and Balcony Gardens

Citizen engagement has the potential to bring forward new and transformative voices and narratives, but this requires the creation of multiple arenas for discussion and dialogue. By tapping into this potential, engagement processes can strengthen and diversify both expected and unexpected social outcomes, fostering social learning, a stronger sense of belonging, environmental stewardship, as well as greater inclusiveness and equity (Kiss et al. 2022).

In the context of the ABG project, the applied participatory approaches included activity-oriented focus group discussions with ABG youth visitors, in-depth semi-structured interviews with potential ABG owners, and a broader ABG conference utilizing the World Café methodology. Each method was selected to suit the nature of the stakeholder group and to encourage open and constructive engagement. From these experiences, several key lessons were identified:

- **Know your audience:** Participatory approaches should be adapted to the types of participants. Engaging with youth requires a different style than interacting with institutions and property owners, as each group requires different communication preferences. Customization in approaches ensures meaningful participation and leads to more representative and insightful outcomes.
- **Use open-ended questions:** Framing questions in an open-ended manner encourages deeper conversations and allows participants to express their thoughts more freely, resulting in richer and more nuanced data collection.
- **Incorporate challenge and gamification:** Particularly when engaging youth, presenting the experience as a challenge or competition proved effective in enhancing participation. Gamifying elements of the engagement such as plant bingo games increased both interest and active involvement.

To explore stakeholder perspectives in the project on balcony gardens (BG), the following participatory methods were employed: in-depth semi-structured interviews with both BG and non-BG owners, as well as with green balcony champions — individuals who actively promote and maintain balcony gardens. Additionally, focus group discussions were conducted with university students to gain insights from a younger, potentially influential demographic. Several key lessons emerged from this engagement process:

- **Snowball sampling** starting with the researcher social and professional network proved effective, particularly in cases where the target group was relatively small or niche.
- **Selecting the right methodology** is important to tailor the approach to the specific stakeholder (e.g. youth are more open to discuss when in groups while older residents prefer a private meeting for the interviews).
- **Integrating visual elements** — such as photos, sketches, or maps — into interviews and discussions enriched communication and improved participants' ability to express ideas clearly.
- **Understanding the local context and cultural background** of participants was critical for ensuring respectful, meaningful, and context-sensitive engagement.

Fig. 21: Pictures of a residential balcony garden in Beirut, Lebanon (Photo: American University of Beirut)

Box 10: Addressing the problem of monoculture forest plantations in the Ötscher region of Austria and the potential of participatory processes

In the project, the local community is involved in a transdisciplinary process to identify possible NbS balancing environmental, social, and economic sustainability. The key lies in engaging the community to take ownership, facilitating mutual learning through participatory approaches, and showcasing the long-term benefits of a restored ecosystem. This transformative initiative aims not only to combat overforestation but also to redefine our relationship with nature for a more harmonious and prosperous future.

How were stakeholders identified and selected? The selection of experts occurred via internet research and the network of the University for Continuing Education Krems. In addition, the Nature Park had contacts in the region, which were addressed directly. Engagement efforts included three workshops, inviting scientists from biology, cultural anthropology, ecological forestry, and agriculture, alongside local farmers. While the scientific community showed strong commitment from the outset, farmers' participation was hampered by practical constraints such as COVID-19 waves, severe storms, scheduling conflicts, and communication gaps. Nonetheless, despite initial scepticism—largely due to perceived critiques of local forestry practices—farmers recognized the importance of addressing overforestation. The participatory methodology helped ease concerns by valuing each perspective.

Why were stakeholders relevant for the specific case? The involvement of local farmers and scientists was essential because overforestation is a nuanced problem, difficult to perceive and understand due to its slow development and complex socio-ecological dynamics. Farmers, who manage the land daily, bring practical insights on forestry practices and land use, while scientists provide ecological, social, and economic perspectives necessary to identify balanced Nature-based Solutions. The Nature Park acted as a gatekeeper, enabling farmer participation that would otherwise have been unlikely. Engaging these diverse stakeholders helped redefine local relationships with nature and supported ownership and mutual learning, crucial for long-term ecosystem restoration.

Which methods or tools were used? The project team conducted six interviews and three workshops to facilitate knowledge integration, while involving only two individuals of each group of stakeholders (being local farmers, Nature Park experts and researchers). The workshop format was based on research into group awareness and communication, aimed at fostering mutual understanding and efficient collaboration. Personal contact and face-to-face communication were prioritized over email outreach to increase participation and build trust, especially among local farmers balancing demanding daily responsibilities.

What were the lessons learnt? While contacting locals via email did not prove successful, personal contacts significantly increased their willingness to participate. Putting special emphasis on each individual perspective and contribution helps reduce initial scepticism, making sure all participants feel acknowledged. Despite practical challenges like COVID-19 restrictions and scheduling conflicts, the strong rapport developed within the workshop group sustained ongoing collaboration.

How did stakeholder engagement influence the outcomes of the NbS project? Engagement was crucial for the generation of a comprehensive model, visualizing different viewpoints and aspects to be considered. As local participation was a direct objective of the study, stakeholder engagement was invaluable for its success.

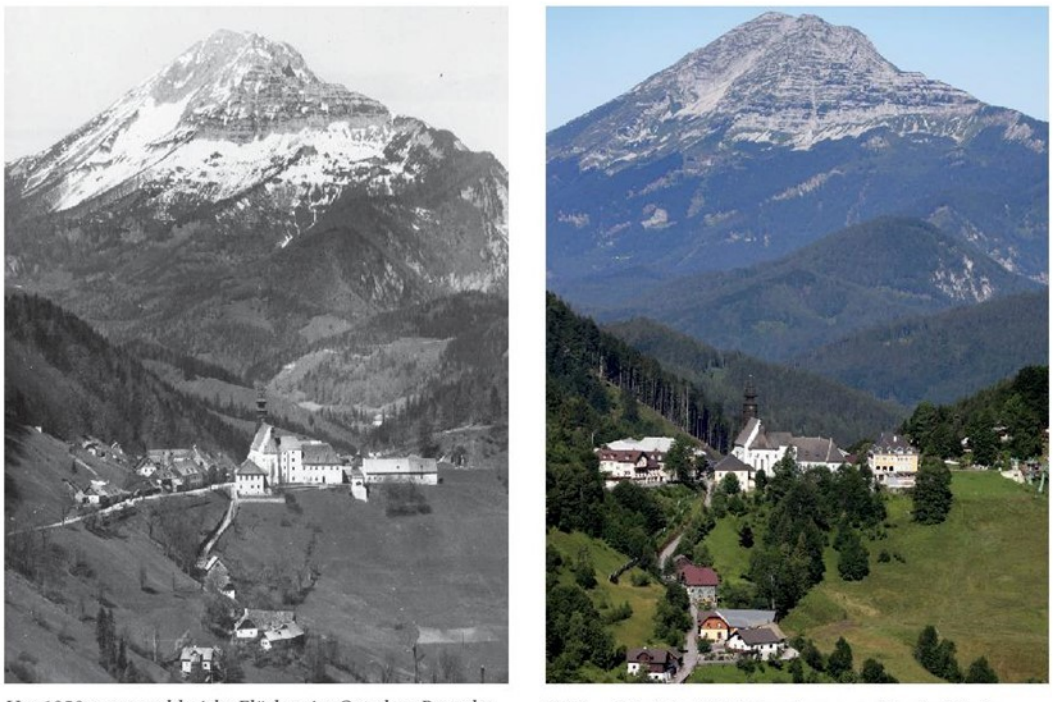

Fig. 22: In 1950 (left), there were numerous areas in the municipality of Annaberg without trees; in 2015 (right), the forest has taken over many of these areas (Source: Gemeinde Annaberg).

Box 11: Insights from the lived experience working with actors and stakeholders in the Agroforestry case study in Côte d'Ivoire

Diversity of actors and stakeholders: The BioClimSocial partners conducted a detailed stakeholder mapping for Nature-based Solutions (NbS) implementation across the country. This exercise revealed a diverse and multi-layered network of actors: government agencies (e.g., Ministry of Environment, Ministry of Agriculture, Agence Nationale d'Appui au Développement Rural – ANADER, Société de Développement des Forêts - SODEFOR), research institutions (e.g., Centre National de Recherche Agronomique de Côte d'Ivoire - CNRA, universities), NGOs, international organizations (e.g., UNDP, IUCN, CIFOR-ICRAF), traditional authorities, private sector actors such as the Cocoa Board, and farmers' cooperatives. Together, these actors form a complex system of governance, implementation, and knowledge exchange that shapes the country's NbS initiatives.

Roles and contributions of key actors and stakeholders: Government agencies develop policies and coordinate large-scale environmental programmes, while organizations like SODEFOR and FAO promote agroforestry and provide training. Research institutions contribute with studies and fieldwork, especially in forest and cocoa zones. NGOs and international partners offer funding, expertise, and help scale nature-based solutions, adapting them locally. Farmers and local communities play a crucial role by adopting and managing these practices on the ground.

Geographic distribution of stakeholder activity: The partners implementing the case study on Agroforestry found a notable spatial imbalance in the distribution of stakeholders and project activity. The southern forested zones of Côte d'Ivoire, which host more institutional infrastructure and environmental initiatives, benefit from stronger stakeholder networks

and more concentrated interventions. In contrast, the drier northern savannah regions face significant gaps in institutional presence, technical support, and investment, leading to disparities in the reach and effectiveness of NbS implementation across regions.

Challenges identified in stakeholder engagement: Despite the rich diversity of actors involved, several systemic challenges limit the effectiveness of stakeholder collaboration:

- Limited cross-sectoral coordination: Fragmented responsibilities and weak communication across institutions hinder strategic alignment.
- Inadequate funding and rigid funding conditions: Many initiatives suffer from lack of financial resources or funding structures that are not adaptive to local needs.
- Weak community participation: Local communities, particularly traditional authorities and marginalized groups, often have limited influence in decision-making processes.
- Capacity and knowledge gaps: Variations in technical knowledge, bureaucratic complexity, and mismatched expectations between actors pose ongoing obstacles to effective collaboration.

Learnings and recommendations: Insights from the case study emphasize the need for more intentional and inclusive engagement strategies. Respondents recommend:

- Fostering social networks: Create opportunities for learning through field visits, hands-on case studies, exchanges with other NbS stakeholders, and semi-formal gatherings to build relationships and share experiences.
- Using creative and culturally grounded tools: Incorporate art, culture, and celebrations to maintain interest and foster a sense of ownership.
- Participatory and reflexive approaches: Engage stakeholders in knowledge dialogue, address power relations, use participatory monitoring, and adopt intercultural, intergenerational, and gender-sensitive methods. Trained facilitators are crucial for ensuring inclusive and adaptive processes.

Fig. 23: Pictures of existing agroforestry projects in Côte d'Ivoire in different agroclimatic zones (Source: N'Golo Abdoulaye Koné & Kolotchèlèma Simon Silué)

6 Enablers and challenges of integrating the social dimension of NbS

6.1 Overview of enablers and challenges

Chapter 3 examined the 'what' and 'wherefores' of the social dimension of Nature-based Solutions (NbS) – specifically, how NbS influence human society from their inception and implementation to their impacts at interpersonal, intrapersonal, and community levels. Chapter 5 built on this by exploring participatory and transdisciplinary approaches, both in theory and practice, concluding with insights from the BioClimSocial case studies on their own experiences of reflective practice in this context. In this chapter, the focus is shifted to ask why optimal social outcomes from NbS may or may not be achieved. Drawing on evidence from the BioClimSocial project, including case studies, survey data, selected interview excerpts, and schematic outputs from the World Café session during the conducted expert workshop, the project team examines the key enabling and constraining factors that shape meaningful transdisciplinary participation in NbS research and practice.

A thematic mind map, developed during the World Café exercise (Fig. 24: Challenges and enablers of transdisciplinary NbS practicesFig. 24), illustrates the wide range of internal and external factors that influence the success of transdisciplinary NbS. The BioClimSocial team arranged the factors into four categories including stakeholder engagement and governance, land use practices and conflicts, policy, planning and institutional support, as well as economic and financial factors. In line with Chapter 5, the workshop participants pointed out the role of existing **social dynamics** and ways of addressing it: ownership, relationships, communication, and representation for stakeholder engagement. The aspect of land use practices and conflicts are also important factors to consider in particular in terms of **land use rights**. Support from institutions, policy, and planning are other aspects highlighted, implying the need for **appropriate backing at multiple levels,** including local governance and national initiatives. This also includes the full adoption of implementation plans as well as the need for regular evaluations and audits of NbS projects. Furthermore, **economic and financial considerations**, including adequate resources, fair compensation, and recognition of time and effort invested by participants, are key to sustaining involvement. This expert assumption was also supported by about 20% of respondents in the BioClimSocial questionnaire, indicating that financial remuneration or compensation of participants (e.g. food arrangements and coverage of travel costs) is the most important positively influencing factor for active stakeholder engagement. All of these factors are interlinked with each other, alongside other factors not listed here. In particular they are often affected by political, economic, and ecological uncertainties, which requires adaptive and resilient NbS planning and implementation at all stages. This underlines the importance of remaining responsive to contextual shifts, whether social, political, or ecological, and managing expectations realistically throughout the project cycle. Together, these insights underscore that successful NbS implementation depends on context-sensitive, inclusive, and collaborative approaches.

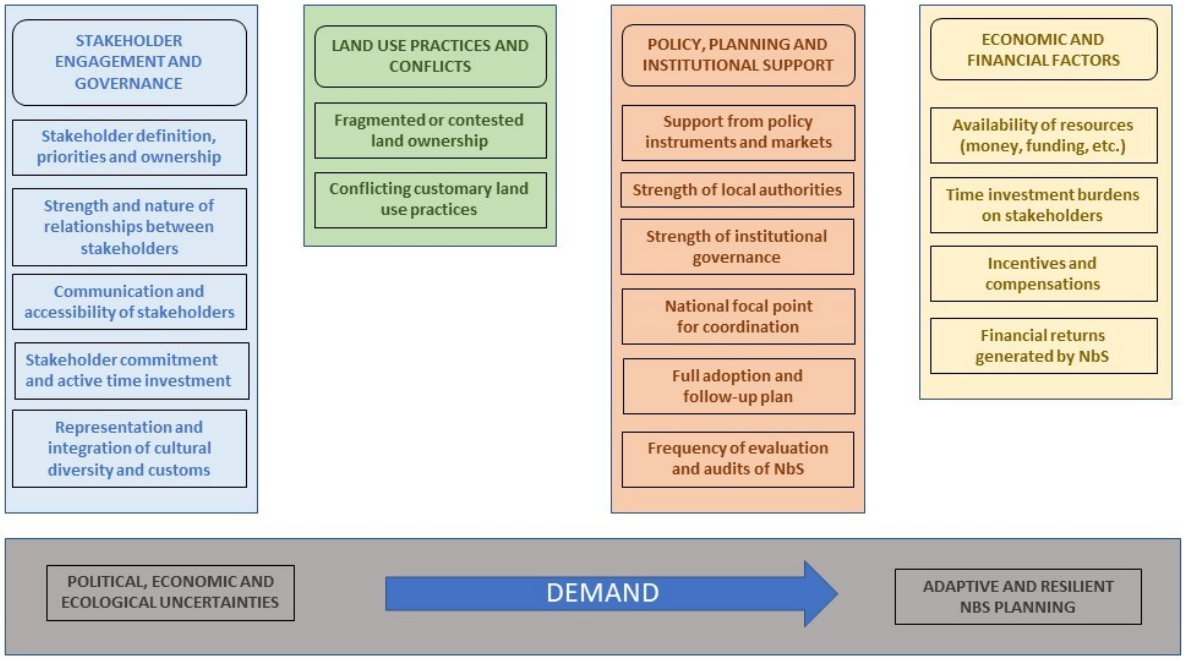

Fig. 24: Challenges and enablers of transdisciplinary NbS practices

When provided with a selection of factors that may hinder the successful implementation of NbS, respondents to the BioClimSocial questionnaire highlighted the role of land tenure, trust, and power/authority (Fig. 25). Other factors such as education, socioeconomic status, gender, and age of stakeholders participating in the process seemed to be less relevant for the engagement process. While the World Café figure (Fig. 24) above provides a nuanced systems perspective - mapping interrelations among political, cultural, and institutional drivers - the bar chart below quantifies which of these factors stakeholders perceive as most influential in practice. Both confirm that power, land tenure, trust, and institutional support are consistently critical to enabling participatory decision-making in NbS projects. As the questionnaire was conducted before the workshop with all participants, the categories and factors are not exactly the same as the ones that were mentioned during the World Café session.

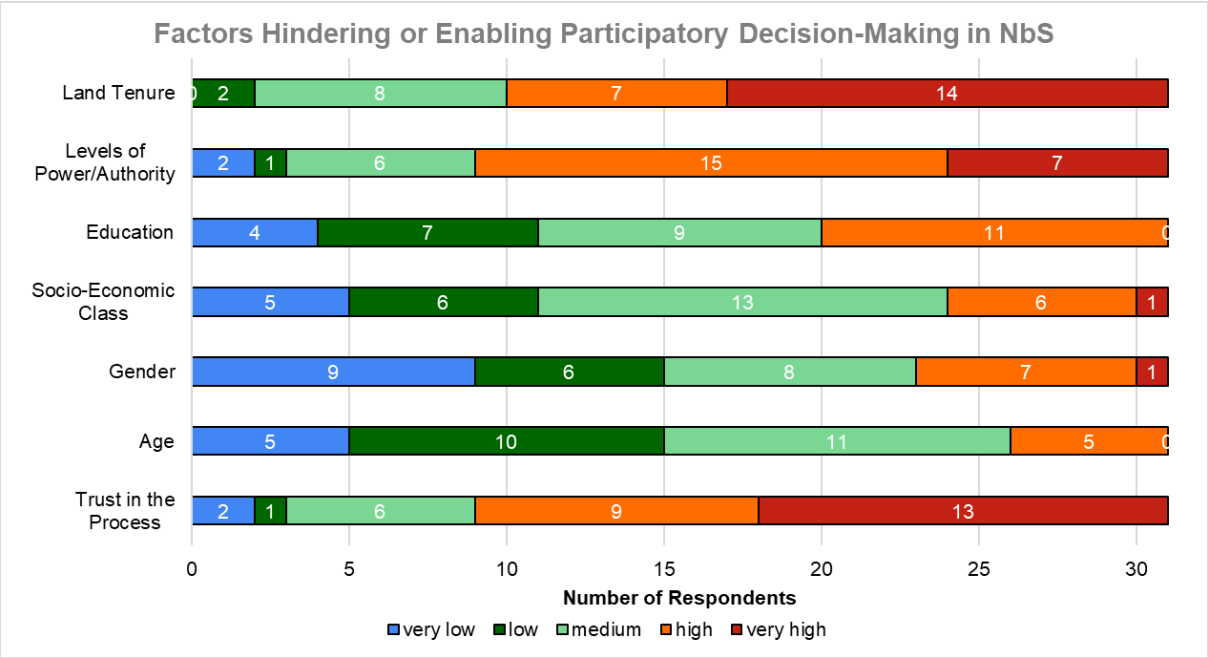

Fig. 25: Number of respondents assessing factors hindering or enabling participatory decision-making and implementation in NbS as a response to the question: Please rate to what extent the following external factors hinder the NbS decision-making process in finding consensus among stakeholders (1=least and 5 = most).

Respondents to the BioClimSocial questionnaire also highlighted the role of the overall project design with approximately 50% of respondents recognizing that the NbS project design (e.g. **use of transdisciplinary or interdisciplinary approaches**) was the most positively influencing factor.

Although education did not seem to play an important role in these two assessments, the BioClimSocial team found that more than 60% of the respondents agreed (category 4 or 5) that there is a positive correlation between **pre-established local knowledge of NbS** and willingness of stakeholders to participate throughout the whole cycle/process of NbS (see Fig. 26). In other words, where stakeholders are aware of the concept and benefits of NbS applied locally, the more likely they are to engage throughout the process in a meaningful way. If prior knowledge is lacking, it is essential that stakeholders receive comprehensive information about and fully understand NbS and its relevance to them during the early planning stages.

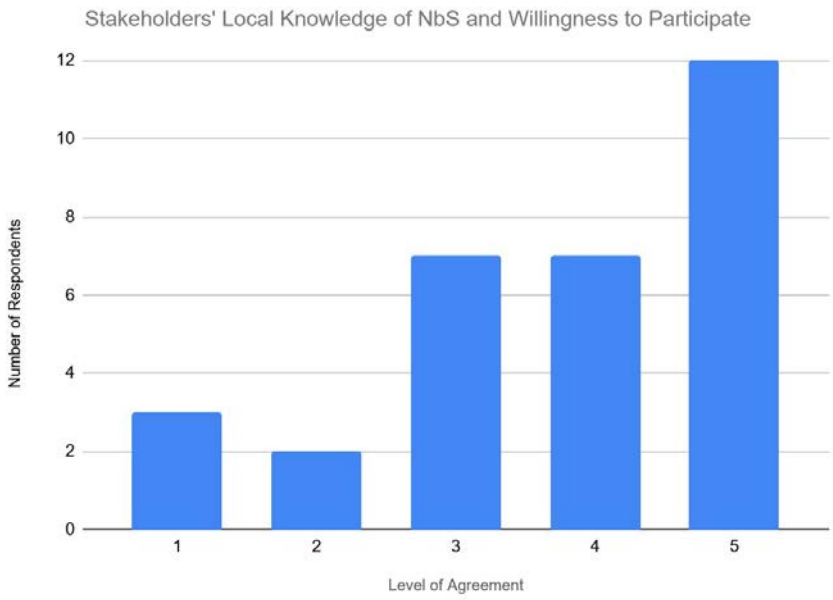

Fig. 26: Level of agreement to the statement: The greater the stakeholder´s pre-existing NbS knowledge, the greater the engagement and willingness to participate in the NbS intervention (1= least agree, 5= strongly agree)

These findings point to clear opportunities for improving stakeholder engagement in future NbS initiatives. Project developers and planners should prioritise inclusive, interdisciplinary design processes that actively involve various actors and stakeholders from the outset. At the same time, investing in early communication and capacity-building, particularly in areas where awareness of NbS is limited, can significantly enhance long-term participation and ownership. Addressing practical needs through modest financial support can further lower participation barriers, particularly for communities with limited resources. Ultimately, a combination of thoughtful design, clear communication, and logistical support creates the conditions for more equitable, effective, and resilient NbS outcomes.

Many factors highlighted by the questionnaire as well as the World Café are beyond the control of the NbS project teams, relevant actors, and stakeholders. However, an acute awareness of the dynamics that can both enrich and distort the NbS process, and its perceived success, cannot be underestimated or understated. For instance, all the BioClimSocial NbS case study partners acknowledged that political agendas inevitably influence the freedoms of choice that NbS offer to stakeholders, along with the issue of finances, long-term investment, and fiscal restrictions on departments of environment that place constraints on the implementation of a given NbS. For instance, the Ancillary Botanic Gardens (ABG) and Balcony Gardens projects in Lebanon faced both shared and distinct challenges in implementation and engaging with the local stakeholders (Tab. 3). Common enablers included the use of local language, ethical engagement, and engaging stakeholders who already had an interest in nature. These elements have built trust and improved communication between the local researchers and the target group, elements which were also outlined by the BioClimSocial questionnaire and workshop results. Enablers specific to the ABG project focused on early institutional engagement and aligning with organizational values, while Balcony Gardens relied primarily on building personal trust with residents due to the private nature of the intervention. Shared disablers such as political instability delayed or limited access across both projects. ABG-specific

disablers included school closures during summer and irregular institutional schedules. For Balcony Gardens, residential access and summer relocation of urban dwellers were key challenges. This highlights that success in NbS projects depends on adapting to local socio-political, cultural, and seasonal contexts, with trust-building and flexibility being crucial across settings.

Tab. 3: Ancillary Botanic Gardens and Balcony Gardens: evidence of enablers and disablers in NbS research practice

	Ancillary Botanic Gardens	Balcony Gardens
Researched or experienced enablers	• Establishing institutional connections early on, before engaging with youth • Knowing the institutional values • Following ethical research, considerations, and consent • Using the local language • Existing interest in nature (e.g. some stakeholders/property owners have a deep connection to nature which made the discussion flow much easier and facilitated approval)	• Establishing trust with stakeholder • Using the local language • Following ethical research practices • Existing interest in nature (e.g. some residents have a deep connection with nature which made the interview flow much easier)
Researched or experienced disablers	• Socio-political context (e.g. political instability in the county made it nearly impossible to access/visit potential ABG sites) • Seasonal context: Students are the primary audience, but with schools closed during summer reaching them required an alternative approach. This led the researchers to focus on scout groups to engage a similar demographic.	• Socio-political context (e.g. political instability in the county made it nearly impossible to access peoples' homes) • Cultural context (e.g. residents move to summer houses in rural areas) • Trust and security issues related to residential access (accessing the privacy of people's homes)

6.2 Factors supporting engagement of Indigenous Peoples and local communities

Understanding what enables IPLCs to engage meaningfully throughout the entire NbS process is essential for ensuring these initiatives are contextually grounded, socially equitable, and sustainable over time. While the term NbS has been picked up by more recent international policy initiatives, it is crucial to acknowledge that the principles and practices it represents have existed for generations within the so-called Global South under different frameworks rooted in Indigenous and local knowledge systems. Recognising and supporting the enabling conditions for the engagement of IPLCs is therefore fundamental to advancing transdisciplinary, process-led NbS. Qualitative responses from the BioClimSocial questionnaire highlighted four interconnected enablers that motivate IPLCs to engage throughout the NbS process: self-agency and self-governance, perceived benefits, social relevance, and personal interest. Many responses overlapped across these categories, reflecting the complex motivations behind sustained participation.

In the context of the BioClimSocial case studies for example, engagement of IPLCs in marine conservation initiatives in Colombia is supported by a deep historical and cultural connection to coastal and mangrove ecosystems. López-Angarita et al. (2016) highlight how the historical use and misuse of mangrove resources across Latin America, including Colombia, reveal both the resilience and vulnerability of communities dependent on these ecosystems. Their study underscores the importance of incorporating traditional ecological knowledge and local stewardship practices into contemporary conservation strategies. Similarly, Oldenburg (2025) explores the interplay between marginalization, environmental degradation, and emerging alternative futures in Cartagena's mangrove landscapes. By situating mangrove conservation within the broader political and cultural context of the Colombian Caribbean, Oldenburg emphasizes how local communities reimagine sustainable relationships with their environment through grassroots initiatives and cultural expression. Together, these studies demonstrate that the engagement of IPLCs in marine governance not only enhances ecological outcomes but also promotes social justice and the co-creation of inclusive environmental futures.

A central driver of engagement at the local level is the desire for **ownership** in managing environmental decisions that affect communities' lands, livelihoods, and futures. One respondent from the BioClimSocial interviews clearly expressed this sentiment:

> "People nowadays want to be involved in the management of their living environment, as they are aware of the consequences of the misuse and degradation of their environment. The local and national management authorities do not care about the well-being of people, but succumb to capital, which is continuously destroying our environment. Therefore, people want to influence these processes in order to protect themselves, their children and their future by protecting and conserving their environment and hence also enhancing their well-being and that they are committed to the sustainable use of natural resources."

Others emphasised the importance of **inclusive and respectful engagement** throughout the decision-making process:

> "Indigenous peoples become truly involved when they feel they have an important place in the whole decision-making process, with the respect and consideration that goes with it. At the end of the whole process, it is essential to go back to these communities to inform them of the conclusions of the work. This means being in constant contact with them and showing them that they remain the central element in the process."

Empowerment through participation was also highlighted:

> "To have the power to decide, to have the feeling of ownership, to express their opinion and needs and, furthermore, to participate in decision-making process."
>
> "Indigenous Peoples and local communities engage in the whole NbS process of deliberation to ensure that their rights are respected and that their interests and needs are prioritized, to maintain control over their territory and influence decision making. They participate throughout the NbS deliberation process when their right to self-determination is recognized, they lead decision-making, their culture and forms of organization are respected, and NbS goals are linked to improving their livelihoods and quality of life in their own terms."

Linking engagement of IPLC in NbS with rights-based co-management frameworks

Insights from the BioClimSocial questionnaire show that IPLC engagement is driven by factors such as self-governance, perceived benefits, social relevance, and personal interest —underscoring the importance of agency, ownership, and recognition of rights. These findings resonate directly with the institutional dynamics observed in the case study from Inácio da Cunha (2024), where the shift from consultative to deliberative co-management of protected areas in the Amazon region is presented as a pathway for transforming historically unequal and exclusionary governance systems (see Box 12).

Echoed by the BioClimSocial research results, this additional case study highlights that genuine and sustained IPLC engagement requires more than consultative processes. It calls for institutional transformation that recognizes communities' **rights to self-determination**, co-decides **access rules**, and respects **traditional knowledge** systems. Just as respondents in the BioClimSocial questionnaire emphasized the need for inclusive decision-making and ongoing feedback loops, the proposed analytical framework from the research project focused on the Brazilian Amazon illustrates how **deliberative councils** can institutionalize this participation - leading to more just and effective NbS outcomes.

Crucially, this case study also supports the previous notion that rights-based, deliberative governance structures are not only ethically necessary but functionally beneficial. They help bridge social-ecological trade-offs by creating co-managed spaces where IPLCs are empowered to shape both conservation outcomes and the socioeconomic conditions tied to their lands and livelihoods.

Box 12: From consultation towards deliberative co-management of protected areas of Amazônia as a Nature-based Solution. * **Marcelo Inácio da Cunha (PhD) – Center for International Forestry Research and World Agroforestry (CIFOR-ICRAF)**

The point of departure in this case is an analytical framework (Fig. 27) for understanding access limitations to resources — non-timber forest products (NTFPs) — by socioeconomically marginalized forest stewards. In this case, traditional local communities of Afro-descendants (Quilombolas) whose traditionally used collective land overlapped with a Protected Area (PA) — the Trombetas River Biological Reserve (TRBR) established in 1979 in the state of Pará, Brazil.

The analytical framework zooms into rights-based access to livelihood-relevant natural resources (Ribot & Peluso 2003; Peluso & Ribot 2020), i.e. Brazil nuts—a NTFP, which occurs naturally in the TRBR. By analysing determinants and processes of access to resources, the framework provides insights for leveraging effective participation of local communities, in the realm of joint deliberative co-management of PAs, along with environmental authorities as a Nature-based Solution.

In the TRBR, resource access is further limited by a formal rule known as the Term of Compromise (TDC, as per acronyms in Portuguese) between the state and affected local communities living in PAs. The TDC was issued by the Chico Mendes Institute for Biodiversity Conservation (ICMBio), Brazil's environmental responsible entity, at national level, for managing PAs. It is a federal decree aimed at resolving conflicts over natural resources in PAs where traditional communities live in and work with the forests. Its goal was to reconcile environmental protection with socioeconomic needs of local communities living in PAs. The

TDC restricts the number of Brazil nut buyers, which has resulted in unintended implications for the Quilombola communities (Inácio da Cunha 2024).

While intended to help manage social-ecological trade-offs around protected areas, this rule has created unintended negative consequences in the case of the TRBS. It reinforced inequalities in Brazil nut access, use and trade (Inácio da Cunha 2024). By limiting the number of buyers who can enter the forest reserve to purchase Brazil nuts directly from local communities, the TDC creates a market where a few buyers have greater power to set prices, while many gatherers—including Quilombola communities—are left with weaker bargaining positions.

These trade relations were already unbalanced, and by formalizing them without effective community input for deciding on the conditions for Brazil nut access, the TDC has made social-ecological trade-offs worse. The traditionally used land and resources, whose use was locally managed per customary norms on a sustainable basis within communities, have been replaced by the formal rule of the TDC—unilaterally written by the environmental entity.

The suggested framework helps to analyse challenges and to inform pathways to overcome resource access limitations by marginalized forest stewards and user groups. On the left side, it identifies the restrictions and power imbalances that currently limit rights-based access. On the right side, it presents pathways for more equitable and inclusive access. These include adapting the TDC to reflect local realities by creating co-management councils where environmental authorities and communities make decisions together and strengthening governance structures of PAs that go beyond rare local consultation. Such changes would give local communities, including Brazil nut gatherers in Quilombola communities within the TRBR, a real say in how resources are used and traded, while also ensuring conservation goals are met. In zooming into the social dimension of forest biodiversity conservation, the framework provides ingredients for changing natural resource governance in PAs with strict environmental protection.

Transforming governance in this way means moving away from consultative management—where environmental authority rarely conducts local consultations but centralizes decision-making over natural resources — towards deliberative co-management, where affected communities and the state share decision-making power. For Quilombola communities in the reserve, this could mean effective participation in adapting the TDC and securing more equitable access to NTFPs, such as Brazil nuts. It could further help turn current trade-offs between conservation and livelihoods into synergies that support both biodiversity and community well-being.

Recommended options for achieving this include locally adapting the TDC through participatory processes by creating deliberative councils to effectively co-manage PAs with currently strict environmental protection. In short, the analytical framework allows for identifying leverage points for context-sensitive Nature-based Solutions with inclusive governance structures that leave no local community and no forest behind.

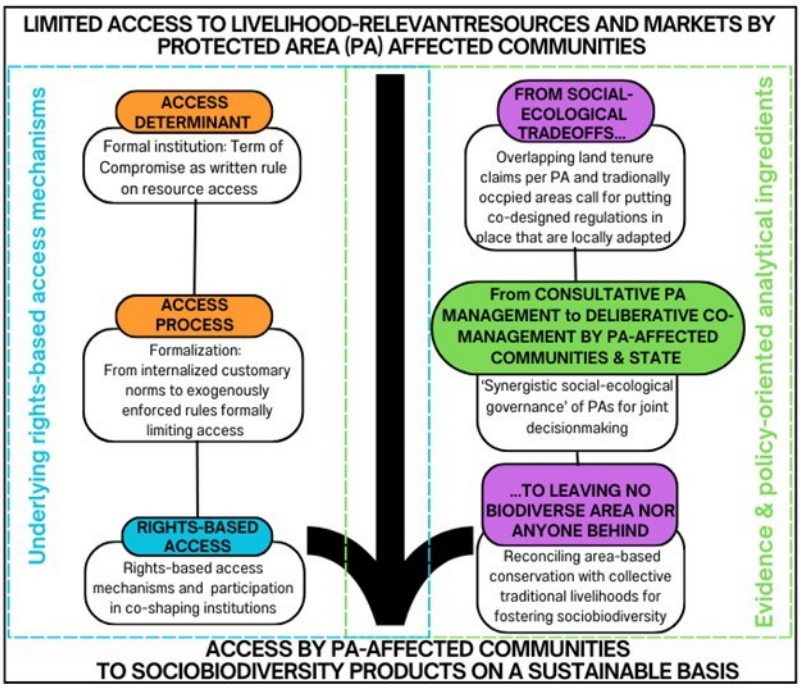

Fig. 27: Analytical framework illustrating the institutional transition in governing forest conservation and resource access by traditional communities – from consultative management towards deliberative co-management of protected areas of Amazônia (Inácio da Cunha 2024)

7 Final reflections

Nature-based Solutions hold immense potential for transformative and far-reaching impact. They contribute not only to climate change mitigation and adaptation, the recovery of natural ecosystems, and the preservation of biodiversity, but also provide opportunities for communities worldwide to become empowered actors in safeguarding the planet from an anthropogenic existential crisis. Importantly, their benefits extend beyond ecological gains: the positive social outcomes of NbS interventions are equally significant and clearly multitudinous – ranging from enhanced individual well-being to strengthened community cohesion and resilience.

Because NbS unfold within complex socio-ecological contexts, they require approaches that can integrate diverse needs, perspectives, values, and forms of knowledge. To ensure effectiveness and long-term sustainability of NbS and to avoid initiatives amounting to mere greenwashing, researchers and practitioners overseeing respective projects must acknowledge and address the complex social matters surrounding NbS. This means tailoring interventions to specific local contexts, optimising collaboration with diverse actors, and fostering meaningful stakeholder engagement. While participatory approaches needed for that cannot follow a single blueprint, adopting transdisciplinary principles is universally beneficial. Transdisciplinary NbS research and implementation entail bringing together academic and non-academic actors and stakeholders, such as IPLCs, policymakers, scientists and practitioners, etc. in collaborative processes aiming at deliberation, joint decision-making and co-creation.

The BioClimSocial team's research on the social dimension of NbS has yielded a number of critical insights regarding trandisciplinarity in NbS. The findings, summarized in this Guidance Report, highlight the challenges, opportunities, methodological approaches and enablers that shape transdisciplinary NbS research and practice. Some final reflections presented below aim to support and advance future work in this evolving and incredibly important field.

NbS science and practice: Addressing the complexity of the social dimension

NbS science is undergoing a shift, with natural scientists increasingly integrating colleagues from social science into project teams to tackle the complex and multifaceted social dimension of interventions entangling both social dynamics within NbS processes and the socially relevant outcomes. Furthermore, NbS projects often aim to consistently engage a broad range of actors and stakeholders throughout their lifecycle. However, barriers to genuine transdisciplinarity persist. Projects are often initiated in ways that treat stakeholder input as feedback rather than as foundational to project design and decision-making. For NbS research to be impactful, applied and solution-oriented science must take precedence over purely theoretical inquiry. Likewise, to achieve meaningful outcomes, NbS implementation must move beyond prescriptive and top-down approaches and embrace co-designed, participatory processes that integrate multiple perspectives, anticipate social trade-offs, and foster inclusive and adaptive governance. But good intentions alone are not sufficient. Although co-creation is increasingly embedded in project plans and funding requirements, reality is often constrained by tight timelines, resource limitations, and temporary funding.

Defining the research question

Where NbS initiatives are initiated within research projects, their effectiveness depends on research questions derived from real-world challenges as experienced by local communities. Yet, for these questions to be scientifically rigorous and actionable, they must also be shaped by robust methodological standards. Critically, guiding questions in the pre-planning phase

must remain open to revision in response to the evolving stakeholder needs, especially those whose lives are directly affected by NbS interventions. Conflicts may arise when researchers (or governmental agencies, donor organisations, etc. initiating NbS) and local stakeholders, for example, the community, identify divergent priorities. In such cases, the success or failure of a project may hinge on whether consensus can be reached on the problems to be addressed.

NbS planning and early engagement

The project planning phase often begins with a formation of a cross-disciplinary team, which is followed by identification of further actors and stakeholders. Interestingly, in research projects, some scholars even view themselves as stakeholders, further blurring disciplinary lines in a productive manner. Genuine transdisciplinary engagement requires investing in trust-building, local networking, and well-tailored participatory approaches, for example, in the form of local-level workshops that unite diverse rights and knowledge holders like community members, NGOs, businesses, policymakers, etc. Empowering these diverse groups to voice their perspectives is central to the planning process. The influence of divergent stakeholder agendas, especially in the pre-planning phase, must be explicitly acknowledged. Conflicts between 'proof of concept' approaches and the broader, often messier, perspectives of local communities can lead to tension. Understanding and negotiating these agendas is vital to maintaining legitimacy and stakeholder buy-in.

The central role of Indigenous Peoples and local communities and their knowledge that enriches the quality of NbS

One of the perhaps most profound learning at the close of this BioClimSocial Guideline Report is that of the role played by IPLCs. Not least, their knowledge is the most significant factor in ensuring robustness and sustainability in NbS, as such knowledge (and practice) embodies a deep, place-based understanding of ecosystems developed over millennia through continuous interaction with the habitat. This knowledge, when fully utilised, integrates cultural, spiritual, and ecological insights that provide context-specific, empirical wisdom crucial for NbS; NbS that provide sustainable, equitable environmental management, measurable climate adaptation and an agency to those whose livelihoods depend on the health of their ecosystems.

Communication and flexibility

Transparent communication, including openly sharing both successes and failures, is essential. Integrating communication specialists into NbS teams can help bridge gaps between academic, policy, and community stakeholders, ensuring that messages are clear, context-sensitive and actionable. Effective engagement may also require researchers and practitioners to adapt their approach, for example by meeting stakeholders (such as farmers) directly on-site. Communication should balance assertiveness with flexibility, keeping planning and decision-making processes responsive to new insights, emerging challenges, and changing conditions. NbS initiatives must scale effectively, guided by a clear understanding of how stakeholders perceive the challenges at hand. Indeed, one of the most significant challenges for NbS is to determine whether stakeholders even share a common understanding of the problem at hand.

Co-creation is good in theory but faces challenges in practice

Co-creation in transdisciplinary NbS often remains underdeveloped in practice because it sits at a complex intersection of knowledge, power, and institutional realities. Reflecting on this,

one can see how the integration of diverse scientific and local knowledge systems is not an interface that is easily or readily met but is one fraught with challenges that question our assumptions about collaboration. It requires navigating not only differing worldviews but also entrenched institutional frameworks and attitudes that may inadvertently be resistant to such inclusive approaches. Moreover, the tension between the ideal of open, iterative, participatory processes and the reality of needing timely, measurable outcomes highlights an ongoing struggle. Also, conventional research parameters and scientific publication standards often fall short in supporting transdisciplinary science, which requires flexible, context-driven approaches beyond rigid disciplinary metrics. This reflection invites a deeper appreciation of why co-creation, while conceptually powerful, is often so difficult to achieve and to fully materialize, urging us to consider the nuanced socio-political and practical conditions that shape its application.

Finance, valuation and funding

Funding dynamics can significantly shape, and sometimes distort, the trajectory of NbS projects. External funding sources, particularly from international organizations and private donors, can inadvertently override local priorities, leading to projects that lack relevance or local support. Moreover, the economic outcomes of NbS, both direct and indirect, must be taken seriously as part of their social impact. On the practical side of engaging stakeholders in NbS planning and implementation, providing financial compensation, such as travel costs and lost income from attending meetings, is not a courtesy but a necessity. Without this, inclusive participation is likely to be compromised, particularly for marginalized groups.

Monitoring and evaluation of social outcomes

The successes of NbS are often measured primarily by their ability to address the targeted issue (e.g., climate mitigation), while potential co-benefits, particularly social impacts, tend to be overlooked. While there is strong focus on ecosystem service valuation, less attention is given to how NbS interact with labour markets (e.g., green jobs), land tenure systems, and local economies (e.g., smallholder farmers, urban informal economies). Quantifying intangible benefits like empowerment, well-being, community cohesion, etc. remains a big challenge and is therefore inconsistent and fragmented, largely lacking unified, holistic evaluation frameworks and appropriate indicators. Pathways through which NbS contribute to generating overall social change, shifting institutions, norms, and values are poorly understood and require further attention by science, policy, and practice.

Sustainability

Addressing long-term social sustainability in NbS demands careful attention to tenure, institutional embedding, and sustainable finance. Secure land rights help ensure local actors remain stewards rather than passive beneficiaries and the absence of such tenure guarantees undermines long-term outcomes (Lehmann et al. 2025). Lehmann et al. (2025) also highlight that sustaining NbS requires adaptive monitoring, appropriate tenure arrangements, and integration into governance institutions to ensure long-term benefits. In addition, McPhearson et al. (2025) identify inclusive and participatory governance processes as essential for long-term success and emphasise that NbS need to be integrated into planning and governance systems at all levels. On the financing side, McPhearson et al. (2025) note that sustainable financing and political support are necessary to maintain positive outcomes beyond project lifetimes.

Positive feedback loops

Insights from the BioClimSocial project suggest that the more carefully NbS are planned and implemented with social principles at the core, the more successful they are in generating direct and additional benefits. In this regard, well designed stakeholder engagement that is socially inclusive, culturally appropriate, and equitable plays a crucial role in advancing through the NbS cycle as it increases relevance, acceptance, effectiveness, and the overall impact of the measures. Positive outcomes, in turn, underpin trust and engagement, creating a self-reinforcing feedback loop that amplifies both the social and ecological performance of NbS. As environmental challenges intensify, climate impacts grow, and competition for resources increases, fostering such positive feedback loops offers a pathway to solutions that are not only environmentally sound but also socially robust and thus overall, more sustainable.

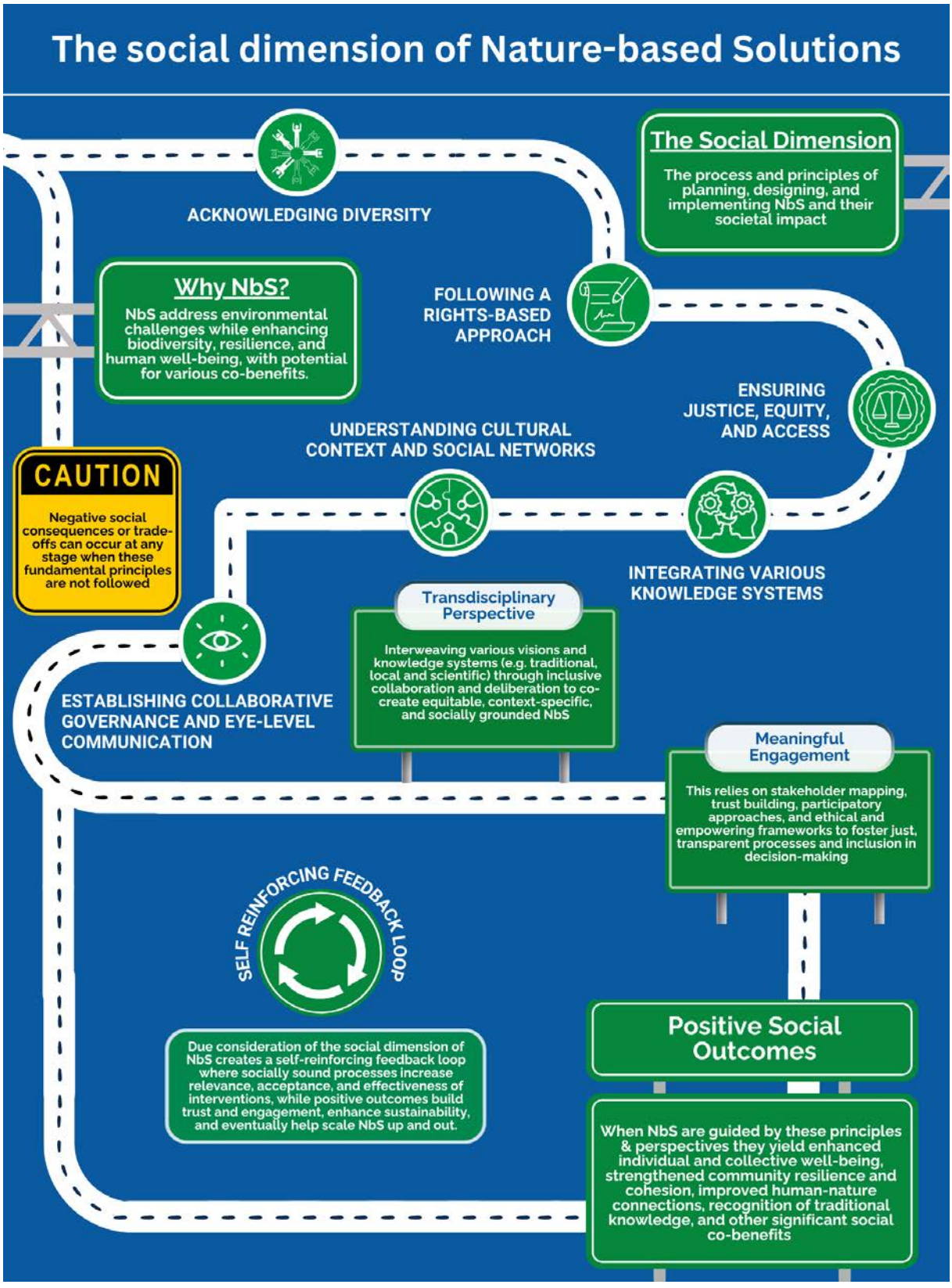

Fig. 28: Considering the social dimension in Nature-based Solution: the process, principles, approaches, and social outcomes (Infographic by Thomas Waln)

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Acronyms and abbreviations

Acronym / Abbreviation	Explanation
ABGs	Ancillary Botanic Gardens
ANADER	Agence Nationale d'Appui au Développement Rural (National Agency for Support to Rural Development)
BfN	Bundesamt für Naturschutz (Federal Agency for Nature Conservation)
BG	Balcony garden
BMUKN	Bundesministerium für Umwelt, Klimaschutz, Naturschutz und nukleare Sicherheit (Federal Ministry for Environment, Climate Action, Nature Conservation and Nuclear Safety)
BOND	British Overseas NGOs for Development
CBD	Convention on Biological Diversity
CIFOR-ICRAF	Center for International Forestry Research and World Agroforestry
CIPRA	International Commission for the Protection of the Alps
CNRA	Centre National de Recherche Agronomique (National Center for Agronomic Research)
COP	Conference of the Parties
DIIS	Danish Institute for International Studies
EbA	Ecosystem-based adaptation
EBM	Ecosystem-based mitigation
FAO	Food and Agriculture Organization
FPIC	Free, Prior and Informed Consent
ICMBio	Chico Mendes Institute for Biodiversity Conservation
IUCN	International Union for Conservation of Nature
ILK	Indigenous and local knowledge
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IPLCs	Indigenous Peoples and local communities
NAP	National Adaptation Plan
NbS	Nature-based Solutions

Acronym / Abbreviation	Explanation
NCS	Natural Climate Solutions
NDCs	Nationally Determined Contributions
NGO	Non-Governmental Organization
NTFPs	Non-timber forest products
OECD	Organization for Economic Co-operation and Development
PA	Protected Area
PES	Payments for Ecosystem Services
PSIDS	Pacific Small Island Developing States
REDD+	Reducing Emissions from Deforestation and Forest Degradation in Developing Countries
SDG	Sustainable Development Goal
SODEFOR	Société de Développement des Forêts (Forest Development Company)
TCD	Term of Commerce
TLK	Traditional and local knowledge
TNFD	Taskforce on Nature-related Financial Disclosures
TRBR	Trombetas River Biological Reserve
UN CEO	United Nations Chief Executive Officer
UNALAB	Urban Nature Labs
UNDP	United Nations Development Programme
UNEA	United Nations Environment Assembly
UNFCCC	United Nations Framework Convention on Climate Change
UNGA	United Nations General Assembly
UNHCR	United Nations High Commissioner for Refugees
WBCSD	World Business Council for Sustainable Development
WEF	World Economic Forum
WWF	World Wide Fund for Nature
ZEF	Zentrum für Entwicklungsforschung (Center for Development Research)

Glossary

Keyword	Explanation
Nature-based Solutions (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 and resilience and biodiversity benefits**.**
Agroforestry	A land management system that integrates trees and shrubs with crops and/or livestock. As a nature-based solution, it enhances livelihood diversification, food security, community empowerment, and climate resilience.
Coastal NbS	Actions that protect, manage, or restore coastal ecosystems, such as mangroves, coral reefs, and salt marshes, to address challenges like coastal erosion, flooding, and climate change impacts. These solutions enhance coastal resilience, support biodiversity, and provide essential ecosystem services.
Montane NbS	Strategies involving the conservation, restoration, or sustainable management of mountain ecosystems to tackle issues such as landslides, soil erosion, and water scarcity. By maintaining healthy ecosystems like forests and grasslands in montane regions, these solutions help regulate water flow, stabilize slopes, and preserve biodiversity.
Urban NbS	Interventions that incorporate natural elements like green roofs, urban forests, wetlands, etc. into urban environments to address challenges such as, for example, air pollution, urban heat islands, and storm-water management. These solutions improve urban resilience, enhance biodiversity, and promote human well-being.
Transdisciplinarity	A research strategy that integrates knowledge from multiple disciplines and involves collaboration among various stakeholders, including scientists, policy-makers, and community members. This approach aims to develop comprehensive solutions to complex environmental and societal challenges by transcending traditional disciplinary boundaries.
Participatory processes	Methods that actively involve stakeholders, particularly local communities, in the planning, implementation, and evaluation of projects. These processes ensure that interventions are contextually appropriate, culturally relevant, and more likely to be sustainable.
Stakeholder engagement	The systematic inclusion of all relevant parties, such as local communities, governments, NGOs, and businesses, in decision-making processes. Effective stakeholder engagement fosters collaboration, builds trust, and enhances the legitimacy and effectiveness of interventions.

Keyword	Explanation
Social dimension	In the context of this publication, the social dimension of NbS is conceptualised in two interconnected ways: as the process and principles of considering and implementing social dynamics through the full cycle of NbS interventions, and as the social impacts or outcomes resulting from these interventions.

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