Delivering Transformative Change and Multiple Benefits: The evidence base of nature-based solutions and ecosystem-based adaptation

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Delivering Transformative Change and Multiple Benefits: The evidence base of nature-based solutions and ecosystem-based adaptation

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Content

Introduction

Over the last decade, policy-makers and practitioners have increasingly turned to nature-based solutions (NbS) to deliver transformative change and address the interconnected crises of climate change and biodiversity degradation. NbS harness the power of nature to help reduce greenhouse gas emissions, strengthen resilience, protect biodiversity and ecosystems, and deliver human well-being benefits to people and communities.

The United Nations Environment Assembly (UNEA, 2022, p. 2) defines NbS as "actions to protect, conserve, restore, sustainably use and manage natural or modified terrestrial, freshwater, coastal and marine ecosystems which address social, economic and environmental challenges effectively and adaptively, while simultaneously providing human well-being, ecosystem services, resilience and biodiversity benefits." NbS represent an umbrella concept for ecosystem-based approaches that address a wide range of environmental and societal challenges, including climate change, biodiversity decline, pollution, and public health issues. As climate change impacts increase around the world, an increasing number of policy-makers and practitioners are turning to ecosystem-based adaptation (EbA) to help communities and ecosystems adapt to the changing climate. EbA is a type of NbS that focuses on "using biodiversity and ecosystem services as part of an overall adaptation strategy to help people adapt to the adverse effects of climate change" (Convention on Biological Diversity [CBD], 2009).

With an increasing number of global assessments, studies, and reports on the effectiveness of NbS and EbA, this brief provides updated, state-of-the-art summary and analysis of the latest science–policy interface assessments and relevant reports related to NbS and EbA. It also outlines the evidence base for the ability of NbS and EbA to deliver multiple benefits and transformative change to solve societal and environmental challenges. Finally, it provides forward-looking recommendations on scaling up the implementation and support of NbS and EbA. This brief is targeted toward policy-makers and practitioners involved in the development, planning, and financing of climate change and biodiversity policy, programs, and projects, as well as negotiators involved in the United Nations Framework Convention on Climate Change (UNFCCC) and the CBD processes.

Delivering Transformative Change Through NbS and EbA

To address the climate and biodiversity crises effectively and to achieve the goals of the Paris Agreement and the Kunming-Montreal Global Biodiversity Framework (KMGBF), governments, governments need to enact transformative change to tackle the root causes of biodiversity loss and climate vulnerabilities. The Intergovernmental Panel on Biodiversity and Ecosystem Services (IPBES)'s latest Transformative Change Assessment Report (IPBES, 2024b) identified three underlying causes of biodiversity decline: 1) disconnection from and domination over nature and people; 2) concentration of power and wealth; and 3) prioritization of short-term, individual and material gains.

These entrenched and mutually reinforcing social norms, patterns, and behaviours shape and reinforce drivers of biodiversity degradation and climate vulnerabilities. Addressing these root causes requires "a fundamental, system-wide reorganization across technological, economic and social factors, including paradigms, goals and values" resulting in "shifts in views, structures and practices" (IPBES, 2024b, pp. 9, 12).

The latest assessments by the Intergovernmental Panel on Climate Change (IPCC, 2022) noted that well-designed and implemented NbS and EbA projects have shown promising results in delivering multiple benefits and are highly effective in achieving mitigation and adaptation outcomes, as well as contributing to climate-resilient development. They have the potential to deliver transformative change by enabling shifts in views, structures, and practices that help address the root causes of biodiversity loss and climate vulnerabilities; they also offer strategies and solutions for key sectors to enact climate and biodiversity actions.

SHIFTING VIEWS: CHANGING WAYS OF THINKING, KNOWING, AND SEEING

NbS and EbA challenge the dominant paradigm that treats nature as a passive resource for exploitation, and instead **encourage and foster a reciprocal, regenerative relationship with nature.** NbS and EbA interventions emphasize the interdependence between nature's contribution to people and the health and integrity of ecosystems. This reframing of nature partially addresses the disconnection from and domination over nature and people, and it aligns with many Indigenous worldviews and local perspectives that value reciprocity, connection with the environment, and stewardship (IPBES, 2019a).

Existing standards and guidelines on NbS and EbA, including the International Union for Conservation of Nature (IUCN)'s Global Standard for NbS and the CBD's Voluntary Guidelines for the Design and Effective Implementation of Ecosystem-based Approaches for Climate Change Adaptation and Disaster Risk Reduction, include criteria and safeguards on **integrating Indigenous and Traditional Knowledge, as well as local knowledge systems** in the design and implementation of NbS (CBD, 2019; IUCN, 2020).

This aspect of NbS and EbA aligns with **Strategy 5** proposed by the IPBES *Transformative Change Assessment Report*: Shifting societal views and values to recognize and prioritize fundamental interconnections between humans and nature.

SHIFTING STRUCTURES: CHANGING WAYS OF ORGANIZING, REGULATING, AND GOVERNING

When designed and implemented well, NbS and EbA can **promote more inclusive, accountable, and adaptive governance systems** that meaningfully involve local communities and Indigenous Peoples in decision making, stewardship, and the distribution of benefits. This shift in organizing, regulating, and governing partially addresses the concentration of power and wealth by **granting more agency and ownership to local communities and ensuring co-creation, co-management, and equitable benefit sharing.** The ENACT 2024 NbS Discussion Paper noted that "NbS bolster community resilience by engaging local communities and respecting local values, as evidenced by high levels of local participation and successful community-managed projects" (Bertram et al., 2024).

In addition, NbS and EbA are powerful tools to **advance synergies and policy coherence between climate change mitigation, adaptation, and biodiversity** plans and actions including through the alignment between policy instruments such as nationally determined contributions (NDCs), national adaptation plans (NAPs), and national biodiversity strategies and action plans (NBSAPs) (Deutsche Gesellschaft für Internationale Zusammenarbeit [GIZ], 2025; Qi et al., 2024; Terton et al., 2022). Integrated approaches, such as NbS and EbA, can help governments maximize synergies and minimize trade-offs and duplication of work.

This aspect of NbS and EbA aligns with **Strategy 4** proposed by the IPBES *Transformative Change Assessment Report*: Transforming governance systems to make them integrated, inclusive, accountable and adaptive.

SHIFTING PRACTICES: CHANGING WAYS OF DOING, BEHAVING, AND RELATING

NbS and EbA **promote the protection, conservation, restoration, and sustainable usage and management of natural ecosystems.** Existing standards and guidelines of NbS and EbA require interventions to be designed and delivered at the appropriate scales and maintain the ecosystems' ability to evolve over time (CBD, 2019; IUCN, 2020). Its long-term focus on adaptability, building ecological resilience, as well as the recognition of the intrinsic value of nature, counters the prioritization of short-term, individual and material gains.

NbS and EbA **offer valuable solutions for key sectors that heavily contribute to climate change and biodiversity decline,** including the agriculture and livestock, fisheries, forestry, infrastructure, mining, and fossil fuel sectors (GIZ, 2022; IPBES, 2024b). Literature shows that NbS and EbA interventions generally yield positive results in biodiversity conservation, quality of life, climate-resilient and nature-positive development, and disaster risk reduction (see the section below on the growing evidence base of NbS and EbA).

This aspect of NbS and EbA aligns with **Strategies 1 and 2** proposed by the IPBES *Transformative Change Assessment Report*: Conserving and regenerating places of value to nature and people; and driving systemic change in the sectors most responsible for biodiversity loss and nature's decline.

Additionally, the various principles of NbS and EbA proposed by existing standards and guidelines, as well as the UNEA definition of NbS, align with the four principles of transformative change: equity and justice, pluralism and inclusion, respectful and reciprocal human-nature relationships, and adaptive learning and action (IPBES, 2024b, KM.3).

The Growing Evidence Base of NbS and EbA

The evidence base for NbS and EbA has grown substantially over the last decade, supported by numerous assessments, reports, and studies demonstrating their effectiveness. This growing body of knowledge demonstrates the value of NbS and EbA as integrated solutions that can address multiple environmental challenges while simultaneously delivering a range of co-benefits for sustainable development and human well-being.

The IPCC and IPBES emphasize the importance of working with ecosystems to address the climate and biodiversity crises. Evidence from both scientific bodies shows that biodiversity loss can exacerbate the impacts of climate change and vice versa, whereas actions to protect, conserve, restore, sustainably use, and manage ecosystems and biodiversity can enhance climate resilience and reduce disaster risk (IPBES, 2019a; IPCC, 2022; Renaud et al., 2013). Recognition of the interconnectedness of the two crises is evident in countries' NAP documents, where 86% of countries refer to these links (Terton, Qi & Jang, 2024). Among the different types of NbS, restoration actions are consistently highlighted as one of the most effective and well-established measures, delivering promising results for adaptation, mitigation, and biodiversity across various ecosystems (Biodiversa+, 2024; Duarte et al., 2020; IPCC, 2022). Their widespread use and proven effectiveness are underscored by the UN Convention to Combat Desertification (UNCCD)'s *Global Land Outlook* (UNCCD, 2022), which focuses specifically on restoration to address climate change, biodiversity loss, and desertification, as well as the UN's commitment to the Decade on Ecosystem Restoration (2021 – 2030). It is interesting to note that although restoration actions are included in most NAPs (48 out of 57), sustainable management measures are more common, appearing in 52 out of 57 NAPs (Terton, Qi & Jang, 2024).

Two key aspects of the appeal of NbS and EbA are their multifunctionality and ability to generate an array of co-benefits. The IPCC's Sixth Assessment Report (2022) indicates with high confidence that NbS can deliver benefits for climate change adaptation, mitigation, and sustainable development. It recognizes EbA as a key climate change adaptation measure capable of generating multiple co-benefits. Similarly, both the IPBES *Global Assessment on Biodiversity and Ecosystem Services* (2019) and the IPBES *Nexus Assessment* (2024) have concluded that NbS implemented with the proper environmental and social safeguards can be cost-effective strategies to deliver

positive results and offer multiple benefits across the biodiversity, water, food, health and climate change nexus, including contributing to climate change adaptation, mitigation, disaster risk reduction, biodiversity conservation, and sustainable development efforts (IPBES, 2019a, 2024a). Out of the 71 response options identified by the Nexus Assessment, 35 can be considered as NbS (Figure 1).

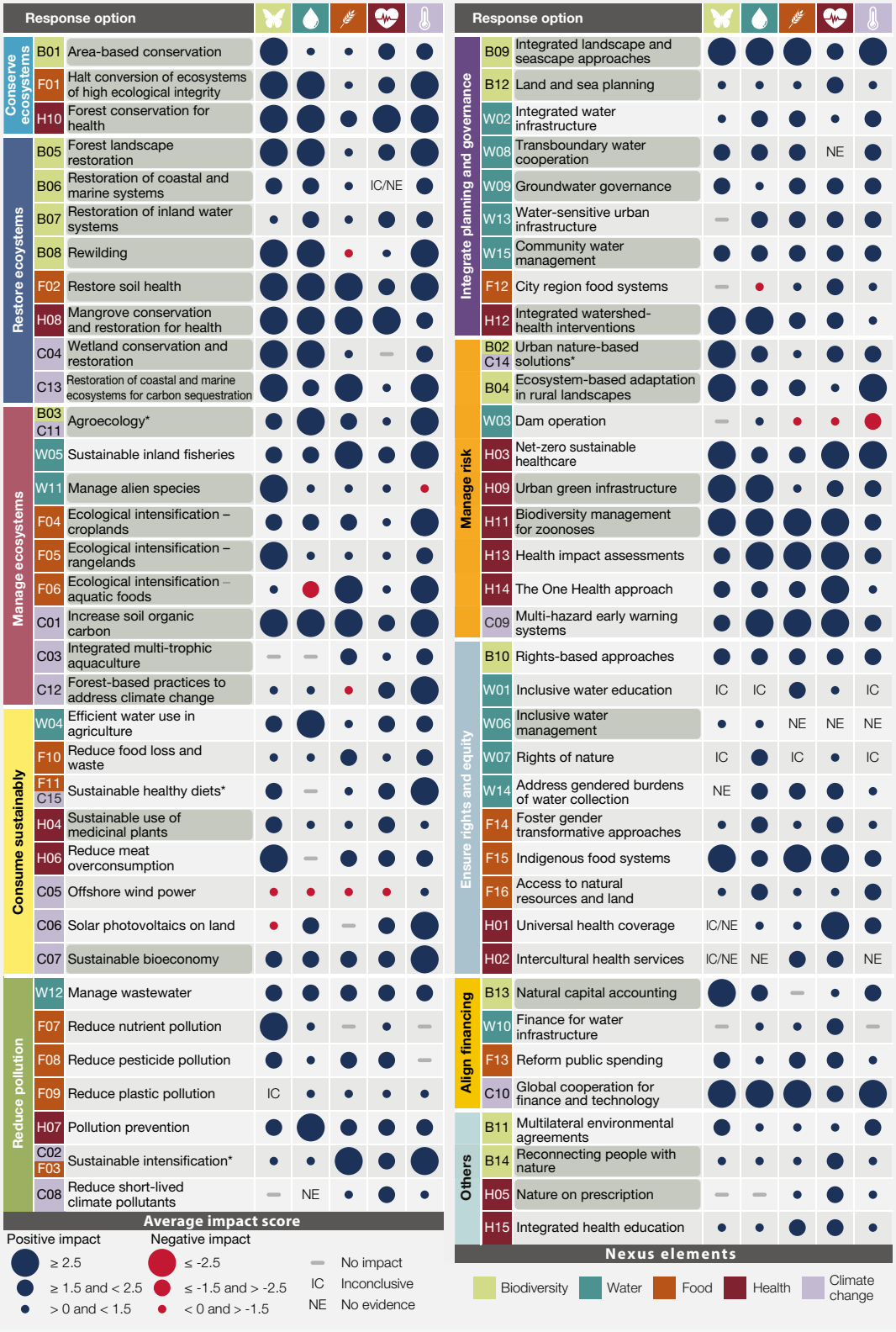

Figure 1
Response options identified by the IPBES Nexus Assessment (highlighted options can be considered NbS).

Source: Adapted from IPBES, 2024a, Figure SPM.8.

The multiple benefits that NbS and EbA can provide have been widely documented (e.g., in Bertram et al., 2024; GIZ, 2022; IPBES, 2019a; IPBES, 2024a; IPCC, 2022), including, inter alia, the following:

- **climate change adaptation**: NbS and EbA play a key role in climate change adaptation efforts, as they can help reduce the impacts of climate change on people and biodiversity through the protection, restoration, conservation, sustainable use, and management of ecosystems. Mangrove protection and restoration measures, for example, can help reduce vulnerabilities to coastal flooding and storm surges, as well as act as a physical buffer to protect shorelines from erosion (GIZ, 2022; IPBES, 2024a; IPCC, 2022). Similarly, the introduction of green infrastructure (e.g., rain gardens, urban tree canopy cover, or green roofs), a type of NbS, can help improve stormwater management systems and address the urban heat island effect by providing shade in warm areas, thereby reducing the impacts of flooding and rising temperatures on cities (IPBES, 2024a; IPCC, 2022). A study by Woroniecki et al. (2023) showed that 95 % of NbS and EbA interventions reported positive outcomes in reducing vulnerability of local communities and ecosystems.

- **climate change mitigation:** Nature plays a crucial and leading role in mitigating climate change, with terrestrial ecosystems absorbing approximately 30% of anthropogenic greenhouse gas emissions worldwide (Pörtner et al., 2021). The IPCC Sixth Assessment Report shows that, after wind and solar, many of the most cost-effective mitigation actions are nature-based, such as reduced conversion of forest and other ecosystems, carbon sequestration in agriculture, ecosystem restoration, afforestation, and reforestation (IPCC, 2022). Coastal and marine ecosystems, such as mangroves, salt marshes, and oceans, also serve as major carbon sinks, with research showing that some of these ecosystems can store more carbon per area than terrestrial forests (Herr & Landis, 2016; Howard et al., 2017; IPBES, 2025). The carbon sequestration potential of all ecosystems can be further enhanced through NbS and EbA actions, such as sustainable management practices (Pörtner et al., 2021). Additionally, when implemented with the necessary environmental and social safeguards, IPBES (2019a) estimates that NbS can provide over one-third of the climate change mitigation needed to keep global warming below 2° C by 2030.

- **biodiversity conservation**: NbS and EbA help restore and maintain the health and functionality of biodiversity and ecosystems. In turn, this allows for ecosystems to provide a range of ecosystem services, such as pollination, flood and erosion control, recreational opportunities, the provision of food, and soil formation, amongst others (Terton & Greenwalt, 2021). NbS and EbA play a pivotal role in enhancing ecological resilience, as research indicates that ecosystems with higher levels of biodiversity are more resilient to climate impacts and other environmental stresses (Key et al., 2022). This is because ecosystems with higher levels of biodiversity are better able to maintain essential functions due to the overlapping roles that different species possess, even when some are unable to adapt to changing conditions (Key et al., 2022). In addition to improving the health

and functionality of ecosystems, NbS and EbA actions, such as restoration, have also been shown to contribute to species recovery in marine and coastal ecosystems, thus enhancing biodiversity outcomes (Duarte et al., 2020; IPCC, 2022).

- **human well-being:** NbS and EbA directly support human well-being by sustaining livelihoods, improving health, and providing recreational value. There is substantial evidence of NbS and EbA enhancing the lives and livelihoods of communities, such as through strengthening food and water security for communities through the implementation of more sustainable management practices or restoration of key ecosystems, creating new jobs and livelihood opportunities, and improving the sustainability of operations for key nature-based industries, such as fisheries, forestry, and agriculture (Boyle & Kuhl, 2021; GIZ, 2022; IPCC, 2022; International Fund for Agricultural Development, 2021). Moreover, the IPBES Nexus Assessment (2024a) highlights the ability of NbS and EbA to improve mental and physical health through the creation of parks and urban green spaces, for both recreational purposes and air quality improvement.

- **economic benefits:** NbS and EbA can generate significant economic benefits by reducing climate-related loss and damage and providing high returns on investment. For example, to protect its coastline and existing dikes, Vietnam invested in the restoration of 12,000 hectares of mangroves. As mangroves act as a natural storm buffer, this investment reduced dike maintenance costs and led to savings of approximately USD 7.3 million per year (GIZ, 2022; Powell et al., 2011). On a broader scale, the World Resources Institute (Brandon et al., 2025) estimates that each US dollar invested in adaptation will generate more than USD 10 in benefits within a decade. Additionally, the World Economic Forum (2020) indicates that investing in NbS to enhance natural water supply sources, as opposed to using engineered solutions, has the potential to save USD 140 billion per year. In general, evidence shows that NbS and EbA are often more cost-efficient and effective than engineered infrastructure (Dasgupta, 2021; GIZ, 2022), with one review finding that 71% of studies identified NbS as a "consistently cost-effective approach" for disaster risk reduction (Bertram et al., 2024, p. 8; Vicarelli et al., 2024).

- **community resilience:** When designed and implemented equitably, NbS and EbA can enhance community resilience and adaptive capacity by engaging with groups that are often excluded from climate and biodiversity governance, such as Indigenous Peoples, local communities, women, and youth. Palomo et al. (2021) found that 94 % of the NbS projects surveyed combined two or more community engagement instruments, with 95 % of NbS involving consultations and co-management with local communities. The meaningful engagement of these groups can provide opportunities to strengthen individual and collective adaptive capacities through inclusive governance processes and knowledge sharing; thus, strengthening overall community resilience.

Additionally, NbS and EbA that incorporate Indigenous and local knowledge have been found to be more effective, as the specialized knowledge of Indigenous Peoples and local communities stems from years of lived experience (IPBES, 2019a). However, despite almost all the NbS projects surveyed in Palomo et al. (2021) involving community consultations and co-management, a review by Turner et al. (2022) found that only 16% of NbS projects incorporated Indigenous and local knowledge in their planning and implementation, highlighting a gap to be addressed. It is also important to note that NbS and EbA that do not account for gender and social inequalities run the risk of maladaptation and worsening inequalities (Caswell & Jang, 2024).

The growing evidence base demonstrates that when well-designed, NbS and EbA offer integrated and cost-effective approaches to enhance biodiversity, strengthen climate resilience, and contribute to the achievement of the SDGs. Their potential to create synergies across multiple domains and contribute to achieving global goals and targets has been acknowledged by policy-makers and reflected in key international documents and declarations, including the Paris Agreement (2015) (para. 2), the Kunming-Montreal Global Biodiversity Framework (Targets 8 and 11), the UN Convention to Combat Desertification's 2018 – 2030 Strategic Framework (2018) (Strategic Objective 1), the Sendai Framework for Disaster Risk Reduction (2015) (Article 28d), the Ramsar Convention on Wetlands' Wuhan Declaration (2022) (para. 5), the G20 Bali Leaders' Declaration (2022) (Article 15), and the G7 Climate, Energy and Environment Ministers' Communiqué (2023) (Article I.9). This potential for synergies has been similarly recognized by countries, with an increasing number of countries integrating NbS and EbA into their NDCs, NAPs, and NBSAPs (Terton, Tsioumani et al., 2024).

Recommendations: Scaling Up NbS and EbA

Creating an enabling policy environment is essential for scaling up NbS and EbA as strategic responses to climate change and biodiversity degradation. This environment should be underpinned by the systematic integration of NbS into national development frameworks, climate action plans, and biodiversity strategies. It requires inclusive governance structures that promote meaningful local engagement and community participation, the establishment of coherent and supportive policy instruments, and the allocation of adequate, long-term financial resources. These components are critical to ensuring that NbS and EbA initiatives deliver measurable outcomes that are effective, equitable, and sustainable across sectors and regions.

Embed NbS and EbA Across National and Sectoral Policies and Decision-Making Processes

To successfully embed NbS and EbA into national and sectoral policies, it is essential to mainstream these approaches within the broader frameworks of national and sectoral decision making. This requires that NbS and EbA interventions be explicitly acknowledged as viable and effective strategies within national-level policy documents, including national development strategies and the implementation instruments of the various multilateral environmental agreements. Among these, the NDCs, NAPs, and NBSAPs are particularly critical, as they serve as key policy tools that define climate and biodiversity priorities and should actively promote these integrative approaches. Embedding NbS and EbA into national strategies, commitments, and planning frameworks enables countries to synergistically address biodiversity loss, land degradation, and climate change while also enhancing the clarity, feasibility, and impact of integrated climate-biodiversity objectives. Crucially, the effectiveness of NbS and EbA is maximized when implemented across entire landscapes and at large scales – such as ecosystems, regions, or urban areas. National and sectoral policies and decision-making processes provide essential platforms for coordinated, cross-sectoral dialogue, which is vital for building consensus and facilitating the large-scale implementation of NbS and EbA.

Scale Up Finance and Investments for NbS and EbA From All Sources

Efforts to protect, restore, and sustainably use biodiversity are severely underfunded compared to the economic value generated by industries that depend on nature (IPBES, 2024b, p. 12). Finance flows to NbS amounted to USD 200 billion in 2022, only a third of the levels needed to reach climate, biodiversity and land degradation targets by 2030 (United Nations Environment Programme, 2023), yet the global economy draws heavily on nature, with sectors dependent on it generating around US$ 58 trillion, representing over half of the global GDP (IPBES, 2024b, p.37). Mainstreaming NbS and EbA will require significant scaling of finance and investments for nature, including domestic budgets, multilateral development banks, multilateral climate and biodiversity funds, bilateral development agencies, private sector actors, and philanthropic sources in the form of grants over loans.

Many current financial, economic, and regulatory policies, such as taxes, fees, tradable permits, and regulations, often discourage environmentally friendly practices. Governments continue to heavily subsidize industries that use practices which harm biodiversity, including agriculture, livestock, fisheries, forestry, and fossil fuels. However, these tools could be used in ways that support nature if reformed. Some governments have started adjusting their policies, such as offering subsidies based on environmental standards. Still, progress has been slow. Research shows that subsidies are increasingly being portrayed as beneficial for nature, although this view is not yet fully supported by evidence.

To close the funding gap and reduce pressure on nature, strategies must include reforming harmful subsidies, as well as embedding environmental costs in market prices, rethinking global debt structures, and increasing private sector investment.

Engage Diverse Actors and Ensure Representation of Multiple Worldviews and Knowledge Systems in the Design and Implementation of NbS and EbA

Embracing Indigenous and local knowledge, and working together to create new knowledge, can lead to meaningful and lasting change in the implementation of NbS and EbA. This means recognizing different ways of understanding the world, linking knowledge to action, and moving beyond traditional Western thinking and science. Combining Indigenous and scientific knowledge helps improve biodiversity management and ensures strategies are culturally respectful, scientifically sound, and ecologically effective. Principles like equity, respect, and collaboration make these efforts inclusive and supportive of marginalized groups. Studies show that co-creating knowledge leads to better decision making, stronger communities, and long-term improvements in well-being and innovation (IPBES, 2019a; Palomo et al., 2021).

However, ignoring Indigenous and local knowledge blocks progress. Policies that support consent, cultural autonomy, and justice – such as recognizing customary law, protecting intellectual property, and ensuring data sovereignty – are essential.

Facilitate a Society-Wide Approach and Joint Planning to Co-develop NbS and EbA

Applying a whole-of-society approach to planning and carrying out NbS and EbA ensures that Indigenous Peoples, local communities, women, girls, youth, and other marginalized groups are fully, fairly, and meaningfully represented and involved throughout the process. This inclusive approach leverages diverse strengths and fosters shared responsibility, resulting in greater collective impact. Governments can make policies more consistent and effective when they use a coordinated, whole-of-government approach. This helps different sectors, groups, and actors work together, avoids conflicting policies, and reduces unexpected problems. Governments can break out of rigid systems by involving new voices and encouraging learning and adaptation across political lines and government levels to maintain progress beyond election cycles.

Uphold the Principle of Equity and Justice to Make Climate and Biodiversity Efforts Fair and Lasting

Ensuring equity is central to integrated climate and biodiversity action and can help shape solutions that are fair and sustainable for both present and future generations. This involves adopting human rights-based approaches that consider gender, land tenure, and other social factors to promote inclusion in NbS and EbA. Respecting principles like Free, Prior, and Informed Consent, adherence to social and environmental safeguards, and active involvement of both marginalized rights-holders and decision-makers in capacity-building efforts are key. For NbS and EbA strategies to be truly inclusive and effective, they must be co-designed with communities, integrating safeguards and mechanisms that support shared decision making and equitable access to benefits, all while protecting ecosystems and the people who depend on them.

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