Enhancing Biodiversity Co-Benefits From Nature-Based Solutions

NCAI TECHNICAL REPORT

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In partnership with Canada

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Nature for Climate Adaptation Initiative

The Nature for Climate Adaptation Initiative (NCAI) seeks to increase the knowledge and capacity of civil society to design and deliver nature-based climate solutions (NBCS) that are socially inclusive, gender responsive, and that enhance biodiversity and ecosystem resilience to change.

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June 2023

Written by Veronica Lo and Ashley Rawluk

Photo: Lauriston Mangrove Restoration, Grenada (Samuel Ogilvie/IISD)

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Summary

- Protecting and supporting biodiversity and ecosystems are fundamental to climate-resilient development because of their crucial roles in adaptation and other services to communities.
- Nature-based solutions (NbS) for adaptation that are implemented with environmental and social protection and support measures can offer multiple benefits for biodiversity and society; they are a critical part of an overall integrated adaptation strategy.
- To demonstrate and maximize biodiversity co-benefits, a range of biodiversity and ecosystem function indicators should be explicitly considered, quantified, and monitored over appropriate timelines.
- Available standards and guidance tailored to local socio-economic contexts should be holistically considered to deliver biodiversity co-benefits.
- Traditional Knowledge and diverse knowledge systems, alongside a human rights-based approach and meaningful, inclusive stakeholder engagement, are crucial for effective NbS that deliver multiple co-benefits.

About This Technical Report

This technical report provides a set of recommendations to help plan, design, and implement NbS for adaptation that enhances biodiversity and ecosystem integrity. It responds to a critical knowledge gap in designing, operationalizing, and monitoring "biodiversity-positive" NbS. The report is part of a compendium of resources developed by the International Institute for Sustainable Development (IISD) for the Nature for Climate Adaptation Initiative (NCAI), which is supported by Global Affairs Canada.

The NCAI strengthens the knowledge and capacity of civil society organizations to design and implement NbS for climate change adaptation through three key tools:

- a self-paced, accessible e-learning course developed in partnership with the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) and the International Union for Conservation of Nature (IUCN);
- an online learning space with technical guidance, resources, case studies, and events focused on gender equality, social inclusion, and biodiversity co-benefits; and
- targeted virtual and in-person learning exchange opportunities that foster a community of practice around NbS for adaptation.

The intended audiences of this report are civil society organizations and actors who are designing, implementing, or otherwise supporting climate adaptation and development projects, including under Global Affairs Canada's Partnering for Climate program. Projects in this program are considered "nature positive" if their principal purpose is to reduce climate vulnerability and if they integrate biodiversity co-benefits through NbS for adaptation as part of project design and outcomes.

The report was developed through a review of relevant literature, discussions with experts, and the development and review of case studies. A case study document will accompany this report, providing a "deep dive" into the concepts described herein, and an e-learning course, developed by IISD and partners and offered through the SDG Academy, provides further information and capacity building on the topic of biodiversity and ecosystem-based adaptation (EbA), which is one type of NbS.

Important Terms

In this technical report, we refer to biodiversity co-benefits and biodiversity positive as the net gains to biodiversity and ecosystem functioning and services that can be attained from the implementation of NbS for adaptation. In addition, the term "NbS for adaptation" is taken as synonymous with EbA and adaptation-focused nature-based climate solutions (NbCS). This report assumes some familiarity with NbS, EbA, NbCS, and related terminology, which are covered in more detail in an introductory guidance note by the NCAI (Lo et al., 2022) and in the e-learning course. For consistency, we use NbS for adaptation or "NbS" for brevity. Forthcoming technical reports developed under the NCAI will offer further insights into gender equality and social inclusion, as well as Traditional Knowledge.

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1.0 Introduction

1.1 Untangling the Meaning of Biodiversity and Its Role in Adaptation

Biodiversity and ecosystems are terms that are becoming increasingly familiar to society as awareness of their role in sustaining life on Earth grows. Yet "biodiversity," "ecosystem," "ecosystem services," and other related terminology are complex terms and are easily conflated, even among scientists and the conservation community. The globally accepted definition of **biodiversity** is the variability among living organisms and the ecological complexes of which they are a part, including diversity within and between species and ecosystems (Convention on Biological Diversity [CBD], 1992). An **ecosystem** is a dynamic system of plant, animal, and micro-organism communities and the nonliving components of their environment (such as energy, air, water, and mineral soil), all interacting as a functional unit (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services [IPBES], 2019). Thus, ecosystems include biodiversity (and abiotic features), but the diversity of ecosystems is also a measure of biodiversity. Biodiversity underpins and supports **ecosystem functioning**, or the flow of energy and materials through an ecosystem (IPBES, 2022), such as soil nutrient cycling aided by microbial communities. **Ecosystem health** can be a subjective term (IPBES, 2022), but it may be useful to think of a healthy ecosystem as one with a species composition and biodiversity similar to that of a reference or baseline ecosystem, with intact ecosystem functions; good water, soil, and air quality; and resilience to environmental change (Key et al., 2022).

Ecosystem functions enable the delivery of services that can be realized in the presence of human beneficiaries, giving rise to **ecosystem services** (Haines-Young & Potschin, 2010), which are the benefits that ecosystems provide to people, including through the provision of food and water, climate regulation, and recreational opportunities. Building on this, the concept of **nature's contributions to people** places a heavier emphasis on cultural dimensions of ecosystems by including diverse worldviews and interpretations of how nature contributes to people's quality of life, including through non-material social, cultural, spiritual, and religious aspects important to living a good life (Díaz et al., 2018). Conceptualizing the contributions of biodiversity and nature to people is an evolving discipline involving diverse worldviews.

One of nature's contributions to people is the role it plays in increasing the resilience of individuals and communities to the risks of climate change and increased risks posed by natural disasters. For example, planting vetiver grass (a deep-rooted perennial) in appropriate places can reduce flood risks by stabilizing sediments and preventing erosion (e.g., Ledwell, 2020); restoring wetlands can support drought and flood resistance by enhancing water quality and absorbing floodwaters; and greening cities with native or locally appropriate vegetation can reduce the "urban heat island" effect produced by concrete surfaces.

Biodiversity not only contributes to the regulation of ecosystem processes and supports the delivery of ecosystem services, as outlined above, but it can also be considered a final ecosystem service in itself that is valued for the cultural services that it provides, including the appreciation and enjoyment of wildlife, spiritual and religious connections to certain species, ecosystems or land/seascapes, educational opportunities, and recreational activities (Mace et al., 2012). Beyond cultural services, biodiversity is valued in diverse ways across cultures and societies, including intrinsic values independent of human experience and evaluation or relational values focusing on human–nature relationships (IPBES, 2022). Thus, the one simple word "biodiversity" encompasses multiple layers of meaning, connecting to ecosystems, ecosystem functioning and services, values, and worldviews. This complexity can make it challenging for NbS practitioners to interpret and measure biodiversity co-benefits.

1.2 Biodiversity in Crisis

Research shows that higher biodiversity can enable the delivery of multiple ecosystem services, reduce trade-offs and negative impacts, and increase the likelihood that ecosystems will be resilient to changing conditions (Key et al., 2022). Conversely, biodiversity loss can alter ecosystem functioning, diminish ecological integrity, and reduce the provisioning of the essential services upon which human health, well-being, and livelihoods are built (Isbell et al., 2017). Currently, biodiversity is in crisis: there is a global consensus that multiple drivers of change are severely eroding biodiversity faster than at any other time in human history (IPBES, 2019). These drivers are broadly categorized as land-use change, natural resource use and exploitation, climate change, pollution, and invasive species (IPBES, 2019).

1.3 Addressing Climate Change and Biodiversity Loss Through NbS

As climate change and biodiversity loss are often mutually reinforcing and share many of the same drivers, joint actions are needed to address these crises. The conservation and restoration of nature are thus increasingly recognized as critical to enhancing the resilience of communities and ecosystems to the impacts of climate change (Intergovernmental Panel on Climate Change [IPCC], 2022). NbS, widely understood as actions to protect and restore nature to achieve societal goals while promoting socio-ecological resilience, are gaining momentum among both policy-makers and practitioners (Box 1). NbS for climate change adaptation can be a cost-effective way to increase resilience while generating multiple benefits, or co-benefits, for nature and society. For example, coastal wetland rehabilitation and restoration can help coastal communities adapt to floods and sea level rise while generating recreational opportunities and net gains to biodiversity and ecosystem functioning—in other words, biodiversity co-benefits, such as increased species diversity or genetic diversity and enhanced resilience of both communities and ecosystems to climate change. Because intact ecosystems provide more abundant and diverse biodiversity and ecosystem health co-benefits compared to newly restored or constructed NbS projects, the most efficient and cost-effective initiatives, in order of priority, are those that retain and maintain existing intact ecosystems, followed by the restoration of ecosystems that have been lost and, finally, building new ecosystems with the required functions (Méthot et al., 2023).

Box 1. Key international developments to date related to NbS

- In March 2022, an NbS definition was formally agreed on by governments at the United Nations Environment Assembly 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” (United Nations Environment Programme [UNEP], 2022b).
- NbS or, EbAs, were included in the cover decision (Sharm el-Sheikh Implementation Plan) of the United Nations Climate Change Conference COP 27 under the Forest section (United Nations Framework Convention on Climate Change [UNFCCC], n.d.).
- NbS and/or EbAs were included in Targets 8 and 11 of the Kunming-Montreal Global Biodiversity Framework, adopted by parties to the CBD at the 15th Conference of the Parties to the CBD (COP 15) (CBD, 2022).
- The ENACT initiative, part of Egypt’s UNFCCC COP 27 Presidency official program, coordinates global efforts on NbS initiatives that combat climate change, land and ecosystem degradation, and biodiversity loss, with plans for an annual State of NbS report and associated meetings (COP27 Sharm el-Sheikh Egypt 2022, 2022).

1.4 The Challenges of Generating Biodiversity Co-Benefits

The concept of NbS has prompted much debate about how realistic it is to achieve multiple wins for society, people, and the planet and the degree to which these global commitments are being fulfilled. In a global review of more than 100 NbS for adaptation projects, the majority (54%) of interventions had positive outcomes for both adaptation and ecosystem health but identified trade-offs, including the establishment of monoculture plantations of non-native species (Key et al., 2022). The NbS with both successful adaptation and nature outcomes predominantly involved restoration but were mainly concentrated in terrestrial areas, and monitoring included only a limited selection of metrics that rarely assessed functional diversity and habitat connectivity (Key et al., 2022).

Several key gaps in NbS for adaptation planning, implementation, and adaptive management are thus evident with respect to generating both biodiversity and ecosystem health co-benefits, including

- a tendency to neglect "wetter" habitats,
- a lack of indicators for ecosystem functioning that would provide a more comprehensive assessment of ecosystem health, and
- consideration of future climate change-induced impacts, such as modified ecosystem functions, shifts in the population range of relevant species, and human migration.

To achieve co-benefits for biodiversity and ecosystems, it is also critical to understand the power relations that impede overall project success and adopt participatory approaches that prioritize fairness and equity, including gender equality in all its diversities. The long-term persistence of restoration projects, for example, is more likely with inclusive governance and the integration of local people's preferences (Löfqvist et al., 2023). Adopting a human rights-based approach that promotes and protects human rights standards throughout NbS project planning, design, implementation, and monitoring can mitigate the potential socio-ecological trade-offs that can result from poorly designed projects, including loss of land access or rights, deepened marginalization of vulnerable groups, or widening gender inequalities.

2.0 Existing NbS Standards and Criteria

Amid a plethora of planning and implementation tools for NbS, it can be challenging to know which are most relevant or most useful for a particular project or context. At a global level, the IUCN Global Standard on NbS includes biodiversity co-benefits as a criterion (Global Standard 3 of 8) for effective NbS, alongside other criteria addressing inclusive governance, scale, and balancing trade-offs (Box 2) (IUCN, 2020).

Box 2. IUCN Global Standard on NbS Criterion (No. 3) on Enhancing Biodiversity Co-Benefits

1. The NbS actions directly respond to an evidence-based assessment of the current state of the ecosystem and prevailing drivers of degradation and loss.
2. Clear and measurable biodiversity conservation outcomes are identified, benchmarked, and periodically assessed.
3. Monitoring includes periodic assessments of unintended adverse consequences on nature arising from the NbS.
4. Opportunities to enhance ecosystem integrity and connectivity are identified and incorporated into the NbS strategy.

Source: IUCN, 2020.

The voluntary guidelines for the design and effective implementation of ecosystem-based approaches to climate change adaptation and disaster risk reduction, adopted by parties to the CBD in 2018, are another set of guidelines specifically for adaptation-focused NbS.[1] These guidelines include a broad set of principles and social and environmental safeguards to consider for project planning, design, and implementation, with **safeguards** encompassing social and environmental measures to avoid unintended consequences to people, ecosystems, and biodiversity (CBD, 2019).

Interpreting these global sets of guidance can be challenging for organizations that have traditionally focused on development or conservation objectives and are now orienting projects toward achieving adaptation and biodiversity objectives, such as under Canada's Partnering for Climate program. All NbS projects aim to achieve one or more societal goals, such as food security or human health, through the conservation, restoration, and sustainable use of biodiversity. What sets NbS for adaptation apart from other types of NbS is that they are implemented with the primary goal of enhancing resilience and reducing social and

[1] You can see the CBD's biodiversity and climate change guidelines here: https://www.cbd.int/doc/decisions/cop-14/cop-14-dec-05-en.pdf

environmental vulnerabilities to current and future climate change impacts. Adaptation-focused NbS thus require that climate, environmental, and social risk analyses are carried out in the target system as a basis for addressing vulnerabilities. A broad range of conservation or restoration-oriented practices that result in biodiversity co-benefits can "count" as NbS for adaptation if the core requirement of reducing climate risk is satisfied. Each practice may come with one or more sets of principles and guidance, such as the Society for Ecological Restoration's Ecological Restoration Principles, EcoShape's Building with Nature principles for water infrastructure development, or the Center for International Forestry Research and World Agroforestry's principles of Agroforestry Design. More examples of guidance for different types of NbS for adaptation can be found in Appendix A.

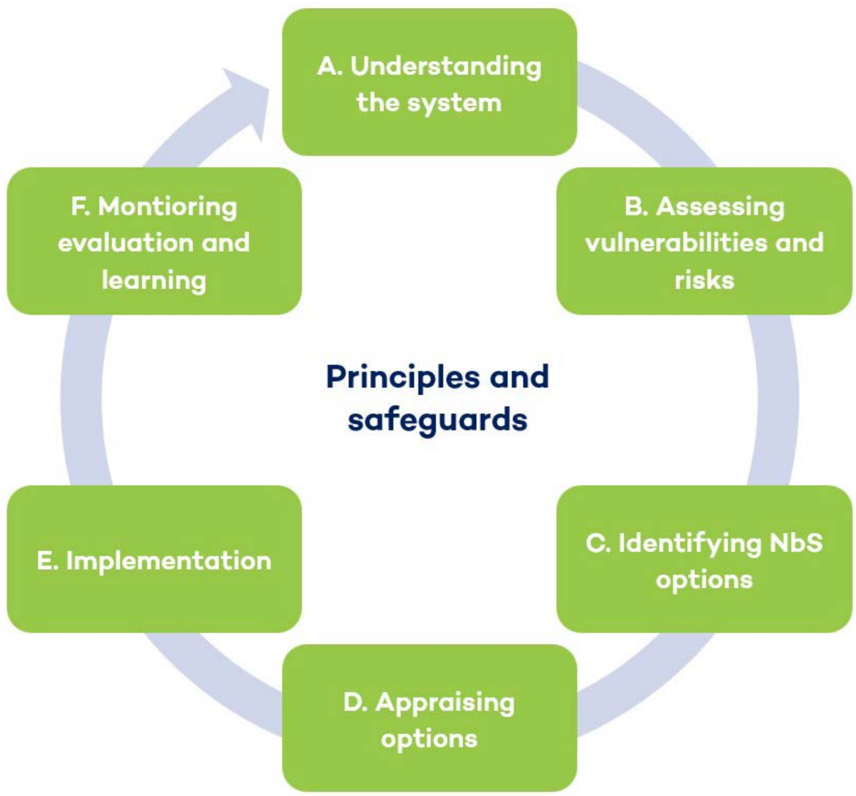
To guide NbS implementation, both practice-specific and global guidance need to be holistically considered together and tailored to suit local socio-economic considerations and contexts. For example, if NbS interventions involve restoring degraded land for multiple uses, forest landscape restoration guidelines should be consulted together with broader guidance on EbA (CBD, 2019) and the IUCN Global Standard for NbS (IUCN, 2020). Depending on the donor, a project or program may also have to apply environmental and safeguard policies that are unlikely to be specific to NbS. In addition, NbS planners will need to draw from a wide range of resources that are not specific to NbS but are key to respecting rights and delivering multiple benefits, including human rights-based and participatory approaches, gender equality, climate justice, and benefit sharing.

A broad range of conservation or restoration-oriented practices that result in biodiversity co-benefits can "count" as NbS for adaptation if the core requirement of reducing climate risk is satisfied.

2.1 Integrating Biodiversity Co-Benefits Into Project Design and Implementation

In this section, we provide an overview of how to implement NbS projects by applying a biodiversity lens to project planning, design, and implementation and developing a monitoring plan with appropriate biodiversity indicators. The voluntary EbA guidelines adopted by parties to the CBD (CBD, 2019) are a useful starting point. They describe a project implementation cycle, beginning with understanding the target social-ecological system through to monitoring, evaluation, and learning (MEL) (Figure 1). This is also known as the EbA Mainstreaming Cycle, as discussed in the EbA e-learning course (GIZ, IUCN, & IISD, 2022). Here, we take users through each step of the project cycle, highlighting where and how biodiversity and ecosystem considerations and co-benefits can explicitly be integrated (Table 1).[2]

Figure 1. NbS project implementation cycle



Source: Modified from CBD, 2019.

[2] Note that only biodiversity elements for each step in the project cycle are covered in this report. For a more thorough description of each step and accompanying tools, please see CBD (2019).

Table 1. Actions to enhance biodiversity co-benefits at each stage of NbS project implementation, with cross-cutting considerations on integrating social and environmental safeguards, Traditional Knowledge, and participatory and inclusive approaches throughout all stages of planning, design, implementation, and MEL

Step	Description	Actions to enhance biodiversity co-benefits	Cross-cutting considerations		
A. Understanding the system	Identify key features of the target system.	Conduct consultations and analyses to identify key biodiversity, ecosystems, and ecosystem services at the relevant scale.	Safeguards and standards	Traditional Knowledge	Participatory approaches
B. Risk assessment	Identify main climate and non-climate risks and impacts.	Assess how climate and non-climate risks affect biodiversity, ecosystem resilience, and the viability of NbS projects, including thresholds and tipping points affecting the provision of ecosystem services and how these risks relate to community vulnerability.			
C. Identifying options	Identify potential NbS options that fit within an overall adaptation strategy.	Screen for NbS options that generate net gains in biodiversity and ecosystem health, starting with the conservation or restoration of key ecosystems providing adaptation functions and considering the scale of management, ecosystem services, monitoring requirements, high coverage of protection and management, and high levels of support from rights holders, government, and stakeholders. Consider risks to biodiversity and ecosystems for each option.			
D. Appraising options	Develop criteria for prioritizing and appraising options.	Select a valuation method to prioritize and appraise the full range of environmental co-benefits from each NbS option, in addition to analyses of trade-offs, synergies, and environmental risks and constraints for each option.			
E. Implementation	Design and implement selected options.	Determine further details of the biodiversity and ecosystem attributes of the NbS project; develop processes to manage previously identified risks for the project (step D) according to social and environmental safeguards; and conduct applicable environmental and social impact assessments.			
F. MEL	Monitor and evaluate the project; learn and adapt to inform future policy and practice.	Develop a comprehensive MEL framework and implement a MEL plan with targets and indicators of biodiversity and ecosystem health and functioning, implemented across the project cycle (steps A–F) and over the different stages of a project.			

Step A. Understanding the system

A crucial first step to NbS implementation is understanding the target social-ecological system in which the intervention will happen. This process involves conducting analyses and consultations with stakeholders, government, practitioners, local experts, and knowledge and rights holders to identify key climate risks and the biodiversity features, ecosystem services, and natural assets that help communities respond to these risks. These analyses pave the way for a more detailed risk assessment in the next step and can generate helpful baseline[3] information to design NbS projects that result in net benefits for biodiversity or ecosystem services (see Step F for further information on conducting baseline studies).

A multidisciplinary team will need to be assembled for these analyses, with appropriate ecological expertise at the local or landscape/seascape level. The expert team can then conduct relevant consultations and analyses to understand the drivers of risk, baseline socio-ecological data, and determine the geographical and temporal scope of potential NbS actions. The Toolkit for Ecosystem Service Site-Based Assessment (TESSA), developed by a compendium of organizations, is an accessible tool for this preliminary stage that helps non-specialists identify important ecosystem services at a site, as well as the benefits for communities using low-cost methods.

Box 3. Step A Example: Understanding the system

The Pacific Ecosystem-based Adaptation to Climate Change Project (PEBACC) explored how NbS can be integrated into development, climate change adaptation, and natural resource management policy and planning in Pacific Island countries. In the first stage of PEBACC, for an NbS project on Tanna Island, Vanuatu, the project team assessed Vanuatu's different ecosystems and their baseline conditions using national vegetation maps and global distribution maps of seagrasses and coral reefs, the associated ecosystem service benefits to local communities, and the main threats to ecosystem health and community resilience from anthropogenic and environmental pressures. Additionally, the project team assessed interactions between local communities and ecosystems and reviewed governance-related factors and supporting policy frameworks. This information enabled a detailed risk assessment of two key ecosystems, fringing coral reefs and kastom forests, and their associated ecosystem services, which in turn served as the basis for the development of locally appropriate NbS options.

Source: Mackey et al., 2017.

[3] Baseline: A minimum or starting point with which to compare other information (e.g., for comparisons between past and present or before and after an intervention) (IPBES, n.d.).

Step B: Assessing the risks of climate-related impacts

Having a baseline understanding of the system and determining the potential scope for NbS activities sets the stage for identifying current and future climate risks to the target system. Risk is a function of vulnerability, exposure, and hazards and thus encompasses all socio-economic and ecological aspects of the system. Climate change risk assessments generally include a preparatory phase that includes the following steps (GIZ, Eurac Research, & United Nations University–Environmental Health and Safety [UNU-EHS], 2018):

1. Understanding the context by assessing the adaptation actions already in place, the institutions and actors that should be involved in the risk analysis, and the necessary resources for conducting the risk assessment;
2. Identifying objectives and outcomes from the assessment, including the target audience; and
3. The geographical scope and focal social groups or sectors.

Following this preparatory phase, climate impact chains can be developed to help understand and analyze the different risk factors affecting a target system.[4] The development of climate impact chains can help planners to understand how biodiversity and ecosystem services are affected by different components of risk (hazard, vulnerability, and exposure) and to demonstrate how biophysical and socio-economic factors interact with and contribute to risk. For example, in the case of extreme precipitation events in flood-prone areas, the resultant erosion, sediment deposition, and riverbed siltation are exacerbated by deforestation and wetland degradation, which reduce the natural floodwater retention capacity of wetlands, ultimately leading to flooding and risk of damage to property, loss of lives, and further wetland degradation.

Non-climatic drivers, such as land-use change or conflict, can also affect risk patterns and impact the viability of a particular project. For example, multipurpose tree and plant species (for timber, fuel, fruits, honey, medicine, and fibre) were planted to restore forests and savannahs in The Gambia to build social and environmental climate resilience to rising temperatures, erratic rainfall, and deforestation. Survival of the seedlings was challenged by continued climate risks, including wildfires; however, non-climate drivers such as illegal logging also challenged the sustainability of the intervention (UNEP, 2022a). Because of a lack of extensive land-use plans and limited knowledge of the movement and ranging patterns of large herbivores, seedlings were also impacted by wildlife, including hippos and baboons (UNEP, 2022a).

[4] For more thorough guidance on all aspects of climate risk assessments as they relate to EbA, consult the *Climate Risk Assessment for Ecosystem-Based Adaptation: A Guidebook for Planners and Practitioners* (GIZ, Eurac Research & UNU–EHS, 2018).

Box 4. Step B Example: Risk assessment

Participatory approaches to risk assessments are critical for enhancing community ownership and relevance of NbS initiatives and ensuring biodiversity co-benefits are attained. For example, in Bishnupur, Nepal, a community forestry project was developed by a community forest user group (CFUG) and supported by RECOFTC, local government, and sectoral agencies. Women leaders of the CFUG led the climate risk assessment process and the identification and implementation of priority actions through regular meetings covering forest quality improvement, climate change, use of forest resources, and land use. The risk assessment considered risks to biodiversity, critical ecosystem functions and services, and communities.

Severe flooding was identified as a major risk, exacerbated by deforestation, forest fires, and the spread of invasive species. The projects selected by the CFUG included planting trees to protect farmland from flooding, installing bio-embankments to stabilize collapsing riverbanks, integrating fruit trees into forests (agroforestry), and beekeeping to diversify livelihoods. The biodiversity co-benefits were realized by planting 546 mango, lychee, and jackfruit trees; 1,000 butter trees; and 400 Indian bay trees in the communities, in addition to over 4,000 fodder trees and grass slips (RECOFTC, 2016). Native species (*Dalbergia sissoo* and *Acacia catechu*) were selected for the bio-embankments based on the Traditional Knowledge of communities (Figure 2) and managed through traditional approaches, such as controlled grazing and fire (UNFCCC, 2021).

Figure 2. A reinforced riverbank (bio-embankment) planted with native species inside Bishnupur's community forest

Source: Reprinted with permission from RECOFTC, 2016.

Step C: Identifying NbS options

With a context analysis and risk assessment in place, potential NbS options can be identified and co-developed through participatory and inclusive processes, such as stakeholder workshops. To ensure that options generate biodiversity co-benefits, an important starting point is locating the ecosystems or landscapes/seascapes that help communities adapt to prioritized climate risks (having previously been identified in Step A) and then working with stakeholders and communities to target conservation or restoration in these ecosystems. Existing adaptation plans or strategies should also be reviewed to help determine entry points for new or improved NbS based on identified gaps, feasibility, effectiveness, and stakeholder support. For example, the following are common types of NbS that can have a stronger emphasis on biodiversity co-benefits by explicitly considering aspects of biodiversity and ecosystem functioning:

- restoration of wetlands and establishment of recreational green space to reduce flood risk and improve water quality *while supporting aquatic organisms at the base of the food web, which are critical to the diet of many species of fish, amphibians, and insects*;
- conservation and restoration of coastal vegetation and coral reefs to buffer the impacts of sea level rise and storm surges *while providing habitats for an abundance of marine life and supporting nearby mangrove and mudflat communities*;

- protection and/or restoration of native grasses, forbs, shrubs, and trees to stabilize slopes and protect against landslides *while increasing habitat for grassland birds*;
- protection and/or restoration of native grasses, forbs, shrubs, and trees in urban areas to reduce the urban heat island effect *while providing diverse flowering species across the season for pollinators*;
- vegetated windbreaks that protect crops, facilities, livestock, people, soil, and water from the wind and windblown material, *while facilitating wildlife movement between patches of fragmented habitats*; and
- hybrid approaches to coastal defence complementing built infrastructure such as seawalls with the restoration of coastal vegetation to help absorb wave energy and reduce erosion *while regulating water temperature to better maintain temperatures required by local aquatic species*.

Step C should result in a list of NbS strategies, projects, and actions that reduce climate risk and enhance the adaptive capacity of target social groups while increasing biodiversity and ecosystem functioning over appropriate and feasible scales. In-depth examples of NbS projects can be found in several databases and online portals, such as the PANORAMA Solutions database, which enables filtering NbS solutions by ecosystem, region, and challenges and identifies building blocks or enabling factors for success (PANORAMA, n.d.).

In Step C, the qualification criteria and standards for EbA (Friends of Ecosystem-based Adaptation [FEBA], 2017) can be consulted to screen for projects that would have a high likelihood of restoring or improving biodiversity and ecosystem health. According to these criteria, the initial screening of projects for biodiversity co-benefits includes evaluating whether:

- the appropriate scale of management is feasible (from broad to fine scale, from landscape to local scale, or from regional to local scale);
- key ecosystem services can be prioritized (from high to low prioritization);
- there are strong capabilities for monitoring biodiversity and ecosystem services (strong to weak);
- adequate coverage of protected or restored areas can be achieved (high coverage to low coverage); and
- there is sufficient support by governments and stakeholders (high to low).

Step D: Appraising NbS options

In this step, the NbS options identified in Step C are appraised using a variety of tools or methodologies, such as multi-criteria analysis or cost-effectiveness. In this step, trade-offs and limitations over the short and long terms are identified and discussed with affected stakeholders. To avoid trade-offs between social and environmental goals, it is crucial to consider safeguards throughout project implementation, such as the safeguards for EbA included in the CBD voluntary guidelines for EbA (CBD, 2019). Other ways to appraise projects, both quantitatively and qualitatively, include the potential to reduce risk exposure, vulnerability, biophysical effects, livelihood and well-being impacts, and social and institutional outcomes (UNEP, 2019).

Following rights-based approaches entails, from the outset, the involvement and informed consent of Indigenous Peoples, local communities, and diverse stakeholder groups, as well as a gender-responsive, intersectional approach. These are minimum requirements to ensure no harm is done and rights are respected, as well as to generate co-benefits. Other considerations when appraising options include alignment with adaptation and biodiversity policies and sectoral plans (e.g., development, water, infrastructure, and agriculture) at local and national levels, including alignment with national adaptation plans and biodiversity strategies and action plans.

Useful tools for appraisal include:

- The NbS Benefits Explorer, a web-based tool that helps users learn about benefit identification and methods for accounting across different ecosystems/biomes and categories of NbS (restoration, management, protection), including benefits for water quantity and quality, biodiversity and ecosystem health, carbon storage, and socio-economic benefits (Brill et al., 2021; NbS Benefits Explorer, n.d.).
- Sustainable Asset Valuation (SAVi), which incorporates the biodiversity benefits of nature-based infrastructure projects into cost-benefit analyses under different climate change scenarios, and a comparative cost analysis of grey infrastructure providing similar services (IISD, n.d.). For example, an assessment of an agroforestry project in Indonesia pointed to higher biodiversity and productivity in agroforestry systems, which in turn lowered the demand for agricultural land and decreased deforestation. In Belgium, the assessment found that agroforestry leads to higher biodiversity through the planting of hedges and trees while also producing fodder, contributing to nutrient cycling, enhancing water absorption capacity and flow regulation, and reducing heat stress on livestock (Bassi et al., 2021).

Box 5. Step D Example: Appraising NbS options

A social benefit-cost analysis (SBCA) was conducted for a suite of potential NbS actions in Tanna Island, Vanuatu, for the PEBACC project. The project aimed to increase garden productivity for food security in the face of extreme weather, land-use change, population growth, and tourism. The SBCA compared the relative values of benefits and costs of a proposed project from a broad societal perspective to determine its economic value over time. The two major categories of NbS considered were (Buckwell et al., 2019):

1. Implementing demonstration garden plots and deploying agricultural extension officers to drive innovation, enhance subsistence yields, and reduce pressure on forest and coral ecosystems; and
2. Providing technical and logistical support for establishing community-based conservation areas and ranger programs to rebuild threatened habitats and formalize reef and tropical forest conservation initiatives.

As a preliminary step to better understand local vulnerabilities, community consultations were conducted in villages around Port Resolution, an important area for subsistence fishing and farming. Because of a strong gender divide in the traditional culture, consultations were conducted separately for men and women. The SBCA was also informed by workshops, focus group discussions, guided field transects, and interviews with government stakeholders.

To assess the economic feasibility of the NbS project, various metrics were used to determine whether the expected benefits to the environment and communities were greater than the associated costs: net present value, the total present value benefit minus the total present value cost for the project as a whole; and the benefit-cost ratio, the ratio of the present value benefits to present value costs, which determines the return on investment. The data to calculate these metrics were derived from relevant publications and economic valuations of changes in ecosystem services provided in The Economics of Ecosystems and Biodiversity valuation database (van der Ploeg et al., 2010). Gains and losses in ecosystem service value were assessed for the following: productivity of subsistence gardens, extent of tropical forests, fisheries values, coastal protection through the conservation of coral reefs, and tourism from the establishment of marine community conserved areas (Buckwell et al., 2019). The assessment built in scenarios over different timelines, and sensitivity analyses were used to explore the response of the methodology to different assumptions. Based on this holistic and systematic consideration of all co-benefits, the SBCA favoured a combination of demonstration garden plots and increased the capacity of communities to balance the management of formally designated forest and reef conservation with customary approaches to management (see Buckwell et al., 2019 for the detailed methodology and results).

Step E: Implementation

Having appraised and selected one or more NbS projects, the project team should then conduct analyses and consultations to develop concrete implementation plans, including investigating key biodiversity and ecosystem attributes of the selected option(s). These consultations could include determining the appropriate vegetation species, mixes, and density for restoration to be used in the NbS project (in consultation with Indigenous Peoples, local communities, and other experts) or conducting workshops to research effective protected area configurations that best promote ecosystem connectivity and climate resilience. The project team develops a design and implementation plan that can include the following elements (CBD, 2019; World Bank Group & World Wildlife Fund, 2013), with the biodiversity co-benefits lens for each emphasized in *italics*:

- Terms of reference for the project, including objectives and expected outcomes, project activities, relevant stakeholders, budget, and important milestones. *Outcomes and activities to generate biodiversity co-benefits should be made explicit in the terms of reference*.
- Logical framework analysis (logframe) matrix, with objectives, expected outcomes, activities, and outputs or deliverables, *again explicitly describing biodiversity co-benefits*.
- A detailed work plan with timelines of activities and milestones, team composition with the allocation of tasks and responsibilities, and identification of risks and assumptions for outcomes and outputs. The work plan would *detail the risks for key biodiversity and ecosystem attributes of the project*.
- A strategy for capacity development, *including training needed for field practitioners or citizen scientists to identify relevant species of flora and fauna and measure biodiversity co-benefits.*
- A funding plan and corresponding budget, *with appropriate allocations for biodiversity experts, assessments of risks to biodiversity and ecosystems, and long-term monitoring to capture the full range of biodiversity co-benefits*.
- Strategies or considerations for institutional and technical support measures and linkages to national, subnational and/or local development plans and policies, *including national biodiversity targets and national biodiversity strategies and action plans under the CBD*.

To ensure risks to the project are accounted for and do not harm biodiversity, ecosystems, or local communities, project teams should revisit the guidelines, standards, principles, and safeguards that were considered in earlier steps.

Step F: MEL

Prior to the implementation of NbS actions, a MEL framework is needed to determine the progress of implementation, assess if the NbS actions are delivering their intended biodiversity outcomes or not, and help identify strategies to improve the actions and communicate the lessons learned throughout the process (Spearman & Dave, 2012). A MEL framework defines clear objectives and sets out a roadmap to achieve the desired impacts in collaboration with the local community, experts, and stakeholders. MEL frameworks can be customized to address the specific socio-ecological context of the NbS project and are implemented across the project life cycle, starting with establishing baselines/targets/indicators during the project design phase.

Monitoring

Monitoring—the collection and analysis of relevant data and information—allows project team members to see changes resulting from project activities, as compared to a baseline state. Monitoring is initiated at the beginning of the project but should continue even after the work is complete, as ecological complexity increases over time for NbS projects and as the impact of project activities on ecosystem functioning may take years beyond the project's lifetime to measure.

Development of Indicators, Baselines, and Targets

Part of developing a monitoring program includes the development of a Theory of Change and the selection of indicators, baselines, and targets. Indicators are critical to understanding whether the NbS project is having the intended impact, while baseline information identifies the project's starting point and level of impact over time. Targets demonstrate the overall progress toward an objective.

There are different ways to categorize indicators, such as process-based indicators, based on the project design (i.e., number of seedlings planted) and results-based indicators, based on the effectiveness of the NbS action (i.e., annual change in fish and shellfish in harvest) (GIZ, United Nations Environment Programme–World Conservation Monitoring Centre [UNEP-WCMC], & FEBA, 2020). Indicators and targets should be specific, measurable, achievable, relevant, and time-bound (SMART) (CBD, 2021). ADAPT principles—adaptive, dynamic, active, participatory, and thorough—are also increasingly used in the adaptation community (Villanueva, 2012). Otherwise, ambiguous and unquantifiable targets can lead to ineffective indicators. Table 2 gives examples of SMART indicators and targets relative to a baseline. Appendix B provides a list of resources that are useful for developing baseline studies and indicators at different scales (global, regional, national, or local).

Table 2. Example of a table for a mangrove restoration project with indicators, baselines, and targets

	Results							
Indicator	**Baseline**	**Target**	**Yr 1**	**Yr 2**	**Yr 3**	**Yr 4**	**Yr 5**	**Target achieved**
No. of seedlings planted	Only 30% of mangrove areas are intact	80% of mangrove areas restored using 100,000 seedlings	10,000	50,000	90,000	95,000	100,000	Yes
Extent (ha) replanted with seedlings		20 ha of proposed area replanted	2	10	20			Yes
% of seedlings surviving in yr 3 and after		Seedling survival rate of 80%			80% survival	80% survival	80% survival	Yes
Annual charge in fish and shellfish harvest	300 tonnes caught	400 tonnes caught annually				350 tonnes	400 tonnes	Yes
Annual change in no. of types of fish and shellfish caught	15	30				20	30	Yes
Annual no. of people affected by annual floods	500	400					400	Yes

Source: GIZ, IUCN, & IISD, 2022.

The number of indicators is an important part of the MEL framework, as too few may miss important aspects of changes in adaptive capacity as well as biodiversity, while too many can be costly and make it challenging to clearly communicate how the project is progressing toward its targets, detracting from the desired outcomes (McQuatters-Gollop et al., 2019). For practical reasons, it is rarely possible to assess all of the important indicators (e.g., plants, animals, social engagement, etc.) within a project, and it is recommended to start with a handful of broad, representative, high-level indicators that can be measured with data that is easily collected in the earlier years of the project (Dekens, 2021).

Indicators for Biodiversity and Ecosystem Functioning

Indicators of biodiversity co-benefits, such as area coverage (i.e., the number of hectares restored or reforested) or species diversity indices, are far more commonly employed in NbS monitoring plans compared to indicators measuring ecosystem functioning, but a mix of biodiversity, structure, functioning, and ecological process indicators are important to assessing ecosystem health and resilience (Key et al., 2021). A carefully developed Theory of Change and MEL framework with biodiversity co-benefits included can help in the selection of feasible and effective indicators. In addition, some indicators can be used as a proxy for hard-to-measure indicators, as they provide a good indication of different facets of biodiversity (Henly & Wentworth, 2021). For example, because native bees have different foraging preferences across species, assessing the diversity and cover of herbaceous plants in a grassland could provide an indication of the different bee species that can be supported, which is easier than counting bee species and abundance.

Metrics for assessing ecosystem health and functioning are an active area of research. For example, the monitoring plan for the rehabilitation of coastal areas in the Nosy Hara marine protected area in Madagascar considered not just increases in the numbers of corals, turtles, and fish but also *resilience*[5] indicators for coral reefs, including benthic animals (bottom dwellers) cover and water quality. These were developed with the involvement of local marine experts (World Wildlife Fund, 2021). Other indicators of reef diversity and health might include temperature variability, amount of nutrient pollution, the degree of sedimentation, occurrence of coral diseases, and fishing pressure (McClanahan et al., 2012). To measure habitat connectivity,[6] or the ability of species to move from one habitat patch to another, Scottish Natural Heritage in Scotland uses the Equivalent Connected Area index, which considers the spatial configuration of individual habitat patches, the resulting fragmentation of the landscape, and the dispersal abilities of a particular species (Blake & Barda, 2018). Appendix B provides some examples of resources that are helpful for system assessments and ecosystem health and functioning indicators.

[5] *Resilience*: Ability of a system and its component parts to anticipate, absorb, accommodate, and/or recover and learn from the effects of a shock, stress, or hazard in a timely and efficient manner, including through ensuring the preservation, restoration, or improvement of its essential basic structures and functions (IPCC, 2022).

[6] *Habitat*: The place or type of region in which plants, animals, and microorganisms naturally occur (CBD, 1992). *Habitat connectivity*: The degree to which the landscape facilitates the movement of organisms (animals, plant reproductive structures, pollen, pollinators, spores, etc.) and other environmentally important resources (e.g., nutrients and moisture) between similar habitats (IPBES, 2019).

Including an array of different biodiversity co-benefit indicators will increase the chance of fully capturing the NbS project's impact on biodiversity and ecosystem health. The range of selected indicators could include (see Key et al., 2021 for a full typology)

- structure (canopy cover, vegetation density, habitat extent),
- diversity (genetic, species richness, species evenness),
- composition (species abundances, community composition),
- ecosystem functioning (survival, growth, or recovery rates),
- landscape structure (connectivity, fragmentation), and
- the conservation status of key biodiversity and ecosystems.

This report focuses on indicators for measuring biodiversity co-benefits, but it is important to remember that an effective monitoring approach also includes other indicators for assessing the socio-economic impacts of the project. Some indices combine biodiversity, ecosystem services, and governance indicators. For example, the City Biodiversity Index is a quantitative self-assessment tool for cities to assess progress in conserving biodiversity. It is comprised of 23 separate indicators spanning native biodiversity in the city and connectivity, ecosystem services, governance, and management (Chan et al., 2014). The indicators specific to biodiversity and ecosystem functioning include bird biodiversity, changes in the abundance of various species, connectivity measures, and the proportion of invasive species. The ecosystem services covered include the cooling effect of vegetation and air quality, which is measured by assessing tree canopy cover as a proxy indicator.

Different indicators for measuring biodiversity, ecosystem health, and socio-economic outcomes are likely needed at different stages of the project. For example, in vegetation restoration initiatives, it will only be possible to measure certain ecological processes after seedlings have been established. A priority set of feasible and replicable ecological and socio-economic indicators for different phases of tropical forest restoration initiatives has been developed through interviews with stakeholders and practitioners (de Oliveira et al., 2021), highlighting the need for long-term monitoring over decades to capture the full range of possible biodiversity co-benefits and the impact of restoration on ecosystem health and functioning. The biodiversity indicators measured over the lifetime of the project can begin with monitoring several indicators over the **initial phase** (2–3 years), such as the survival rate of planted trees and soil fertility and the presence of and coverage by invasive species. As the project continues over time, more indicators can be added to characterize biodiversity, ecosystem functioning, and ecological processes. For example, in the **short term** (3–10 years), MEL teams can focus on indicators like the basal area of trees, the number of regenerating trees, the presence of pollinators, and the occurrence of fruiting. In the **medium** (10–50 years) and **long terms** (50+ years), indicators include planted tree species richness, diversity of other life forms and the presence of species of different functional groups, pollination and seed dispersal, canopy stratification, and the provisioning of essential ecosystem services (de Oliveira et al., 2021).

Evaluation

Once the organization determines what needs to be monitored, the next step is **evaluation**, where the MEL team looks at the data and information collected in the monitoring stage. Part of the evaluation includes ensuring that it can be used effectively by developing a protocol to enter, store, and clean the data, avoiding confusion and mistakes early on (GIZ, UNEP-WCMC, & FEBA, 2020). The analysis method is another important consideration, with a mixed method approach (both qualitative and quantitative) recommended to reflect the fact that NbS projects can be complex and influenced by ecological and social factors (Dickson et al., 2017). Evaluation helps determine the impact of the project activities, both positive and negative, helping to assess whether the actions are having the intended impact on biodiversity.

Catchment conservation measures, including restoring degraded land, afforestation, and soil conservation measures, were implemented in the Himalayas as part of the Rural Livelihoods and Climate Change Adaptation project implemented by the International Centre for Integrated Mountain Development, as well as state and Indigenous community partners. Project activities were evaluated by government departments through regular site visits to identify the strengths and weaknesses of the implementation approach, and adjustments in implementation were made immediately after the field visits and evaluations. The project evaluation pointed to the successful generation of biodiversity co-benefits, including increased biodiversity, improved water quality and quantity, and reduced soil erosion.

Learning

Monitoring and evaluation can help team members, project partners, and stakeholders understand what aspects of NbS are working and what needs adjustment to improve their results, identify and correct unintended negative outcomes, and update the targets and indicators (Dickson et al., 2017). This adaptive management is particularly important to respond to changing social, ecosystem, or climatic conditions and new information. The results should be shared with the audience in an approach and with language that is appropriate and engaging to the different groups. For example, a site visit and discussion might be more interesting to a community group, while a funding body may appreciate a technical report with the data, analysis, and outcomes of the actions.[7]

In the grasslands of Sudan, NbS approaches designed to address the climate vulnerabilities of communities included the restoration of rangelands, forests, and riparian zones through the

[7] Useful resources to consult for more in-depth guidance on the development of the MEL frameworks:

The *Guidebook for Monitoring and Evaluating Ecosystem-Based Adaptation Interventions* (GIZ, UNEP-WCMC, & FEBA, 2020) details the process to design and implement effective MEL for EbA.

The *Results-Based Management for International Assistance Programming at Global Affairs Canada: A How-to Guide* (Global Affairs Canada, 2022) outlines an approach to achieve outcomes, implement performance measurement, learn, adapt, and report on performance and outcomes.

PRISM: Toolkit for Evaluation the Outcomes and Impacts of Small/Medium-Sized Conservation Projects (Dickson et al., 2017) provides guidance on assessing outcomes specific to biodiversity; livelihoods and well-being; capacity; awareness, attitudes, and behaviours; and policy and decision making.

planting of native, climate-resilient species that generated multiple goods and services for local families (UNEP, n.d.). Complementary activities were implemented to reduce the drivers of deforestation, such as the provision of gas cookstoves and sustainable building materials as an alternative to timber. The project identified best practices, including establishing village structures to conduct monitoring and evaluation and setting up a multidisciplinary technical committee to plan, implement, and scale up project activities. The lessons learned revealed that a lack of institutional capacity and coordination caused implementation challenges and that conflict between farmers and pastoralists from competing over scarce resources can be mitigated through participatory land-use planning.

3.0 Cross-Cutting Considerations for Enhancing Biodiversity Co-Benefits Throughout the Project Implementation Cycle

There are several key cross-cutting factors that should be considered for the design, implementation, and MEL of biodiversity-positive NbS projects.

Diverse knowledge systems: Generations of Indigenous Peoples have relied on the land and its resources, passing along Traditional Knowledge and practices to find shelter and harvest the food, fuel, fibre, and water that they need while ensuring their actions support ecosystem well-being and biodiversity. Although global biodiversity is declining at an unprecedented rate, research demonstrates that it remains highest on Indigenous-managed lands when compared to formally designated protected areas, parks, and reserves (Schuster et al., 2019). There is growing recognition that Traditional and Indigenous Knowledge and Indigenous leadership are critical to the development and implementation of NbS actions that truly protect and improve biodiversity. Two-Eyed Seeing is an approach that considers both Indigenous and Western scientific knowledge, integrating the strengths of Indigenous ways of knowing in one eye and the strengths of mainstream ways of knowing with the other (Prairie Climate Centre, 2021). Traditional Ecological Knowledge includes conservation practices that enhance habitats and increase the provisioning of food or raw materials for medicines while respecting the overall functioning of the ecosystem or landscape (Gann et al., 2019). Careful consideration of and collaboration with Indigenous and Traditional Knowledge systems at all stages of the NbS project life cycle are critical in respecting rights-based approaches, including those outlined under the United Nations Declaration on the Rights of Indigenous Peoples, and to help ensure that projects benefit Indigenous Peoples and local communities.

Unintended impacts and trade-offs: Throughout the implementation of an NbS project, unintended or negative impacts and trade-offs are as important to consider as positive impacts, as project adjustments will depend on tracking and responding to these trade-offs and impacts (UNEP, 2019). Biodiversity and resilience goals such as habitat protection can conflict with other important community goals. For example, while restoration efforts that restrict access or fishing in a particular area may have long-term ecosystem and socio-economic benefits, they can cause short-term reductions in household income or supply for subsistence fishers, so actions must be considered that address both the social and economic impacts of the change in ecosystem management (United States Agency for International Development Office of Forestry and Biodiversity, 2020). Not all biodiversity net gain is valued by societies—in some cases, NbS projects may unintentionally result in ecosystem disservices, such as the increased transmission of mosquito-borne diseases resulting from wetland restoration.

Baseline data: Baseline conditions—which help us to understand the system in Step A and are further assessed in Step F and measured against indicators—can be challenging to identify and are an active area of research and debate in conservation and restoration practice. If the bar is set too low—such as setting baselines for an already degraded system with impaired ecosystem functioning—project results will not truly be reflective of the full potential to achieve biodiversity co-benefits. Where appropriate, historical baselines can be considered from when human impacts were significantly lower, or data can be benchmarked from similarly intact locations (McNellie et al., 2020). Traditional Knowledge should be integrated where available. In some cases, baseline data can be supplemented with modelling work to inform the species to use in an NbS project.

The principles and standards for ecological restoration developed by the Society for Ecological Restoration emphasize the need to develop reference models for restoration practice that consider native ecosystems that are environmentally and ecologically similar to the project site but have experienced little or minimal degradation and have the capacity to respond to environmental change (Gann et al., 2019). In many cases, reference ecosystems would include traditional cultural ecosystems, where traditional management practices support native biodiversity, such as seasonal mountain pastures, grazed salt marshes, fire-maintained savannas, and grasslands (Gann et al., 2019).

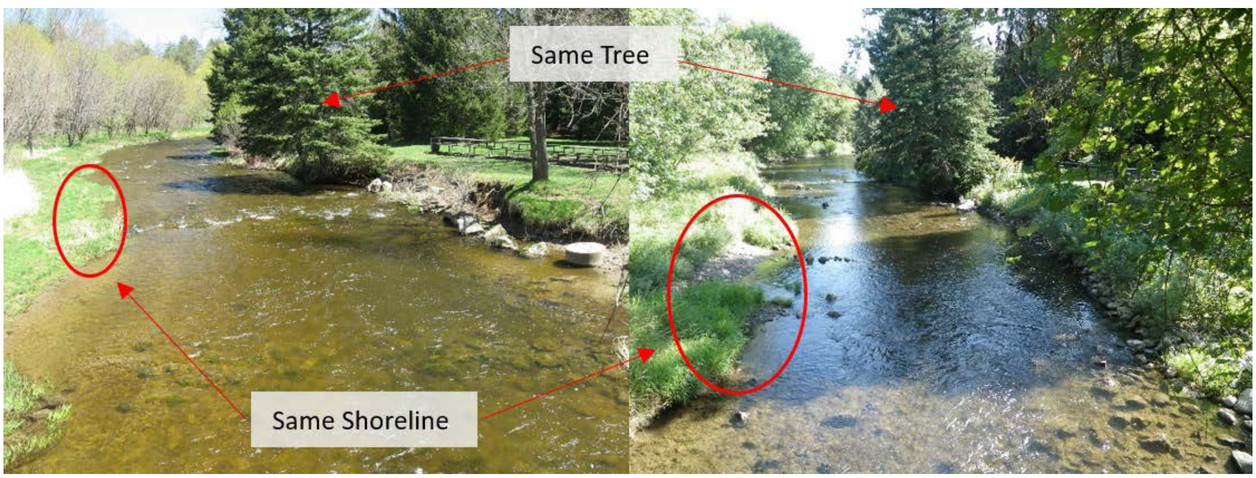
Other tools, such as the Land Degradation Surveillance Framework, developed by the World Agroforestry Centre for assessing soil and ecosystem health, provide guidance to develop biophysical baselines at the landscape level. The tool also offers a framework for monitoring land degradation and evaluating the effectiveness of rehabilitation measures over time and includes important considerations for developing field surveys and sampling designs (Vagen, 2015). Another reference for detailed guidance on conducting biodiversity baseline studies can be found in *Good Practices for the Collection of Biodiversity Baseline Data* (Gullison et al., 2015)

Capacity and skills: Many communities and organizations show interest in NbS but lack the technical expertise, staff capacity, finances, or other resources to design, plan, implement, and monitor projects and measure their impacts on biodiversity (Kapos et al., 2019; Tye et al., 2022). Long-term monitoring, for example, is critical to fully gauge project impacts, but it can be challenging to fund beyond several years, which are typical project timelines. Approaches to support project implementation when capacity and skills are limited include the following:

- **Strategic partnerships** to provide communities with the expertise they need to advance NbS projects. For example, Initiative 20x20 aims to protect and restore 50 million hectares of degraded land in Latin America and the Caribbean. To date, 18 countries and three regional programs have committed, harnessing the skills and capacity of 97 technical organizations and 25 financial partners (Initiative 20x20, n.d.; Tye et al., 2022).
- **User-friendly and low-cost tools**: Biodiversity monitoring options can be costly and challenging to incorporate with limited time and budgets. However, there are some low-cost techniques available to monitor changes in indicators over time. Photo monitoring can help visualize biodiversity indicators such as changes in vegetative cover or species

at small sites (whereas remote sensing imagery may be more efficient for larger sites). Figure 3 shows a photo-monitoring example of NbS actions to improve flood resilience and restore fish habitats in Bronte Creek in Ontario, Canada, including indicators such as increases in the cover of different types of vegetation (trees, shrubs, and grasses), decreases in bare ground, and tree and shrub survival. These indicators, which are evident in the photos, can also give insight into conditions that will improve fish habitats and populations. For example, more deep-rooted vegetation along the streambank prevents erosion and reduces turbidity while also providing shade to keep the water cooler, both of which are critical for the survival of fish and aquatic invertebrates. Detailed photo-monitoring guidance is shared in the *Guide to Photo Monitoring of Ecological Restoration Projects* (Office of Environment and Heritage New South Wales, 2015).

Figure 3. An example of photo monitoring to show the changes in the value of indicators over time, before (left) and after (right) at an NbS restoration project to improve flood resilience and restore fish habitat on Bronte Creek in Burlington, Ontario



Source: Photos courtesy of Trout Unlimited Canada

Citizen science: Public participation in projects is an effective way to conduct biodiversity and ecosystem surveys while promoting local interest and harnessing local knowledge. For example, the Bishan-Ang Mo Kio Park and Kallang River Restoration project in Singapore addressed floods, urban heat, drought, and erosion by planting vegetation on riverbanks combined with soil bio-engineering approaches. Citizen science monitoring programs helped to quantify increases in populations of birds, butterflies, and dragonflies (World Wildlife Fund, 2021). Examples of citizen science tools can be found in the Government of Canada's Citizen Science Portal, ranging from tracking fish health, using mobile phone apps to collect observations, or sharing bird sightings (Government of Canada, 2023).

Project time frames: NbS projects may not have a timeline or funding that lasts long enough to fully monitor the achievement of adaptation and biodiversity benefits (GIZ, UNEP-WCMC, & FEBA, 2020). Adaptation and biodiversity benefits tend to increase over time as the project becomes established, with many biodiversity improvements only realized several years after implementation. If the project time frame is too short, there may not be enough time for the components of the project to become established and support the intended function, potentially skewing the outcomes and taking away from the project's success. If an ecosystem is severely degraded, it may take even longer to see positive improvement in indicators specific to biodiversity, despite the improvement of other indicators. For example, while the water quality of rivers in the United Kingdom has improved over time through targeted interventions, only a partial ecological recovery has been observed (Frame et al., 2016), possibly due to other pressures on the system or the inability of less-mobile species to move to improved areas (Murphy et al., 2014). As such, any project will benefit from monitoring and maintenance beyond the original project timeline.

Local socio-economic contexts: The implementation and MEL of NbS projects can face a number of challenges, including remote project locations, limited connectivity, and tight budgets that need creative approaches. For example, Conservation South Africa signed conservation agreements with local farmers to avoid overgrazing, resulting in enhanced vegetation cover, increased erosion control, and improved water quality and quantity (Conservation South Africa, 2023). To encourage participation, farmers received incentives like market access and vaccinations, in addition to direct project benefits of improved productivity, grazing availability, and water access. Both biophysical and socio-economic indicators were measured using a combination of ground data, online surveys, remote sensing, and satellite imagery. However, data collection was challenged by a lack of mobile phone service to use automated data collection tools, the limited experience of farmers with electronic devices, and theft (GIZ, IUCN, & IISD, 2022). The project team addressed these issues by training farmers to use electronic devices, using technology that does not require cell services, and discouraging theft by strategically placing electronic devices near the homes of long-time project partners or in low-traffic locations (GIZ, IUCN, & IISD, 2022).

4.0 Conclusion

NbS for adaptation can generate biodiversity co-benefits, but these can only be enhanced and sustained when a biodiversity lens is intentionally applied to all aspects of planning and implementation. This includes conducting analyses with the buy-in and participation of local communities to understand the target socio-ecological system; assessing risks to biodiversity, ecosystems, and communities; and identifying NbS options that not only support adaptation to climate risks but also have a high likelihood of resulting in a net gain in biodiversity or ecosystem functioning at the appropriate scale.

To effectively assess outcomes for biodiversity and ecosystem health alongside resilience, NbS project indicators need to go beyond area coverage and biodiversity indices to include ecosystem health and functioning (for example, riparian and rangeland health assessments in Appendix A) and adequately cover terrestrial, coastal, and ocean ecosystems. An inclusively developed MEL framework should include cross-cutting considerations like indicators of biodiversity and ecosystem functioning and services that are measured over an appropriate time frame and conducted with the required skills, capacities, and resources.

By enhancing the resilience of nature and increasing biodiversity, other benefits of NbS can be realized for society, in addition to those for climate change adaptation, including improved livelihoods; health, food, and water security; and gender equality and human rights.

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Appendix A. Examples of Guidance Tailored to Different Types of Nature-Based Solutions or Ecosystem-Based Approaches

Nature-based solutions practice with climate risk lens	Associated guidance
Agroforestry	*Principles of Agroforestry Design* (Center for International Forestry Research and World Agroforestry)
Building with nature/green infrastructure/nature-based infrastructure	"Green Infrastructure Planning Principles: An integrated literature review" (Monteiro et al. 2020) Integrating *Building with Nature Principles* into water infrastructure development (EcoShape)
Ecosystem restoration	*International Principles & Standards for the Practice of Ecological Restoration, 2nd Edition* (Society for Ecological Restoration) Forest Landscape Restoration Principles (World Resources Institute–Global Restoration Initiative) *Principles for Ecosystem Restoration to Guide the United Nations Decade 2021-2030* (Food and Agriculture Organization of the United Nations, UN Environment Programme) *The 4 Returns Framework for Landscape Restoration* (Commonland, Wetlands International, International Union for Conservation of Nature [IUCN] Commission on Ecosystem Management)
Ecosystem conservation	*Ecological Restoration for Protected Areas*: Principles, Guidelines and Best Practice (IUCN) *Safe Havens: Protected Areas for Disaster Risk Reduction and Climate Change Adaptation* (IUCN) *Climate Adaptation Toolkit for Marine and Coastal Protected Areas* (Climate Adaptation Knowledge Exchange)
Feminist climate justice	*A Feminist Approach to Climate Justice* (Association québecoise des organismes de cooperation internationale and Inter-Council Network)
Flood risk	*Nature-Based Solutions for Disaster Risk Management* (World Bank) *Natural and Nature-Based Flood Management: A Green Guide* (World Wildlife Fund)

Nature-based solutions practice with climate risk lens	Associated guidance
General	*Making Ecosystem-Based Adaptation Effective: A Framework for Defining Qualification Criteria and Quality Standards* (Friends of Ecosystem-based Adaptation) *A Framework for Assessing the Effectiveness of Ecosystem-Based Approaches to Adaptation* (International Institute for Environment and Development) *Nature-based Solutions to Climate Change* (NbS Guidelines) *Evaluating the Impact of Nature-Based Solutions: A Handbook for Practitioners* (European Commission)
Landscape approach	"*Ten principles for a landscape approach* to reconciling agriculture, conservation, and other competing land uses" (Sayer et al., 2012) *Landscape Approaches: Background Paper* (Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH)
Marine spatial planning	*Guidance for Marine Spatial Planning* (Intergovernmental Oceanographic Commission)
NbS for disaster risk reduction	*Words Into Action: Nature-Based Solutions for Disaster Risk Reduction* (UN Office for Risk Reduction) *Voluntary Guidelines for the Design and Effective Implementation of Ecosystem-Based Approaches to Climate Change Adaptation and Disaster Risk Reduction* (Convention on Biological Diversity)
Peatlands	*Global Guidelines for Peatland Rewetting and Restoration* (Ramsar Convention on Wetlands)
Urban NbS	Urban Nature Based Solutions: Cities Leading The Way *case studies* (World Wildlife Fund)

Appendix B. List of Resources for Baseline Data and Indicators, Organized by Scope

Scope	Name with link	Description
General information	Biodiversity A-Z	Provides definitions, information, and links about biodiversity prioritization frameworks, structured around themes (Acronyms, Areas, Countries, Marine, and Terms).
Ecosystem assessments	Biodiversity and Ecosystem Services Trends and Conditions Assessment Tool (BESTCAT)	A mapping application designed for companies to review the value and condition of ecosystems and their associated biodiversity to identify locations that require risk management due to potential environmental issues.
Ecosystem assessments	The IUCN Red List of Ecosystems	(Global) Conservation assessments to identify ecosystems across the world that are at the greatest risk of biodiversity loss. The database includes a description of the ecosystem, a risk category, characteristic biota, soil type, biotic processes, threats, risk assessment, and a scenario for ecosystem collapse.
Ecosystems	Protected Planet	Updated monthly to provide the most up-to-date sources of data on protected areas and conservation-based measures around the world. It also assesses protected areas through different themes, including equitable governance, connectivity, Indigenous and community-led initiatives, and marine areas.
Ecosystems	UN Biodiversity Lab	(Global) Spatial data from across the globe that creates map layers for monitoring and reporting.
Ecosystem health and functioning	Riparian Health Assessments	A rapid survey tool to help assess the health and function of riparian areas of streams and small rivers; large rivers; and lakes, wetlands, and sloughs. The questions and indicators are designed around visual assessments of the ecosystem's ability to function, such as the degree of stream channel incisement, which indicates if the stream can access the floodplain.

Scope	Name with link	Description
Ecosystem health and functioning	Rangeland Health Assessment for Livestock, Forest & Tame Pasture	A visual assessment with a range of health indicators that relate to function and help identify if actions or management strategies are meeting objectives. For example, plant residue helps retain moisture, support water infiltration, protect soil, and promote nutrient cycling. Too little residue could indicate overgrazing or poor plant survival, while excess residue may signal that it is time to manage with a disturbance like a controlled burn.
Ecosystem health and functioning	The Land Degradation Surveillance Framework	A tool for the systematic landscape-level assessment of soil and ecosystem health. The methodology is designed to provide a biophysical baseline at the landscape level and a monitoring and evaluation framework for assessing processes of land degradation and the effectiveness of rehabilitation measures (recovery) over time.
Ecosystems & species	Integrated Biodiversity Assessment Tool (IBAT) Protected Planet	(Global) A collaboration of three global datasets (IUCN Red List of Threatened Species, World Database on Protected Areas, and World Database of Key Biodiversity Areas) that provides different levels of reports based on user needs and subscription level, including information like visual data maps of protected areas, key biodiversity areas, and threatened species.
Ecosystems & species	NatureServe	Measures and tracks detailed, robust data for more than 100,000 species and ecosystems in North America, including detailed profiles of species and ecosystems, distribution maps, datasets, invasive species mapping, decision tools, and custom data requests.
Ecosystems & species	Gap Analysis	Provides maps and datasets for species, land cover, and protected areas in the United States.
Ecosystems & species	NBS Benefits Explorer	A web-based tool that clarifies the broad range of benefits from nature-based solutions and identifies indicators and calculation methods to quantify the benefits, including biodiversity. The tool was developed based on the Benefit Accounting of Nature-Based Solutions for Watersheds Guide (Brill et al. 2021).
Ecosystems & species	Biodiversity Indicators Partnership (BIP)	(Global) A initiative to promote the development, delivery, and use of biodiversity indicators that is used in global frameworks like the Sustainable Development Goals.

Scope	Name with link	Description
Ecosystems & species	Restor	Restor uses data from the Google Earth Engine to help plan and support funding for restoration or conservation projects and monitor projects over time.
Ecosystems & species	NatureMetrics	A subscription-based service using NatureMetrics eDNA technology, which uses a DNA sampling program to quantify changes in biodiversity and the impact of nature-based solutions or resource development.
Species	The IUCN List of Threatened Species	(Global) an open-source database providing researchers and citizens with organized and accessible information on biodiversity in all regions of the world.
Species	Global Biodiversity Information Facility (GBIF)	(Global) An international network and dataset about all types of species, with many analyses covering topics like climate change impacts and invasive species spread.
Species	Map of Life	(Global) An open-source database that provides global, species-level information about plants and animals, including species range maps and access to datasets. New developments include a mobile app and a map feature of where life has yet to be discovered.
Species	Botanical Information and Ecology Network (BIEN)	(Global) A initiative that facilitates the development, delivery, and use of biodiversity indicators and is also useful in monitoring progress toward global targets like the Convention on Biological Diversity and the Sustainable Development Goals.
Species	FishBase The IUCN List of Threatened Species	(Global) a list of the extinction risk status of animals, fungi, and plants, with information on range, population size, habitat and ecology, use and/or trade, threats, and conservation actions.
Species	Botanical Information and Ecology Network (BIEN)	A baseline dataset of New World plant species to monitor and understand the impact of climate change on plant diversity.
Species	FishBase	(Global) A biodiversity information system on finfishes, including taxonomy, biology, trophic ecology, life history, and uses, as well as historical data reaching back to 250 years for >33,000 species.
Species	Species Threat Abatement and Restoration (STAR)	Part of IBAT, STAR is a new platform that supports nature-positive action with a simple, standardized, and scalable approach. It helps identify opportunities for positive biodiversity actions and set targets for threatened or near-threatened terrestrial birds, mammals, and amphibians, as well as track and report on progress.

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