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Accelerating Investments for Nature-based Solutions in the Global South

A Unified Framework for Mapping and Estimating Benefits

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About CEEW

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The Council's major contributions include: Informing India's net-zero goals; work for the PMO on accelerated targets for renewables, power sector reforms, environmental clearances, *Swachh Bharat*; pathbreaking work for India's G20 presidency, the Paris Agreement, the HFC deal, the aviation emissions agreement, and international climate technology cooperation; the first independent evaluation of the *National Solar Mission*; India's first report on global governance, submitted to the National Security Advisor; support to the National Green Hydrogen and Green Steel Missions; the 584-page *National Water Resources Framework Study* for India's 12th Five Year Plan; irrigation reform for Bihar; the birth of the Clean Energy Access Network; the concept and strategy for the International Solar Alliance (ISA); the Common Risk Mitigation Mechanism (CRMM); India's largest multidimensional energy access survey (ACCESS); critical minerals for *Make in India*; India's climate geoengineering governance; analysing energy transition in emerging economies, including Indonesia, South Africa, Sri Lanka, and Viet Nam. CEEW published *Jobs, Growth and Sustainability: A New Social Contract for India's Recovery*, the first economic recovery report by a think tank during the COVID-19 pandemic.

The Council's current initiatives include: State-level modelling for energy and climate policies; consumer-centric smart metering transition and wholesale power market reforms; modelling carbon markets; piloting business models for solar rooftop adoption; fleet electrification and developing low-emission zones across cities; assessing green jobs potential at the state-level, circular economy of solar supply chains and wastewater; assessing carbon pricing mechanisms and India's carbon capture, usage and storage (CCUS) potential; developing a first-of-its-kind Climate Risk Atlas for India; sustainable cooling solutions; developing state-specific dairy sector roadmaps; supporting India's electric vehicle and battery ambitions; and enhancing global action for clean air via a global commission 'Our Common Air'.

The Council has a footprint in over 20 Indian states, working extensively with 15 state governments and grassroots NGOs. Some of these engagements include supporting power sector reforms in Uttar Pradesh, Rajasthan, and Haryana; energy policy in Rajasthan, Jharkhand, and Uttarakhand; driving low-carbon transitions in Bihar, Maharashtra, and Tamil Nadu; promoting sustainable livelihoods in Odisha, Bihar, and Uttar Pradesh; advancing industrial sustainability in Tamil Nadu, Uttar Pradesh, and Gujarat; evaluating community-based natural farming in Andhra Pradesh; and supporting groundwater management, e-auto adoption and examining crop residue burning in Punjab.

Contents

Mangroves prevent more than USD 65 billion in property damages and reduce flood risk to some 15 million people every year (Menéndez, P. et al. 2020).

Image: Anthony Ochieng/Climate Visuals

Executive summary

Over the last two decades, a staggering 750 million South Asians, representing over half of the region's population, have experienced the impacts of various natural disasters such as floods, droughts, and cyclones. Projections indicate that if current patterns persist, the Global South is poised to incur an average annual loss of USD 160 billion by 2030 due to climate impacts, implying that this region, in particular, is disproportionately vulnerable to the effects of climate change (World Bank 2022). Therefore, it is crucial to develop effective strategies to enhance resilience and mitigate the impacts. An effective approach to mitigating climate impacts in the developing world is deploying nature-based solutions (NbS). NbS encompass a broad range of strategies that utilise natural processes and ecosystems to reduce flooding, sequester carbon, preserve biodiversity, and enhance living standards by providing fresh air, clean water amongst others. NbS have the potential to cost-effectively achieve around 30 per cent of the mitigation needed by 2030 to stabilise the global temperature increase to below 2°C (IUCN 2019).

Although the benefits of NbS are recognised globally, their financing and implementation often fall short of proposed targets. The global market for NbS is valued at between USD 125 and USD 300 billion annually (WEF 2020), but it receives only about USD 200 billion in investments per year, with the private sector contributing merely 18 per cent. Further, high-income countries, such as those in North America and Europe, receive the lion's share of NbS investments, accounting for approximately 75 per cent of the total (UNEP 2022).

In contrast, low-income countries receive only a small fraction of NbS investments, despite being more vulnerable to the impacts of climate change. **The absence of standardised measures and reporting on the impacts of NbS make it difficult to evaluate their effectiveness and, consequently, hinder investments in this sector and the scaling up of successful projects.** A lack of expertise and methodologies for mapping benefits further discourages investments in NbS in the Global South. Thus, the need of the hour is a common assessment framework that can help stakeholders evaluate the economic and non-economic benefits of NbS.

This report provides a comprehensive understanding of NbS, details the difficulties associated with scaling and implementing such solutions, and proposes a framework to map and estimate the benefits of NbS in the Global South. This framework will allow users to:

a) identify an intervention as an NbS,

b) demarcate its benefits, and

c) estimate the cost-to-benefit ratio by providing a standardised approach to assess and report on their outcomes and costs.

Conducting due diligence before implementing NbS projects will help drive investments in the sector, allow stakeholders to scale up such interventions, and maximise impact in the long run.

Figure ES1 The benefits of investing in nature-based solutions

USD 89.6 billion
worth of benefits through the restoration of wetlands in India over a 30-year period

395 million
jobs can be created by 2030 through investments in NbS

~USD 10 trillion
business opportunities can be unlocked by 2030 through investments in NbS

Source: WEF. 2020. New Nature Economy Report II: The Future of Nature and Business. Cologny, Switzerland: World Economic Forum.

A. ENSURE - A unified framework for mapping and estimating the benefits of nature-based solutions

ENSURE - Effective Nature-based Solutions Utilisation and Resource Evaluation framework comprises three thoughtfully designed categories, each with sub-components, to guide stakeholders through the mapping and estimation process.

Category 1: Identification and categorisation of NbS

This category comprises a five-point criteria that will allow users to examine whether an identified intervention is an NbS. The criteria is essential to ensuring that interventions are contextually relevant and beneficial for the region of implementation, keeping in mind its socio-economic and geographical characteristics. The criteria will also help ensure that interventions align with the principles of sustainable development.

Category 2: Checklist for the implementation of the identified solution

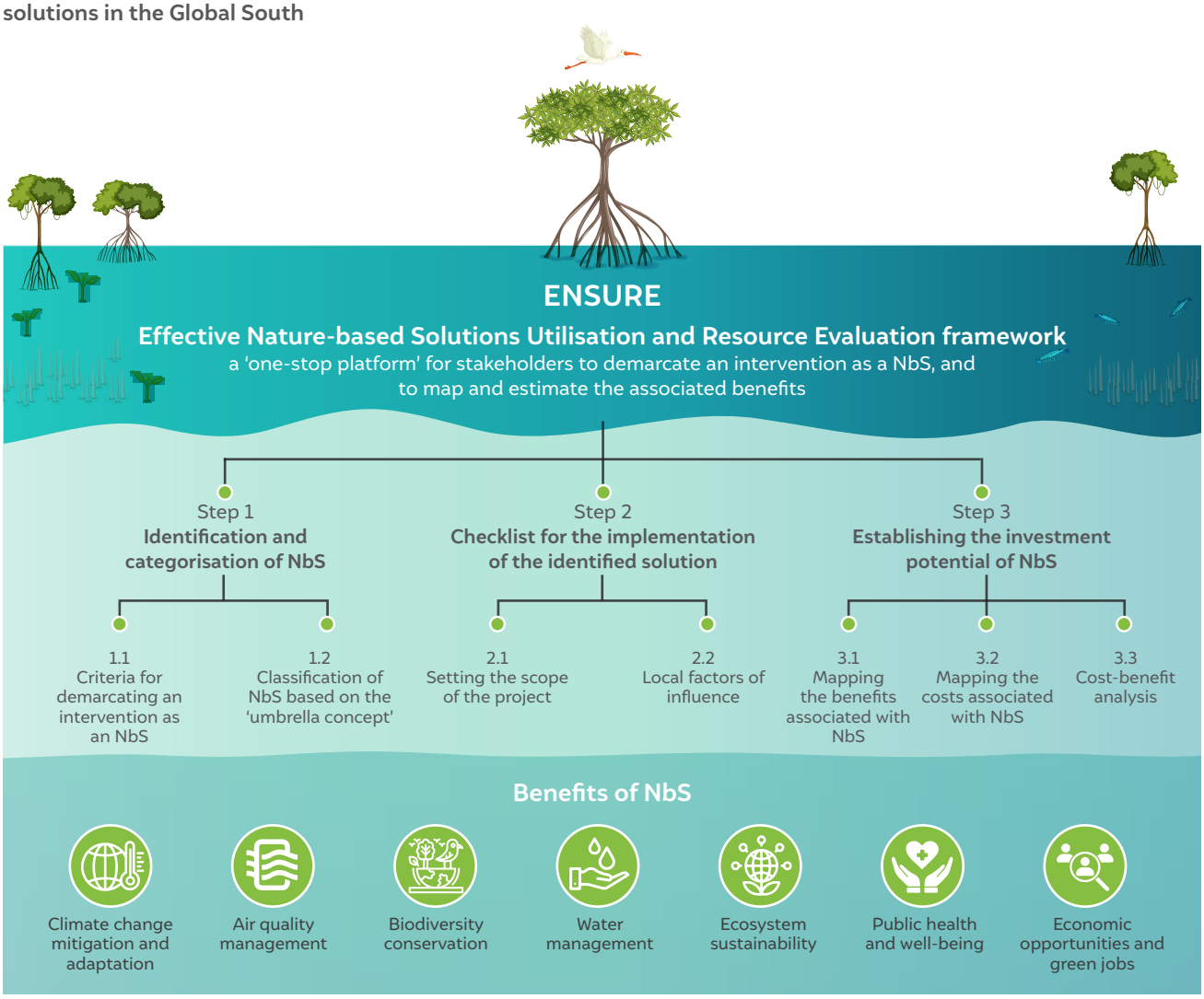
NbS implementation outcomes vary based on geography, scale, and stakeholder involvement – elements collectively termed as '**local factors of influence**' (LFI). Here, 'local' refers to contextual rather than spatial influences. This step helps users understand complex relationships across six categories of factors: social, environmental, species-related, economic, livelihood-related, and cultural. These factors can affect the implementation process positively or negatively. Thus, users must identify these relationships through stakeholder consultations and literature reviews to make informed decisions and discover opportunities for enhancing the impact of NbS.

Category 3: Establishing the investment potential of NbS

Finally, mapping the costs and benefits associated with an NbS project helps lay the groundwork for its successful implementation. This process, which broadly involves cost mapping across four major categories and benefit mapping across seven categories, is essential for establishing the scale and scope of the project. Further, our framework also helps users identify the ecosystem valuation method most suited to estimate the economic value of a desired benefit based on the availability of resources and data. This method will help users accurately and cost-effectively determine the economic value of a given intervention. Figure ES2 provides an overview of the framework and the various steps essential for its accurate implementation.

Floating bamboo houses protect communities in Vietnam, Philippines, and Myanmar from floods, rising water levels, and typhoons, while offering affordable and safe housing options.

Figure ES2 An overview of ENSURE - a unified framework for mapping and estimating the benefits of nature-based solutions in the Global South



Source: Authors' analysis

B. Applications of the framework

The framework for mapping the benefits of NbS has diverse applications across various sectors, empowering key stakeholders to drive sustainable change.

- **For government agencies**, ENSURE provides standardised techniques for data collection, analysis, and reporting. It may also be useful for those involved in the Natural Capital Accounting and Valuation of Ecosystem Services (NCAVES) project. This framework can improve the precision and comparability of natural capital assessments, thus allowing for more informed decision-making regarding sustainable resource management and economic growth. Furthermore, by allowing agencies to map the climate co-benefits of the outcomes of programmes such as the Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS), it will support them in planning interventions that help disadvantaged communities become more resilient to climate change by offering prospects for establishing sustainable livelihoods. Additionally, it will help governments meet the targets they have set for themselves under their Nationally Determined Contributions (NDCs) by making it easier to quantify the contributions of NbS in reducing emissions and by assisting in the formulation of climate action programmes.
- **For private entities**, ENSURE helps in understanding and quantifying the environmental and economic co-benefits of NbS. It enables companies to make informed investment decisions and leverage mechanisms such as green credits in alignment with their sustainability goals. The tradable green credits generated through NbS projects can contribute to market-based environmental initiatives, thereby creating new revenue streams and fostering sustainable practices.

- **Implementation agencies** can benefit remarkably from our framework by gaining standardised approaches for identifying and monitoring projects. This will lead to more effective and accountable project implementation through the availability of guidelines on selecting appropriate NbS interventions based on ecological and socio-economic factors. Moreover, the framework will enable implementation agencies to communicate the wide range of benefits accrued through NbS projects, including social, economic, and health benefits, in addition to environmental advantages. This comprehensive understanding of outcomes will help drive stakeholder support and attract funding for NbS initiatives.

In conclusion, the ENSURE framework offers a comprehensive, one-stop solution for planning, implementing, and monitoring the outcomes of NbS projects. By providing detailed steps and guidelines, this framework equips decision-makers, practitioners, and communities with the tools needed to harness the potential of NbS, to create a more sustainable and resilient future, in particular, for the Global South.

1. Introduction

Over the past decade, amidst the triple crisis of climate change, biodiversity loss, and socio-political-economic upheaval, it has become necessary to identify interdisciplinary solutions. In the beginning of the 21st century, solutions that build upon the symbiotic relationship between humans and nature gained attention and were formally recognised as a key component of human development. In 2009, the International Union for Conservation of Nature (IUCN) termed these solutions as 'nature-based solutions' (NbS). However, it was only in 2022, during the fifth United Nations Environment Assembly (UNEA), that the first multilaterally agreed upon definition of NbS was proposed. The UNEA described 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 and resilience and biodiversity benefits"* (UNEP 2022c).

Rainwater harvesting systems collect and store rainfall for later use, reducing the demand for potable water, slowing runoff, and providing drought protection.

Harnessing nature for climate mitigation and adaptation serves a dual purpose: it enables the preservation and propagation of ecologically vital ecosystems and safeguards human health and well-being as well as critical infrastructure.

While there is a dearth of studies assessing the effectiveness of NbS in India, research from other regions underscores their potential. Notably, it has been found that investing in NbS could have helped prevent over USD 50 billion in damages resulting from extreme flood events over the past two decades in the Gulf Coast (Reguero et al. 2018). These investments are estimated to yield substantial returns: every USD 1 directed towards wetland and ridge restoration is expected to save USD 7 in damage prevention and mitigate more than 45 per cent of climate risks (Reguero et al. 2018). Specifically, focusing on water conservation and watershed management through NbS has been shown to reduce the impact of severe drought events significantly (United Nations World Water Assessment Programme/UN Water 2018; UNEP 2022).

The evolution of nature-based solutions

In the 1970s, the world began paying greater attention to the ecosystem services provided by nature and their role in human well-being. Following this, the need for a more systematic approach to evaluating these services was recognised (Cohen-Shacham et al. 2016). The idea of measuring the 'value of nature' first appeared in the Millennium Ecosystem Assessment (MEA) in 2005, which assessed the consequences of ecosystem change for human well-being (MEA 2005). The MEA concluded that almost 60 per cent of the assessed ecosystems had degraded over 50 years. These findings highlighted the need to consider nature an integral resource in tackling climate and economic challenges, subsequently leading to the conceptual development of NbS.

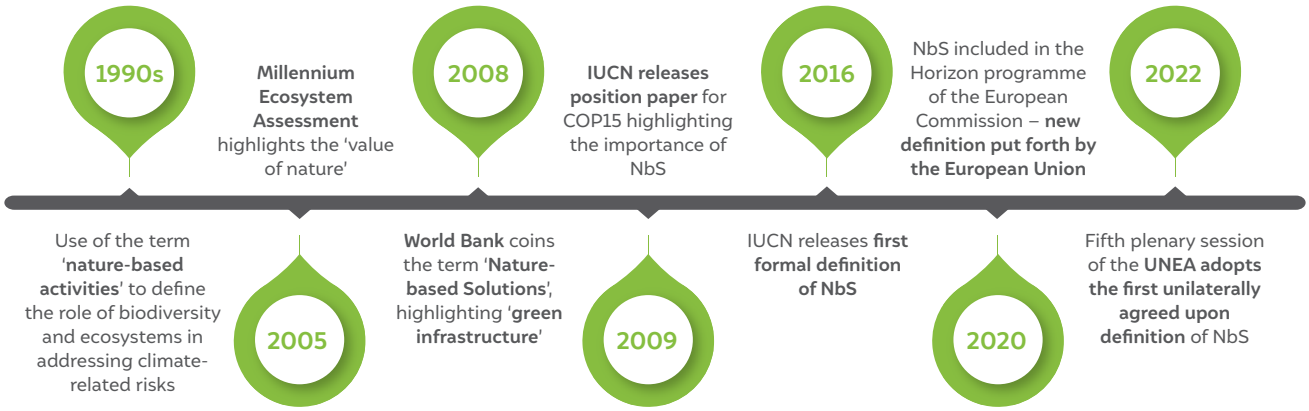
NbS as a concept was introduced by the World Bank in 2008 (MacKinnon, Sobrevila, and Hickey 2008) and the IUCN in 2009 (IUCN 2009). However, the use of such solutions has been recorded throughout history across the globe (Cassin 2021). The role of NbS was initially demonstrated in the context of climate change and biodiversity conservation. Over the years, several case studies conducted globally have showcased the multiple benefits of properly implemented NbS (Giannini 2021; Rizvi, Baig, and Verdone 2015). Figure 1 presents a timeline of the global evolution of NbS as a concept. The rapid growth of the discourse around NbS has brought multiple challenges to the fore. These challenges include the misuse of the phrase 'nature-based solutions' and the lack of data proving their effectiveness compared to alternatives such as grey infrastructure[1]. Furthermore, the lack of clarity and uncertainties associated with the concept have resulted in poor investment flows towards the domain.

While NbS are effective in mitigating climate change, enhancing biodiversity, and improving human well-being, emphasising their role in sustainable ecosystems. Significant gaps and challenges hinder the scalability of NbS, particularly in the Global South. These include limited financial resources, lack of technical expertise, insufficient policy support, and socio-economic barriers. Addressing these obstacles is crucial to fully realizing the potential of NbS and ensuring their integration into environmental strategies. The next section of the report delves into these gaps and challenges in detail, examining how they vary across different regions and identifying potential solutions to overcome them. By understanding and addressing these barriers, we can pave the way for more effective and equitable deployment of NbS, ultimately contributing to a healthier and more sustainable planet.

> **In 2022, NbS received ~USD 200 billion, falling far short of the needed USD 436 billion to meet global targets (UNEP 2023).**

1. Grey infrastructure refers to traditional, human-engineered systems and structures designed for environmental management, such as flood control, water purification, and transportation. Examples include dams, levees, wastewater treatment plants, roads, and bridges. These infrastructures rely on concrete, steel, and other artificial materials and are typically designed to control natural processes rather than work with them.

Figure 1 Timeline highlighting the evolution of NbS



Source: Authors' analysis

2. Gaps and challenges associated with NbS

NbS have been gaining traction in terms of attracting investments as well as recognition and inclusion in policies and actions (Knowledge Centre for Biodiversity 2023; White House Council on Environmental Quality, White House Office of Science and Technology Policy, and White House Domestic Climate Policy Office 2022). However, adoption of NbS across the world remains low, and there are several implementation gaps that must be addressed.

Thus far, NbS have largely been implemented in developed countries, which are equipped with the tools and data necessary for assessing their potential. These countries also have the investment sources needed to support such interventions over long periods (Seddon et al. 2020). This is reflected in the volume of global investments that flow into nature-related projects in developed regions. The 2022 *State of Finance for Nature* report by the United Nations Environment Programme (UNEP) highlights that approximately 82 per cent of investments aimed at protecting environmentally sensitive areas are directed toward projects in Europe and North America (excluding Latin America and the Caribbean) (UNEP 2022d).

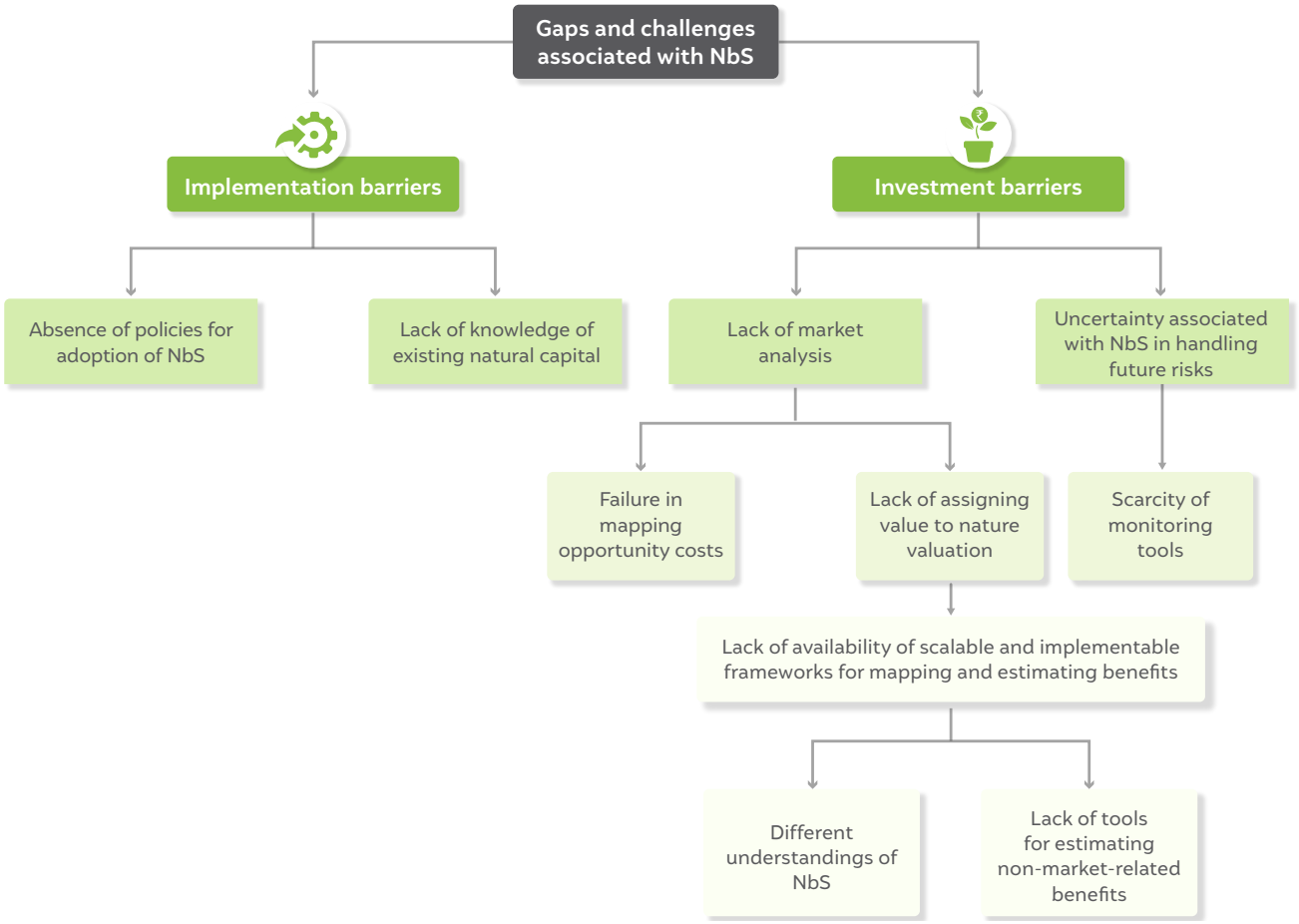
A systematic review of the literature highlights two categories of gaps and challenges associated with NbS: implementation and investment barriers. Implementation barriers are more specific to stakeholders in the Global South who typically do not possess the knowledge and tools required to implement NbS at scale. Implementation agencies and investors face investment barriers as the market value of NbS interventions has been poorly established and there are several uncertainties around the returns and benefits of such solutions. Figure 2 provides an overview of the gaps and challenges associated with NbS.

These categories of gaps and challenges are often interlinked, especially in the context of the Global South (Kabisch et al. 2016). The lack of knowledge and technological resources, and the absence of guidelines on integrating NbS into policy regimes, pose challenges for countries in providing substantial evidence on the effectiveness of NbS. In turn, this hinders their ability to attract potential investors for NbS projects. This further impacts replicability and hinders the rapid uptake of NbS across regions with similar geographies and socio-economic conditions (Viti et al. 2022; UNEP 2022).

Monitoring NbS projects also poses complex challenges. Due to the lack of a recognised framework to measure the effectiveness of NbS, the monitoring and evaluation of NbS have been based on subjective measures, thus reducing the credibility of such solutions. This has also led to cases wherein the implementation of NbS has led to maladaptation and undesired impacts due to poor knowledge of a given ecosystem and a lack of implementation guidelines (Work et al. 2019). A detailed overview of the gaps and challenges can be found in Annexure I.

To address these gaps and challenges our research aims to provide a one-stop solution in the form of a unified framework for mapping and estimating the benefits associated with NbS. Before delving into the proposed framework and its applications, it is crucial to understand the current status of NbS globally.

Figure 2 Implementation and investment barriers that hinder the mainstreaming of NbS



Source: Authors' analysis

NbS: Current global scenario

Despite the above-mentioned gaps and challenges, recent developments in the NbS landscape reveal a growing acknowledgment of their potential benefits for sustainable development. Globally, NbS are increasingly being recognised for the multitude of benefits they offer. In line with this, the United Nations has designated the 2020–30 decade as the 'decade on ecosystem restoration', aiming to promote the revitalisation of natural ecosystems such as wetlands, forest landscapes, and mangroves. Several initiatives have been taken at the global level – such as the Bonn Challenge and the African Forest Landscape Restoration Initiative – which intend to leverage NbS to solve the twin challenges of climate change and desertification.

NbS provide local benefits as well. Several countries have included NbS in their Nationally Determined Contributions (NDCs) as well as national adaptation plans (NAPs). Based on an analysis by Oxford University, more than 84 per cent of the revised NDCs included various components under the broader head of NbS (Nature-based Solutions Initiative 2022). It is necessary to address the gaps and challenges associated with NbS to build upon this momentum and scale such solutions, especially in the Global South.

3. Why we need a unified framework to map and estimate the benefits of NbS

There is an urgent need for a unified framework that can guide stakeholders in mapping and estimating the benefits of NbS. It should take inspiration from existing tools and guidelines currently deployed across the globe. Such a framework will help policymakers, conservationists, investors, and other relevant stakeholders by allowing them to draft plans and propositions more effectively to attract finances and identify the multifaceted benefits of NbS. This is especially important for countries located in the Global South, which not only lack the necessary technologies to deploy NbS successfully but also lack the finances to map and monitor the co-benefits produced by NbS.

The framework must also be flexible; it should apply to a wide variety of ecosystems while ensuring consistency across indicators. This will allow stakeholders to draw comparisons between different NbS and gather data for the future . It will also help stakeholders identify best practices, thus optimising the returns from future investment flows. Most importantly, the unified framework must contain a mechanism through which countries can track their progress vis-à-vis global targets for climate change mitigation, biodiversity preservation, sustainable development, and desertification prevention such as NDCs, NAPs, the Sustainable Development Goals (SDGs), the Kunming-Montreal Global Biodiversity Framework, and their respective national missions. In a rapidly changing world, a unified framework for NbS assessment is essential for informed decision-making and fostering a harmonious coexistence between nature and human societies.

Currently, multiple frameworks are being used across the globe to map and estimate the benefits of NbS. However, they lack comparability, and their usage is limited to a few geographies in the Global North. The latter can be explained by an insufficiency in the relevant funds, technologies, and expertise to implement these frameworks in developing countries. Most of these frameworks were developed in the European Union (EU) and lack replicability and flexibility, which makes it challenging to utilise them in other countries, especially developing and low-income countries. The existing tools and frameworks have been highlighted in Annexure II. Therefore, a framework was required for the countries of the Global South, which balances economic growth and development requirements and environmental needs.

The framework we propose in this work builds upon the existing literature, primarily the frameworks established by The Economics of Ecosystems and Biodiversity (TEEB), IUCN, and EU. These frameworks have been utilised and improved upon over the years and have greater acceptance across different agencies as compared to other tools. However, each of these frameworks faces different challenges such as:

- limited scope in identifying the wide range of benefits arising from NbS, such as benefits to public health, improvements in air quality, and contributions to the local and national economy;
- significant dependence on empirical data and statistical expertise (Ring et al. 2010);
- poor applicability in developing and low-income countries since such regions lack formal systems of data collection and analysis in addition to lack of technology, funds and expertise.

There is a pressing need for a comprehensive framework that not only helps identify relevant NbS and co-benefits but also provides a detailed list of indicators that can be used to estimate their benefits. Quantifying the benefits will in turn help in determining the investment potential of NbS. Since NbS are region-specific and are heavily influenced by local factors, the framework must be adaptable and scalable, both in terms of implementation and uptake.

Additionally, the framework must be linked with decision-making criteria, which will support stakeholders in determining the benefits of investing in NbS. With regard to cost–benefit analyses (CBA), the framework should also be able to provide methods to identify relevant ecosystem valuation methods for different benefits and highlight the steps in conducting an in-depth analysis.

Our proposed **Effective Nature-based Solutions Utilisation and Resource Evaluation (ENSURE) framework** is unique as it provides flexibility to the user by integrating local environmental factors as well as socio-economic conditions. The application of ENSURE requires minimal financial support, technical expertise, and tools. This allows stakeholders, such as communities and local non-governmental organisations (NGOs), to use the framework with ease.

4. CEEW's unified framework to map and estimate the benefits of NbS: ENSURE

ENSURE provides a 'one-stop platform' for stakeholders to designate an intervention as an NbS and to map and estimate its benefits. Further, the framework will help users identify the type of the NbS, map the factors that influence its implementation, and customise an intervention based on the targeted geography, its scale, and the stage of implementation. Additionally, ENSURE also includes a provision for conducting CBAs, which will allow stakeholders to estimate the investment potential of the NbS.

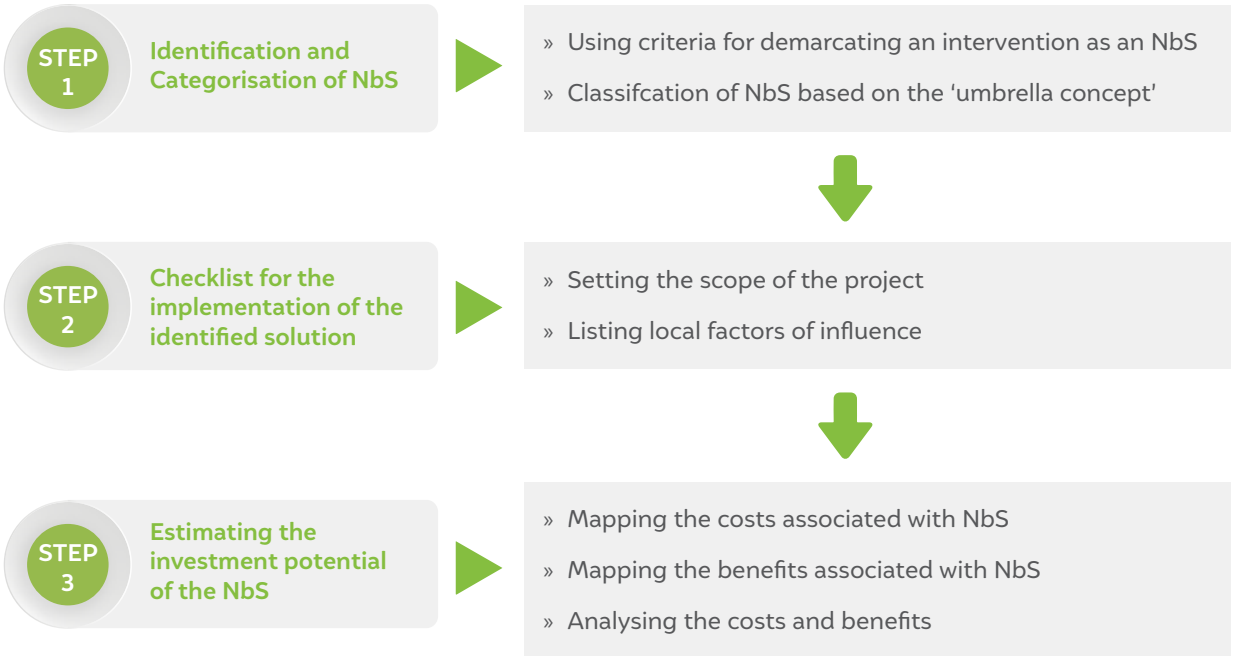
ENSURE has seven components that are essential for conducting a comprehensive economic assessment of an NbS intervention and implementing it. This section provides a step-by-step guide on the various components and their application. Figure 3 provides an overview of the framework.

4.1 Step 1: Identification and categorisation of NbS

It is essential to note that not every restoration, management, protection, and conservation activity can be deemed as an NbS. It is crucial to define the scope of the NbS in order to achieve the ideal level of development for both the communities involved and the environment. A clear understanding of which interventions qualify as an NbS is also necessary for directing finances to specific activities and preventing the harmful impacts that may arise due to misalignment with existing ecosystems and communities.

The criteria for identifying an intervention as an NbS has been explained in the IUCN Global Standard on NbS (IUCN 2020). However, the criteria must be amended to recognise the unique local contexts of countries in the Global South. In light of this, we delineate a list of tailor-made criteria that can serve as a foundation for identifying NbS interventions in developing and low-income countries in the Global South. Figure 4 below provides an overview of the steps that help identify an intervention as an NbS.

Figure 3 Structure of the ENSURE framework to map and estimate the benefits of a NbS



Source: Authors' analysis

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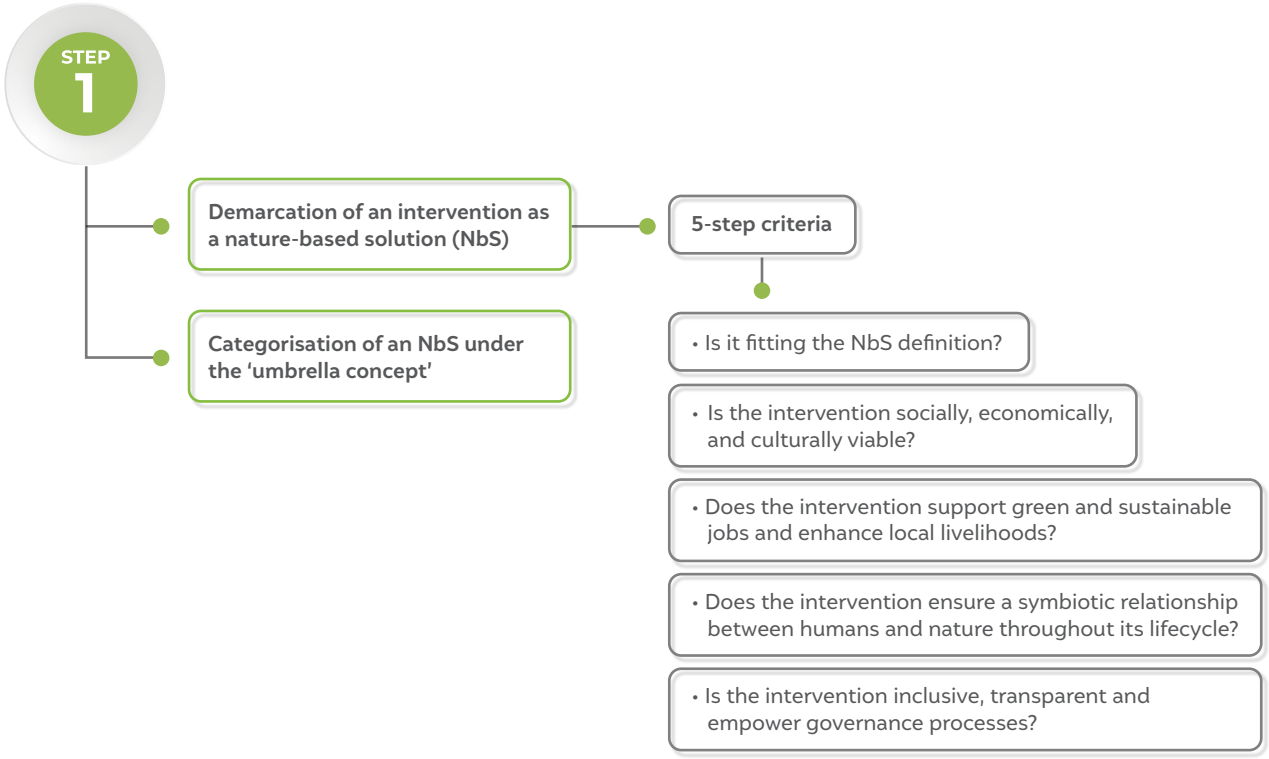
Using criteria for demarcating an intervention as an NbS

The criteria listed in Table 1 verifies that the NbS intervention is contextually relevant, is beneficial for the Global South, and also aligns with principles of sustainable development. Our framework also provides a list of indicators against each criterion to help stakeholders: identify if a particular intervention can be considered an NbS. It is critical to note that **an intervention must satisfy all the criteria to be deemed an NbS.**

Table 1 lists the indicators that will guide the user in estimating if the project meets each criterion.

Figure 4 Identifying an intervention as an NbS



Source: Authors' analysis

Seaweed farms are marine-based NbS that provide mitigation-related benefits by sequestering carbon and creating marine habitats. They also provide fishermen with income diversification.

Table 1 Criteria for selecting NbS

S.no.	Criterion	Indicator	Rationale	Guidelines
1.	**Are the activities fitting the NbS definition?** "NbS are actions to protect, conserve, restore, sustainably use and manage natural or modified terrestrial, freshwater, coastal and marine ecosystems, which address social, economic and environmental challenges effectively and adaptively, while simultaneously providing human well-being, ecosystem services and resilience and biodiversity benefits" (UNEP 2022).	The intervention undertakes one of the following types of activities: protection/ restoration/management/ sustainable use/ conservation/creation of habitats.	The intervention must perform one of the activities listed in the definition of an NbS agreed upon by the UNEA.	The implementation agency must clearly state the type of intervention based on the objectives of the project under which the NbS is being implemented. It is important to note that the intervention might be classified under multiple types, which is acceptable.
		The activity provides at least one or more ecosystem services based on the classification provided by TEEB (Kumar 2010).	As per the definition provided by the UNEA, an intervention must provide at least one ecosystem service to be classified as an NbS. TEEB has identified four different types of ecosystem services: provisioning, regulating, cultural, and supporting services.	Such ecosystem services must be validated by the members of the local community as well as members of the research community working in the region. Ecosystem services may include the protection of agricultural fields against floods, the provision of raw materials, etc.
2.	The identified intervention should ensure a symbiotic relationship between humans and nature throughout its lifecycle.	The intervention should lead to an increase in the Human Development Index (HDI) score[2] of the local area.	The HDI measures growth in terms of three key indicators: health, education, and economic factors. These factors provide a comprehensive view of the elements necessary for the development of communities and have been used across multiple levels of government to measure progress in terms of development.	Progress must be measured with respect to the indicators for each of the three factors (Sen and Anand 1994).
		The intervention should contribute to achieving targets under the Kunming-Montreal Global Biodiversity Framework.	The Kunming-Montreal Global Biodiversity Framework was adopted during the 15th Conference of Parties (COP15) in 2022 – where all the parties took the collective decision to reduce the loss of nature and biodiversity – and is a critical agreement that prioritises nature conservation and restoration.	The framework provides a list of headline indicators for each of the 23 targets, which should be used to assess the performance of the intervention (Convention on Biological Diversity 2022).

2. The authors acknowledge the criticisms on the use of HDI as an indicator for growth. However, until there is widespread use of an alternative indicator for which the data is available for most of the countries in the Global South, the HDI remains the most suitable indicator to highlight development.

S.no.	Criterion	Indicator	Rationale	Guidelines
3.	The identified intervention should be socially, economically, culturally, and ecologically viable as per the region of implementation.	The intervention is viable to implement on the basis of social, economic, cultural, and ecological factors.	It is necessary to understand the socio-economic barriers and limitations of an intervention during and after its implementation to prevent any scope of maladaptation or negative response from the community.	The implementation agency must conduct primary research to gauge the understanding of the community members and other relevant stakeholders, such as local institutes and experts, to identify the indicators for measuring the social, cultural, economic, and ecological viability of the intervention.
4.	The identified intervention should be inclusive and transparent and empower governance processes.	The intervention must adhere to the IUCN's standard guidelines for NbS as mentioned in the *Global Standards for Nature-based Solutions* (Cohen-Shacham et al. 2016).	The intervention must involve every community and must not exclude anyone due to any form of discrimination on the basis of caste, gender, religion, income group, social status, or other identity. Empowering local governance will be the most efficient method of ensuring transparency, given the scale of intervention and involvement of local communities.	The implementation agency must engage with all stakeholders and attempt to build a community-level partnership to manage the ecosystem. The agency must also clearly define the roles and responsibilities of stakeholders and try to include the local system of governance in the implementation of the intervention (Hawxwell, et al. 2019).
5.	The intervention should support green and sustainable jobs as well as enhance local livelihoods.	The intervention should lead to the development of green/ sustainable jobs[3].	NbS are usually implemented for a short period of time. However, they require constant monitoring and evaluation to assess their benefits. Hence, it is necessary to ensure community engagement by creating permanent jobs (ILO 2016). Moreover, providing jobs also incentivises communities to engage with interventions more regularly.	The provision of jobs may be a part of policies. One example is the *Mahatma Gandhi National Rural Employment Guarantee Scheme* (MGNREGS) in India, which guarantees the unskilled rural population at least 100 days of wage employment. Many activities listed as natural resource management could be re-categorised as NbS (ILO, UN Environment Programme, and International Union for Conservation of Nature 2022).
		The intervention must enhance local livelihoods by either boosting existing ones or generating alternatives.	Increasing livelihoods in the local region will boost people's motivation to support NbS, which will lead to additional benefits such as the protection of biodiversity and an increase in green space.	Local livelihoods could be enhanced by analysing the contribution of NbS-related jobs to the gross value added (GVA).

Source: Authors' compilation based on literature review

3. Green jobs help preserve or restore the environment, be it in traditional sectors, such as manufacturing and construction, or in emerging green sectors, such as renewable energy and energy efficiency (ILO 2016).

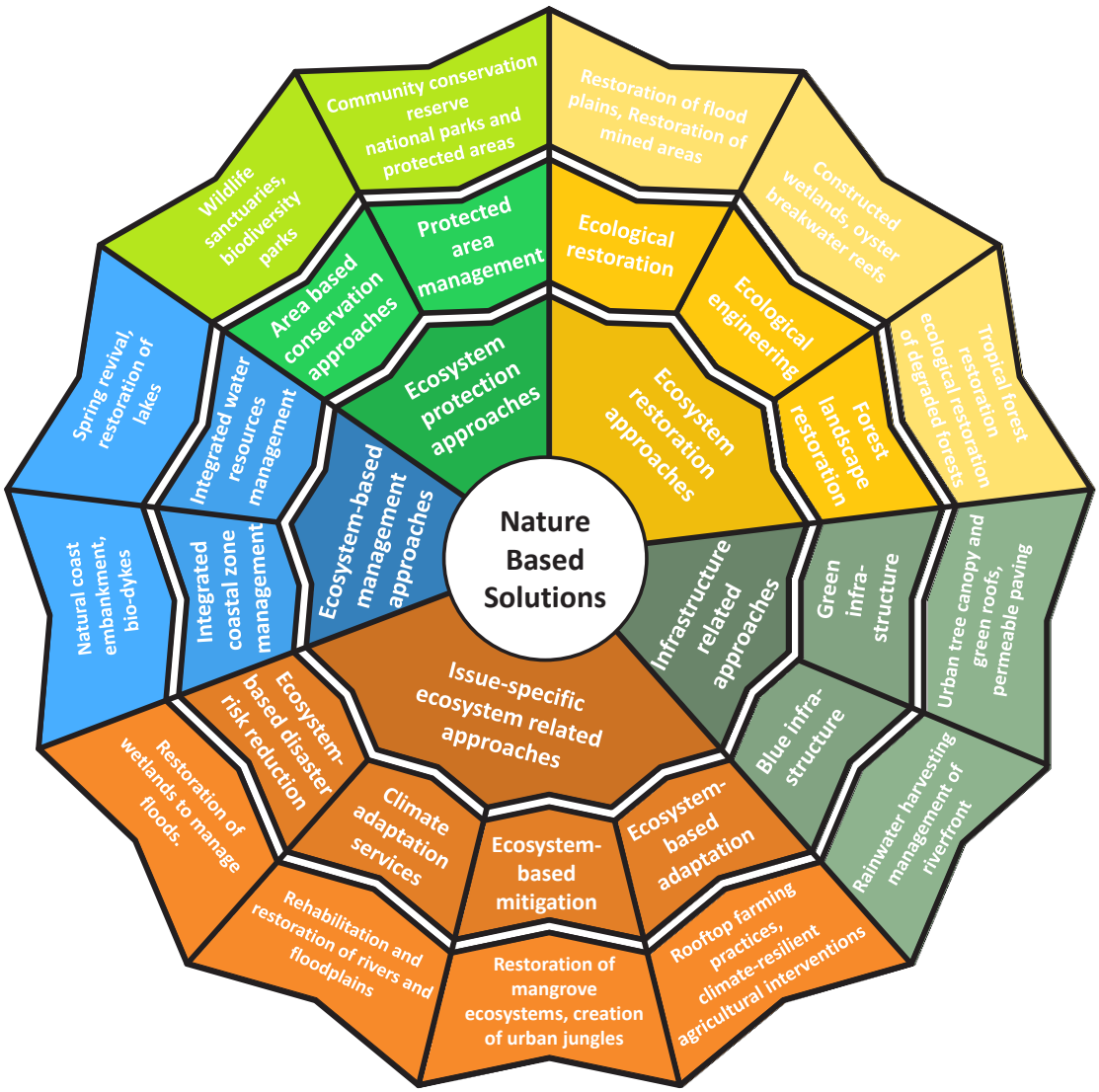
Classification of NbS based on the 'umbrella concept'

After identifying an intervention as an NbS based on the criteria mentioned in Table 1, we can proceed to identifying its various benefits. The implementation of an NbS varies based on its type. NbS is a broad concept and encompasses a wide range of closely related approaches. Thus, categorising NbS is necessary in cases where the objectives of implementing an NbS either overlap or are unclear. This process of categorisation will also help in defining and identifying a desired set of benefits, which can also lead to improved allocation of resources.

Classifying the benefits derived from an NbS is a critical step in comprehensively understanding its advantages. Our categorisation, based on the 'umbrella concept', helps implementers dissect the multifaceted benefits of NbS interventions. By grouping these benefits into categories such as adaptation- or mitigation-based, ecosystem-based, or infrastructure-based, implementers can understand how an NbS project contributes to various aspects of sustainability. This holistic view not only facilitates informed decision-making but also allows stakeholders to communicate the full spectrum of benefits to policymakers, investors, and communities, thus fostering greater support for and engagement with NbS initiatives.

Our research builds upon a thorough analysis by IUCN that categorises NbS into five groups based on solutions practised across the globe (Cohen-Shacham et al. 2016). Figure 5 provides an overview of NbS as an umbrella concept and all the approaches that fall under it.

Figure 5 NbS as an umbrella concept



Source: Authors' compilation based on Cohen-Shacham E., G. Walters, C. Janzen, and S. Maginnis. 2016. Nature-based Solutions to address global societal challenges. Gland, Switzerland: IUCN

NbS provide multifaceted benefits, influence and are influenced by several socio-economic and environmental factors. Hence, several NbS fall under multiple categories. For example, although mangrove ecosystem restoration can be categorised under 'ecological restoration', it also provides mitigation-, adaptation-, and disaster-related benefits. Therefore, it can also be identified as an '**ecosystem-based approach**'. This characteristic of NbS, where they span various categories under the umbrella concept, highlights the varied impacts of such solutions on multiple aspects (Cohen-Shacham et al. 2019). For example, the restoration of mangrove forests offers climate change mitigation, coastal protection, enhanced biodiversity, improved water quality, support for local livelihoods, and boosts in recreation and tourism. Consequently, NbS must not be understood as silos but rather as solutions that benefit multiple systems.

The definitions of all the different types of NbS have been presented in Annexure III. The needs and requirements of ecosystems vary based on the geography of the place and the socio-economic conditions prevalent there, necessitating the implementation of context-specific solutions (Ruangpan et al. 2020). Grouping all interventions under a single category with uniform outcomes and approaches hinders NbS implementation. A one-size-fits-all approach can hamper the scaling and implementation of specific NbS initiatives. Instead, NbS should be categorised based on geography, typology, and hazard profiles and should be integrated into local-level planning and policy documents to enhance regional resilience (Romnee and Herde 2015; Zhang and Chui 2018).

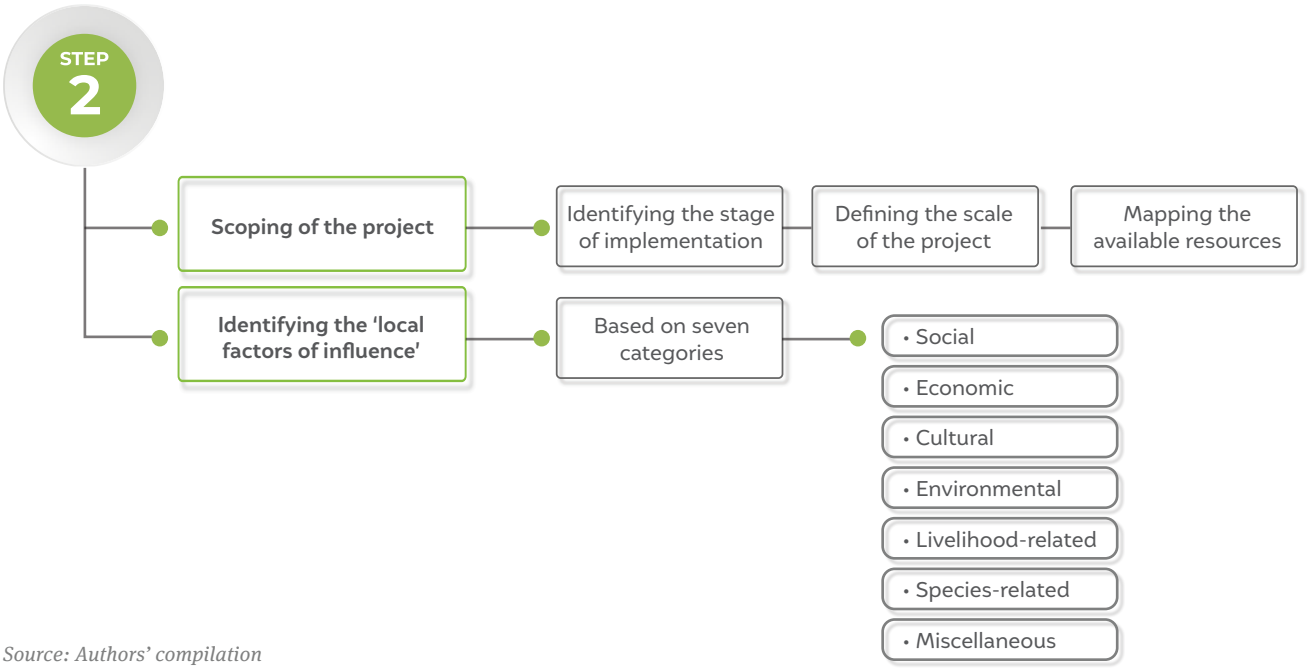
4.2 Step 2: Checklist for implementing the identified solution

This checklist aims to offer guidance to the implementing authority at every crucial step. Firstly, it helps define the stage and scope of implementation, enabling the implementation authority to create a clear roadmap for the effective execution of the project. Secondly, it aids in identifying the **local factors of influence (LFI)**, shedding light on how the intervention may either impact existing ecosystems or be affected by them. By addressing these critical aspects, this checklist can help ensure that the solution aligns seamlessly with the local environment and contributes positively to both nature and the communities it serves. Proper implementation of this step is key to averting any maladaptation or negative socio-economic results that may plague the implementation process.

Setting the scope of the project

The project's scope establishes the limitations and requirements for implementing the NbS. As stated previously, NbS are context-specific, and defining the scope of a given intervention will help the implementation agency address project-related risks. By outlining the project's requirements, the scope simplifies its enforcement.

Figure 6 Checklist for implementing an identified solution



Source: Authors' compilation

Aspects related to diversity and inclusion, such as gender and caste, must be integrated at various project phases. Acknowledging and integrating these aspects can greatly aid in efficacious project implementation.

Throughout all phases of project implementation, a gender, caste, and diversity-inclusivity lens should be employed to promote a more thorough, equitable, and sustainable approach.

The nature of NbS evolves constantly during their implementation. Thus, there are three essential considerations when it comes to scoping a project. The first crucial factor is to **identify the stage of project implementation** (Albert et al. 2020). Broadly, any project will have three stages:

i. **Pre-implementation phase**: This phase has two crucial parts, namely, initiation and planning. During this phase, the stakeholder plans the implementation of the project and gathers resources such as finances, technologies, and human resources. The project's objectives are identified and various milestones are developed to track progress. Activities such as feasibility studies and community engagement to gauge the effectiveness of different solutions are also conducted. This stage also includes activities such as estimating capital and operational costs, identifying team-specific tasks, and developing timeframes for internal checks and management, which is also known as "scope management" (Barron and Barron 2020).

ii. **Implementation phase**: During the implementation phase, the project begins its operations. The stakeholder establishes monitoring systems to track progress and future resource requirements. This phase might require making adjustments to the plans finalised in the ideation stage . In this stage, progress is monitored continuously and appropriate adjustments are made and recorded. The stakeholder conducts activities such as site and landscape preparation that involve making changes in the ecosystem, which can affect the local biodiversity of the region, human–ecological dynamics, and the overall functioning of the existing natural ecosystem. During this phase, most of the resources are mobilised and engagement with relevant stakeholders, such as local government authorities, community members, and implementation agencies, takes place.

iii. **Post-implementation phase**: This phase marks the completion of the intervention. The benefits associated with the intervention or, in some cases, maladaptation – for instance, increasing the tree cover around a creek and making it too crowded for the fisher population to access the creek, thereby leading to a loss in livelihoods – are observed during this phase. This phase also involves monitoring the intervention to establish a feedback loop to examine what went well and what did not.

The optimal approach for planning and executing NbS is to deploy the proposed framework during the initial phase, specifically, the pre-implementation phase. Our framework is tailored to assist implementation agencies in the early stages or ideation phase of the intervention. Projects that have already initiated landscape changes may encounter challenges in fully implementing certain aspects of the framework. Nevertheless, depending on the available resources and time constraints, some components may still be partially applicable.

NbS can be scaled across multiple ecosystems and terrains. Hence, the second important component is the **scale of the intervention**, which may range from a small-scale project – such as green walls, rain gardens, and permeable pavements – to large-scale projects – such as establishing mangrove plantations to protect agricultural fields from saline water intrusion or creating protection dikes and walls to make coastal regions resilient against floods.[4] The scale of implementation will depend on the objectives set by the relevant stakeholders. The scale is largely determined by two attributes: the cost (budget) and duration (schedule) of the project. However, it must always be in accordance with the requirements of the community and align with the ecological balance of the region.

> **NbS can reduce the intensity of climate change and weather hazards by at least 26% (IFRC and WWF 2022).**

4. Small-scale projects usually have a limited scope and can be completed within a shorter time frame. They typically involve a few specific tasks or objectives that can be accomplished with comparatively fewer resources. On the other hand, large-scale projects have broader scope and complexity, often requiring multiple phases or stages. These projects are also highly resource intensive.

The third factor to be estimated for the accurate scoping of a project is the **available resources** at any given stage of implementation. A wide variety of resources are required for any intervention. However, for this framework, we have identified resources that will be required for most projects. All interventions require resources such as funds, human resources, technical expertise, and expert elicitation. It is important to note that the resource requirements will vary according to the intervention (Grace et al. 2021; Alves et al. 2022). For example, a small project may not require technical expertise or a significant amount of human labour. However, in many cases, the implementation of interventions may be stalled due to the lack of resources. The availability of resources may be categorised as follows:

i. **Insufficient resource availability**: There is a lack of funds for additional activities, or the available funds are minimal, leading to limited implementation of interventions . Human resource shortages are significant and pose challenges both for intervention administration and implementation. Organisations may also lack the necessary technical and community engagement expertise to implement the project.

ii. **Adequate resource availability**: Current operations can be conducted smoothly, but there is no room for future expansion of the intervention. The project is constrained from adopting new technologies and methods to enhance outcomes. For instance, in a flood-affected area, the project might not be able to conduct predictive risk assessments to assess an intervention's applicability in future scenarios.

iii. **High resource availability**: This implies a surplus of resources. Here, the project has access to additional funds and expertise if needed. Moreover, there is potential to improve methodologies, employ better techniques, and demonstrate the benefits of an NbS more thoroughly.

Before utilising the remainder of the framework, users must determine the current stage of the project. Regardless of the implementation stage and resource availability, delineating and classifying the intervention is crucial. This is necessary not only for ongoing projects but also for those already implemented, as it helps in identifying whether the intervention qualifies as an NbS for potential future applications. Additionally, this process helps identify any gaps left unfilled by previous interventions.

Listing local factors of influence

NbS may provide different ecosystem services based on factors such as the geography of the region, the scale of implementation, the type of stakeholders involved, etc. Such factors, which influence the implementation and quality of NbS, are defined as 'local factors of influence' (LFI). It is important to note that the word 'local' here does not signify the level of influence but rather the context in which the NbS is being implemented. For example, large-scale reforestation might provide multiple benefits, such as an increase in livelihoods and enhanced carbon sequestration. In contrast, small-scale projects will have limited benefits due to the limited scale of their implementation and the involvement of only a few stakeholders.

It is important to identify the LFI while implementing an NbS because such solutions are inherently intertwined with multiple components present in a natural environment. These components may affect the implementation of the NbS or may be affected by the NbS itself. The relationship between LFI and the NbS must be monitored periodically to identify the co-benefits of the solution as well as prevent any unintended consequences. We have categorised the LFI into seven groups : social, economic, cultural, environmental, livelihood-related, species-related, and miscellaneous. Table 2 highlights these groups and mentions a few examples of LFI that may affect the implementation of an NbS.

LFI can be mapped through primary research methodologies such as surveys and participant observation. Identifying such LFI will also allow stakeholders to identify causal relationships between such factors and the production of ecosystem services. It is also important to identify the type of influence that a given local factor will have on the NbS and vice-versa. This will help the implementation agency develop the objectives of the project, set the scope, and monitor its progress.

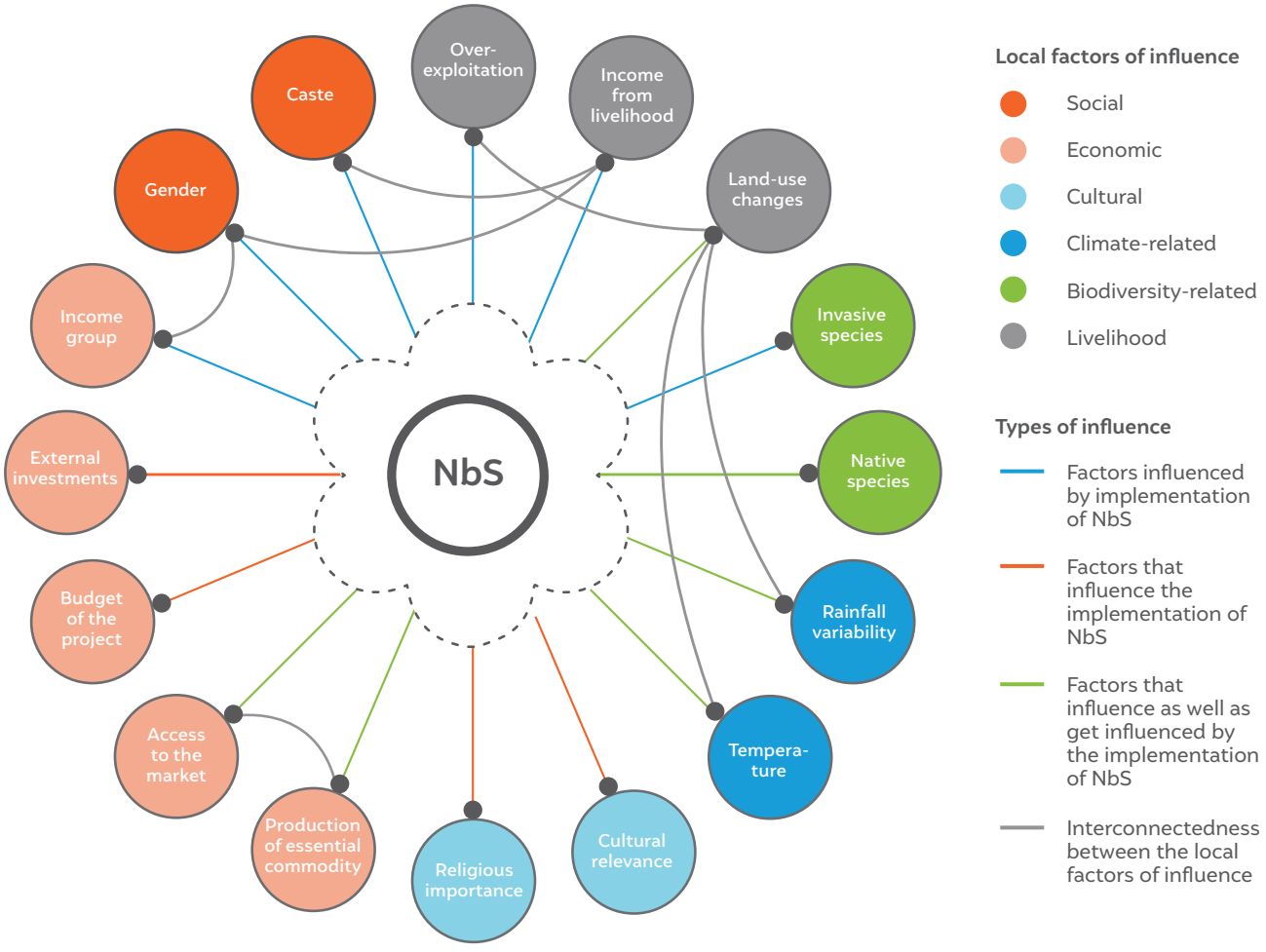
The LFI may also interact with each other to further influence the implementation of NbS. For example, suppose a certain intervention employs women to boost their participation in the decision-making process. In that case, income groups within the region might also witness a shift, as women may be encouraged to form self-help groups (SHGs) after experiencing an increase in income because of the NbS. Figure 7 highlights some key LFI and their relationship with NbS and each other, as identified in the literature.

Table 2 Categories of local factors of influence

S.no.	Category	Local factors of influence
1.	**Social**	Gender (Jongman et al. 2023), caste, race (Gosalvez 2020), other social groups (Haase 2017), etc.
2.	**Economic**	Income group (Lechner et al. 2020); budget of the project; external investments (European Investment Bank 2023); production of an essential commodity (Kumar 2010); access to market (Melanidis, Stavroula, and Hagerman 2022), etc.
3.	**Cultural**	Religious (UNEP 2021) or cultural relevance of the ecosystem/species (Rocha, Almassy, and Pinter 2017), etc.
4.	**Environmental**	Existing ecosystem, temperature, and rainfall variability (Kumar 2010), etc.
5.	**Livelihood-related**	Land-use changes for agriculture/fisheries/construction, etc (Keesstra et al. 2018); overexploitation (Martín et al. 2021); alternate livelihood options (Mangrove Cell of Maharashtra 2020), etc.
6.	**Species-related**	Existing flora and fauna of the region, introduction of invasive species (Casey 2021), etc.
7.	**Miscellaneous**	Regional power dynamics, socio-political scenario of the region, etc.

Source: Authors' analysis

Figure 7 Some key LFI and their relationship with NbS and each other



Source: Authors' analysis

4.3 Step 3: Estimating the investment potential of the NbS

Understanding the investment potential of NbS is pivotal for decision-makers and stakeholders navigating the realms of sustainable development. Estimating this potential involves employing a meticulous CBA methodology, a process that is essential for comprehending both the financial commitments and the myriad benefits associated with NbS interventions. By quantifying the costs and benefits, decision-makers gain a holistic view that transcends explicit monetary considerations, enabling them to assess the true value of investing in NbS. This approach not only ensures fiscal prudence but also sheds light on the broader socio-economic and environmental advantages that can be catalysed through strategic investments in such solutions.

Mapping the benefits associated with NbS

NbS provide a plethora of benefits that address different human and ecological needs. The MEA conducted in 2005 provided a first-of-its-kind list of ecosystem services derived from nature. The most prominent services identified across the globe included the provision of raw materials and necessary resources such as food, freshwater, and fuel along with nature's ability to regulate climate, reduce the impact of disasters, and provide a habitat for flora and fauna. Over the years, as the discourse around NbS has matured, several more benefits of NbS have been identified and quantified that has been captured in table 3 below.

Consequently, over the years, global organisations have consistently recognised NbS as essential for meeting targets outlined in international agreements aimed at enhancing global responses to climate change, safeguarding and conserving biodiversity, mitigating land degradation, and advancing sustainable development. The Intergovernmental Panel on Climate Change (IPCC), in its *Sixth Assessment Report*, identified the potential of NbS in responding to both mitigation- as well as adaptation-related needs (Schipper et al. 2022). NbS have also been recognised as a crucial component for achieving all four priorities set under the Sendai Framework for Disaster Risk Reduction (UNDRR 2023). The United Nations has also highlighted the role of NbS in achieving the targets set under SDGs (Steiner 2018). It has also underscored the importance of NbS along with their multiple benefits in *The New Urban Agenda Illustrated Handbook* published by UN Habitat (2020).

Table 3 Different types of benefits obtained from NbS in the local region

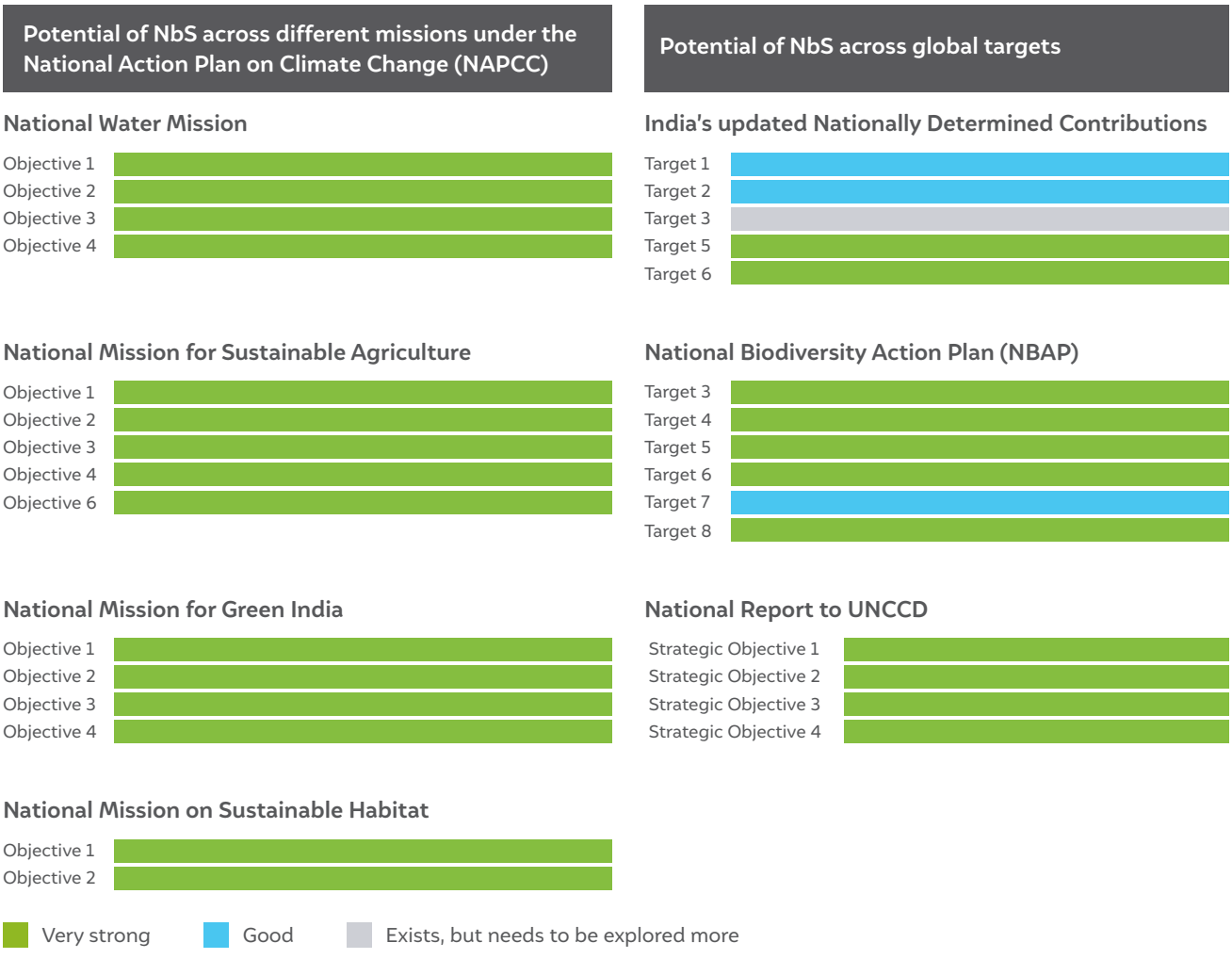
S.no.	Type of benefit	Potential of NbS
1.	**Disaster resilience**	Over the past two decades, nature-based adaptation options could avert more than USD 50 billion in flood-related loss and damage (Reguero et al. 2018)
2.	**Business value**	Nature-positive transitions could generate business opportunities worth USD 10.1 trillion globally by 2030 (WEF 2020)
3.	**Jobs and livelihood**	An estimated 75 million people are currently working with NbS globally (ILO, UN Environment Programme, and International Union for Conservation of Nature 2022); mainstreaming NbS into national policies could create 395 million jobs by 2030 (WEF 2020)
4.	**Economic value/ contribution to gross domestic product (GDP)**	Scaling NbS could contribute significantly to economic growth. Currently, nature markets produce USD 7.3 trillion worth of goods and services – equivalent to 8.6% of the global GDP – which could be scaled manifold (Taskforce on Nature Markets 2022)
5.	**Biodiversity**	NbS could lead to the conservation of species, improve functional diversity, and improve ecosystem health. NbS could also increase the area covered by flora and fauna, thereby increasing the geographical distribution of biodiversity significantly
6.	**Health**	NbS have the potential to address health-related challenges such as risks arising due to excessive heat, poor air quality, and medical conditions such as hypertension. NbS have also been observed to improve both physical and mental health (Knapp and Wong 2020; Boadu 2018). NbS such as sustainable agriculture could also increase access to nutrition and food security (Fattore et al. 2021)

Source: Authors' compilation based on literature review

The Government of India has not yet formally accepted the term 'nature-based solutions' as the benefits of such interventions, which contribute to both adaptation- and mitigation-related objectives, are yet to be clearly defined. Currently, the Indian government has been using the term 'ecosystem-based approaches', which is a category of NbS under the umbrella concept (see Section 4.1). The 'ecosystem-based approaches' term was used in the strategies adopted by the G20 Disaster Risk Reduction Working Group to reduce the risk of disasters (G20 UNDRR 2023).

However, the government has acknowledged the significance of nature-positive activities in its NDCs and the *National Action Plan on Climate Change* (NAPCC). Nature-positive actions, especially indigenous solutions, have been given importance under *Mission LIFE*, which focuses on bringing about behavioural changes in individuals to combat climate change. The *Green Credit Rules*, 2023, launched by the Ministry of Environment, Forest and Climate Change (MoEFCC) mention seven activities under the ambit of NbS to incentivise voluntary environmental actions by individuals, communities, private-sector industries, and companies. The government has also launched intervention-specific schemes such as the *Mangrove Initiative for Shoreline Habitats & Tangible Incomes* (MISHTI) and *Amrit Darohar* to promote the conservation of mangroves and wetlands, respectively. There are several other programmes and schemes in India that consider NbS a crucial part of implementation for building community level resilience at a local scale. Figure 8 illustrates how NbS can play a pivotal role in helping India attain global and domestic targets.

Figure 8 NbS have the potential to help India achieve both global and local targets

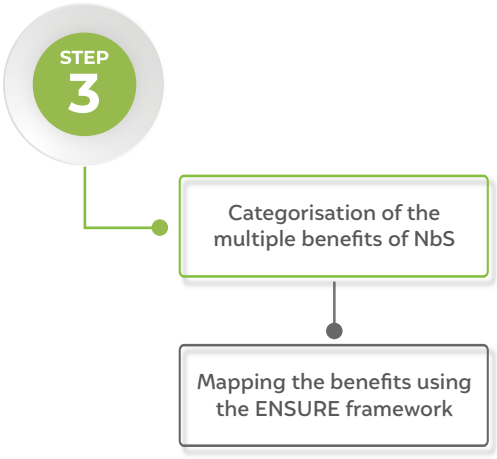


Source: Authors' analysis

Note: Each bar represents a different goal/objective/target under the global and local missions. The colours represent the potential of NbS to help achieve these goals, objectives and targets. Please refer to Annexure IV for the key to this figure.

By leveraging ecosystems and their services judiciously, NbS offer a means to increase the resilience and adaptive capacity of communities as well as ecosystems. The Government of India could further enhance the effectiveness of existing and new policies by identifying the co-benefits associated with NbS. Identifying the vast benefits of such interventions will also help the government formulate targeted policies and allocate funding appropriately.

Figure 9 Mapping the benefits associated with NbS

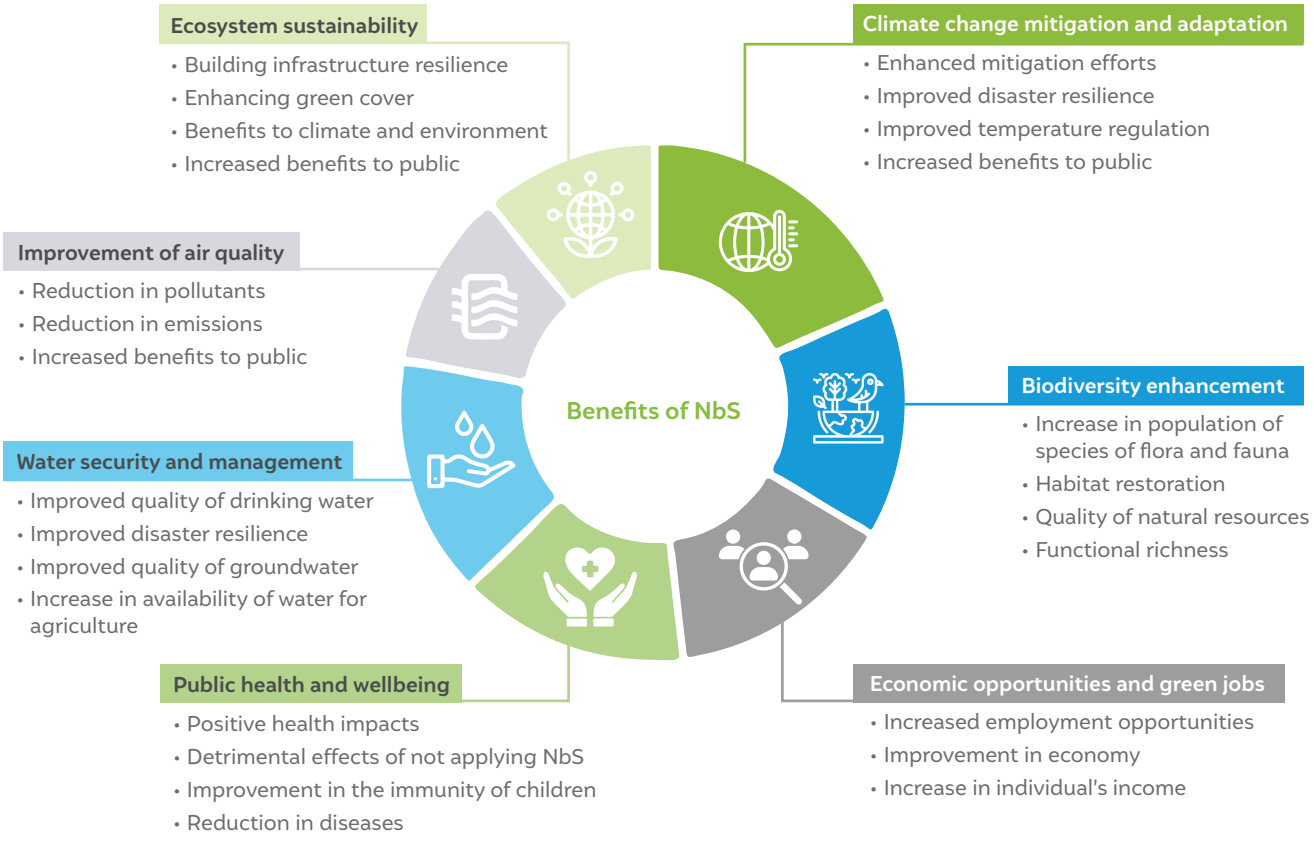


Source: Authors' analysis

It is imperative to accurately identify and map the benefits of each NbS intervention. To address this necessity, Step 3 of our framework categorises NbS benefits into seven broad groups, in line with the IUCN Global Standards. Each category represents a larger global societal challenge that can individually contribute to socio-economic hardships for people, nature, and economies. Additionally, these categories may interact, compounding existing vulnerabilities. This systematic categorisation aids in comprehending and addressing the multifaceted impact of NbS interventions across diverse dimensions. Figure 10 illustrates the seven identified categories.

Multiple benefits are listed under each category. The benefits can be identified through a) primary research methods such as surveys and personal interviews, and b) secondary research methods using data such as satellite imagery, analysis of data collected through monitoring stations, and literature available on similar interventions in different regions. The selection of benefits is a crucial step in this framework, as it allows external stakeholders to identify the scope of the intervention, thus reducing the complexity of NbS implementation.

Figure 10 Benefits of NbS



Source: Authors' analysis

However, it is important to note that several benefits tend to overlap. Moreover, during the implementation of a project, several co-benefits that do not fall under the ambit of the primary objectives might also be identified. Such co-benefits must be identified early in the project to accurately identify the value of its outcome, as this will help reduce uncertainty and assist in accurately measuring the benefits, which will help support decision-making for investors and stakeholders alike.

Therefore, our framework goes beyond categorisation and offers a non-exhaustive list of indicators under each identified category. These indicators serve as valuable tools for estimating the benefits of individual interventions. By providing a comprehensive set of indicators, ENSURE facilitates a nuanced assessment of the diverse impacts of NbS interventions.

The indicators are unique to each benefit and are measured in standardised units. Indicators are usually designed to monitor the achievement of a certain benefit. The benefits arising from NbS can only be estimated if the indicators can be quantified using a statistical method or an ecosystem valuation method. Several organisations, such as the Convention on Biological Diversity (CBD) (CBD 2020) and UNEP (MEPA 2009), have established frameworks to estimate select relevant indicators that represent various elements in an ecosystem. In this section, we highlight the fragmentation of categories into benefits, the indicators specific to each category, and whether an indicator is quantifiable or not.

We build on the impact evaluation framework presented by Wadhawan and Bajpai (2023), which proposes a list of benefits and indicators based on socio-economic and environmental factors and the technical capacity of stakeholders in the Global South. We have updated the list of benefits and indicators based on an additional literature review and stakeholder consultations. Table 4 presents a sample view of the framework, designed to showcase the larger set of benefits and indicators associated with multiple NbS and not specific to a singular intervention. The table has been created using the EU-designed *Evaluating the Impact of Nature-based Solutions* (European Commission 2021), which builds on *An Impact Evaluation Framework to Support Planning and Evaluation of Nature-based Solutions Projects*, published under the EKLIPSE project of the EU (Raymond et al. 2017).

It must be noted that NbS are context-specific. Hence, the benefits that accrue from an intervention may not include all the categories of benefits mentioned in Table 4. This is a non-exhaustive list of benefits, and some interventions may experience benefits unique to the geography or socio-economic context of the region, which are not mentioned here. However, the list mentioned below may be utilised by implementation agencies for projects currently in any of the implementation phases.

41% of all revised NDCs (50 countries) explicitly used the term 'Nature-based Solutions' in their communications.

Planting mangroves in coastal areas can reduce the impact of storms on human lives and economic assets, while providing a habitat for many species of birds and fishes.

Table 4 Category-specific list of benefits and indicators for mapping benefits

Category	Benefit	Potential of NbS
Climate change mitigation and adaptation	Enhanced mitigation efforts	• Total carbon removed or stored in vegetation and soil (Davies et al. 2011; Demuzere et al. 2014; Baro et al. 2014) • Soil carbon content (Keenor et al. 2021) • Surface area of restored/created wetlands (Ramachandra, Rajinikanth, and Rajini 2004)
	Improved disaster resilience (against hydrometeorological and climatological disasters)	• Mean annual direct and indirect losses due to natural and climate hazards (Badola and Hussain 2005; Mulakkuveettil and Devi 2015) • Agricultural and industrial buildings potentially exposed to risks (Raymond et al. 2017) • Transportation infrastructure and lifelines are vulnerable to risks (Raymond et al. 2017) • Flood hazards (Brouwer et al. 2009; Hu et al. 2021)
	Improved temperature regulation	• Decrease in mean or peak daytime local temperatures (Lee, Villaruel, and Gaspar 2016) • Monthly mean maximum and minimum temperatures (Burke, Hsiang, and Miguel 2015) • Urban heat islands (Miner et al. 2016; Johnson et al. 2020)
	Increased benefits to the public	• Energy and carbon savings (Jin and Kim 2019) • Number of students benefiting from education and research about coastal resilience/amenity (Piwowarczyk, Kronenberg, and Dereniowska 2013; Shuster and Doerr 2015)
Water security and management	Improved quality of drinking water	• Metal concentration or load (He et al. 2014) • Water quality: Total faecal coliform bacteria content of NbS effluents (Raymond et al. 2017) • Calculated drinking water provision (Hutton 2012; UN 2021)
	Improved disaster resilience	• Rate of evapotranspiration (Raymond et al. 2017) • Flood excess volume (Brouwer et al. 2009; Hu et al. 2021) • Flood peak reduction (Brouwer et al. 2009; Hu et al. 2021)
	Improved quality of groundwater	• Chemical status of groundwater (UN 2021) • Quantitative status of groundwater (Feyen and Gorelick 2004) • Aquifer surface ratio with excessive metallic content (arsenic, nitrate, lead, etc.) (Raymond et al. 2017)
	Increase in availability of water for agriculture	• Water dependency for food production (D'Odorico et al. 2020) • Rainwater or greywater is used for irrigation purposes (Al-Karablieh et al. 2012)
Ecosystem sustainability	Building infrastructure resilience	• Effective green infrastructure at the urban-rural interface (Young, Jones, and Symons 2015) • Percentage of green infrastructure integrated into existing structures (Green-Gray Community of Practice 2020) • Frequency of use of green and blue spaces (Kabisch and Haase 2014)
	Enhancing green cover	• Distribution of public green space, total surface or per capita (Dumenu 2013) • Total vegetation cover (Cohen et al. 2012) • Annual trend in vegetation cover in urban green infrastructure (Krasny et al. 2013) • Green space accessibility (Tamosiunas et al. 2014)

economic/quantifiable non-economic/non-quantifiable

Category	Benefit	Potential of NbS
	Benefits to climate and environment	• Soil organic matter content (Keenor et al. 2021) • Tree biomass stock change (Ramachandra, Rajinikanth, and Rajini 2004) • Land-use change and green space configuration (Hertel 2018) • Percentage of waste averted from going into landfills (European Commission 2000; Waste Economics Team, DEFRA 2011)
	Increased benefits to the public	• Recreational opportunities provided by green infrastructure (Kabisch and Haase 2014) • Food production in urban allotments and NbS (Grafius et al. 2020) • Sustainable transportation modes allowed (Badassa, Sun, and Qiao 2020)
		• Community garden areas (Kabisch and Haase 2014)
Biodiversity enhancement	Increase in population of species of flora and fauna	• Number of native species (Bell 1997; Yepsen, Moody, and Schuster 2016; Diagne et al. 2021; Lewis et al. 2022) • Number of invasive alien species (Casey 2021) • Number of conservation priority species (Key et al. 2022)
		• Species richness (Key et al. 2022; Mori et al. 2021)
	Habitat restoration	• Proportion of protected areas (Task Force on Economic Benefits of Protected Areas of the World Commission on Protected Areas (WCPA) of IUCN 1998) • Percentage of contaminated area reclaimed (Goddard, Dougill, and Benton 2010)
		• Habitat connectivity (Préau et al. 2022; Key et al. 2022)
	Enhanced quality of natural resources	• Soil and water quality within habitats (He et al. 2014) • Food web stability (European Commission 2021) • Quantity of blue-green space (Kabisch and Haase 2014) • Ecosystem disservices (increase in the number of mosquitoes and plants emitting allergic pollen) (European Commission 2021)
	Functional richness	• Diversity of functional groups (European Commission 2021) • Pollinator species presence (Gallai et al. 2016; Hanley et al. 2014)
Improvement of air quality	Reduction in pollutants	• Total particulate matter removed by NbS vegetation (Baro et al. 2014; Bealey et al. 2007; Bottalico et al. 2016; Roome 2022) • Trends in emissions of nitrogen oxides (NOx) and sulphur oxides (SOx) (Raymond et al. 2017) • Concentration of particulate matter and other gases in ambient air (Grote et al. 2017; Tallis et al. 2011; Dechezleprêtre, Rivers, and Stadler 2020)
	Reduction in emission	• Total carbon removed or stored in vegetation and soil (Davies et al. 2011; Demuzere et al. 2014; Baro et al. 2014)
	Increased benefits to the public	• Premature deaths and hospital admissions averted per year (Tiwary et al. 2009) • Mortality due to poor air quality (WHO n.d.) • Avoided costs for air pollution control measures (Manes et al. 2016) • Reduction in the number of people with respiratory diseases (Raymond et al. 2017)
Public health and well-being	Positive health impacts	• Self-reported mental health and well-being (Roe et al. 2013; Knapp and Wong 2020; Layard 2016) • General well-being and happiness (Boadu 2018) • Improvement in the nutritional content of products obtained from NbS measures (Fattore et al. 2021)

economic/quantifiable non-economic/non-quantifiable

Category	Benefit	Potential of NbS
	Detrimental effects of not applying NbS	• Mortality due to poor air quality (WHO n.d.) • Exposure to noise pollution (Swinburn, Hammer, and Neitzel 2015) • Hospital admissions due to high temperatures during extreme heat events (Garcia-Leon et al. 2021) • Level of chronic stress (Roe et al. 2013; Knapp and Wong 2020; Layard 2016)
	Improvement in the immunity of children	• Cognitive and social development in children (Amoly et al. 2014; Grosse and Zhou 2021)
		• Exploratory behaviour in children (Amoly et al. 2014) • Reduced percentage of obese people and children (Tremmel et al. 2017)
	Reduction in diseases	• Infant mortality rate (Raymond et al. 2017) • Reduction in the number of people with respiratory diseases (WHO n.d.) • Reduced number of cardiovascular morbidity and mortality events (Tamosiunas et al. 2014)
Economic opportunities and green jobs	Increased employment opportunities	• Number of new jobs created (Saraev 2012) • Number of new jobs created related to NbS construction and maintenance (Rizvi, Baig, and Verdone 2015) • New businesses attracted and additional business rates (Eftec 2013) • Net additional jobs in the green sector enabled by NBS projects (Saraev 2012; Tyler et al. 2013)
	Improvement in economy	• Mean land and/or property value in proximity to green spaces (Eftec 2013) • Retail and commercial activity in proximity to green spaces (Raymond et al. 2017) • GVA to local economy from new business creation (Rizvi, Baig, and Verdone 2015) • GVA to the local economy from the availability of raw materials (Moser and Feiel 2019) • Private finance attracted towards the NbS site/private investment in the bio-economy (Raymond et al. 2017)
	Increase in individual's income	• Average land productivity and profitability (Rizvi, Baig, and Verdone 2015) • Increase in income (Rizvi, Baig, and Verdone 2015) • Individual earnings uplift arising from skills enhancement in the design and implementation of NBS (Falxa-Raymond, Svednsen, and Campbell 2013) • GVA per employee based on full-time equivalent jobs in the green sector (Tyler et al. 2013)

economic/quantifiable non-economic/non-quantifiable

Source: Authors' compilation based on Wadhawan and Bajpai (2023) - Pathways to Unlock the Potential of Nature-based Solutions in Climate and Disaster Resilient Infrastructures: Contributing Paper to Global Infrastructure Resilience: Capturing the Resilience Dividend.

Mapping the costs associated with NbS

Mapping the costs associated with an NbS project is a fundamental step in laying the groundwork for its successful implementation. This process, which broadly encompasses four aspects – capital expenditure, operational expenditure, transactional costs, and costs due to disservices – is essential for establishing the scale and scope of the project. By estimating these costs, implementing agencies can not only gain a comprehensive understanding of the financial commitments involved in an NbS but also lay the foundation for realistic project expectations. Quantifying costs and, consequently, return expectations also allows investors to compare NbS with those projects that already have empirical records. Without such quantification, investors will lean towards projects that have a track record of being successful and already attract substantial amounts of investments . This proactive approach allows stakeholders to navigate the intricacies of budgeting and resource allocation effectively, ensuring that the project aligns with its intended goals. Additionally, a thorough cost-mapping exercise enables decision-makers to anticipate potential challenges and optimise the benefits derived from NbS interventions, fostering a strategic and sustainable approach to environmental conservation and resource management. Figure 11 highlights the categories recognised for conducting a cost estimation. A detailed breakdown of the cost calculation categories and methods has been provided in Annexure V.

Applying the framework to conduct the economic valuation of NbS

CBA, or the process of comparing the costs and benefits of an intervention, has been identified as a highly useful tool for decision-making (Arrow et al. 1996). It allows stakeholders to choose between the alternatives available for a particular project. This process also assists governments in allocating budgets and resources, thus improving the efficiency of public spending.

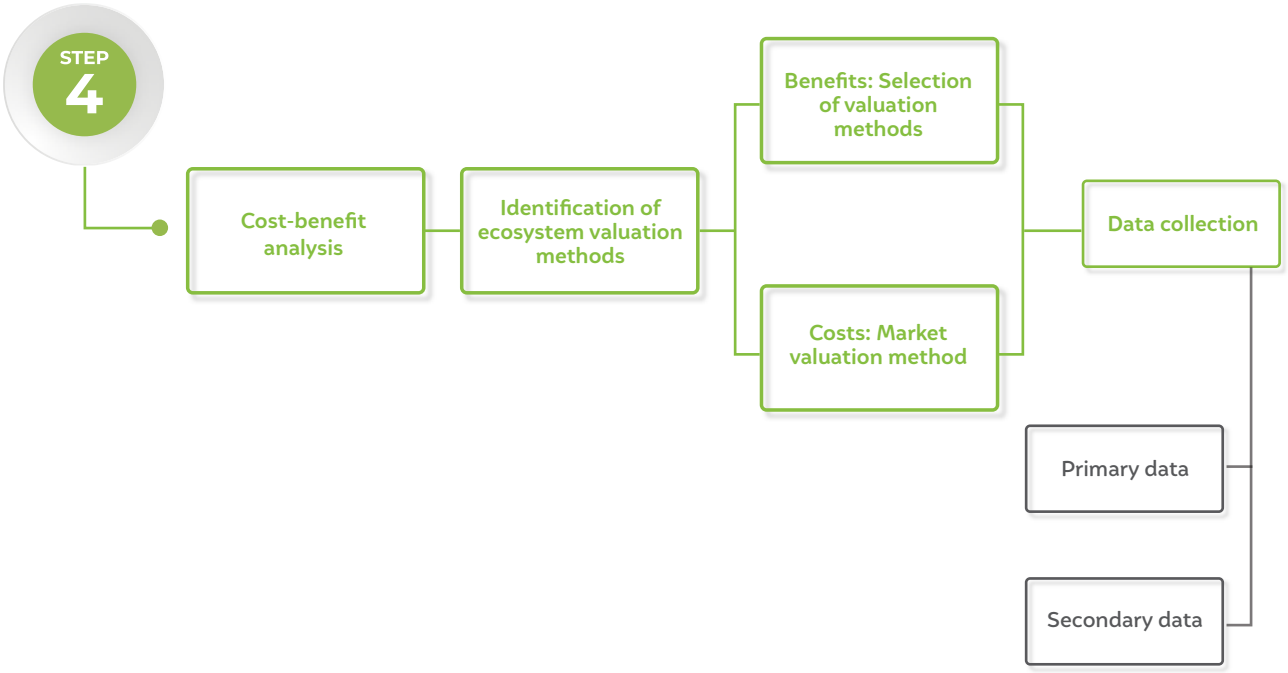
CBA has been used to differentiate between multiple ecosystem services since the late 20th century (Costanza et al. 1996). Following the publication of the MEA in 2005, there was a much-required push in the scientific and research community to conduct more CBA assessments. Since its release, this method has invited criticism since such an assessment does not consider the non-monetary costs of an ecosystem service or product (Wegner and Pascual 2011). Over the years, several new methods have been developed as an alternative to the CBA. Nevertheless, this method continues to be widely used in decision-making processes regarding ecosystem services and goods. Figure 12 presents an overview of the stepwise approach for applying the framework to conduct the economic valuation of NbS.

Figure 11 Estimating costs before investing in an NbS

Capital expenditure	Operational expenditure	Transactional costs	Costs due to disservices
Design and planning	Monitoring and technology	Community engagement	Negative impacts: Pests
Land management	Ecosystem maintenance	Scoping and technical costs	Negative impacts: Opportunity costs
Site preparation	Land protection		
Project-related permits	Human resources		

Source: Authors' compilation based on Van Zanten, Boris Ton, Gonzalo Gutierrez Goizueta, Luke Mckinnon Brander,Borja Requero Gonzalez, Robert Griffin, Kavota Kapur Macleod, Alida Ivana Alves Beloqui, Amelia Midgley, Luis Diego Garcia Herrera and Brenden Jongman. 2023. Assessing the Benefits and Costs of Nature-Based Solutions for Climate Resilience: A Guideline for Project Developers. World Bank.

Figure 12 Conducting a cost–benefit analysis using the proposed framework



Source: Authors' analysis

It is crucial to update national and global databases with consistent economic evaluations, as it will enable us to track progress, identify the most feasible and scalable solutions, and quantify advancements towards the SDGs. Our common measurement system not only quantifies progress but also facilitates the monitoring of broader environmental shifts that can impact a nation's capacity to mitigate risks.

4.4 Validation of the framework through stakeholder consultations

The framework has undergone rigorous validation through a comprehensive process of stakeholder consultations and validation workshops. Initially, the indicators were selected based on an extensive literature review. Subsequently, the indicators and their corresponding sub-indicators were subjected to prioritisation exercises conducted in collaboration with a diverse array of stakeholders, including both national and international experts. These consultations served as a platform for soliciting valuable feedback and insights, allowing for refinement and optimisation of the framework.

Through an iterative process of engaging with stakeholders, the framework was validated to ensure its relevance, comprehensiveness, and practical applicability in addressing pertinent challenges in scaling NbS across the Global South. The active involvement of stakeholders has not only bolstered the credibility of the framework but has also enhanced its alignment with the needs and realities of the contexts it seeks to benefit.

One of the key takeaways that emerged during these stakeholder consultations was to produce a toolkit or dashboard with a user interface that allows stakeholders to implement the framework easily and increases its applicability. Therefore, the authors are currently developing a toolkit based on this framework in addition to a guidebook that provides step-by-step instructions for applying the framework.

Snapshots from the CEEW's multi-stakeholder consultation-cum-validation workshop.

4.5 Limitations of the framework

We have found that the ENSURE framework might not provide accurate results in certain instances due to the limitations of the user and the methodologies used in estimating the costs and benefits associated with the NbS. Some of these limitations are highlighted below:

1. The framework has been designed to aid countries located in the Global South, which lack the knowledge, tools, or human resources to identify certain benefits. For example, countries that lack a formal carbon trading market might find it difficult to quantify the economic value of carbon sequestration due to NbS.
2. The framework utilises several ecosystem valuation tools that are based on multiple assumptions and require technical expertise to conduct economic evaluations. These methods may fail to highlight the true cost of the benefits attained from NbS, which may result in overestimating or underestimating the economic potential of an NbS.
3. The framework requires implementation agencies to use primary data to demarcate an intervention as an NbS, understand LFIs, and estimate the costs and benefits associated with an NbS. However, several implementation agencies or countries might have limited resources. In such a case, secondary data may be used. It should be noted that the data used from other sources may not provide accurate results, as it may have its own set of limitations and assumptions.

5. Application of the framework

In this section, we examine how ENSURE has been applied to map the benefits of NbS in diverse settings and elucidate how key stakeholders can use it to drive sustainable change. From government agencies seeking to enhance their environmental policies to private entities aiming to make informed investments and implementation agencies striving for effective project execution, we explore how this comprehensive framework can be applied to meet a range of environmental and socio-economic objectives.

5.1 Applications for government

- **Enhancing the *Natural Capital Accounting and Valuation of Ecosystem Services* (NCAVES) project**: In 2017, UNEP, along with CBD and the EU, launched the NCAVES project, which aims to improve how ecosystem services are measured, mainstream biodiversity and ecosystems into policy planning and implementation, and contribute to the development of internationally agreed-upon methodologies (Ministry of Statistics and Programme Implementation 2017). The programme is being implemented in India with the support of the Ministry of Statistics and Programme Implementation (MoSPI), and the valuation of ecosystem services is currently being done using the country's existing literature. However, ENSURE can help governments improve the NCAVES project by providing standardised methods for data collection, analysis, and reporting. Such standardisation can help enhance the accuracy and comparability of natural capital assessments, enabling more informed decisions on sustainable resource management, environmental protection, and economic development.
- **MGNREGS – Mapping climate co-benefits**: MGNREGS is a government programme that provides rural employment to unskilled workers for at least 100 days per year. It also plays a significant role in increasing the climate resilience of local communities. Currently, the MGNREGS dashboard does not map a wide variety of benefits, which hinders the development of communities and ecosystems (CSTEP 2023). Almost 60 per cent of the existing projects under the MGNREGS fall under the domain of natural resource management (Ministry of Rural Development 2023), a majority of which

Image: Abir Abdullah/Climate Visuals

Green walls are not only spectacularly beautiful, but also lower both indoor and outdoor temperature, as well as provide healthier indoor air quality (Yeh 2012).

satisfy the criteria for being considered as NbS. Using ENSURE, governments can better identify and map the climate co-benefits of MGNREGS activities, such as afforestation, watershed management, and soil conservation. This information can help governments prioritise projects that contribute not only to employment generation but also to climate mitigation and adaptation goals.

- **Achievement of targets under NDCs**: Many countries have committed to reducing greenhouse gas emissions and increasing efforts towards climate change adaptation under the Paris Agreement. ENSURE can aid governments in assessing the contributions of NbS to achieving NDC targets. It helps quantify emissions reduced through activities such as reforestation and wetland restoration and supports informed decision-making regarding NbS investments as part of climate action plans.

5.2 Applications for private entities

- **Understanding the benefits of interventions**: According to a study conducted by The Nature Conservancy (TNC), companies have experienced several benefits after adopting NbS, such as a reduction in project costs, better management of regulatory requirements and risks, mitigation of natural disaster risks, improved marketing and branding, achievement of sustainability goals, etc. (The Nature Conservancy Business Council 2023). Companies have also reported that investing in nature has led to an increase in shareholder and customer confidence (European Investment Bank 2023). The suggestions released by the Task Force on Nature-related Financial Disclosures (TNFD) and the International Sustainability Standards Board (ISSB) show that private companies are increasingly becoming aware of their impact on nature and wish to explore possibilities of working in tandem with nature. In such cases, ENSURE may be used to assess the environmental and economic benefits of NbS. Such analyses will enable companies to make more informed decisions regarding which projects to invest in. For example, they can evaluate the long-term returns associated with investing in carbon offset projects, green infrastructure, or sustainable supply chains. This information can guide corporate sustainability strategies and investments.
- **Leverage green credits**: The MoEFCC launched the Green Credit Rules in 2023 . The rules aim to incentivise nature-positive actions by issuing green credits based on the environmental benefits of a given action. The credits can then be traded on a domestic market platform (MoEFCC 2023). These actions include a wide variety of activities such as water management, tree plantation, sustainable agriculture, waste management, mangrove conservation and restoration, and sustainable building and infrastructure. The majority of the permissible activities fall under different kinds of NbS, as explained in the umbrella concept. By applying ENSURE, private entities can accurately quantify the environmental benefits of their projects and potentially convert them into green credits. These credits can then be traded on markets, incentivising sustainable practices and creating new revenue streams for organisations engaged in NbS projects.

5.3 Applications for implementation agencies

- **Better understanding for identifying and monitoring NbS**: Implementation agencies are responsible for executing NbS projects as well as for monitoring the co-benefits that arise from them. At present, such agencies follow neither a standardised method for identifying an intervention as an NbS nor guidelines to map and estimate the economic value of the benefits that accrue from its implementation. ENSURE will help implementation agencies follow a systematic approach for project identification and monitoring, which will further support them in aligning their project to national and global guidelines and missions.
- **Improved communication of NbS**: ENSURE can help implementation agencies communicate the diverse benefits of NbS to stakeholders and decision-makers. It will also enable them to improve their reporting mechanisms and support them in highlighting the benefits of their work more, thus helping them attract the necessary finances to scale the implementation of their projects.

> More than half of the world's GDP, totaling USD 44 trillion, relies heavily on nature and its services, making it vulnerable to nature loss (WEF 2020).

Table 5 Overview of the various applications for the proposed framework

S. no.	Stakeholder	Name of the project	Application
		Public sector: Government	
1.	**Ministry of Environment, Forests and Climate Change (MoEFCC)**	Nationally Determined Contributions (NDCs)	The proposed framework can aid governments in assessing the contributions of NbS toward achieving NDC targets. It will help quantify emissions reductions from activities such as reforestation and wetland restoration as well as support informed decision-making regarding NbS investments as part of climate action plans
2.	**Ministry of Rural Development (MoRD)**	*Mahatma Gandhi National Rural Employment Guarantee Act* (MGNREGA)	By using the proposed framework, the ministry can better identify and map the climate co-benefits – such as afforestation, watershed management, and soil conservation – of MGNREGA activities. This information can help in prioritising projects that contribute not only to employment generation but also to climate mitigation and adaptation goals
3.	**Ministry of Statistics and Programme Implementation (MoSPI)**	*Natural Capital Accounting and Valuation of Ecosystem Services* (NCAVES) project	The framework can help governments improve the NCAVES project by providing standardised methods for data collection, analysis, and reporting. This will enhance the accuracy and comparability of natural capital assessments, enabling more informed decisions on sustainable resource management, environmental protection, and economic development
		Private sector	
1.	**Private companies, investors, and philanthropies**	Corporate social responsibility (CSR) and disclosures	The framework may be used to assess the environmental and economic benefits of NbS. Thes assessments will help private entities make more informed decisions about which projects to invest in. For example, they can evaluate the long-term returns on investments in carbon offset projects, green infrastructure, or sustainable supply chains. This information can guide corporate sustainability strategies and investments. It can also help private companies determine the market value of activities, which can be exchanged for green credits under the *Green Credit Rules* launched by the MoEFCC in 2023
		Implementation agencies and research organisations	
1.	**NGOs, CSOs, and other on-ground organisations**	Implementation and monitoring of NbS	Implementation agencies that are responsible for executing NbS projects can benefit from the standardised and systematic approach to project identification and monitoring mentioned in the framework. This includes clear guidelines on how to select appropriate NbS interventions based on ecological and socio-economic factors and how to assess their performance over time. This will lead to more effective and accountable project implementation
		Mapping of benefits	The framework can help implementation agencies communicate the diverse benefits of NbS to stakeholders and decision-makers. Beyond environmental benefits, NbS can offer social, economic, and health advantages, such as improved air and water quality, enhanced recreational opportunities, and job creation. Understanding and showcasing these wide-ranging benefits can garner support and funding for NbS projects
2.	**Research institutes and think tanks**	Policy analysis and strategy recommendation	Researchers could utilise certain components of the framework to analyse the performance of policies that aim to promote NbS. For example, using this framework, the *National Agroforestry Policy* published by the government in 2014 could undergo a CBA analysis to assess community benefits

Source: Authors' analysis

6. Conclusion and way forward

Our proposed unified framework for mapping and estimating the benefits of NbS offers a critical advancement in addressing current environmental and socio-economic challenges. ENSURE addresses the challenges faced by stakeholders all across the Global South in attracting finances towards NbS interventions by providing detailed criteria to identify them accurately in addition to a methodology to estimate the economic potential of these interventions. Identifying the plethora of benefits that can accrue from NbS will also contribute to an increase in cross-sectoral climate finance, since NbS provide both mitigation- and adaptation-related benefits.

The framework's multifaceted utility extends beyond financial mobilisation and builds upon the foundational principle that humans and nature have a fundamentally symbiotic relationship. ENSURE encourages participation by local community members and empowers local decision-makers by requiring them to provide inputs at every stage of implementation. Moreover, it also adheres to the principles highlighted in the Kunming-Montreal Global Biodiversity Framework, which encourages governments and businesses alike to consider biodiversity and nature in decision-making. One of the greatest strengths of ENSURE lies in its ability to adapt to diverse socio-economic and environmental settings, thus having particular relevance for countries located in the Global South. As the scale of development continues to accelerate both at national and global levels, the framework can be updated regularly to maintain its relevance and importance. ENSURE will evolve in response to advancing ecological understanding, technological innovations, and implementation insights.

The next phase of our research involves piloting ENSURE across the Indian sub-continent, specifically, to evaluate the economic potential of selected solutions in the Indian context. While this pilot study extended beyond the initial scope of Phase 1, it represents a vital step in refining and validating the framework's applicability in diverse settings. In Phase 2 of the project, the team conducted an extensive study of the mangrove ecosystem in the districts of Thane and Mumbai Suburban, Maharashtra, to examine the potential of ENSURE. The team surveyed the local communities responsible for the protection and restoration of mangroves with support from the Mangrove Cell of the state of Maharashtra. The study provides the benefits of using ENSURE and lists the challenges that other implementation agencies might face while using the framework. The team collected approximately 50 responses from 10 villages, government representatives from the Mangrove Cell, and private-sector stakeholders, such as officials from Godrej, to understand the different benefits attained from the restoration and protection of mangroves. This was done to conduct a CBA to highlight the investment potential of mangroves as an NbS.

Moving forward, the continuous development and application of this dynamic framework will play a pivotal role in steering our collective journey toward balancing economic growth with environmental stewardship. It stands as a beacon for a more sustainable and resilient future, offering a practical and adaptive guide for harnessing the power of NbS for the benefit of our planet and generations to come.

Coastal wetlands like mangrove forests safeguard tens of millions of people in the tropics by stabilising coastlines, reducing erosion, protecting against storms, filtering pollutants, and storing carbon.

Acronyms

CBA	cost–benefit analysis
CBD	Convention on Biological Diversity
COP15	15th Conference of Parties
CSO	civil society organisation
CSR	corporate social responsibility
EU	European Union
GDP	gross domestic product
GVA	gross value added
HDI	Human Development Index
ILO	International Labour Organization
IPCC	Intergovernmental Panel on Climate Change
ISSB	International Sustainability Standards Board
IUCN	International Union for Conservation of Nature
LFI	local factors of influence
MEA	Millennium Ecosystem Assessment
MGNREGS	*Mahatma Gandhi National Rural Employment Guarantee Scheme*
MISHTI	*Mangrove Initiative for Shoreline Habitats & Tangible Incomes*
MoEFCC	Ministry of Environment, Forests and Climate Change
MoRD	Ministry of Rural Development
MoSPI	Ministry of Statistics and Programme Implementation
NAP	national adaptation plans
NAPCC	*National Action Plan on Climate Change*
NbS	nature-based solutions
NCAVES	*Natural Capital Accounting and Valuation Of Ecosystem Services*
NDC	Nationally Determined Contribution
NGO	non-governmental organisation
SDGs	Sustainable Development Goals
SHG	self-help group
TEEB	The Economics of Ecosystems and Biodiversity
TNC	The Nature Conservancy
TNFD	Taskforce on Nature-related Financial Disclosures
UNCCD	United Nations Convention to Combat Desertification
UNDRR	United Nations Office for Disaster Risk Reduction
UNEA	United Nations Environment Assembly
UNEP	United Nations Environment Programme
WEF	World Economic Forum
WWAP	*World Water Assessment Programme*

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