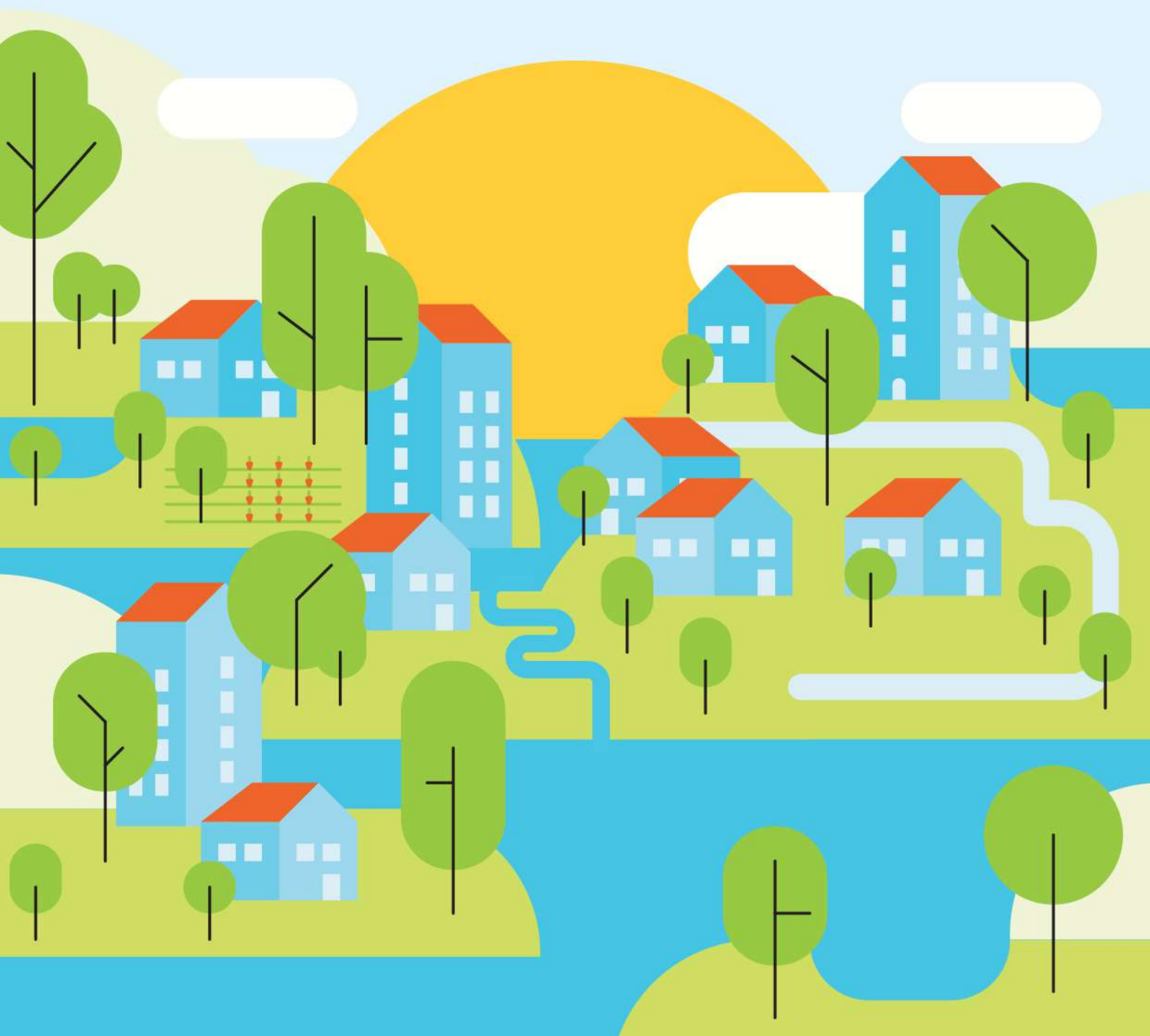


NATURE-BASED INFRASTRUCTURE **(Executive Summary)**

How natural infrastructure solutions can address sustainable development challenges and the triple planetary crisis



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Executive Summary

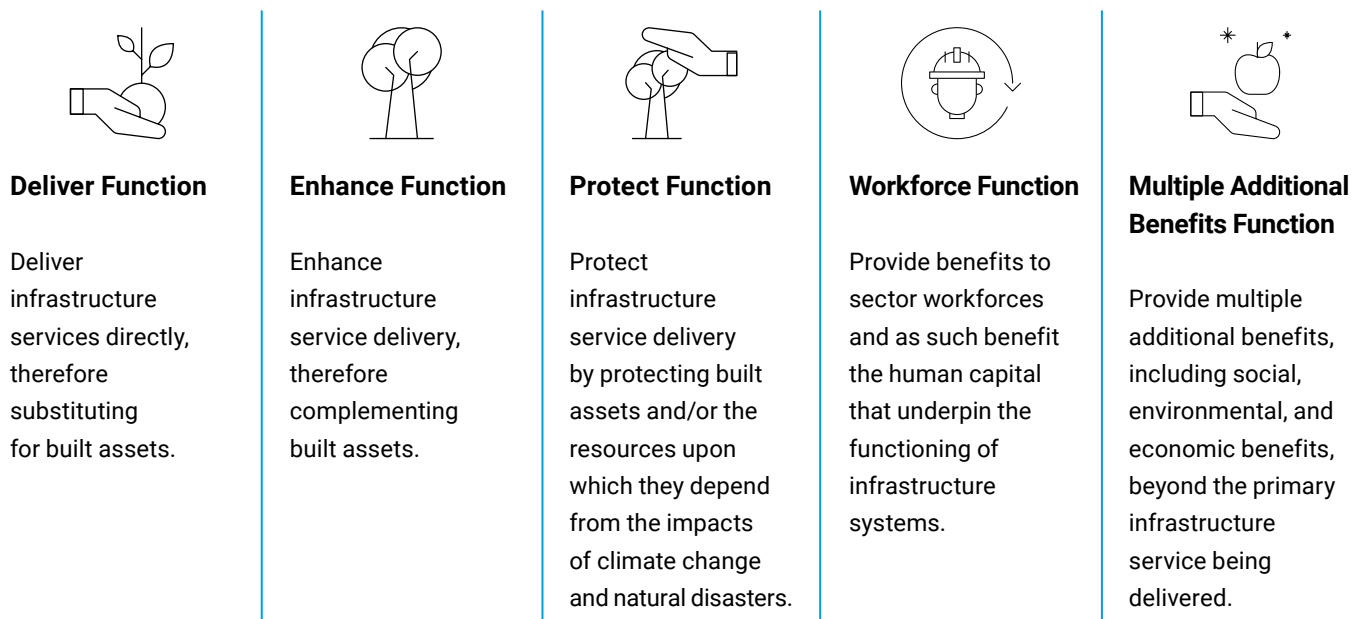
Countries are facing global challenges of development, climate change, and biodiversity loss. Decisions on infrastructure are an essential component of meeting these challenges. A disproportionate focus on built infrastructure is leading to negative outcomes, including driving climate change through greenhouse gas (GHG) emissions, and the loss and degradation of nature (Seiler 2003; Ibisch et al. 2016). Nature-based infrastructure solutions (Nbi) offer decision-makers opportunities to address these challenges simultaneously and progress development agendas including the 2030 Agenda for Sustainable Development, the Paris Agreement and the Convention on Biological Diversity, through strategic integration with built infrastructure systems.

It is estimated that almost US \$100 trillion of investment in infrastructure is required globally by 2040 (Global Infrastructure Hub 2022). Investments in infrastructure lock in patterns of development for decades to come, whether that be positive or negative. Finite resources mean that countries need to invest wisely and in solutions that can maximize benefits and minimize negative trade-offs (Thacker et al. 2019). It is therefore imperative that Nbi are factored into infrastructure planning from the outset, to ensure they are optimized for climate-compatible development.

The purpose of this report is to assess the contribution that Nbi can make to addressing global sustainable development challenges, with a view to increasing awareness and uptake. It provides a framework for thinking about Nbi and the benefits of its deployment as an alternative or complement to built infrastructure, and identifies barriers to scaling its deployment. This report provides recommendations for overcoming the barriers and for increasing implementation of Nbi as a key component of sustainable infrastructure systems.

A framework for thinking about Nbl

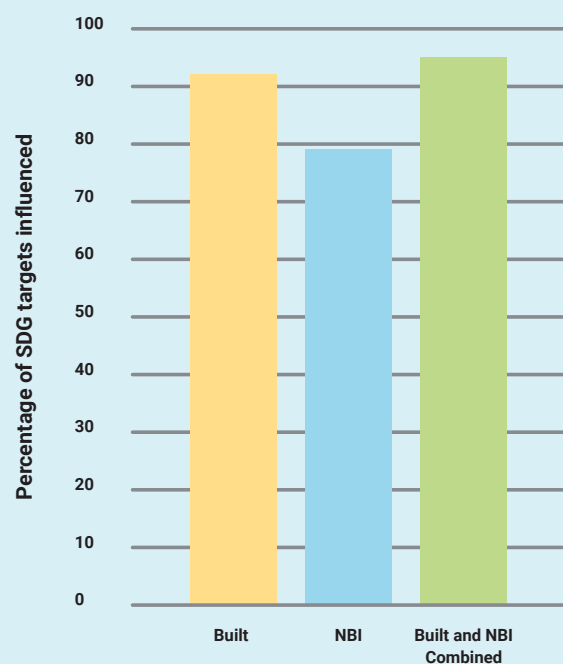
This report provides a framework for thinking about nature-based solutions (NbS) in the context of infrastructure service delivery. Following Haggis et al. (forthcoming), and building on the work of Ozment et al. (2015) and Browder et al. (2019), this report defines five functions through which Nbl can provide benefits to infrastructure and beyond, with respect to the provision of services:



The role of Nbl in sustainable development

The applicability of Nbl to some infrastructure sectors, such as water, is well-known (e.g. UN 2018). However, by assessing the potential for nature to provide services to infrastructure across a range of sectors, this report finds that Nbl has much broader applicability to infrastructure, and that all infrastructure sectors can integrate Nbl via one or more of the five functions. Three sectors – culture and recreation, health, and water - can deploy Nbl to deliver the service of their sector directly. Ten sectors – buildings, education, energy, finance, health, manufacturing, retail, solid waste, transport, and water – can implement Nbl to enhance the quality, quantity and reliability of the service. All sectors can derive benefits from Nbl through the “protect”, “workforce”, and “multiple additional benefits” functions. The systematic consideration of Nbl across all sectors is necessary to ensure that the value of Nbl is recognized and factored into infrastructure decision-making as a means of providing services and benefits.

Figure 1. The influence of built infrastructure versus Nbl on the SDG targets



Nbl and the SDGs

This report assessed the 8 infrastructure sectors that Thacker et al. (2019) report could influence up to 92% of SDG targets (civic, digital communications, education, energy, health, solid waste, transport, and

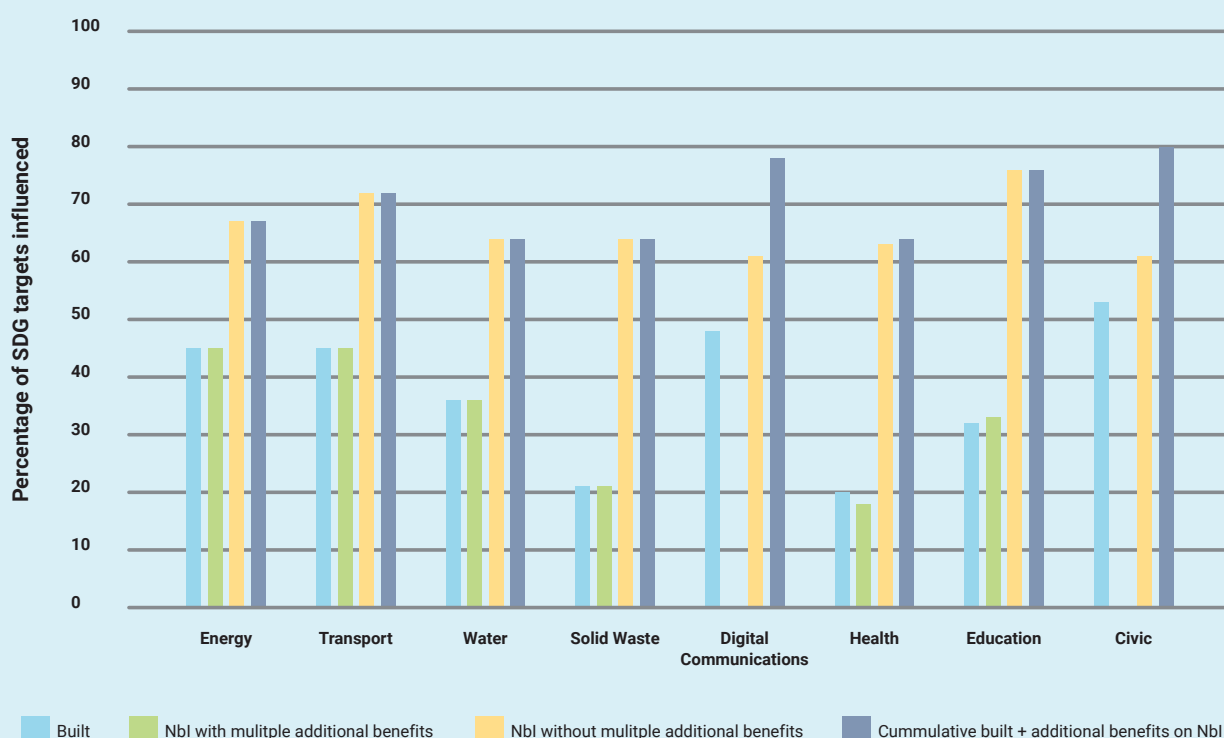
water), and found that Nbl can influence up to 79% of SDG targets across all 17 SDG Goals (see *figure 1*), including four targets that were not considered to be influenced by built infrastructure (see *table 1*).

Table 1. Targets that can be influenced only by Nbl and not by built infrastructure across the eight infrastructure sectors considered by Thacker et al. (2019). Based on evidence from Blicharska et al. (2016); Fuldauer et al. (2022) and Thacker et al. (2019).

Target	Description	Justification
15.9	By 2020, integrate ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts.	Influenced via services including environmental education and value for scientific research.
15a	Mobilize and significantly increase financial resources from all sources to conserve and sustainably use biodiversity and ecosystems.	Environmental education: better understanding of ecosystems helps makes the case for increasing financial resources to conserve them.
15b	Mobilize significant resources from all sources and at all levels to finance sustainable forest management and provide adequate incentives to developing countries to advance such management, including for conservation and reforestation.	
17.3	Mobilize additional financial resources for developing countries from multiple sources.	

When Nbl solutions are combined with built infrastructure assets, infrastructure systems can have greater cumulative impact on the SDG targets than either built infrastructure or Nbl can alone, influencing up to 95% of SDG targets. For any individual sector, integrating Nbl with built infrastructure can influence 24%-47% more SDG targets compared to the use of built infrastructure alone in that sector (see *Figure 2*). This is owing to the ability of Nbl to provide multiple additional social, environmental and economic benefits in addition to the primary intended infrastructure service (Thorn et al. 2021; UNEP 2014).

Figure 2: Percentage of SDG targets influenced by infrastructure with and without built infrastructure with and without the multiple additional benefits of nature



Nbl and the Paris Agreement

In addition to the SDGs, Nbl can also contribute to climate mitigation and adaptation objectives. On the adaptation side, Nbl can protect infrastructure in all sectors from the impacts of climate change, as well as support national adaptation outcomes more broadly. Some Nbl are also more flexible and adaptable to climate change, and therefore themselves more resilient to climate impacts than built infrastructure options (Ozment et al. 2015; Kapos et al. 2019). Through the provision of additional benefits, such as diversification of income streams, improved livelihoods, provision of food and other natural resources, provision of habitat and species diversity, Nbl can support the wider resilience of economies, natural ecosystems, and societies, including indigenous communities and women.

The benefits of Nbl for meeting mitigation targets associated with the Paris Agreement are well-known - the deployment of Nbl can provide carbon sequestration services and avoid land use change. However, this report finds that Nbl could

have a potentially larger role in contributing to mitigation strategies across all infrastructure sectors. By substituting built infrastructure assets, Nbl can remove or reduce GHG emissions embedded within the built infrastructure lifecycle, including within materials, transport, operation, maintenance and decommissioning of built infrastructure components. By complementing built infrastructure assets, Nbl can help to reduce emissions embedded within the maintenance of built infrastructure, including through reduced requirements for dredging and mowing, and embedded within inputs such as flocculants. By protecting built infrastructure assets, Nbl can extend the lifespan of built infrastructure components (Ozment et al. 2015), and the frequency at which they are maintained and repaired, leading to reductions in associated GHG emissions.



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Nbl and Investment

Nbl options can also be more cost-effective than built infrastructure options (Browder et al. 2019). They can reduce the need for investment in built infrastructure assets, provide lower cost solutions compared to built infrastructure, reduce costs associated with built infrastructure maintenance, and generate multiple additional economic benefits, such as tourism, increased property prices and marketable products. They can also increase in value over time, as ecosystems mature (Ozment et al. 2015; Kapos et al. 2019; UNEP 2014).

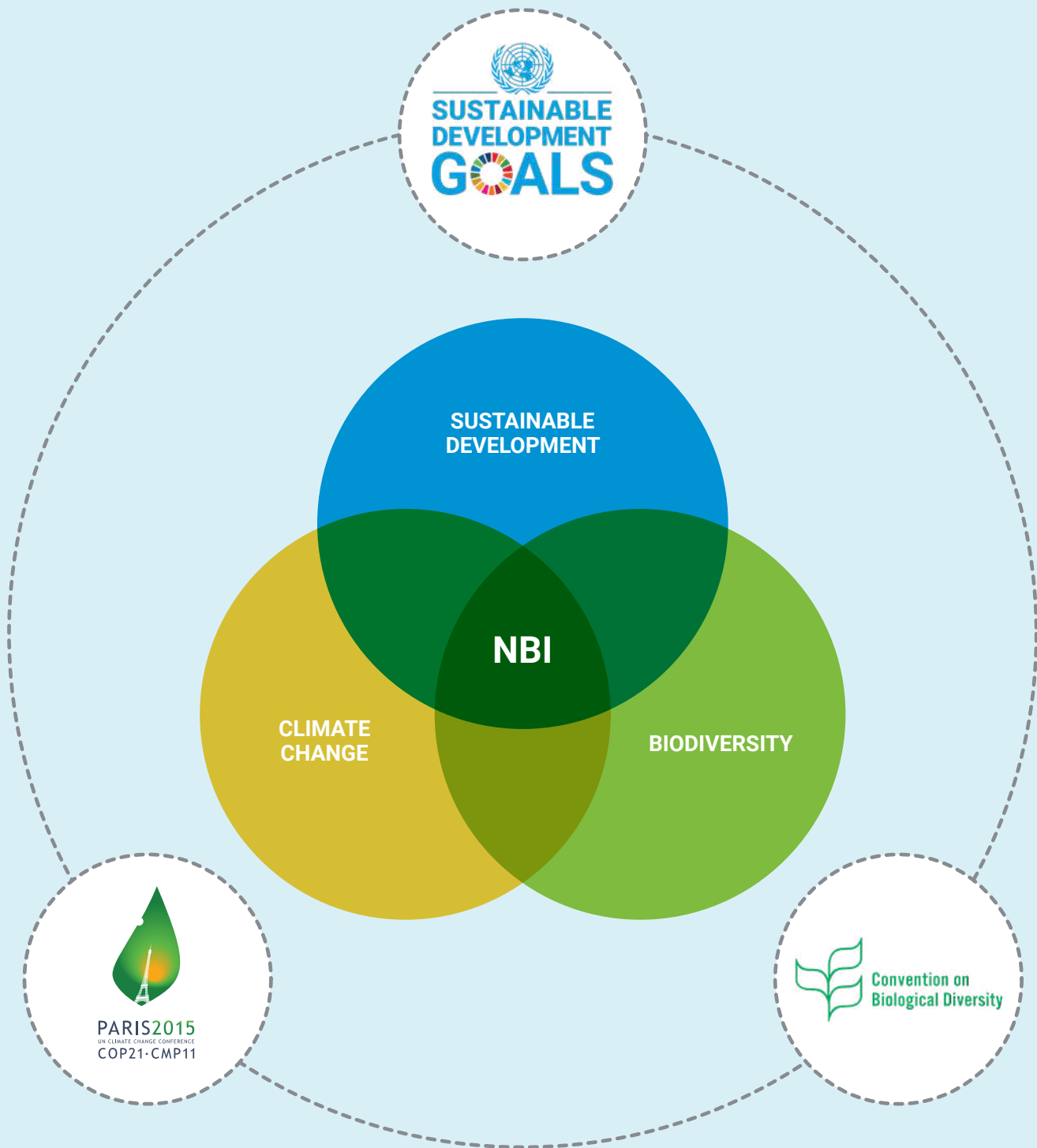
There is an investment gap of US \$15 trillion that will be needed by 2040 in order to meet the US \$94 trillion required for infrastructure investment. At the same time, there is an annual average shortfall of approximately US \$330 billion per year in funding for nature by 2030 (UNEP 2022). Nbl can help countries to maximize the use of finite resources and close both the infrastructure and nature financing gaps. Through the deployment of Nbl, infrastructure funds can help to bridge the nature financing gap, while nature funds can help to fill the infrastructure financing gap.

The barriers to Nbl

The deployment of Nbl has the potential to provide many benefits. However, Nbl solutions are complex, and there are multiple uncertainties, challenges and constraints that mean that the deployment of Nbl is not yet being planned, financed, and implemented consistently as part of mainstream practice. Key challenges include:

- **Time delays to benefit provision:** Nbl options have different timeframes over which they develop, function and have capacity for service provision. Many take time to implement and achieve full potential for service delivery (Kapos et al. 2019; UNEP 2014), longer than built infrastructure options, and others have seasonal functionality, which can be a factor in suitability for implementation. Delays in benefit provision mean that cost-benefit ratios which underpin infrastructure decisions can change over time. However, not all infrastructure projects will require solutions to reach 100% potential for service provision immediately.

Figure 3: Nbi is the only type of infrastructure that can contribute to mutual, synergistic progress on sustainable development, climate change, and biodiversity



- **Resilience of Nbl:** the ability of Nbl to persist, function and provide services is impacted by local and broader-scale socio-political and environmental conditions, including infrastructure development, agricultural intensification, climate change, invasive species, pests and disease. These factors are not all fully understood but need to be accounted for in decisions on Nbl to ensure the solution will be viable long-term.
- **Data and information availability:** there are gaps in data and on the applicability of Nbl to different infrastructure sectors, and the costs, benefits and potential effectiveness at service provision that impede the scaling of Nbl. This includes data on implementation cost breakdown, maintenance costs, the outcomes of Nbl, and their capacity for providing multiple additional benefits.
- **Management and maintenance:** the management and maintenance of Nbl will impact the effectiveness of a solution. This can be challenging under social, economic and political contexts that change over time, and where funding or technical skills and institutional capacities for such activities are limited.
- **Trade-offs:** there are many potential trade-offs related to Nbl that need to be balanced in the decision-making process to ensure that potential negative outcomes do not undermine progress on development, climate change, and biodiversity. For example, many Nbl options require more space than built infrastructure options, which must be balanced against other needs, such as space to provide food.
- **Alignment and collaboration of multiple different stakeholders:** the deployment of Nbl is complex and will involve a diverse range of stakeholders who have different beliefs, values, and potentially competing interests. Coordination and alignment of stakeholders—including across national and other administrative boundaries—will be a challenging but necessary part of scaling Nbl.
- **Costs and who pays:** although some Nbl can be more cost-effective than built options, there are various costs associated with implementation, management, and maintenance. Given that Nbl can provide benefits to multiple

stakeholders simultaneously, there are questions as to who should pay for the costs of Nbl.

- **Transboundary decision-making:** both built infrastructure and Nbl networks can extend across country borders - considering Nbl within the context of transboundary infrastructure decisions will add another layer of complexity through the addition of more stakeholders who may have different interests, and costs and benefits which are distributed across borders. This will require coordination and cooperation of stakeholders on potentially regional scales, to implement, monitor and maintain the Nbl long-term.

Recommendations

Overcoming the challenges and barriers to scaling will be complex and require:

- **Nbl to be embedded into infrastructure and development planning:** Thinking on Nbl needs to begin from the start of the infrastructure lifecycle, during the planning and design of infrastructure systems. This should include systematic consideration of Nbl in infrastructure decisions, and the embedding of Nbl into National Adaptation Plans, National Development Commitments, Nationally Determined Contributions and National Infrastructure Plans.
- **Valuation of the services and multiple additional benefits of Nbl:** the potential for Nbl to provide infrastructure-relevant services and multiple additional benefits simultaneously can make a strong case for investment. The full range of costs and benefits and how they change over time needs to be factored into decision-making. Multi-criteria decision-making can be a useful tool in the assessment of Nbl options and their range of benefits, including their effectiveness at infrastructure service provision, benefits for adaptation, mitigation, societies, economies and the environment, and consideration of time and space requirements.
- **Consideration of time:** Nbl should be developed and implemented in a manner that is consistent with the time that Nbl take to develop and the complexity of the ecosystem. Approaches with

long timeframes, of approximately 20-50 years, have the best chance of success. There may be a need to integrate Nbl with built infrastructure or other natural solutions until the chosen Nbl option reaches the planned potential for service provision.

- **Long-term monitoring, management and data collection:** Nbl options should be monitored and managed long-term to build an evidence base of the costs and benefits of different Nbl options in different contexts, identify opportunities to improve performance, and to implement actions that can improve the functioning of an Nbl solution (World Bank, 2017; Browder et al, 2019). This should include monitoring of performance, documentation of costs, adaptive management, and collection of gender disaggregated data to help ensure that service provision is meeting the needs of both women and men.
- **Development of sector-specific guidance and awareness raising:** development of sector-specific guidance on Nbl can support the systematic scale-up of Nbl across infrastructure sectors. This should include details on the applicability of different Nbl options to meet the needs of each infrastructure sector, good practice guidelines, and performance benchmarks.
- **Funding:** investors and other funders can support the scaling of Nbl, including through funding Nbl across the lifecycle, embedding flexibility into funding, funding training and capacity building, and mandating / prioritizing the inclusion of Nbl as an eligibility criterion for funding.
- **Human, institutional, and technical capacity building:** this should include institutional training and awareness raising, capacity building of infrastructure practitioners, and skills development for monitoring and management. Efforts to build capacity of women and increase their participation in infrastructure planning and delivery across the lifecycle should be made.
- **Stakeholder alignment and collaboration:** practitioners should aim to co-design Nbl solutions with local and indigenous communities, create specific working groups to bring together different stakeholders, and facilitate community management of projects.

Civil society organisations may be appointed to support local stakeholder engagement.

- **New and continued research:** informed decision-making that considers the limits of Nbl and variations in performance, potential trade-offs and variations in costs and benefits over time will require further research and broad-scale analysis. This should include research into the ability of Nbl to function in different contexts, the importance of condition, connectivity and intactness, the extent to which Nbl can be generalized from one site to another, the impact of time on costs and benefits, the resilience of Nbl in different contexts, and trade-offs over space and time.



