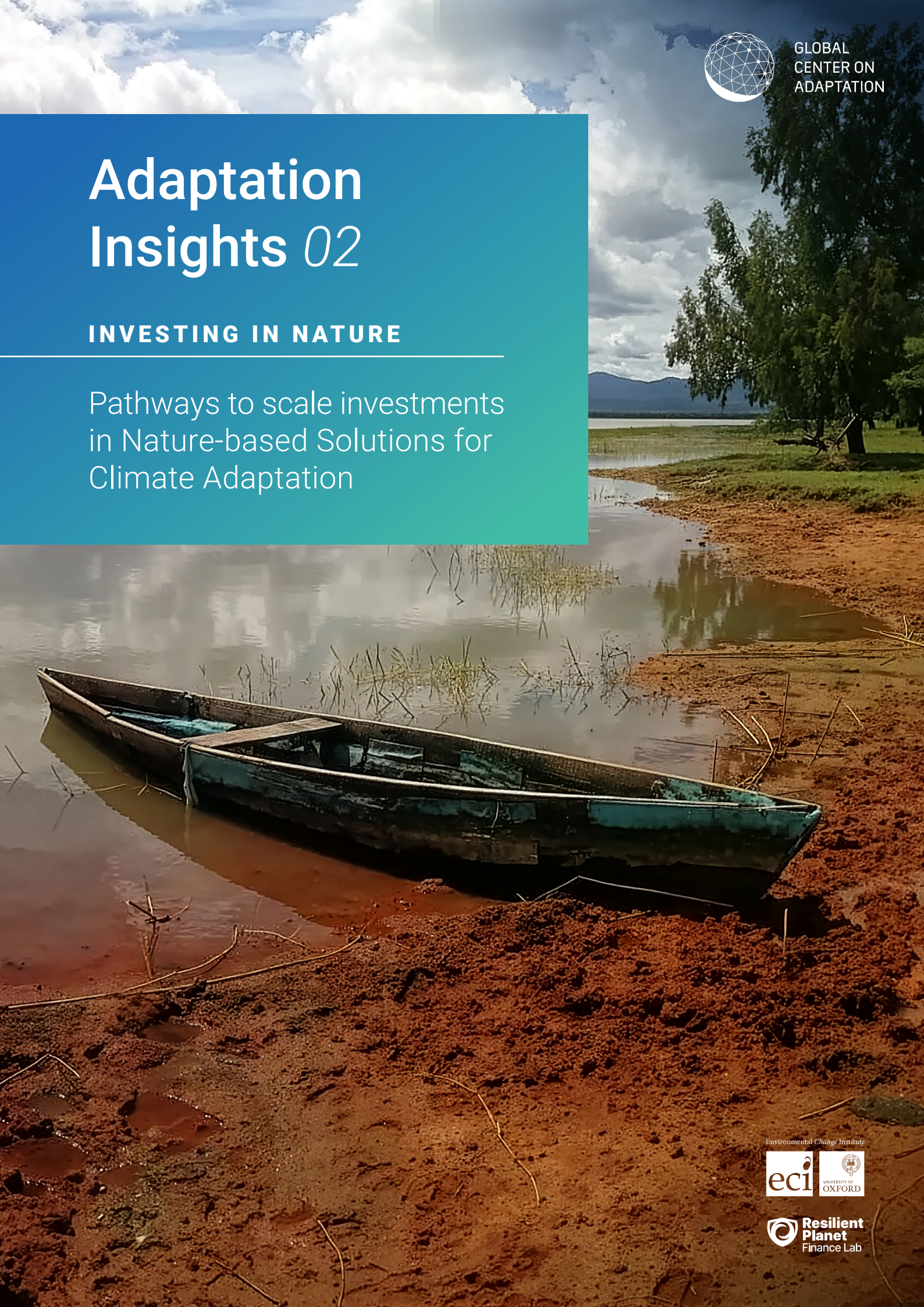

GLOBAL CENTER ON ADAPTATION

Adaptation Insights *02*

INVESTING IN NATURE

Pathways to scale investments in Nature-based Solutions for Climate Adaptation

Environmental *Change* Institute

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Resilient Planet Finance Lab

Authors & Acknowledgements

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Developed by:

GLOBAL CENTER ON ADAPTATION

ABOUT THE GLOBAL CENTER ON ADAPTATION

The Global Center on Adaptation (GCA) is an international organization, hosted by the Netherlands, which works as a solutions broker to accelerate action and support for adaptation solutions from the international to the local, in partnership with the public and private sector, to ensure we learn from each other and work together for a climate resilient future.

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ABOUT THE ENVIRONMENTAL CHANGE INSTITUTE

The Environmental Change Institute at the University of Oxford was established in 1991. Its aim is to organize and promote interdisciplinary research on the nature, causes and impact of environmental change and to contribute to the development of management strategies for coping with future environmental change.

Resilient Planet Finance Lab

The Resilient Planet Finance Lab was established in 2023 as a collaborative research and innovation program hosted within the Environmental Change Institute, in partnership with the United Nations Office for Disaster Risk Reduction (UNDRR) and the Insurance Development Forum (IDF), to work with financial institutions, governments, civil society, organizations and development finance institutions to deliver evidence and common metrics, toolkits, frameworks and guidance to accelerate the mobilization of finance for resilience and nature.

Partner Organizations:

AFRICAN DEVELOPMENT BANK GROUP

CSE Centre de Suivi Ecologique

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Abbreviations

Acronyms	Definitions
AAAP	Africa Adaptation Acceleration Program
AFD	Agence Française de Développement
AfDB	African Development Bank
AIIB	Asian Infrastructure Investment Bank
AU	African Union
BCR	Benefit-Cost Ratio
CDP	Carbon Disclosure Project
CRA	Climate Risk Assessment
DFI	Development Finance Institution
EAC	East African Community
EAD	Expected Annual Damages
EBRD	European Bank for Reconstruction and Development
EEA	European Environment Agency
EIB	European Investment Bank
ESG	Environmental, Social, and Governance
GEF	Global Environment Facility
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GCA	Global Center on Adaptation
GFDRR	Global Facility for Disaster Reduction and Recovery
FMO	Netherlands Development Finance Company (Dutch Development Bank)
ICSI	International Coalition for Sustainable Infrastructure
IUCN	International Union for Conservation of Nature
MDB	Multilateral Development Bank
MRV	Monitoring, Reporting, and Verification (implied in carbon credit context)
NbS	Nature-based Solutions
NCMC	National Carbon Monitoring Centre (Tanzania)
O&M	Operations and Maintenance
OECD	Organization for Economic Co-operation and Development
PPIAF	Public-Private Infrastructure Advisory Facility
SMEs	Small and Medium Enterprises
UIC	International Union of Railways
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
VCM	Voluntary Carbon Market
WBG	World Bank Group
WRI	World Resources Institute

Foreword

The numbers are uncompromising: between 1998 and 2017, economic losses from climate-related disasters reached $2.9 trillion, a 251% increase on the previous 20-year period. Climate change is now a daily reality for billions of people. More frequent and intense hazards are straining infrastructure, threatening development gains, and exposing communities to escalating risk.

Yet these numbers do not only tell a story of loss. They also point, with absolute clarity, to where smart, forward-looking investment can change the trajectory of our shared future.

Over the past three decades, the world has lost nearly 10% of its forests—an area larger than India. Mangroves, our quiet coastal guardians, have shrunk from around 15.3 million hectares in 1996 to 14.8 million in 2020. These trends weaken ecosystems and reduce biodiversity, leaving people and economies more exposed to storms, floods and erosion. But they also reveal where we can act with purpose. Wherever countries protect and restore forests, wetlands and mangroves, the results are striking: communities are safer, livelihoods are strengthened, and nature begins to heal.

Nature remains one of our greatest sources of resilience and hope. Healthy ecosystems buffer societies against floods, storms and heatwaves. They stabilise soils, regulate water, and shield coastlines. They sustain livelihoods, culture and identity. Nature-based Solutions (NbS)—actions that protect, sustainably manage and restore ecosystems—are therefore not a peripheral option. They are central to any serious strategy for climate-resilient development.

Investing in NbS is a choice to back one of the most effective, inclusive and future-proof forms of adaptation we have. By harnessing natural processes, we can protect lives and assets, reduce losses, and generate new opportunities for growth. If we are to close the adaptation finance gap, then unlocking the full potential of NbS is not just desirable—it is indispensable.

Across Africa and around the world, the Global Center on Adaptation's work shows that well-designed, locally led NbS deliver impressive returns. They protect communities from shocks, support food and water security, and create jobs, while conserving biodiversity. In many cases, they outperform "grey" infrastructure alone, especially when considering their long-term benefits. In short, they are good climate policy, good development policy, and good economics.

The problem is not that NbS do not work. The problem is that our financial systems still struggle to recognise and reward their true value—particularly when benefits are long-term, shared by many, and not easily captured in conventional balance sheets. That is where the opportunity lies. We now have the chance to reshape how we price risk, value resilience and channel capital.

This report is an invitation to seize that opportunity. It calls for innovation that is both ambitious and practical. Blended finance must become a norm, not an exception, in the NbS investment landscape. Public finance can and should take on strategic early-stage risk, paving the way for private capital to scale what works. Existing instruments, such as carbon credits, can be retooled to support this agenda. Historically focused on mitigation, carbon credits can also be designed to support adaptation where NbS measurably reduce climate risk. If developed with rigour and integrity, adaptation-aligned carbon credits can generate long-term revenue streams that keep NbS thriving long after the first project phase ends.

However, innovative instruments alone are not enough. Financiers and policymakers need trusted evidence. They need to know what works, where, for whom, and with what return. That is why common metrics and methodologies for valuing NbS are so important. When we can quantify avoided losses, resilience dividends, co-benefits for livelihoods, and long-term savings, NbS move from being "nice to have" to being core, investable assets in national infrastructure plans.

Through our collaboration with Oxford University and the development of our Global Tools for NbS, the Global Center on Adaptation is working to build this evidence base and put it in the hands of decision-makers. Our aim is simple: to give governments, development banks and investors the confidence, data and tools they need to scale NbS rapidly and responsibly.

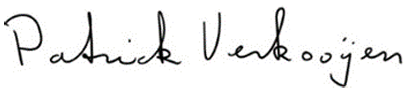
Scaling also requires a strong pipeline of investable projects. Countries need national project pipelines that identify priority NbS interventions, quantify their benefits, and provide the analytics required for sound investment decisions. The Global Tools for NbS, alongside risk assessments and valuation methods, are designed precisely for this. They help countries move from ideas to implementation—from concepts on paper to projects on the ground, and from pilots to sustained, large-scale programmes. These pipelines underpin the NbS Financing Roundtables that GCA is convening with governments, multilateral development banks and private investors to mobilise capital at speed and scale.

We stand at a decisive moment. Faced with deforestation, degraded ecosystems and a changing climate, the world has two choices. We can continue to underinvest in the natural systems that protect and sustain us. Or we can make Nature-based Solutions a cornerstone of climate-resilient, inclusive development.

The encouraging news is that we are not starting from zero. The evidence is growing. The tools exist. Solutions are already emerging in every region, often led by communities who have long understood the value of nature. What is needed now is coordinated action, more innovative financing, and the political will to scale up what we know works.

The Global Center on Adaptation is working with governments, cities, communities, development banks and investors to accelerate this transformation: building strong national pipelines, deploying robust metrics, and bringing public and private actors together around a shared vision—one in which Nature-based Solutions safeguard people, prosperity and our planet.

Nature is not only a victim of climate change; it is one of our most powerful and reliable allies in confronting it. It is a treasure—an asset of immense and enduring value. If we choose to protect and invest in nature, nature will continue to protect and invest in us. It is time our financial system recognised this, and treated nature accordingly.



Professor Patrick V. Verkooijen
President & CEO
Global Center on Adaptation

Executive Summary

Nature's value remains undervalued, despite high benefits to costs.
Despite benefit–cost ratios of 2:1–4:1 observed by the GCA across studies in Mozambique, Uganda, and Tanzania, NbS still struggle to attract investment because ecosystem services like flood control and carbon storage are rarely monetized.

Public finance can lead to crowd in private capital for nature financing.
Grants, concessional loans, and guarantees can de-risk early-stage projects, while blended finance structures mobilize private investment and turn public funds into multipliers for resilience.

Quantified evidence builds investors' confidence.
Standardized valuation and resilience metrics—such as avoided damages and risk reduction—enable NbS to be a cost-effective and viable complement to grey infrastructure within infrastructure investment pipeline.

Scaling NbS from pilots to national-scale unlocks resilience benefits.
GCA and Oxford study shows that targeted USD 3.6 billion in NbS investments across Africa could generate USD 7.6 billion in avoided losses by 2100, with benefit–cost ratios up to 8:1 when strategically applied at corridor, catchment, or landscape scale.

Leveraging new instruments: carbon finance for resilient transport.
NbS integrated along railway corridors can generate verified carbon credits to fund long-term infrastructure maintenance. Emerging governance frameworks in Tanzania, Kenya, Nigeria, and Gabon show how strong MRV and carbon-rights systems can unlock private capital.

This **Adaptation Insights** builds on GCA technical assistance to integrate green and grey adaptation measures into large-scale infrastructure investment programs under the Africa Adaptation Acceleration Program. It further draws on advanced research conducted by the Environmental Change Institute at the University of Oxford, in partnership with GCA, on the application of spatial analytics and financial frameworks to scale nature-based solutions for transport infrastructure resilience globally (Scaling Investments for NbS: GCA portal). The observations presented reflect cumulative evidence and experience derived from collaboration with multilateral development banks and implementation partners engaged in mainstreaming climate adaptation within infrastructure planning and finance.

Mobilizing Finance for Nature

Nature-based Solutions (NbS) remain underfinanced and underutilized at scale despite their proven adaptation benefits, largely due to market limitations. Proven ecosystem services such as flood protection, carbon sequestration, and water regulation are rarely monetized, while investment frameworks, valuation metrics, and transaction structures for NbS are still underdeveloped. Public finance has traditionally relied on grants, which are essential for early-stage support but insufficient to cover long-term operational costs, leaving many projects unable to attract private investment. The complexity and long-term nature of NbS, combined with limited revenue streams, further deter mainstream financial participation.

Scaling NbS from fragmented pilots to mainstream, bankable investments depends on coordinated public–private action and stronger financial foundations. While many projects have demonstrated NbS' technical and ecological value, the challenge remains in structuring them as investable propositions. Achieving this transformation requires strategic risk-taking, standardized valuation methods, and an enabling policy environment that embeds nature-positive strategies within broader regulatory and economic systems.

Public finance can play a catalytic role in this transition. By deploying concessional loans, guarantees, and first-loss capital, governments and development finance institutions can reduce investment risk and unlock private capital for NbS. When combined with grants, technical assistance, and project preparation support, these instruments strengthen project readiness and enhance investor confidence. Blended finance structures that layer public and private resources have already shown strong potential to mobilize significant private investment while generating measurable ecological, social, and economic benefits.

Developing standardized valuation frameworks is another critical step to accelerate investment in NbS. Quantifying resilience and adaptation value—through indicators such as avoided losses, reduced risk exposure, and social co-benefits—creates a common financial language for investors, governments, and project developers. Standardization also improves comparability across projects, allowing NbS to be systematically assessed and integrated into planning, procurement, and investment processes.

Strategic pipeline development: from NbS pilots to systemic approaches that maximize benefits

Infrastructure systems provide a scalable entry point for operationalizing this approach. Physical infrastructure such as roads, railways, and urban drainage systems face growing climate risks, yet integrating NbS into these investments can deliver measurable financial and resilience returns. Demonstrating how NbS reduce flood and erosion risks, lower maintenance costs, and improve safety and reliability offers compelling evidence for financiers and policymakers alike. Embedding resilience metrics and valuation methods into infrastructure design enables NbS to compete directly with—and often outperform—traditional grey alternatives, transforming them from one-off pilots into core components of national adaptation and investment strategies.

Strategic utilization of NbS at system-wide scales—such as catchments, corridors, or landscapes—provides multiplies resilience benefits across sectors. GCA case studies from Mozambique, Uganda, and Tanzania show how slope stabilization, floodplain restoration, and vegetation management can reduce hazards, safeguard assets, and protect livelihoods while delivering benefit-cost ratios of 2:1 to 4:1. Integrating these measures into national pipelines of projects strengthens the evidence base, enhances access to climate finance, and increases investor confidence, creating a path from pilot initiatives to scalable, mainstream solutions for adaptation.

Local governance and community ownership remain essential for long-term success. While aiming for deployment at scale and financial inclusion in international financing mechanisms, local governance, stakeholder engagement, and community ownership must remain the cornerstone of implementing NbS effectively. Technical solutions must be paired with inclusive management, consultations across levels, and integration into long-term operational frameworks. When communities are actively involved in project execution and maintenance, NbS become more durable, socially acceptable, and capable of delivering sustained climate resilience.

Advanced spatial analytics enables decision-makers to identify NbS opportunities with the highest resilience and economic returns and attract different pool of capital. By embedding NbS into infrastructure pipelines, decision-makers can prioritize interventions with the highest resilience impact, unlock climate finance, and secure additional co-benefits for biodiversity, carbon sequestration, and local livelihoods. With clear, evidence-based investment opportunities, NbS can move from pilot initiatives to mainstream, large-scale adaptation solutions that combine climate resilience with economic and social benefits. GCA and Oxford Global Tools for NbS provide such analytics to identify high-priority interventions, assess avoided damages, and calculate benefit-cost ratios, enabling governments and investors to target resources efficiently and attract private capital. **Analysis across Africa shows that well-targeted investments of $3 to 4 billion in mangrove restoration and reforestation could generate more than $7 billion in avoided damages by 2100, with benefit-cost ratios ranging from 2 to 8 for the most effective projects.**

Enabling environment and financing instruments – case of carbon markets for adaptation and resilience

Leveraging innovative financing instruments such as carbon credits can support infrastructure developers and operators in integrating NbS as part of their long-term adaptation strategy. As an emerging instrument for adaptation, carbon markets can finance both the implementation and long-term management of climate-resilient infrastructure. As an example, railway rights-of-way provide ideal platforms for ecological restoration, including reforestation, wetland rehabilitation, and agroforestry. These interventions stabilize slopes, reduce flood risks, and enhance operational safety, but also generate quantifiable carbon credits, creating recurring revenue streams to support financing the project establishment and maintenance.

Carbon revenues—whether from voluntary or compliance markets—can help bridge the financing gap, providing predictable income over decades. However, clear quantification of carbon sequestration, combined with robust Monitoring, Reporting, and Verification (MRV) systems, is essential for credibility and investor confidence. Institutional organization and governance frameworks are critical to scale carbon-financed NbS. Projects must clarify carbon rights, integrate NbS into national and sectoral planning, and adopt regulatory and financial mechanisms such as public–private partnerships, advance credit purchase agreements, and blended finance structures. Experiences from Tanzania, Kenya, Nigeria, and Gabon highlight the importance of national registries, designated authorities, and capacity-building to manage MRV, coordinate stakeholders, and ensure long-term sustainability. By establishing strong institutional frameworks, countries can unlock carbon finance at scale, ensuring that NbS deliver measurable climate, social, and economic benefits.

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KEY TAKEAWAYS FOR SCALING NBS FOR CLIMATE ADAPTATION INVESTMENT

Scaling Up Finance

1. **Public-private coordination maximizes impact.** Public finance reduces risk and catalyzes innovation, private investors provide scale and efficiency, and specialized funds link the two, creating multiplier effects that deliver social, ecological, and economic benefits.

2. **Strategic risk-taking is essential to attract private capital.** NbS projects often have long payback periods and complex, hard-to-monetize benefits. Public actors can absorb early-stage risk through concessional loans, guarantees, or subordinated positions, making projects bankable and appealing to commercial investors.

3. **Carbon markets can provide sustainable financing for NbS.** By monetizing carbon sequestration, NbS along railway corridors generate recurring revenue streams that can support funding of both implementation and long-term maintenance, reducing dependence on grants or short-term financing.

4. **Robust governance and institutional frameworks are essential to action carbon credit benefits.** Clear carbon rights, MRV systems, regulatory oversight, and capacity-building enable carbon-financed NbS to scale, maintain integrity, and attract private investment while aligning with national climate and development priorities.

Building Impact-Oriented Pipelines

5. **Early-stage support builds pipelines of investable projects.** Grants, technical assistance, and project preparation funding enable project developers, communities, and local governments to structure projects, gather baseline data, and meet due diligence requirements. This foundation reduces transaction costs and increases investor confidence.

6. **Systematize NbS valuation for financeable evidence.** Quantifying benefits such as avoided damages, livelihood gains, and resilience dividends enables NbS to be embedded in project appraisals, infrastructure planning, and investment decisions. Standardized methodologies provide the evidence investors and development banks need to allocate finance at scale.

7. **Scale from individual assets to system-wide interventions.** Applying NbS at the level of corridors, catchments, or landscapes multiplies resilience dividends across sectors. Drawing lessons from implemented projects—both successes and challenges—helps refine designs, improve efficiency, and inform replication. Integrated approaches protect more than a single asset, reduce cumulative risks, and attract larger-scale public and private investment.

8. **Build evidence-based pipelines to attract investment.** Quantifying NbS benefits, such as avoided damages and ecosystem services, enables governments and investors to prioritize interventions with the highest returns. Standardized tools and spatial analysis provide the data needed to guide decision-making and unlock private capital.

Strengthening the Enabling Environment

9. **Standardization and enabling policies unlock scalable investment.** Fragmented reporting, unclear valuation, and regulatory uncertainty limit private participation. Common measurement frameworks, deal structures, and supportive policies ensure projects are replicable, credible, and integrated into broader development strategies.

10. **Embed governance and local ownership.** Inclusive stakeholder engagement and community involvement ensure that NbS are technically sound, socially sustainable, and operationally durable. Strong governance and local participation increase project feasibility, long-term maintenance, and resilience outcomes.

11. **Integrate NbS into national and sectoral planning.** Embedding NbS into infrastructure and development pipelines ensures projects are actionable, replicable, and aligned with national adaptation strategies. Coordinated planning strengthens investor confidence, improves financial viability, and maximizes socio-ecological benefits.

Image credits: © GCA

Introduction

Nature-based solutions (NbS) are emerging as a cornerstone for sustainable climate adaptation efforts, offering multiple dividends by enhancing ecosystems, strengthening socio-economic outcomes, and building long-term climate resilience. NbS can refer to various actions to protect, sustainably manage and restore ecosystems that address societal challenges (See Box 1), and aim to help societies address a variety of environmental, social and economic challenges in sustainable ways (European Commission (2015)). By working with natural processes, such as restoring mangroves to reduce coastal flooding, reforesting watersheds to stabilize slopes, or rehabilitating wetlands to manage riverine floods, NbS provide cost-effective, and scalable measures that reduce climate risks to assets, systems and communities, while generating co-benefits for biodiversity and livelihoods.

As climate and environmental pressures intensify globally, the case for NbS has never been stronger. According to the World Bank's *Reboot Development*[1] report, 90 percent of people globally already live with at least one of the following stressors: degraded land, unhealthy air, or water scarcity. In low-income countries, 80 percent of people face all three simultaneously. In parallel, climate change is sharply increasing the frequency and severity of hazards, with climate-related damages escalating. Floods already cost transport infrastructure between $3.1 and $22 billion annually, with losses projected to rise significantly as exposure grows. By 2050, the length of roads exposed to flood hazards may increase by nearly 20 percent, while disruption times in some regions could be up to 14 times higher than historic levels. Evidence consistently shows that climate adaptation pays off, with benefit-cost ratios for NbS and other resilience measures often ranging from 2:1 to 10:1.

It should be recognized that important progress has been made in mainstreaming NbS into global and national policy frameworks, with growing recognition that NbS can also play an effective role in achieving UN Sustainable Development Goals and meeting Paris Agreement targets. Over 80 percent of updated Nationally Determined Contributions (NDCs) now reference the protection or restoration of ecosystems,[2] and nearly all new National Adaptation Plans (NAPs) prioritize ecosystems and biodiversity as core components of adaptation[3]. This policy shift is reflected in tangible action observed on the ground: for instance, the number of new NbS projects initiated across sub-Saharan Africa increased by an average of 15% annually from 2012 to 2021[4], and between 2012 and 2024, the World Bank financed about 250 investment projects that harness nature to build climate resilience[5].

Yet despite their promise, NbS remain underfunded and underutilized at scale. UNEP (2023) estimates current global finance flows for NbS at $200 billion a year, just one third of what is required to meet climate, biodiversity, and land degradation goals by 2030. Of this, 82 percent comes from governments, with private capital remaining marginal. In Europe, only 3 percent of NbS projects receive substantial private investment, and four out of five are valued under €10 million - too small to attract institutional investors. This leaves most NbS fragmented, grant-dependent, and difficult to scale. Meanwhile, private sector investment in activities that directly harm nature is at least $5 trillion annually, almost 140 times greater than flows into nature-positive solutions. This imbalance highlights both the scale of the challenge and the growing opportunity to redirect capital towards NbS as a mainstream adaptation strategy.

This *Adaptation Insights* explores some of the barriers that are holding back financing and action for NbS at scale, as well as the opportunities to overcome them. It builds on findings from the Global

1. Reboot Development: The Economics of a Livable Planet
2. Nature-based Solutions Initiative | Revised climate pledges show enhanced ambition for nature-based solutions
3. napgn-en-2024-tracking-progress-nbs-eba-nap-processes.pdf
4. Growing Resilience: Unlocking the Potential of Nature-Based Solutions for Climate Resilience in Sub-Saharan Africa | World Resources Institute
5. Mobilizing Nature-Based Solutions for Disaster and Climate Resilience

Center on Adaptation's (GCA) project experience, analytics, and convening efforts[6], alongside a wider evidence base of literature review, to share key insights and lay foundation for recommendations aimed at scaling up and systemically integrating NbS into investment decisions for climate adaptation.

The forthcoming chapters move from examining financing models to exploring practical conditions that enable investments in NbS. They will seek to answer questions such as: How can private capital be effectively mobilized to increase finance flows for NbS? What role can investment-ready metrics play in translating NbS concepts and pilots into larger scale implementable projects? How can existing tools help stakeholders assess project readiness and structure investments more effectively? And how can emerging carbon credit frameworks offer new pathways to ensure long-term financing of NbS?

The analysis will explore four specific pathways to scale NbS for climate adaptation investments:

- **Leveraging public funds** to de-risk and unlock private investments for NbS.
- **Quantifying resilience value and adaptation benefits of NbS** through standardized valuation frameworks to define financing rationales that support access to dedicated climate finance.
- **Developing national pipelines of investable NbS projects**, supported by analytical tools and spatial prioritization to integrate NbS into planning and infrastructure portfolios.
- **Leveraging innovative financing instruments such as carbon credits**, to support implementation and long-term development of NbS.

Fundamentally, the insights in this paper aim to underline that NbS can move beyond fragmented pilots to become mainstream, financeable strategies for climate-resilient development. It recognizes that the challenge is not only to close the financing gap, but to reframe NbS as essential strategies for climate adaptation, to be embedded systematically in planning and project preparation, supported by robust pipelines, and backed by capital flows that align with their multiple dividends and long-term value.

Box 1: Nature-based Solutions Definition and Financing Context

Nature-based solutions (NbS) are defined as "actions to protect, sustainably manage, and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits"[7]. They leverage the power of natural processes to tackle issues like climate change, natural disasters, water security, and food security, while also ensuring benefits for people and the environment.

Not all Nature-based Solutions (NbS) offer the same financial appeal. Many current investments focus on established sectors like agriculture, forestry, aquaculture, and tourism, which have clear revenue streams from products and services while also enhancing community and supply chain resilience. More innovative NbS—such as green infrastructure and ecosystem restoration—deliver significant social and economic benefits, including adaptation and resilient benefits, but struggle to generate direct financial returns -This adaptation insight focuses on mobilising finance for this type of NbS. The third type of NbS is traditional conservation projects, which focus mainly on protecting nature.

6 Through their technical assistance programs, GCA aims to support governments and multilateral institutions in mainstreaming NbS into climate adaptation investments, e.g through: identifying and prioritizing NbS through appraisals and multi-dimensional cost-benefit analyses, developing metrics and tools to demonstrate their adaptation value, and supporting efforts to mobilize financing. Through platforms such as the NbS Financing Roundtables, GCA works to bring together policymakers, financiers, and technical partners to align priorities, share insights, and accelerate collective action on NbS for climate resilience.

7 Definition from IUCN Global Standard for NbS

01

Mobilizing Finance for Nature-Based Solutions: Public Funds as Catalysts for Private Investment

Mobilizing Finance for Nature-Based Solutions: Public Funds as Catalysts for Private Investment

Bridging the NbS finance gap and realizing their full potential depends on unlocking private finance at scale. Mobilizing private investment, however, is constrained by structural barriers inherent to NbS. NbS projects are often novel, location-specific, small in scale and require long-term operational support. Their benefits (such as resilience, biodiversity and social inclusion) are difficult to monetize, making them less attractive to commercial investors unless risks are shared and enabling conditions are in place.

A little portion (15% worldwide (World Bank, 2019)) of bank loans are “green” as the financial capital of lending institutions, leave NBS strapped for funds they need to operate and grow a business. While there is a number of critical bottlenecks constraining the growth of a highly-productive bioeconomy, financing NBS remains the leading cross-cutting catalyst and an additional source of income. Demand for finance in NBS spans a range of different types of capital – a portfolio that varies from short-term returns to long-term gains and equity investment. Regardless of the operating model, financing NBS can stimulates investments in offsetting loss and damage while increasing productivity through positive outcomes for policymakers, development institutions, private sector and local communities.

Recent literature has underscored the importance of blended finance and institutional innovation in overcoming the challenge of mobilizing private investment for NbS. Van Raalte and Ranger (2023) highlight the role of specialized investment managers and nature-focused funds in structuring complex, high-impact transactions that integrate Environmental and Social Governance (ESG) and adaptation outcomes. Earth Security (2021) outlines a typology of blended finance instruments—including concessional capital, guarantees, and technical assistance—that can be deployed to de-risk investments and crowd in private capital. Swann et al. (2021) emphasize the need for public international finance to evolve beyond grants, recommending more strategic use of concessional instruments to support long-term viability. Terranomics (2022) points to the lack of standardization and trusted investment structures as key barriers, calling for clearer metrics and risk-sharing mechanisms to engage mainstream financial actors.

This chapter builds on these insights to explore how public and concessional finance can be leveraged to mobilize private investment in NbS and generate multiplier effects.

1.1 Addressing Market Failures: Why Nature Remains Undervalued

NbS are undervalued in financial markets despite proven adaptation benefits. The perceived higher risk for investments in the NBS sector, along with lower expected returns compared to other productive systems significantly limit the flow of finance into the sector. The real challenges which limit the attractivity of NBS is its obvious determinant as co-variant of several risk profiles. Practical challenges exists such as fragmented supply chains, non-harmonized approach, inefficient governance and land tenure. As a result of both perceived and real considerations, banks and other financial institutions tend to limit the involvement in NBS when building their portfolios. The chances to find NBS in business case will be when blended in know sectors such as agriculture or forestry which often apply unique operating models that defer from the plurality of NBS options. Ecosystems provide essential services such as flood protection, carbon sequestration, and water regulation, but these are rarely monetized. Consequently, capital flows favor sectors with clearer commercial returns, such as agriculture, forestry, aquaculture or tourism, leaving adaptation-specific outcomes underfunded (Van Raalte & Ranger, 2023).

The absence of standardized metrics and investment structures limits replicability and investor confidence. Financial institutions perceive NbS for adaptation as a novel and complex asset class. Unlike infrastructure or renewable energy, NbS lacks common valuation frameworks and transaction templates. Terranomics (2022) highlights that the lack of such for metrics[8] and methodologies makes it difficult for developing countries, project developers, development institutions, and investors to appraise and compare NbS options against other investment options; thus, they often are not prioritized.

Public funding is overly reliant on grants, constraining its leverage potential. In 2018, up to 80% of tracked international funding for NbS was grant-based (Swann et al., 2021). Grants are essential for early-stage support but insufficient to support longer-term operational costs. Many NbS projects lack stable revenue streams to cover these costs and limited visibility on how O&M will be financed often deters investors—widening a funding gap that neither private capital nor developing countries can realistically fill. In this context, concessional instruments and results-based financing could play a critical role in attracting commercial investment.

The complexity and illiquidity of NbS investments deter mainstream financial participation. Nature-focused funds often operate in private markets using bespoke instruments such as ESG-linked covenants, carbon dividends, and impact-adjusted interest rates. These require active post-investment management and long-term horizons, making replication difficult and limiting appeal to traditional asset managers (Van Raalte & Ranger, 2023).

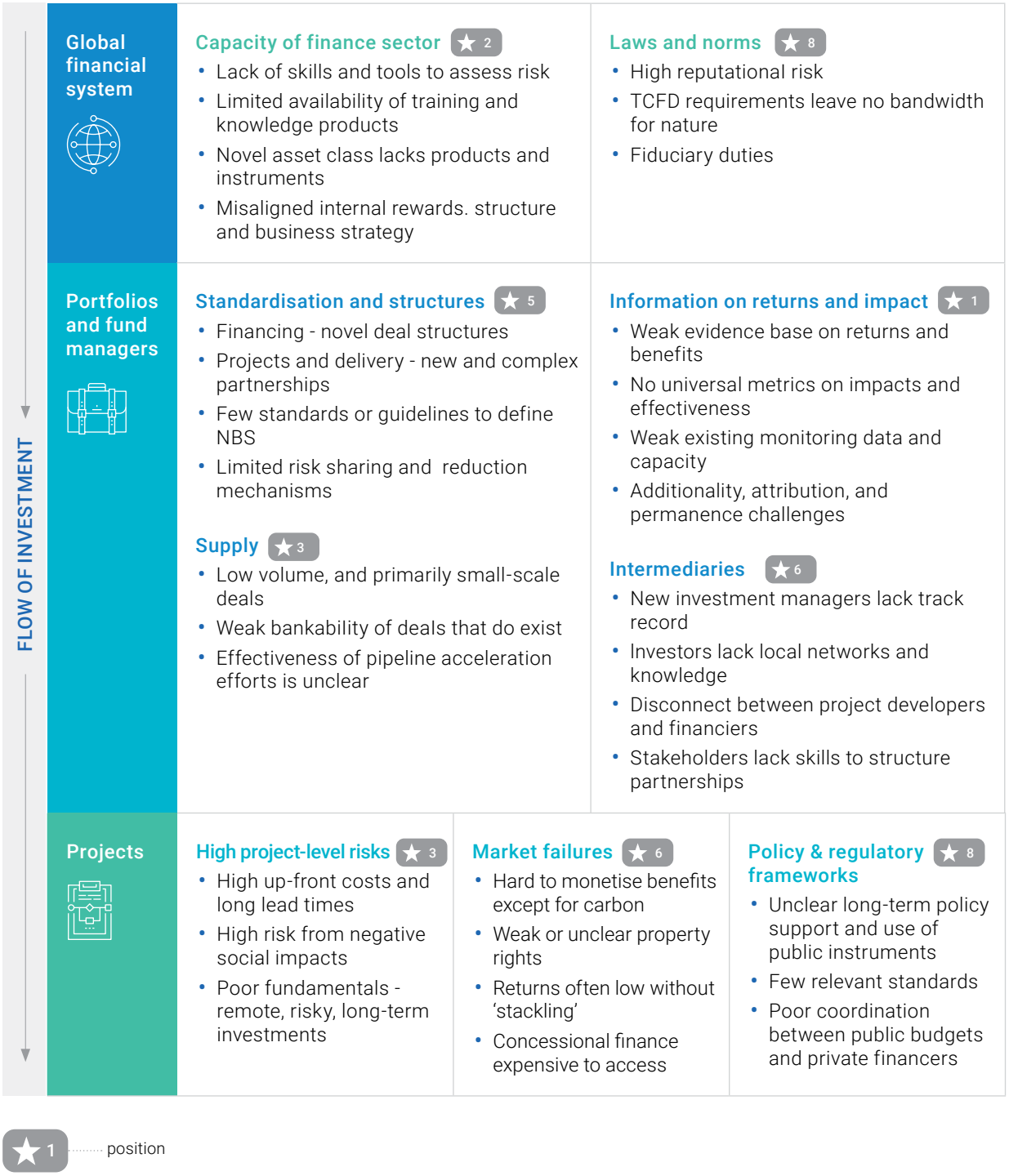
1.2 Blended and De-risking Instruments to Unlock Private Capital

Public finance plays a foundational role in catalyzing private investment in nature-based solutions (NbS). By providing concessional loans, guarantees, and first-loss capital, development finance institutions and donor governments reduce the perceived risks that often deter private investors. These instruments lower the cost of capital and increase project bankability, enabling private actors to participate in projects that would otherwise be considered too risky or uncertain. Strategic deployment of public funding is particularly impactful when it addresses specific barriers such as long payback periods, complex regulatory environments, or uncertain revenue streams (Van Raalte & Ranger, 2023).

8. Although there are some systems, standards, and tools currently in development (For example, the International Union for Conservation of Nature has been leading the development of a global standard for NbS writ large, and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) supported the development of a framework for defining criteria and standards for NbSA in 2018 (see FEBA 2017)), as of now, no commonly agreed upon set of performance metrics to determine the impact of NbSA investments (individually or collectively) exists.

Figure 1: Barriers to investment in Nature Based Solutions

On the basis on qualitative interviews with experts from mainstream financial institutions, impact investors, and NbS-focused intermediaries, the Terranomics (2022) report provides a ranked analysis of key barriers to scaling NbS finance. *This ranking reflects the frequency of mentions for each barrier.*



Beyond financial de-risking, public actors support early-stage project development through grants and technical assistance. These interventions help project developers conduct feasibility studies, establish impact measurement frameworks, and build local capacities, all of which are critical for attracting private capital. Well-prepared project pipelines reduce transaction costs for private investors and improve confidence in both ecological and financial outcomes. This combination of preparatory support and financial instruments demonstrates how public interventions create the conditions necessary for private participation at scale (Swann et al., 2021; Terranomics, 2022).

Blended finance structures provide a central mechanism through which public and private actors interact. Blending finance for addressing different unmet finance needs in the NBS sector appeals tor different types of financial intermediaries and providers of capital –from commercial banks to private equity funds, state-run agricultural development banks, microfinance institutions and non-banking financial entities such as merchant banks, credit unions, insurance companies and mobile money providers. By layering concessional finance with commercial capital, blended structures allow private investors to achieve market-rate returns while sharing risk with public entities. Blended finance has successfully mobilized substantial private investment in projects ranging from forest restoration to coastal resilience. These structures illustrate that public finance does not substitute for private capital; rather, it leverages it, creating a multiplier effect that increases the total volume of funding for NbS. (Earth Security, 2021).

Specialized investment managers and nature-focused funds act as intermediaries, translating public support into viable investment opportunities. They bring expertise in deal structuring, risk management, and monitoring of environmental and social outcomes, ensuring that both public and private objectives are met. Supporting these specialized actors through blended finance accelerates market formation, enhances private capital flows, and improves the quality and impact of funded projects (Van Raalte & Ranger, 2023).

Ultimately, the complementarity between public and private actors is what enables NbS to scale. Public finance reduces risk and builds pipelines, technical assistance improves project readiness, and specialized funds convert these conditions into bankable opportunities. Private investors bring scale, efficiency, and additional capital, allowing projects to expand beyond what public funding alone could achieve. This synergistic relationship is essential for mobilizing the investment required to deliver measurable climate, biodiversity, and social outcomes at scale (Swann et al., 2021; Terranomics, 2022).

1.3 Key Lessons for Scaling Finance for Nature-Based Solutions

Coordination and complementarity between public and private actors maximize impact. No single actor can scale NbS alone. Public finance reduces risk and catalyzes innovation, private investors bring scale and efficiency, and specialized funds link the two. Strategic coordination ensures capital flows are leveraged effectively, generating multiplier effects that deliver social, ecological, and economic benefits. This principle is echoed across all four reports, with Van Raalte & Ranger (2023) calling for deeper collaboration between DFIs, nature-focused funds, and commercial investors to build viable markets for adaptation finance.

Tailored investment structures and strategic public risk-taking are essential to scale NbS. Adaptation benefits are long-term and difficult to monetize, making NbS inherently complex investments. Public actors must strategically absorb risk—through concessional capital, guarantees, or subordinated positions—to make projects bankable and attractive to private investors. Van Raalte & Ranger (2023) emphasize that Nature Funds often rely on highly structured transactions with ESG-linked features and blended capital stacks to manage downside risk and attract commercial co-investment.

Box 2: Specialist investment managers and dedicated nature funds complement DFIs by deploying targeted, high-impact capital in emerging areas.

Their value lies in niche expertise, innovative structuring, and active management.
For example:

- The &Green Fund, managed by Sail Ventures, blends concessional and commercial capital to finance sustainable commodity supply chains, demonstrating how de-risking structures can attract private investors to sectors with high deforestation risks.

- Aqua-Spark, a Dutch impact fund dedicated to sustainable aquaculture, shows how specialist managers can build credibility and scale in a niche NbS sector. By focusing on fish feed innovation and sustainable farming practices, Aqua-Spark delivers both adaptation benefits and financial returns.

- In Latin America, the Cloud Forest Blue Energy Mechanism exemplifies this approach: hydropower companies invest in forest restoration to secure long-term water supply, supported by early-stage grants from FMO, GEF, and Conservation International. The mechanism uses results-based financing, where payments from hydropower operators are contingent on verified reductions in sedimentation over a 3–5 year period. These ecological improvements reduce water treatment costs and are projected to extend the operational lifespan of hydropower assets by up to 10 years—demonstrating how nature-positive investment can deliver measurable financial and environmental returns in developing economies (Earth Security, 2021).

These managers act as market innovators: experimenting with equity, mezzanine loans, and impact-linked pricing, while providing hands-on governance and monitoring. They also create pipelines of projects that may not otherwise reach a investable scale. However, most funds remain small (<$250m AUM) and depend heavily on DFIs and concessional capital. Supporting them with anchor investments and innovation incentives is essential to scale their role.

Early-stage support is critical for developing a pipeline of investable projects. Grants, technical assistance, and project preparation funding enable communities, local governments, and SMEs to structure projects, gather baseline data, and meet due diligence requirements. Technical assistance also strengthens institutional capacity and ensures projects are socially inclusive and ecologically sound (Earth Security, 2021). Van Raalte & Ranger (2023) note that many Nature Funds operate dedicated technical assistance facilities to support pre- and post-investment activities, helping bridge the gap between concept and investability.

Public finance must evolve beyond grants to include concessional and risk-sharing instruments. Long-term sustainability and scalability require tools such as subordinated debt, partial credit guarantees, and results-based finance. These allow public finance to catalyze private investment while maintaining accountability for environmental and social outcomes. Swann et al. (2021) highlight the need for donors to deploy flexible instruments across the project lifecycle, especially in contexts where revenue streams are weak or delayed.

Standardization and measurement frameworks are critical for investor confidence. Fragmented reporting and unclear valuation increase transaction costs and limit private participation. Common frameworks for impact measurement, deal structuring, and risk-sharing reduce uncertainty and facilitate replication, building the foundation for NbS as a mainstream asset class. Terranomics (2022) stresses that the lack of trusted standards and metrics remains a key barrier, particularly for institutional investors unfamiliar with nature-related risk and return profiles.

Policy and regulation determine long-term scalability. Governments must embed nature into economic and regulatory frameworks, adopt enabling policies, and catalyze nature-positive investment. This ensures NbS are integrated into national development strategies rather than remaining a niche sector. Van Raalte & Ranger (2023) argue that regulatory reform is essential to mainstream nature into core business and investment practices, and that policy signals can unlock latent demand for nature-positive assets.

Image credits: © GCA

Box 3: Nature-based Solutions Compendium for Urban Resilience in Kenya.

Kenya is rapidly urbanizing, with 31% of the population living in urban areas (2019), a number that is projected to reach 50% by 2050. While urbanization supports economic growth and improved living standards, it also increases the exposure of people, assets and livelihoods to climate hazards, especially to floods and droughts. Nature-based Solutions (NbS) provide an innovative pathway, using ecological processes to enhance resilience while delivering multiple co-benefits, such as improved water management, biodiversity conservation, and greener public spaces.

Through the Africa Adaptation Acceleration Program (AAAP), the Global Center on Adaptation (GCA) is partnering with the World Bank to support the *Second Kenya Urban Support Program (KUSP II)*. The program aims to strengthen the capacity of Kenyan municipalities to plan and deliver climate-resilient urban infrastructure and services. Together with the World Bank, GCA is working to mainstream NbS into urban planning and infrastructure investments.

GCA is advancing the uptake of NbS within Kenya's urban development agenda by documenting, strengthening and scaling local examples of NbS interventions. GCA developed a national NbS Inventory, which compiles a comprehensive collection of NbS interventions across Kenyan cities. The inventory identified 26 existing NbS initiatives in cities such as Nairobi, Mombasa, Nakuru, Eldoret, Wote, and Kikuyu. These cases illustrate how wetland restoration, urban forests, and green corridors can reduce flood risks, lower urban temperatures, and enhance community well-being.

Building on this evidence and the NbS Opportunity Scan conducted by the World Bank's Global NbS Team in six cities (i.e., Eldoret, Kilifi, Kisumu, Mandera Nakuru, and Wote), GCA produced the NbS Compendium for Urban Resilience in Kenya, launched in June 2025. Building on the NbS Inventory, the Compendium prioritizes the most relevant examples, offering in-depth analysis and targeted recommendations to support implementation and integration of NbS into urban planning and investment pipelines. The Compendium was developed through an inclusive process involving field visits, key-informant interviews, and validation workshops with more than 75 stakeholders from national, county, and municipal institutions.

To complement these efforts, GCA has also developed an NbS Training of Trainers (ToT) module to equip municipal officials and urban planners with the knowledge and skills to integrate NbS into urban planning and infrastructure projects. This ToT will be incorporated into GCA's Urban Climate Resilience Masterclass, to be rolled out by the Kenya School of Government, ensuring long-term institutionalization and sustained impact.

02

From Pilots to Systems: Quantifying and Scaling Adaptation Benefits of NbS

From Pilots to Systems: Quantifying and Scaling Adaptation Benefits of NbS

Nature-based Solutions (NbS), despite their proven ability to reduce climate risks, protect assets, and deliver resilience dividends, are still selected only sporadically in infrastructure planning. Too often they remain the exception rather than the rule.

Drawing on GCA's technical assistance in assessing, planning, and mobilizing finance for climate-resilient infrastructure, this chapter shares insights on how upstream standardized methodologies—such as climate-risk stress tests, vulnerability curves, and cost–benefit frameworks—can provide the evidence needed to demonstrate and quantify their value ahead of NbS program implementation. Embedding these approaches into project preparation is the critical step to move NbS from occasional use to a systematic, financeable adaptation strategy.

2.1 Embedding Resilience Metrics into Infrastructure Finance

Demonstrating how NbS boosts the resilience of infrastructure investments is an effective opportunity to unlock finance for their implementation. Meeting global demand for new and upgraded infrastructure will require an estimated $106 trillion by 2040[9], with climate change posing a direct and increasing risk to these investments. Investors and development banks want assurance that every dollar invested into infrastructure will withstand future climate shocks. Demonstrating how NbS reduce climate risks, protect assets, and deliver broader dividends is therefore not only an environmental case—it is a clear economic one. Quantification of these benefits is a critical step: by embedding NbS in infrastructure planning frameworks, their benefits can support financing rationales that can unlock climate funds, concessional finance, and blended capital.

Finance flows to what can be tracked. For multilateral development banks (MDBs), investment projects can only qualify as climate adaptation, and thereby open doors for climate funds and ensure alignment with the Paris Agreement, if they demonstrate three key elements: (i) exposure to climate risk (ii) a plan to reduce it, and (iii) alignment with national or sectoral resilience strategies. This is embedded in joint MDB Paris-alignment principles (MDBs group, 2023) and adaptation finance tracking (EIB, 2022), governing scope and subsequent approval of project preparation phases. Without standardized evidence that demonstrates benefits, NbS risk being overlooked despite their proven potential.

Translation of climate resilience into economic variables has become standard practice. Tools such as the Disaster and Climate Risk Stress Test (WBG, 2021) translate resilience into an economic indicator

9. Green, Alastair, Ishaan Nangia, and Nicola Sandri. 2025. The Infrastructure Moment: Investing in the Expanding Foundations of Modern Society. McKinsey & Company.

by stress-testing assets against hazards and comparing the effectiveness of measures. Fragility and vulnerability curves, now available in global databases of over 1,500 datasets (Nirandjan et al. 2024), allow transport, energy, and water projects to be stress-tested with increasing precision. To address these growing risks, grey adaptation solutions (i.e., engineered or built infrastructure solutions) more often clear the bar because their direct positive impacts are simpler to quantify and their implementation is more straightforward. The investment case for NbS too often stumbles—not for lack of demonstrated impact, but due to weak ex-ante and ex-post evidence bases. Ex-ante analyses are constrained by context-specific designs and limited standardization, while ex-post evaluations seldom yield comparable, quantified benefits. Bridging this gap is essential to mainstream NbS as credible, investable adaptation solutions.

Figure 2: Assessing Climate Risks and Identifying Relevant Adaptation Solutions (source: GCA)

GCA's project experience shows that adaptation solutions can deliver strong financial returns by reducing losses and safeguarding revenues of infrastructure assets. For example, in São Tomé, GCA found integrating NbS through bio-engineered road slopes, paired with drainage systems, road elevation, and coastal protections into a road renovation project cut projected climate damages by over a third, with BCRs between 2:1 and 5:1. Along a 1500km Transmission line between Mauritania and Mali, GCA prioritized recommended adaptation measures[10] such as the use of heat resistant conductors or wind erosion tower protections, valued at less than 2% of total investment, yet expected to avert losses equal to 10% of asset value and while securing energy access for 100,000 households. The prioritization included NbS interventions to stabilize slopes and limit desert encroachment to assets such as solar plants and sub-stations, enhancing the long-term sustainability of the resilience measures.

But these remain isolated operational examples of mid- to large-scale NbS for adaptation of infrastructure assets. Unlocking their full potential requires embedding risk assessment, avoided losses, and resilience dividends systematically into planning and investment. Standardized tools—such as climate-risk stress tests, vulnerability curves, cost–benefit frameworks, and the CRVA—provide essential guidance, but there is no one-size-fits-all approach. Each NbS program is shaped by local ecosystems, socio-economic conditions, and geographic realities, so benefits will differ from case to case. Recognizing this, combining standardized assessment with locally grounded data and sustained stakeholder engagement is critical to ensure NbS are not only well-designed but deliver meaningful, context-specific outcomes. Mainstreaming this approach is the path to move NbS from isolated successes to a scalable, investable adaptation strategy.

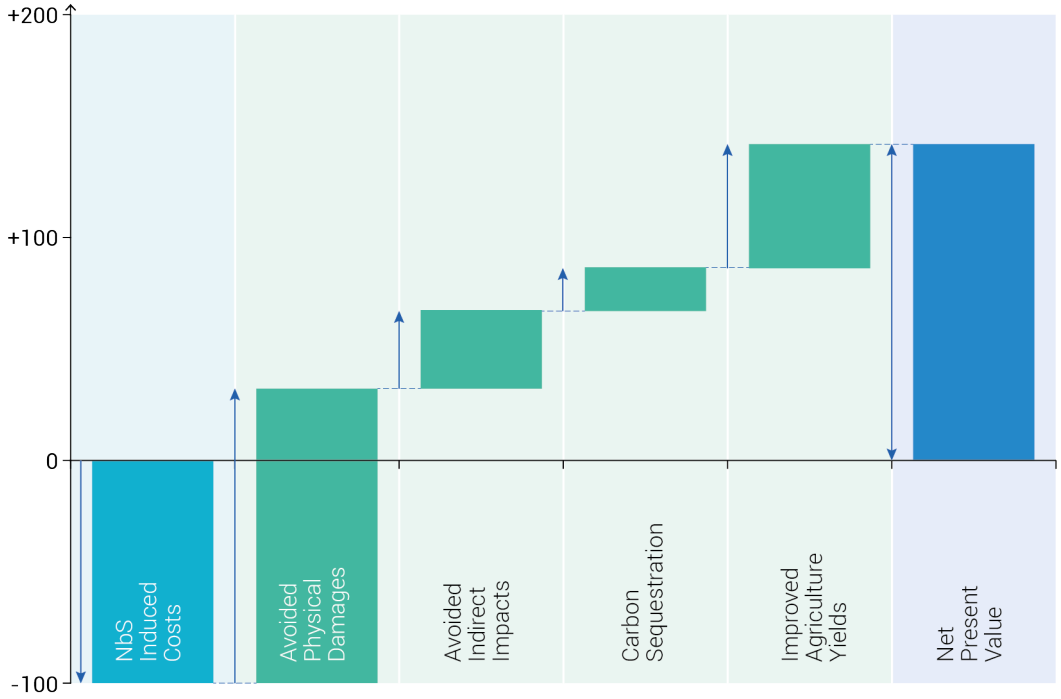
2.2 Operationalizing NbS for System-Wide Resilience

It is well established that NbS deliver more than avoided damages, however methods to quantify their multiple benefits remain to be systematized. The World Bank's Guidelines for Assessing the Benefits and Costs of NbS for Climate Resilience provide a decision framework for building credible valuation studies, based on observed implemented NbS projects, delivering a variety of benefits—flood protection, water supply, erosion control—often in tandem with grey infrastructure.

Embedding socio-economic perspectives into climate risk assessments is essential to fully value NbS, as narrow, asset-based, evaluations often overlook the avoided damages, livelihood gains, and productivity benefits that ripple through communities and markets. GCA's technical assistance on Tanzania's Central Railway Corridor[11] (see Box 4) quantified not only adaptation measures' effectiveness to reduce direct flood and sediment risks to the asset, but also their wider economic and environmental returns. These included (i) avoided rail disruptions - each day of climate-related service interruption was estimated to cost the operator several tens of thousands in financial losses (ii) modal shift benefits from freight and passenger travel moving from road to rail; (iii) improved agricultural yields, and (iv) carbon sequestration. Together, these monetized returns far exceed conventional cost–benefit boundaries. Beyond these benefits, NbS also attenuate hazards at their source, often at catchment scale, providing resilience benefits across multiple sectors. The obstacle is not performance—it is proof with systematic application of valuation methodologies that can translate that performance into financeable evidence and a clear implementation strategy.

10. GCA, Climate Adaptation of Mauritania-Mali Interconnection and Solar Generation Project, 2024
11. GCA, Climate Adaptation of Tanzania Rail Project (TIRP2), 2024-2025

Figure 3: Example of cost-Benefit Analysis for Nature-based Solution for Infrastructure Resilience (Source: GCA) – A positive Net Present Value (NPV) indicates that the monetized benefits of the solution exceed its induced costs



NbS generate system-wide resilience when applied at catchment or corridor level rather than confined to a project's right-of-way. In GCA's technical assistance to AfDB's Mozambique's Songo–Matambo transmission line investment project[12], vegetation management and slope stabilization showed BCRs up to 4:1, not only protecting pylons but also reducing wildfire and landslide risks across entire landscapes. Likewise, on the AfDB Kampala–Malaba railway investment project in Uganda[13], GCA, in partnership with WWF, has provided evidence on how catchment-level interventions—floodplain restoration, reconnection of seasonal streams, and peak-flow controls—can reduce runoff by up to 50%, reducing flood risks and improving reliability for regional trade while also safeguarding surrounding farmland and communities. These examples show that scaling NbS requires a shift in perspective: from single-asset protection to integrated basin management, where resilience dividends multiply across sectors.

Moving from plans to practice depends on more than metrics—it requires meaningful consultation, genuine local ownership, lasting partnerships, and clear pathways for delivery. Consultations are only the beginning; sustained ownership and collaboration are what ensure the longevity and predictability of returns on NbS investments. Embedding the local context—both in decision-making and in implementation—helps maintain relevance as social, political, and economic conditions evolve. Robust implementation plans, backed by practical financing mechanisms, must guide projects from concept to execution while anticipating how local governance and capacity will be maintained over time. Multi-level stakeholder consultation, from national ministries to local institutions, helps align priorities and avoid blind spots. Locally-led adaptation can be a key game changer: building on existing practices, and partnering with local NGOs and community actors, makes NbS feasible, grounded and more durable. In projects from energy corridors to railways, communities already can play a central role wildfire management or in vegetation maintenance, playing a key role in asset adaptation. In Sao Tome, for example, existing GIME[14]'s groups are central actors of road maintenance. GCA support to

12. GCA, Climate Adaptation of Mozambique Songo-Matambo Electricity Transmission Line, 2024-2025
13. GCA, Climate Adaptation of Kampala-Malabe Meter-Gauge Refurbishment Project, 2023
14. GIME: Grupos de Interesse de Manutencao de Estradas (Interest Groups for Road Maintenance)

the WB investment has identified their involvement in adaptation and vegetation maintenance as a primary adaptation solution to be included in project budget. Embedding these approaches including communities ensures NbS are not just designed well but implemented with local lasting roots.

Scaling NbS requires national pipelines built on robust evidence and aligned with global adaptation frameworks. Development banks and line ministries must integrate NbS valuation into project preparation — embedding metrics that speak both to investment returns and to adaptation outcomes. In particular, using the Global Goal on Adaptation (GGA[15])'s targets and indicators provides a credible path for quantifying adaptation benefits (e.g., reduced vulnerability, increased resilience, improved livelihoods) and monitoring progress against global benchmarks. This alignment creates portfolios of truly investable projects with transparent, quantified benefits, strengthens access to international climate finance, and brings private investors to the table. Without this shift, the trillion dollar scale of infrastructure investment required risks locking in vulnerability; with it, NbS can anchor a mainstream resilience strategy.

Image credit © Pegasys

15. Report of the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement - COP29

Box 4: Strengthening Tanzania's Central Railway Corridor resilience with Nature-based solutions and scaling impact at the Catchment scale

Tanzania's railway network is a key driver of regional logistics and economic integration in the country and for landlocked neighboring countries in the region. The World Bank Group launched the Second Tanzania Intermodal and Rail Development Project to rehabilitate 970 km of railway from Dar es Salaam to Isaka. The project also includes rehabilitating six dams in the Kinyasungwe River catchment to mitigate flood impacts.

Yet climate hazards such as flooding, sedimentation, and extreme weather events are increasingly disrupting operations. The most vulnerable section—Kilosa-Gulwe-Igandu—has seen flood-related closures rise from 8 days per year in 2011 to 120 days in 2023, with projections reaching 180 days by 2080 without adaptation measures.

The Global Center on Adaptation (GCA) has providing technical assistance to strengthen the railway's resilience through climate risk assessments, adaptation recommendations, and institutional capacity building. A hydrological and hydraulic study confirmed the severity of flood risks, showing that 20 km of the Kilosa-Gulwe section is overtopped in a 1-in-2-year flood event, increasing to 36 km in a 1-in-50-year event. The broader risk assessment also identified extreme temperatures and landslides as key threats, with 23 km of railway in high-risk landslide zones.

GCA technical assistance led to the identification and impact-based prioritization of adaptation options contributing to building a resilient railway, improving rail operations reliability, and maximizing co-benefits for project beneficiaries and local communities. The study found that rehabilitating six upstream water reservoirs could reduce peak flood flows by up to 50%, significantly lowering risks to the railway. When combined with engineering solutions—such as railway elevation, culvert expansion, and bridge reinforcement—the overall flood risk reduction could reach 76%.

Picture : Kilosa-Gulwe railway section

Large-scale Nature-based Solutions were also identified as critical for reducing runoff, controlling erosion, and mitigating sedimentation at catchment level.

These measures include:

- Reforestation along riverbanks to stabilize soil and reduce erosion.
- Conservation agriculture practices to prevent land degradation and enhance water retention.
- Targeted erosion control measures to manage runoff more effectively.

When NbS are integrated with engineering solutions, the total risk reduction could reach 89%, making them a cost-effective strategy with a global Benefit-Cost Ratio approaching 5:1. These solutions also generate co-benefits for local communities, such as improved agricultural productivity, better water availability, and healthier ecosystems.

GCA's support for this investment project took an integrated approach—addressing railway assets, services, and water catchment areas—while identifying opportunities for improved water management and nature-based risk mitigation options at the basin level. The detailed identification and prioritization of adaptation options have included engineering solutions that offer direct protection, as well as NbS that address the root causes of high runoff and erosion, exacerbated in the context of climate change. This has unlocked pathways to scale impact beyond the railway, enhancing water catchment management and improved agricultural practice initiatives for greater climate resilience.

As climate change intensifies rainfall variability, solutions such as reforestation, conservation agriculture, and erosion control came out of the analysis as sustainable and cost-effective flood mitigation strategies while offering environmental and socio-economic benefits. Given the vast agricultural landscape within the Kinyasungwe River catchment (59,000 ha of agricultural land), these large-scale NbS have been discussed with the World Bank Group and the project stakeholders, and their potential implementation will require further engagement, including with catchment management authorities and national and local irrigation bodies.

In parallel, the insights from GCA's hydrological studies are informing not only railway design improvements but also future dam development, ensuring that flood mitigation is built into infrastructure planning. Beyond protecting the railway, the rehabilitated dams will benefit local communities in Kilosa District — home to more than 300,000 people — by improving irrigation, increasing water storage for fisheries, and securing water availability for household and agricultural use.

This project underscores the importance of a multi-scale approach to climate resilience—combining infrastructure adaptation with broader watershed management and nature-based solutions to reduce risks while generating long-term socio-economic and environmental benefits effectively.

By embedding climate resilience into Tanzania's railway system, TIRP-2 is securing economic growth, enhancing food security, and promoting sustainable development—not just for Tanzania but for the entire East African region.

2.3 Seizing Investment Opportunities for NbS at national and regional scales

Scaling funding to effective Nature-based Solutions (NbS) for adaptation is key to tackling climate change and supporting sustainable development. NbS can play a crucial role in strengthening infrastructure resilience, and delivering multi-dimensional benefits for mitigation, biodiversity, and livelihoods. Through the Global Tools on NbS and at national level, governments and MDBs could use the tools to embed NbS in project pipelines, creating an important entry point for aligning public investment with private capital mobilization.

NbS such as mangrove restoration, basin-level tree planting, and slope stabilization are well recognized for reducing risks from floods, coastal erosion, and landslides. However, their benefits are rarely quantified in ways that convince investors. At the national level, integrating NbS into development planning and public investment pipelines can help overcome this gap by embedding NbS considerations into budgeting, infrastructure planning, and climate strategies. Yet policymakers and financiers often lack standardized data and assessment tools to identify where NbS deliver the strongest resilience gains or how those gains compare to costs. Strengthening national systems for NbS valuation and monitoring is therefore essential to mobilize finance at the scale required and ensure NbS are systematically mainstreamed into national investment decisions.

To address this challenge, the University of Oxford and the Global Centre on Adaptation (GCA), with support from UK International Development, have developed the Global Tools for NbS. These tools provide a common set of metrics that capture and quantify (with sufficient robustness) the benefits of NbS for infrastructure resilience alongside broader outcomes, such as carbon and biodiversity. These analytics enable investors and governments to identify and prioritise investments in NbS where they can deliver a viable financial return and measurable social benefits. Developed at a global scale, these spatial and financial tools can facilitate greater financial flows toward NbS for climate-resilient infrastructure systems.

By providing a standardized framework, the tools enable investors and governments to identify a pipeline of priority NbS interventions that deliver strong financial and social returns. By leveraging spatially explicit modeling, scenario analysis, and valuation of ecosystem services, these tools enable decision-makers to identify NbS options that optimize resilience outcomes relative to costs. For instance, assessments of mangrove restoration, slope forestation, and floodplain reforestation demonstrate high benefit-cost ratios, highlighting their capacity to reduce flood and erosion risks, safeguard livelihoods, and sequester carbon. Integrating these insights into planning processes ensures that NbS investments are targeted to areas with the greatest exposure and vulnerability, maximizing adaptation impact while promoting sustainable development.

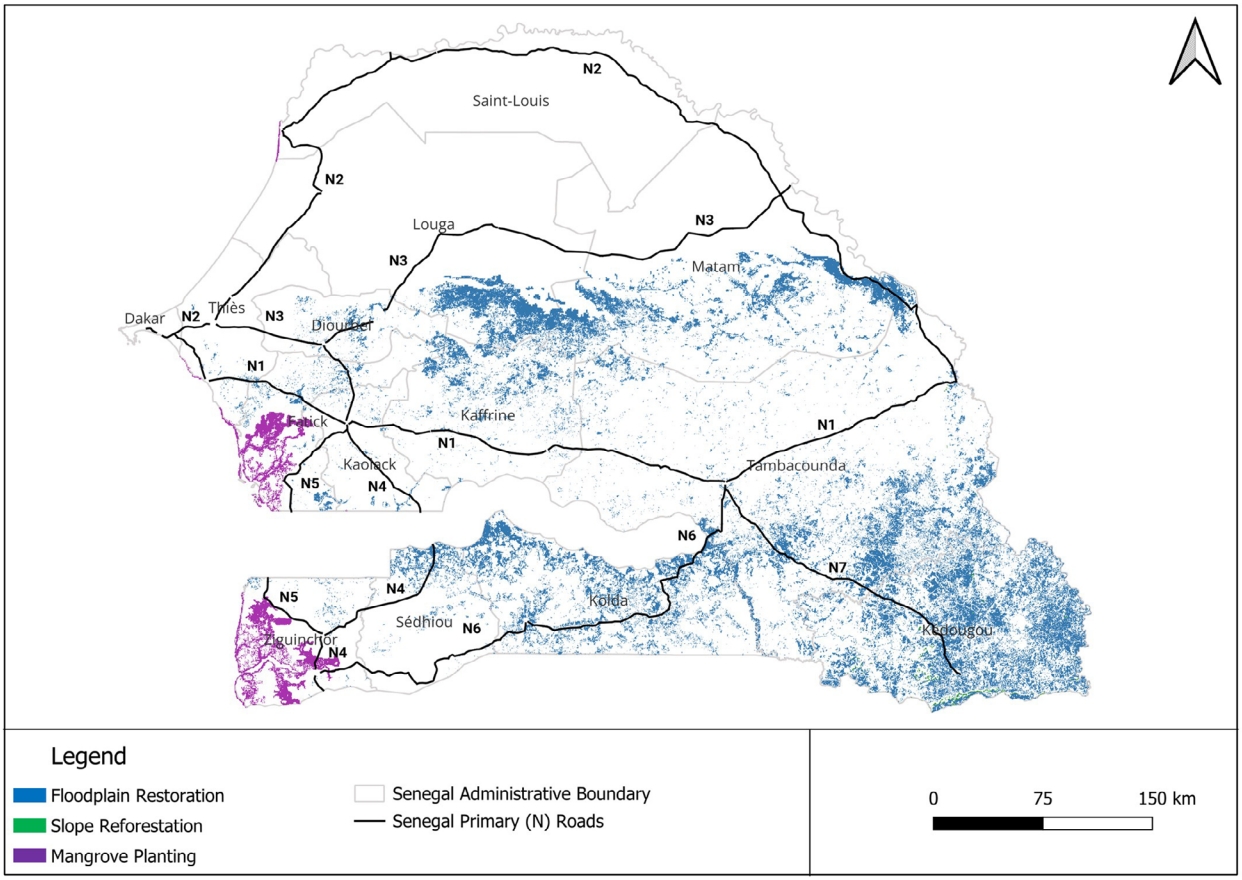
The Global tools on NbS covers three categories of risk reduction:

- Mangrove restoration for reduction of coastal erosion. This is divided into 3 categories, areas with accreting shorelines, areas with neutral to slowly retreating shorelines and areas with fat retreating shorelines, with respective increasing costs in relation to coastal management;

- Tree restoration for the reduction of landslide risk. These are divided into two categories, areas which replace crops (since in some cases the landslide risk may be exacerbated by agricultural activities, and this costly option might be appropriate) and other areas. An additional category where the ground is currently bare is also highlighted. This is a rare case, and may indicate that there is insufficient soil for tree growth;

- Sub basin level plantings for potential flood risk reduction. Here sub basins with risk of flooding are identified, and all potential tree plantings in the sub basin flagged. A variety of different planting approaches can be used to manage flooding, but all require a significant extent of plantings to make a difference. Due to the complexity of river flow, and limited evidence, no downstream effects outside the immediate catchment are considered.

Figure 4: Country-level Assessment - Suitable Areas for Nature-based Solutions in Senegal (source GCA)



Risks of direct damage are calculated for road and rail infrastructure, using return period hazard maps (flooding) or probability of occurrence (landslide) with damage curves and reconstruction/ rehabilitation costs to estimate expected annual damages (EAD) in the current situation, before any NbS intervention. Opportunity areas are identified as patches suitable for planting within each sub-basin, attributed with total area, planting costs, biodiversity and carbon benefits, and the current level of risk to infrastructure posed by each hazard.

The input data and results are visualised within the GRI Risk Viewer, publicly available online, to allow exploration of risks and hazards to infrastructure and potential avoided damages. By combining hazard exposure with asset-level vulnerability curves, the tool estimates avoided costs to transport systems under both current and future climate scenarios. This analysis provides the global results for all opportunity areas, with quantified costs and benefits (Harwood and Russell 2025). The results can be expressed as benefit-cost ratios, return on investment, or avoided damage per capita—metrics that are directly relevant to decision-makers and investors. Based on this, an NBS Opportunity Investment Tool was developed, aiming to support financial decision-making.

Africa is at a pivotal juncture where mounting climate risks and a $100 billion infrastructure financing gap converge with an opportunity for innovation. NbS provide a cost-effective complement to conventional "grey" infrastructure, strengthening resilience while also generating co-benefits for biodiversity, carbon sequestration, and livelihoods.

The analysis highlights the scale of opportunity: $3.6 billion in well-targeted NbS investments could generate $7.59 billion in avoided damages by 2100, a benefit-cost ratio (BCR) of 2.1 that climbs as high as 8.1 for the most effective projects. Even in the near term, the case is strong: an investment of $600 million across 876,829 hectares could yield $1.05 billion in benefits by 2050, delivering a 1.7x return.

This analysis at scale demonstrate that investing in NbS provides financial benefits while addressing challenges of climate adaptation. Returns increase with scale and time, as ecosystem services mature, climate pressures intensify, and implementation efficiencies reduce costs. Top-performing projects with BCRs above 8.0 underscore the potential for NbS to become commercially attractive investments in their own right.

A country-by-country assessment across 54 African nations confirms this potential. Twelve countries, including the Democratic Republic of Congo, Nigeria, Mozambique, and South Africa, show BCRs above 3.0, with nearly 90% of identified opportunities yielding positive returns. The cumulative carbon sequestration potential of 2.38 billion tons further enhances their value, offering access to billions in emerging carbon markets. Taken together, these results make a clear case: scaling NbS is not only a climate and development imperative, but also an investment opportunity. By embedding NbS into infrastructure pipelines, governments and investors can unlock resilience gains, mobilize private capital, and deliver transformative benefits for people and nature across Africa.

The table below presents the assessment results per NbS type across Africa, summarizing the performance of the three NbS interventions prioritized by the project: mangrove restoration, slope forestation, and floodplain reforestation. For each country, the table highlights total cumulative benefits, total costs, benefit-cost ratio (BCR), the percentage of total climate risks addressed, estimated annual damages avoided, and the resulting prioritization of the three NbS options. This overview provides a comparative snapshot to guide investment and implementation decisions, ensuring that resources are directed toward interventions with the highest adaptation impact and economic efficiency.

Table 1: Nature-based Solutions Investment Opportunities By Intervention Type

Intervention	2050 Benefits (USD)	2100 Benefits (USD)	Avg. BCR (2050/ 2100)	Carbon Seq. (t/ ha Avg.)	Area (ha, 2050/ 2100)	Strategic Appeal
Large-Scale Tree Planting	$900M	$6.4B	6.4/ 8.1	500–1,000	751k/ 4.2M	Highest returns; dominates flood prevention across river basins in Central/West Africa
Mangrove Restoration	$65M	$394M	1.5/2.4	200–650	42k/150k	Coastal protection specialist; fastest payback periods; premium ESG appeal
Slope Vegetation	$86M	$817M	1.8/2.2	300–800	84k/597k	Infrastructure protection; stable returns; critical for transport corridors

Box 5: Investing in Nature in Africa: the value at scale

Africa faces an annual adaptation finance gap of $30–50 billion, even as it holds some of the world's greatest untapped opportunities for nature-based investments. Climate impacts are intensifying across the continent -riverine floods, coastal erosion, landslides, and drought- are already imposing heavy costs on infrastructure, livelihoods, and national economies. Yet Africa's vast and diverse landscapes offer enormous potential to deploy NbS at scale, turning risk into opportunity. Well-designed interventions can strengthen resilience while creating jobs, safeguarding biodiversity, and sequestering carbon, delivering multiple dividends from a single investment.

The Global Tools for NbS demonstrate how continent-wide analytics can be translated into investable opportunities for governments, DFIs, and private investors. Developed by Oxford and GCA, the tools show where NbS can reduce risks, generate economic returns, and unlock co-benefits for people, nature, and economies.

Applied to Africa, these tools identify over five million hectares of priority NbS interventions. Investing in just 100 priority opportunities per country could avoid $1 billion in annual damages by 2050, while generating biodiversity and carbon sequestration benefits. At the continental level, $3.6 billion of strategic investment would avoid $7.6 billion in damages by 2100, with benefit–cost ratios averaging 2.1 and reaching as high as 8.1 in top-performing projects. Near-term opportunities are equally strong: $600 million invested by 2050 across 876,000 hectares could yield $1.05 billion in avoided damages, proving commercial viability over a single investment horizon.

The potential varies by intervention type. Floodplain reforestation represents the largest share of potential benefits (84%), highlighting its strong capacity to reduce downstream flood risks in Central and West Africa—though achieving this would require reforestation at an exceptionally large scale. Mangrove restoration, though covering just 3% of the area, provides rapid and cost-effective coastal protection in countries such as Mozambique, where benefits reach $90 million by 2100. Slope stabilization offers more targeted but high-value protection in mountainous regions, with Algeria alone realizing over $500 million in avoided damages by protecting critical transport and trade routes. Together, these interventions provide a diversified portfolio across hazard types and geographies.

The value of NbS is also differentiated across stakeholder groups. For policymakers, NbS transform adaptation from a fiscal burden into an economic engine. From the Global Tools on NbS it's found that every $1 invested generates $2–8 in economic returns, freeing fiscal space for health, education, and infrastructure while delivering visible resilience gains for citizens. For development finance institutions (DFIs), NbS offer a scalable opportunity to meet climate finance mandates. Concessional capital can crowd in $3–5 of private investment for every $1 deployed, multiplying impact and helping to close the $272 billion annual adaptation finance gap. For private investors, NbS provide attractive, risk-adjusted returns with 20–50% upside from carbon credits and ESG premiums, while offering portfolio diversification and a natural hedge against escalating climate risks.

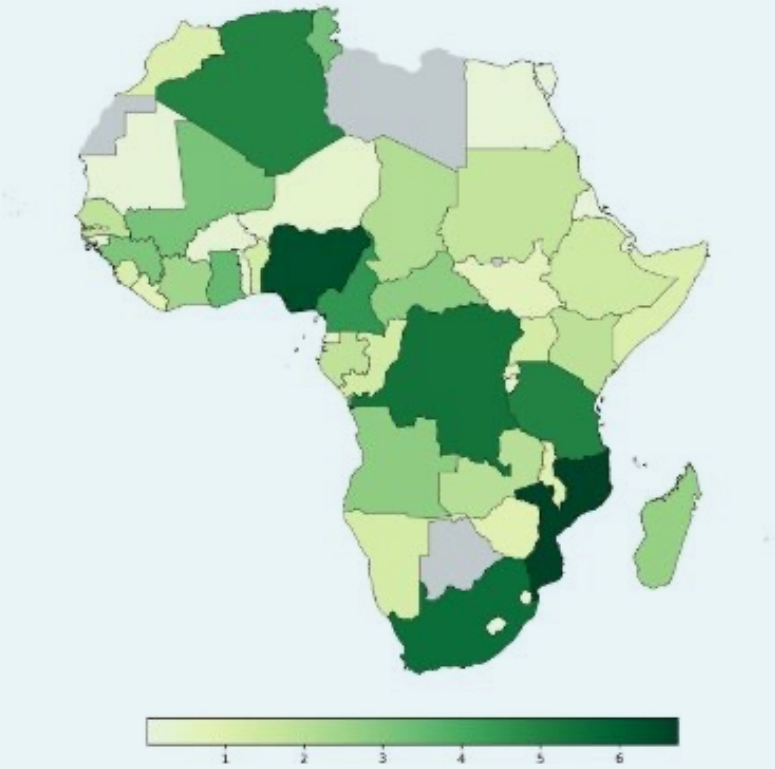
Unlocking this potential requires catalytic action. DFIs play a pivotal role in de-risking NbS investments through concessional finance, first-loss capital, and technical assistance. Successful blended finance funds—such as the &Green Fund and Climate Investor Two, which together have mobilized over $1.7 billion globally—demonstrate that commercial investors will participate when risk is shared and returns are clear. Scaling similar models in Africa can create the enabling conditions for mainstreaming NbS into infrastructure investment pipelines.

In short, Africa illustrates the value of investing in nature at scale. The continent combines high climate vulnerability with vast untapped NbS potential, making it the next frontier for climate-smart infrastructure investment. By leveraging the Global Tools for NbS and GCA's Investor Briefs, governments, DFIs, and private investors have the evidence and pathways needed to convert climate risk into investable opportunity. Investing in nature in Africa can provide transformative economic strategy and mobilize billions, build resilience, and deliver sustainable development across the continent.

Suitable 100 priority opportunities for NbS, per country, would avoid 1 Billion Avoided Annual Damages and provide co-benefits for biodiversity and carbon sequestration by 2050:

- Priority NbS opportunities were selected based on economic performance, spatial suitability, and representation across intervention types.
- From the top 1,000 opportunities per country and NbS type, a balanced subset of 100 (≈33 per type) was retained.
- Selection criteria included a benefit–cost ratio (0.5 < BCR < 50), exclusion of cropland, and a 2050 horizon (10 years growth + 15 years operation).
- The resulting portfolio represents an investment of USD 0.6 billion, generating USD 1.0 billion in benefits (BCR = 1.6).

100 NbS Priority Opportunities per Country



Cumulative Benefits (USD)

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03

Enabling Environments and Innovative Instruments: Exploring Carbon Finance for Resilient Transport Infrastructure

Enabling Environments and Innovative Instruments: Exploring Carbon Finance for Resilient Transport Infrastructure

As climate change intensifies, physical risks to large-scale infrastructure are increasing, driving up repair costs, disrupting operations, and compromising service delivery. These disruptions disproportionately affect vulnerable communities that rely most on reliable infrastructure systems.

This chapter presents a case study on railway systems—critical economic lifelines now facing growing threats from floods, landslides, and rising temperatures that undermine their reliability. It examines carbon credit markets as an innovative financing instrument to support the implementation and long-term development of Nature-based Solutions (NbS) for climate adaptation. Drawing on GCA's technical assistance to AfDB and World Bank railway investment projects in Tanzania and Burundi, developed with the Government of the United Republic of Tanzania and the Tanzania Railway Corporation, this chapter explores how integrating NbS along railway corridors can both climate-proof vital infrastructure and unlock supplementary revenue streams through carbon credits, and assesses the institutional frameworks needed to support this approach.

The Igandu–Kilosa corridor in particular, where over 22% of the line is exposed to high landslide risk and recurrent floods cause service interruptions of up to 120 days annually. shows the urgent need for solutions that deliver resilience. Insights from these projects demonstrate how green rail corridors can simultaneously safeguard assets, support local communities, and unlock carbon revenues to sustain NbS over the long term.

3.1 Using Carbon Credit Revenues to finance NbS Implementation and Long-Term Maintenance along transport infrastructure

Nature-Based Solutions (NbS) provide a powerful pathway to climate adaptation while simultaneously unlocking new financing through carbon markets. Globally, voluntary carbon markets traded more than 450 million credits in 2023, with projections reaching USD 50 billion annually by 2030. Africa has a unique comparative advantage: vast areas suitable for restoration, relatively low opportunity costs of land, and strong potential for community co-benefits. The African Carbon Markets Initiative estimates that the continent could supply 300 million credits annually by 2030.

In the railway sector, NbS are particularly well suited because railways control extensive rights-of-way—linear corridors of land often extending tens of meters on each side of the tracks. These strips of land, frequently degraded, can be restored with vegetation, wetlands, and agroforestry systems that both strengthen infrastructure resilience and generate carbon credits.

Quantifying and monetizing carbon sequestration positions NbS as a credible revenue-generating asset class. While carbon sequestration is often seen only as a co-benefit of NbS for railway adaptation, these measures not only strengthen the resilience of rail infrastructure to future climate impacts but also offer significant opportunities for generating carbon credits. The ability to quantify and monetize carbon sequestration can make NbS financially attractive. Typical sequestration rates include:

- Reforestation and afforestation: 5–10 tCO_2/ha/year depending on ecosystem type.
- Agroforestry and soil carbon enhancement: 3–5 tCO_2/ha/year in semi-arid African landscapes.
- Wetland restoration: 5 tCO_2/ha/year, with additional benefits from methane reduction.

Carbon credits generated from these activities are issued over long crediting periods, typically 20–30 years, ensuring a recurring flow of revenues that align with the ongoing maintenance needs of NbS. This allows railway authorities to finance both the initial implementation (e.g. nursery establishment, planting, earthworks) and long-term management (e.g. pruning, fire prevention, invasive species control).

Assessing the feasibility of implementing NbS along African railways highlights how railway rights-of-way can serve as platforms for ecological restoration while supporting safe operations. Railway rights-of-way provide an excellent platform for ecological restoration. Interventions can be engineered to complement railway safety and operations:

- Slope stabilization using deep-rooted grasses or shrubs strengthens embankments and reduces landslides.
- Vegetated buffers along tracks intercept runoff and prevent ballast from washing away.
- Wetland reconnections dissipate storm surges and moderate flood peaks, protecting embankments.
- Community-based agroforestry near rail corridors improves soil fertility, reduces erosion, and diversifies farmer incomes.

These solutions are not theoretical. Network Rail in the UK is planting millions of trees and hedgerows to protect flood-prone lines, while North American railroads already use constructed wetlands to manage stormwater (Sonagra, 2025). Pilot projects in Tanzania and Benin demonstrate that similar measures are feasible in African contexts.

Picture : Network railway vegetation (UK Network Rail)

The economics and financial performance of NbS demonstrates their capacity to deliver long-term value compared to traditional grey infrastructure. NbS are often more cost-effective than grey infrastructure when full life-cycle costs are considered. Benefits include:

- Lower construction costs: vegetated slopes are typically cheaper to establish than concrete retaining walls, and they self-repair over time. For example, "living shorelines" in the U.S. averaged $361/linear foot compared to $1,022 for bulkheads.

- Reduced maintenance requirements: Nature-based interventions such as forests, wetlands, and vegetative buffers often require less intensive and lower-cost maintenance over time compared to some grey solutions, which can be prone to cracking or damage and require costly repairs. However, in the context of railway operations, active vegetation management along tracks remains essential for safety and service reliability. The key distinction is that while all solutions require maintenance, NbS can in many cases provide more cost-effective and self-sustaining protective functions when appropriately managed.

- Avoided damages: By reducing flood risks and stabilizing vulnerable areas, NbS help mitigate the impacts of climate hazards on railway infrastructure, thereby acting like insurance. The World Bank estimates resilient infrastructure can avert 45% of climate risks over 20 years, saving billions in avoided losses. For railways, even one avoided washout may save several million dollars in reconstruction and downtime.

- Co-benefits: reforestation improves biodiversity, wetlands regulate water quality, and agroforestry raises agricultural productivity. These benefits extend far beyond the railway balance sheet, strengthening the national cost–benefit case.

While NbS are often cost-effective in the long term, their financing can be challenging, as they may require more complex design, longer implementation horizons, and active management -factors that can act as barriers to investment. Carbon revenues provide a direct, quantifiable contribution that can help address this financing gap. According to GCA's study, a Tanzanian reforestation program of 1,000 hectares could sequester around 10,000 tCO_2 annually, yielding $100,000 per year at $10/ton and up to $2 million over 20 years. Similar agroforestry or wetland projects, though smaller in scale, deliver steady streams of credits alongside significant resilience and livelihood benefits.

Examining carbon market dynamics reveals how carbon compliance and voluntary systems shape the financial viability of NbS projects. The broader carbon market context reinforces the opportunity:

- Compliance markets surpassed USD 1.5 trillion in 2024, dominated by regulated trading schemes.
- Voluntary markets are scaling rapidly, driven by corporate net-zero commitments.
- Price ranges vary widely, from $5–10 per tonne for standard credits to $15–20+ for high-integrity, nature-based removal credits.
- Convergence with Article 6 of the Paris Agreement is increasing, which means high-quality voluntary credits may soon count toward compliance obligations, further raising demand.

For African railways, this means that NbS interventions can access a global market hungry for removal credits with biodiversity and community co-benefits. Carbon markets could thus provide not just a supplementary income stream but a structural financing mechanism to sustain NbS throughout their lifetime.


Image credits: © GCA

3.2 Enabling Environments: Institutional and Governance Frameworks for Carbon Markets – The Case of Tanzania

Unlocking the full potential of carbon credit markets for NbS requires more than technical feasibility and financing models. It depends on institutional organisation and robust governance frameworks that ensure integrity, attract investment, and embed NbS into national development strategies.

For carbon-financed NbS to succeed, they must be integrated into the planning frameworks of infrastructure sectors. Railway design manuals and investment programs should explicitly consider NbS alternatives alongside conventional grey measures. In practice, this means that feasibility studies, environmental and social impact assessments, and detailed engineering designs should evaluate options such as reforestation, slope stabilization through vegetation, or wetland reconnection as standard. Pilot projects like those on the Central Line in Tanzania are critical for demonstrating effectiveness and creating an evidence base for mainstreaming into national railway investment plans (see box5).

Equally important is aligning NbS with broader national policies. Projects must be framed not only as railway resilience measures but also as contributions to national climate priorities. Embedding NbS in Nationally Determined Contributions (NDCs), National Adaptation Plans (NAPs), and land-use planning instruments ensures coherence, increases legitimacy, and unlocks access to international climate finance. For example, reforestation along railway corridors can be counted toward national forest restoration targets under AFR100 or the Bonn Challenge, while wetland rehabilitation can be linked to water management strategies.

The legal treatment of carbon rights is central to project viability. Clear regulations must specify who owns the credits generated on public or leased land—whether it is the railway authority, the project developer, or the state. Without clarity, disputes can delay projects and discourage private investors. National registries play a key role by recording projects, issuing credits, and preventing double counting, especially when credits are exported internationally under Article 6 of the Paris Agreement.

Article 6 transactions require additional layers of approval, including "corresponding adjustments" to a country's emissions inventory. This ensures that credits sold abroad are not simultaneously counted toward domestic NDCs. Institutional frameworks therefore must empower a Designated National Authority (DNA) or equivalent to approve such projects, verify alignment with national priorities, and authorize transfers.

Institutional frameworks also determine how projects are financed. Governments can encourage investment in NbS by providing enabling conditions such as:

- Tax incentives for carbon revenues reinvested in project maintenance.
- Public–private partnerships (PPPs) where developers invest in NbS in exchange for a share of future credits.
- Blended finance structures combining concessional loans from development banks with carbon income streams, lowering the overall cost of capital.
- Advance purchase agreements where buyers commit to purchase credits once verified, reducing financial risk and unlocking early-stage funding.

By adopting such mechanisms, NbS projects move from one-off donor initiatives toward market-driven, long-term sustainability.

Strengthening operational governance and monitoring ensures that NbS interventions deliver long-term resilience, financial performance, and community benefits. Credibility is paramount in carbon markets. Projects must implement robust Monitoring, Reporting and Verification (MRV) systems to ensure that carbon sequestration is real, additional, and permanent. This requires investment in satellite monitoring, biomass surveys, and soil carbon testing, coupled with transparent reporting protocols. Independent third-party verifiers accredited by standards such as Verra or the Gold Standard provide the assurance buyers demand.

Risk management is another institutional challenge. Carbon permanence can be threatened by fires, pests, or land-use change. To address this, registries typically require a buffer pool—setting aside 10–20% of credits as insurance against reversal. Governance frameworks must establish rules for buffer contributions, reversal management, and benefit-sharing with local communities to maintain both environmental and social integrity.

Comparing regional experiences with NbS highlights transferable lessons that can inform railway adaptation across Africa. Tanzania's Carbon Trading Guidelines (2022, amended 2023) demonstrate one approach, establishing a DNA, a National Carbon Committee, and approval processes for both voluntary and Article 6 markets. This system empowers public enterprises like the Tanzania Railway Corporation to participate directly in carbon finance.

Other African countries provide useful comparisons. Kenya has established a national carbon registry and is piloting integrated land-use NbS projects that link to its NDC. Nigeria has developed a regulatory framework to govern voluntary market participation while preparing for Article 6 engagement. Gabon has gone further, issuing sovereign carbon credits from large-scale REDD+ programs, demonstrating how governments can monetize their forests directly on international markets. Each model provides lessons on balancing investor confidence with national sovereignty.

Ultimately, institutional frameworks are only as strong as the capacity behind them. Railway authorities will need to establish specialized NbS or environment units capable of managing MRV, coordinating with ministries, and engaging with local communities. Governments must invest in training regulators, developing carbon accounting expertise, and strengthening cross-sectoral coordination mechanisms. Without this institutional depth, carbon-financed NbS risk remaining pilots rather than scaling to the national level.

In summary, developing robust institutional organisation and frameworks is not an optional extra but a necessity for carbon-financed NbS. By embedding NbS into planning, clarifying carbon rights, creating supportive financial mechanisms, ensuring credible MRV, and learning from regional leaders, countries can unlock the full potential of carbon markets to sustain adaptation measures over the long term.

Box 6: Tanzania Railways leveraging NbS using Carbon Credits

Application Example developed by GCA, looking at the opportunity of Greening Tanzania Railways leveraging NbS using Carbon Credits, along the Right-of-Way of the Tanzania Railway Corporation on one section and National Railway Network.

The Igandu–Kilosa section of Tanzania's Central Line, which is a section to be renovated included in the World Bank Group's (WBG) Second Tanzania Intermodal and Rail Development Project (TIRP2), provides a detailed example of how NbS can be implemented and financed through carbon credits. This 120-kilometer corridor has experienced repeated flooding and erosion, causing costly service disruptions (see more context in Box 3). This section has been identified at high climate risks however with significant opportunities for the implementation of NbS as adaptation solution to reduce the vulnerability and exposure of the railway asset.

GCA's study identified 338 hectares within the railway reserve suitable for NbS interventions:

- 127 hectares for reforestation,
- 210 hectares for agroforestry, and
- 2 hectares for wetland restoration.

Based on conservative sequestration rates, these interventions are expected to capture 33,820 tonnes of CO_2 over 20 years. After applying a standard 20% risk buffer, the net volume of tradable credits is 27,056 tonnes.

Potential revenues are significant:

- At $5 per tonne → $135,280
- At $10 per tonne → $270,560
- At $15 per tonne → $405,840

Scaling this approach to Tanzania's 3,676 km railway network would create opportunities for around 20,000 hectares of NbS, with sequestration of over 1.4 million tonnes of CO_2 in 30 years. At a premium price of $15 per tonne, this could yield $20 million in cumulative revenues.

Beyond carbon, the adaptation co-benefits are critical. Reforestation stabilizes embankments, reducing washouts that can cost millions in emergency repairs. Agroforestry improves soil fertility and farm incomes, while wetlands act as natural flood regulators, protecting both the railway and surrounding communities. These measures also enhance biodiversity and create rural jobs in nursery management and long-term landscape maintenance. It is estimated that more than one million Tanzanians could directly or indirectly benefit from a nationwide program of railway NbS.

The Igandu–Kilosa pilot study, embedded in the TIRP 2 project, thus demonstrates the potential for practical integration of NbS into infrastructure adaptation planning. It illustrates how carbon finance could transform a railway from a vulnerable transport corridor into a climate resilience corridor, generating both environmental and economic dividends.

04

Call for Action

Call For Action

Nature-based solutions (NbS) are increasingly recognized as essential for climate adaptation, offering resilience, biodiversity, and socio-economic benefits. Yet they remain underfunded, under-integrated, and often sidelined in mainstream investment strategies.

There is a need for a coordinated, multi-actor approach to move NbS from fragmented pilots to scalable, systemic solutions, through three strategic action areas: Scaling Up Finance, Building Impact-Oriented Pipelines, and Strengthening the Enabling Environment.

The 11 takeaways below provide a roadmap for governments, development finance institutions (DFIs), private investors, and technical partners to unlock the full potential of NbS.

Scaling Up Finance

1. **Public-private coordination maximizes impact** Public finance reduces risk and catalyzes innovation, while private investors bring scale, efficiency, and market discipline. Specialized funds and managers serve as critical intermediaries, linking concessional capital with commercial investment and translating complex NbS projects into bankable opportunities. This coordination creates multiplier effects that deliver social, ecological, and economic benefits. Governments and DFIs must actively foster these partnerships through blended finance structures, co-investment platforms, and shared risk mechanisms.
2. **Strategic risk-taking is essential to attract private capital** NbS projects often involve long payback periods, diffuse benefits, and complex delivery models. To make them investable, public actors must absorb early-stage risk through concessional loans, guarantees, or subordinated positions. These instruments reduce perceived risk, improve project bankability, and unlock commercial investment. Strategic public risk-taking is not a subsidy—it is a catalyst for innovation, scale, and resilience.
3. **Carbon markets can provide sustainable financing for NbS** By monetizing carbon sequestration, NbS—especially those implemented along corridors or landscapes—can generate recurring revenue streams that support both implementation and long-term maintenance. This reduces dependence on grants or short-term financing and creates incentives for ecological performance. Governments and developers should explore voluntary and compliance markets, ensuring that NbS credits are credible, measurable, and aligned with national climate goals.
4. **Robust governance and institutional frameworks are essential to action carbon credit benefits** To scale carbon-financed NbS, institutional clarity is essential. This includes defining carbon rights, establishing robust MRV systems, and ensuring regulatory oversight. Capacity-building for local institutions and alignment with Article 6 mechanisms can enhance integrity and investor confidence. Without these foundations, carbon markets risk fragmentation and underperformance.

Building Impact-Oriented Pipelines

5. **Early-stage support builds pipelines of investable projects** Grants, technical assistance, and project preparation funding enable developers, communities, and local governments to structure projects, gather baseline data, and meet due diligence requirements. This early support reduces transaction costs, improves feasibility, and increases investor confidence. Governments and MDBs should prioritize funding for project preparation as a strategic investment in pipeline development.
6. **Systematize NbS valuation for financeable evidence** Quantifying benefits such as avoided damages, livelihood gains, and resilience dividends enables NbS to be embedded in project appraisals, infrastructure planning, and investment decisions. Standardized methodologies—such as benefit-cost frameworks and multi-criteria valuation tools—provide the evidence investors and development banks need to allocate finance at scale. These tools must be mainstreamed into public investment screening and climate finance proposals.
7. **Scale from individual assets to system-wide interventions** Applying NbS at the level of corridors, catchments, or landscapes multiplies resilience dividends across sectors. Integrated approaches protect more than a single asset, reduce cumulative risks, and attract larger-scale public and private investment. Governments and planners should prioritize system-wide interventions that align with regional development and climate strategies.
8. **Build evidence-based pipelines to attract investment** Quantifying NbS benefits—such as avoided damages and ecosystem services—enables governments and investors to prioritize interventions with the highest returns. Standardized tools and spatial analysis provide the data needed to guide decision-making, structure deals, and unlock private capital. Evidence-based pipelines are essential to move from scattered pilots to scalable portfolios.

Strengthening the Enabling Environment

9. **Standardization and enabling policies unlock scalable investment** Fragmented reporting, unclear valuation, and regulatory uncertainty limit private participation in NbS. Common measurement frameworks, standardized deal structures, and supportive policies ensure projects are replicable, credible, and integrated into broader development strategies. Governments must lead in creating a coherent policy environment that supports NbS as mainstream adaptation solutions.
10. **Embed governance and local ownership** Inclusive stakeholder engagement and community involvement ensure that NbS are technically sound, socially sustainable, and operationally durable. Strong governance and local participation increase project feasibility, long-term maintenance, and resilience outcomes. Funding mechanisms and delivery models must reflect local priorities and build institutional capacity at the community level.
11. **Integrate NbS into national and sectoral planning** Embedding NbS into infrastructure and development pipelines ensures projects are actionable, replicable, and aligned with national adaptation strategies. Coordinated planning strengthens investor confidence, improves financial viability, and maximizes socio-ecological benefits. Governments should treat NbS not as standalone projects but as integral components of climate-resilient development.

By advancing these three action areas and the 11 takeaways within them, stakeholders can move NbS from fragmented pilots to a mainstream adaptation strategy—one that delivers measurable resilience outcomes, protects ecosystems, and supports sustainable development across vulnerable regions. The time to act is now: scaling NbS is not just a climate imperative, but a strategic opportunity to build a more inclusive, nature-positive future.

Box 7: GCA Initiative to Mobilize DFIs and Scale Up Investments in Nature-Based Solutions
GCA has launched an initiative to mobilize development and private capital for nature-based solutions (NbS) that strengthen infrastructure resilience across Africa. Through this effort, GCA engages with development finance institutions (DFIs) and private investment funds, helping them apply global tolls for NbS to identify and assess priority investment opportunities that complement their portfolios. These opportunities are supported by key benefit metrics such as expected annual damages (EAD), return on investment (ROI), or carbon sequestration potential. The initiative ultimately seeks to secure financial commitments from DFIs and private investors for NbS interventions across the continent.

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