Harnessing Nature to Build Climate Resilience:

Scaling Up the Use of Ecosystem-based Adaptation

ISBN: 978-92-807-3952-7

Job Number: DEP/2449/NA

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Published by: United Nations Environment Programme (UNEP), Nairobi

Citation: United Nations Environment Programme (2022). *Harnessing Nature to Build Climate Resilience: Scaling Up the Use of Ecosystem-based Adaptation*. Nairobi.

Author: Celia A. Harvey

Report Director: Barney Dickson

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Acknowledgements

We are grateful to the following experts and practitioners for reviewing drafts of this report, participating in interviews and providing access to reports and other data.

Experts who reviewed chapter 4 and/or were interviewed for ideas on how to scale up EbA: Angela Andrade (IUCN, CI), Aloke Barnwal (GEF), Jonathan Cook (USAID), Radhika Dave (UNDP), Alex Forbes (UNEP), Ania Grobicki (GCF), Xiaoting Hou Jones (IIED), Srilata Kammila (UNDP), Valerie Kapos (UNEP-WCMC), Peter King (IGES), Harald Lossack (GIZ), Shaun Martin (WWF), John Matthews (AGWA), Michael Mullen (OECD), Sean O'Donoghue (eThekwini Municipality Government (Durban), South Africa), Suzanne Ozment (WRI), Daniel Pouakouyou (UNEP), Ali Raza Rizvi (IUCN), Christine Wamsler (Lund University) and Graham Wynne (WRI).

Experts who reviewed the full report: Chizuru Aoki (GEF), Wendy Atieno (IUCN), Aloke Barnwal (GEF), Tom Bishop (GCF), Amber Bjerre (IUCN), Alexandre Chausson (University of Oxford), Gemma Cobb (Griffith University), Emily Corwin (CI), Molly Cross (WCS), Radhika Dave (UNDP), Birte Derrix (IKI), Chris Dickinson (GCF), Camila Donatti (CI), Nathalie Doswald (UNEP), Mareile Drechsler (IKI), Paul Elsen (WCS), Cordula Epple (UNEP-WCMC), Giacomo Fedele (CI), Veronica Galmez (GCF), Borja Gonzalez Reguero (UCSC and World Bank), Emily Goodwin (IUCN), Xiaoting Hou Jones (IIED), Kendall Jones (WCS), Oscar Ivanova (UNEP), Anna Kilponen (UNEP), Sumalee Khosla (UNEP), Bruno Locatelli (CIRAD, CIFOR), Harald Losack (GIZ), Mauricio Luna-Rodríguez (GIZ), Annika Min (IUCN), Norah Ngeny (UNEP), Eric Philippe (IKI), Ali Raza Rizvi (IUCN), Sebastian Rodriguez Claros (CAF/UNEP), Shahryar Sarabi (Eindhoven University of Technology), Arghya Sinha Roy (ADB), Gautam Surya (WCS), Jessica Troni (UNEP), Nazeem Wasti (GCF), Greg Watson (IDB), Sylvia Wicander (GIZ), Suyeon Yang (UNEP) and Olaf Zerbock (USAID).

Experts who provided background information for the report: Aloke Barnwal (GEF), Bryce Bray (UNEP), Camila Donatti (CI), Giacomo Fedele (CI), Ania Grobicki (GCF), Veronica Galmez (GCF), Anna Kilponen (UNEP), Oscar Ivanova (UNEP), Eric Philipps (IKI), Luise-Katharina Richter (GIZ) and Suyeon Yang (UNEP).

The report is an output of the Global EbA Fund which is implemented jointly by UNEP and IUCN.

This report was made possible through the generous contribution of our donor: International Climate Initiative under The Federal Ministry for Economic Affairs and Climate Action, Germany.

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Acronyms

ADB	Asian Development Bank
AF	Adaptation Fund
AGWA	Alliance for Global Water Adaptation
ASAP	Adaptation for Smallholder Agriculture Programme
BfN	Federal Agency for Nature Conservation (Germany)
BMUV	Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (Germany)
CbA	Community-based adaptation
CBD	(United Nations) Convention on Biological Diversity
CCRI	Coalition for Climate Resilient Investment
CI	Conservation International
COP	Conference of the Parties
CSO	Civil society organization
DRR	Disaster risk reduction
EbA	Ecosystem-based adaptation
Eco-DRR	Ecosystem-based disaster risk reduction
EEA	European Environment Agency
ESCAP	Economic and Social Commission for Asia and the Pacific
EU	European Union
F4B	Finance for Biodiversity Initiative
FAO	Food and Agriculture Organization (of the United Nations)

FEBA	Friends of Ecosystem-based Adaptation
FEMA	Federal Emergency Management Agency
GAN	Global Adaptation Network
GCA	Global Commission on Adaptation
GCF	Green Climate Fund
GDP	Gross domestic product
GEF	Global Environment Facility
GFDRR	Global Facility for Disaster Reduction and Recovery
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (German Agency for International Cooperation)
GPP	Green Public Procurement
ICF	International Climate Finance
IDB	Inter-American Development Bank
IFAD	International Fund for Agricultural Development
IGES	Institute for Global Environmental Strategies
IIED	International Institute for Environment and Development
IKI	International Climate Initiative (Germany)
IMF	International Monetary Fund
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
IUFRO	International Union of Forest Research Organizations
KfW	German Development Bank
LDCF	Least Developed Countries Fund
MDB	Multilateral development bank

NAP	National Adaptation Plan
NbS	Nature-based solutions
NbSA	Nature-based solutions for adaptation
NDC	Nationally Determined Contribution (to the United Nations Framework Convention on Climate Change)
NGO	Non-governmental organization
NH-NbS	Natural Hazards – Nature-based Solutions platform
NORAD	Norwegian Agency for Development
OECD	Organisation for Economic Co-operation and Development
PPCR	Pilot Program for Climate Resilience
SCBD	Secretariat of the Convention on Biological Diversity
SCCF	Special Climate Change Fund
SDG	Sustainable Development Goal
SDIA	Swedish International Development Cooperation Agency
SEEA	System of Environmental Economic Accounting
SEEA EA	System of Environmental Economic Accounting Ecosystem Accounting
SEK	Swedish krona
SuDS	Sustainable urban drainage systems
TCFD	Task Force on Climate-related Financial Disclosures
TNC	The Nature Conservancy
TNFD	Taskforce on Nature-related Financial Disclosures
UCSC	University of California – Santa Cruz
UK	United Kingdom
UN	United Nations
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme

UNEA	United Nations Environment Assembly
UNEP	United Nations Environment Programme
UNEPFI	United Nations Environment Programme Finance Initiative
UNEP-WCMC	United Nations Environment Programme – World Conservation Monitoring Centre
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development
WAVES	Wealth Accounting and Valuation of Ecosystem Services
WBCSD	World Business Council for Sustainable Development
WCS	Wildlife Conservation Society
WEF	World Economic Forum
WFP	World Food Programme
WRI	World Resources Institute
WWF	World Wildlife Fund

Executive summary

Ecosystem-based adaptation (EbA) has the potential to significantly enhance the resilience of society to climate change and could be a key part of national and global adaptation efforts. However, despite growing interest among policymakers, donors, scientists and practitioners, the current pace and scale of EbA implementation falls far short of its potential. The aim of this report is to highlight the opportunities for scaling up the use of EbA to help put the world on a more climate-resilient and nature-positive pathway.

The report begins by examining the role of EbA in helping society adapt to climate change, while also contributing to biodiversity conservation, climate mitigation and sustainable development efforts. It assesses the current state and trends in EbA implementation. Next, it explores the barriers that are currently slowing the widespread application of EbA in policy and practice. Finally, the report provides a set of recommendations on how to enhance the scale and pace of EbA implementation to more fully harness the potential of ecosystems to deliver adaptation benefits. The report is based on a detailed review of over 750 documents (including scientific papers, technical publications, policy briefs and project reports) as well as input from 59 global EbA experts from 30 organizations. Throughout the report, the term "ecosystem-based adaptation" is treated as equivalent to nature-based solutions (NbS) for adaptation, in line with the recent definition of NbS by the United Nations (United Nations Environment Assembly [UNEA] 2022).

Building resilience to climate change

EbA can be defined as the use of ecosystems and biodiversity as part of a broader adaptation strategy to help people adapt to the adverse impacts of climate change. It involves the active conservation, restoration and management of ecosystems to foster climate resilience. EbA can help enhance the resilience of society to climate change by protecting communities from the effects of climate hazards such as strong storms, floods and heatwaves, and by ensuring that ecosystems continue to deliver key ecosystem services (such as food or access to water) that help people meet their diverse needs in a changing climate.

Common examples of EbA measures include the conservation or restoration of mangroves to protect coastal communities from storm surges and sea level rise, the establishment of green roofs, street trees and urban parks to reduce the risks of heatwaves and flooding in cities, and the conservation of upslope forests to prevent landslides and downstream flooding under extreme weather events.

EbA has many qualities which make it a potentially attractive approach for policymakers, donors, investors and practitioners. EbA measures can be applied in a wide range of socioecological settings (from coastal zones to cities to mountains) and can meet the adaptation needs of a diverse set of sectors and stakeholders. In addition to providing significant adaptation benefits, EbA can generate a large and diverse array of co-benefits to society, including biodiversity conservation, climate mitigation, food security, job creation, livelihood opportunities and economic development. As such, EbA can make a significant contribution to multiple international policy goals related to climate change, biodiversity conservation, ecosystem restoration and sustainable development.

While EbA is a versatile and widely applicable approach, there are some limitations to its use. For example, there may be some circumstances in which EbA cannot address the specific adaptation needs of targeted stakeholder groups. In addition, ecosystems are themselves vulnerable to climate change, so unless urgent action is taken to reduce greenhouse gases and slow the rate of climate change, the ability of ecosystems to protect communities and deliver essential ecosystem services will decline over time.

Current status and trends in ecosystem-based adaptation policy, practice and finance

Understanding the current status and trends in EbA implementation is difficult because data on EbA practice, policy and finance are incomplete, scattered and insufficiently detailed. Assessing the extent of action is also complicated due to the large diversity of EbA measures, the wide range of socioeconomic contexts and sectors in which EbA can be applied, and the diverse range of stakeholder groups involved.

Nevertheless, our assessment of available information (databases, publications, websites and reports) suggests that there is already substantial EbA action under way. There are at least several thousand EbA initiatives being implemented across the world, with support from a diverse suite of actors, including United Nations organizations, bilateral and multilateral development agencies, multilateral development banks and funds, international NGOs, research organizations, national governments, local communities and the private sector. Since many EbA initiatives are not labelled as such, the number of initiatives is certainly much larger than what is currently documented in the literature. EbA also has significant traction in the international policy arena and features prominently in the Nationally Determined Contributions and National Adaptation Plans of many (but not all) countries. In addition, numerous high-level policy initiatives, reports and declarations have called for greater deployment of ecosystem conservation, restoration and management in support of climate change adaptation. EbA is currently being funded by a small number of key bilateral donors, multilateral donors and climate and environment funds, with public finance for EbA in 2018 estimated to be between US$ 3.8 billion and US$ 8.7 billion in 2018 (Swann *et al*. 2021).

Our assessment suggests that the pace of EbA activity is increasing, albeit at a slow rate. Several key bilateral and multilateral organizations have increased the number of projects using EbA to foster climate resilience. There is a growing number of organizations that have joined collaborative networks that support EbA action. There also appears to be a trend of increasing finance for EbA among some of the major bilateral and multilateral donors. Finally, there has also been a growing number of policy declarations and commitments by multilateral development banks, bilateral donors and others to increase the finance directed towards ecosystem-based approaches. The burgeoning number of publications, case studies, research and guidelines on EbA also points to growing interest in EbA and increased implementation.

However, at the same time, the current level of level of EbA implementation falls far short of its potential. The number of EbA initiatives under way, while significant, is too little to have a meaningful impact on the hundreds of millions of people who are threatened by climate change. There is a significant funding gap for EbA, as the amount of available funding falls short of what is needed. International public finance for EbA, for example, still makes up less than 2 per cent of total climate finance flows. There have been numerous high-level calls (such as the Nature-based Solutions for Climate Manifesto (2019)[1], the Leaders' Pledge for Nature (2020)[2], the Glasgow Climate Pact (2021; (United Nations Framework Convention on Climate Change [UNFCCC] 2021b), and the Glasgow Leaders' Declaration on Forests and Land Use (2021)[3], to better harness the conservation, restoration and management of ecosystems for delivering climate adaptation, and to significantly scale up financial support for NbS.

In short, there is a growing consensus that EbA can play a much greater role in global adaptation efforts.

Barriers to the use of ecosystem-based adaptation

Our review of the scientific and technical literature suggests there are multiple barriers that are hindering the widespread adoption and scaling up of EbA.

One of the most common barriers is the lack of awareness and understanding of the role of ecosystem conservation, restoration and sustainable management in fostering climate resilience. This

1 For more information, please visit https://wedocs.unep.org/xmlui/bitstream/handle/20.500.11822/29705/190825NBSManifesto.pdf?sequence=1&isAllowed=y.

2 For more information, please visit https://www.leaderspledgefornature.org/.

3 For more information, please visit https://ukcop26.org/glasgow-leaders-declaration-on-forests-and-land-use/.

View of the london city dam. Thames flood barrier over river thames.

limited awareness and understanding of EbA (especially among policymakers, private sector actors and the local authorities and technicians who are tasked with implementing EbA on the ground) can discourage or prevent its inclusion in relevant policies, regulations, budgets, adaptation plans and investments.

A related challenge is the lack of sufficient knowledge and information for scaling up EbA. Despite a rapidly growing evidence base, many policymakers, donors and practitioners lack the necessary information to design and implement EbA. For example, they may lack climate change projections, information on stakeholder vulnerability, adaptation and the extent of ecosystems, or information on the costs, benefits and effectiveness of different EbA measures. In addition, there is limited information on the biophysical limits to EbA and the opportunities to integrate EbA with conventional engineering approaches. These knowledge gaps often make it difficult to design effective EbA initiatives.

Inadequate technical capacity is another key constraint. Policymakers and local authorities often lack staff with the necessary technical skills to effectively design, implement and mainstream EbA into relevant policies, plans and investments. In addition, many of the engineers, planners and technicians who are tasked with implementing EbA on the ground are trained in conventional engineering approaches and lack the requisite skills for ecosystem management and related stakeholder consultation processes.

Another challenge to scaling up EbA action is the lack of sufficient political and public support. Without strong political leadership and public support, it is difficult to raise the profile of EbA, secure funding, mainstream EbA into policies, regulations and budgets, and mobilize action and collaboration across diverse institutions, governance levels and stakeholders.

EbA implementation is often constrained by the lack of clear institutional arrangements and collaboration among the multiple government departments, institutions and sectors that are involved in ecosystem conservation, restoration and sustainable management. In addition, building effective, cross-sectoral and multi-stakeholder partnerships that address the diverse vulnerability and adaptation needs of different stakeholder groups (including Indigenous Peoples, local communities and women) is often challenging.

The lack of supportive policies and regulations can also slow EbA implementation. Since EbA is a fairly new approach, it has not yet been fully integrated into relevant national policies, sectoral strategies, regulations and related budgets. As a result, many national policies do not explicitly promote the use of EbA or provide the resources necessary for its application. Mainstreaming the use of EbA into economic development strategies and relevant sectoral strategies (e.g. infrastructure, transportation, energy and agriculture) has also been challenging. In addition, the lack of coherence across policies, laws and regulations related to ecosystem conservation, restoration and management can constrain EbA implementation.

Financial challenges are also commonly encountered by EbA initiatives. The main challenge is the lack of sufficient funding from both the public sector and the private sector to support EbA at scale. Despite growing interest in EbA, the current levels of funding fall far below what is needed. Other challenges include the lack of financial incentives and business models that could entice greater private sector investment in EbA, and the fact that existing financial instruments (e.g. subsidies or tax breaks) often discourage businesses or private sector actors from implementing EbA.

A final challenge is the fact that most EbA interventions require that space be set aside for the conservation, restoration and sustainable management of ecosystems for climate adaptation. In places where land is already built upon or used for livelihood activities or where land is prohibitively expensive, finding space for EbA implementation can be difficult.

Recommendations for scaling up the use of ecosystem-based adaptation globally

In order for EbA to play a greater role in global adaptation efforts, it is important to overcome the current barriers to EbA implementation and find ways of accelerating both the pace and scale of action. Overcoming these barriers and scaling up EbA will require action on diverse fronts by a broad set of stakeholders, including indigenous and local communities, national and local governments, civil society organizations, the private sector, the research community, bilateral and multilateral organizations, United Nations organizations and others.

Based on our analysis and discussions with EbA experts from around the world, we suggest that there are five broad categories of action that could help overcome many of the current barriers to EbA and ramp up the pace and scale of EbA implementation globally. These are:

1. creating a supportive policy and regulatory framework
2. using innovative policy and regulatory instruments to promote EbA
3. increasing the number of actors supporting EbA
4. using innovative approaches to finance EbA
5. targeting EbA implementation to the contexts where the greatest benefits will likely accrue.

Creating a supportive policy and regulatory framework

Creating a conducive policy and regulatory framework for EbA is a critical – and often foundational – step for mobilizing action on EbA. Policy and regulatory frameworks are important because they reflect government priorities, determine which actions can be undertaken and guide the allocation of public technical and financial resources.

One important opportunity is to raise the profile of EbA in national commitments to international policy processes related to climate change, biodiversity conservation and sustainable development. While many national governments have already included EbA as a key component of their NDCs and NAPs, there is scope for more ambitious action. In both existing and future rounds of NDCs, governments could set more specific, ambitious and measurable targets for how, when and where EbA will be deployed and funded. They could also ensure that NDCs cover all relevant ecosystem types (not just forests, but also grasslands, wetlands, coral reefs and mangroves, among others). In addition to raising the profile of EbA within the climate agenda, governments should also seek to integrate EbA into their national-level commitments for biodiversity, sustainable development, ecosystem restoration and related policy initiatives, and foster linkages across these commitments.

Another way to ensure policy support is to mainstream the consideration of EbA not only into national climate adaptation and related environmental policies, but also into economic development plans and other long-term strategies. The EbA approach could be systematically mainstreamed into the national strategies, policies, plans and budgets of all key sectors where its use can support sectoral goals (e.g. agriculture, water, forestry, health, energy, infrastructure and transportation). Mainstreaming EbA will help align policies and decision-making within governments, facilitate planning and implementation of ecosystem-based initiatives, promote cross-sectoral collaboration across different ministries, departments and institutions, and reduce the cost of adaptation planning, ultimately resulting in the greater use of EbA.

Using innovative policy and regulatory instruments to promote ecosystem-based adaptation

A second major category of actions that can help spur EbA interventions is the use of innovative policy instruments. If designed and implemented appropriately, such policy instruments can help to increase awareness of the importance of EbA, encourage its widespread use by both the public and private sectors, and channel greater levels of funds towards EbA implementation.

The use of natural capital accounting by national governments could help to spur greater action on EbA. Natural capital accounting involves measuring the stock, condition and value of ecosystems and ecosystem services (including services that contribute to climate adaptation), assessing how ecosystems and their ability to provide services are changing over time, and integrating this information in accounting and reporting systems. The widespread adoption of natural capital accounting by governments could lead to greater use of EbA by creating greater awareness and understanding among policymakers, technicians and other decision makers of the value of nature and its critical role in delivering adaptation (and other) services. In addition, natural capital accounting can help decision makers to identify the specific geographic areas where the intentional conservation, management or restoration of ecosystems is critical for delivering adaptation services. It can also provide valuable information for government investment and budgeting decisions, for example, helping to ensure that public finance is directed towards activities that maintain or enhance ecosystems (and ecosystem services flows) and away from activities that undermine ecosystem functioning.

Governments, multilateral organizations, international development agencies, climate funds and other public funders could encourage the use of EbA by establishing green public procurement processes. “Green public procurement” refers to the public purchase of products and services which are less environmentally damaging than alternatives, when taking into account the whole life cycle of the product or service. Governments with existing green procurement procedures could review and update their technical standards and procedures to ensure that EbA options are always included as potential options in the assessment of new infrastructure or development projects (e.g. roads, energy infrastructure, coastal development, agricultural infrastructure). They could also require that any purchase of goods and services from the agricultural, forestry and fishery sectors come from sustainably managed ecosystems that meet voluntary sustainability standards. Governments also have the potential to ramp up the use of existing green procurement policies by mandating that a certain percentage of public procurement be “green” and that this percentage increase over time. National governments that have not yet adopted green public procurement policies can draw on existing experiences to set up robust systems that encourage ecosystem conservation, restoration and sustainable management for climate adaptation.

Another approach that could significantly accelerate action on EbA is to integrate the use of “green” and “blue” infrastructure (e.g. ecosystems such as forests, parks, wetlands and mangroves) in future infrastructure investments. National and local governments can promote the use of green and blue infrastructure by including it in infrastructure standards, regulations and procurement policies, by requiring that key service providers (such as water utilities, stormwater departments, flood management agencies and power companies) consider its application, and by integrating its use into local and regional planning initiatives. Multilateral development banks and development agencies can similarly require that infrastructure initiatives consider the use of green and blue infrastructure, and provide loans with better rates to support this approach.

Building codes and zoning regulations can be used to promote the conservation, management and restoration of ecosystems for climate change adaptation. National and local governments can develop or update building codes and standards so that they require the consideration of climate risks to buildings, roads, ports and other infrastructure, and mandate the consideration of EbA options for addressing climate risks. Governments can also revise and improve land and coastal zoning regulations so that they protect ecosystems that are critical for adaptation, for example, prohibiting development of vulnerable coastal ecosystems or floodplains that provide valuable flood protection.

Increasing the number of actors supporting ecosystem-based adaptation

A third approach for accelerating EbA action is to increase the number of actors that support EbA, so that there is a larger group of actors who can catalyse action. The effective design and implementation of EbA requires collaboration among a large and diverse suite of stakeholders and entails both bottom-up and top-down action. However, to date, most of the action has been led by national and local governments, international public funders, international and national NGOs and the research community. For EbA to be implemented at scale, it will be necessary to more actively engage a much wider and more diverse set of actors.

Indigenous Peoples, local communities and women can potentially play a much greater role in delivering EbA, as they manage large parts of the world’s land and seas, have livelihoods that are dependent on ecosystems, and stand to directly benefit from effective EbA action. However, to date, the role of local and indigenous actors (including women) has often been overlooked by governments, donors and practitioners, with only 10 per cent of international adaptation funds having reached this local level (Soanes *et al*. 2017). Governments, development agencies and civil society organizations can support greater leadership of local actors by building capacity on EbA, sharing knowledge and information, facilitating their engagement in adaptation policy and planning processes, and

Enhancing climate change resilience of rural communities
living in protected areas of Cambodia.

mobilizing finance for locally led initiatives. Applying the principles for locally led action on adaptation and adopting a gender-responsive approach can also help ensure EbA initiatives meet the diverse needs of Indigenous Peoples, local communities, women and other marginalized groups.

Another group that could play a much larger role in delivering EbA is the business community. Many businesses are unaware of the significant risksthat climate change poses and are not taking action to address these risks. Despite its potential to address both climate change and biodiversity risks, few businesses use EbA. National and local governments can spur greater uptake and use of EbA by businesses by creating supportive policy and regulatory frameworks, mandating climate financial risk disclosures by private businesses, requiring the consideration of EbA in public sector procurement of goods and services, and creating building codes and zoning regulations that incentivize the conservation and restoration of ecosystems. Governments can also incentivize businesses to adopt EbA measures through local fee or tax discounts, reduced property taxes, rebates and other policy instruments.

Greater involvement of the financial sector could also help to accelerate EbA action. Banks, pension funds, microfinance institutions, insurance companies, equity funds and other investors could leverage significant private finance for EbA and help address the current funding gap. To catalyse greater involvement by the financial sector, governments can create supportive policies and regulations for EbA, facilitate access to information on climate change risks and adaptation options, and provide robust business models and proof of concepts to build confidence within the finance community. The public sector can also improve the risk profile of EbA investments by applying public finance instruments that reduce the risks of private sector investment, such as government guarantees, credit lines, or blended finance.

Using innovative approaches to finance ecosystem-based adaptation

A fourth broad set of actions that can help accelerate EbA action is the use of innovative finance mechanisms to generate funding at the pace and scale required. While most funding for EbA continues to stem from public budgets and international assistance, there are increasing opportunities to use new innovative mechanisms to attract greater public and private investment. These innovative finance mechanisms may tap into new sources of funds, blend different sources of funds, de-risk private sector investments or develop novel ways to unlock funds for the conservation, management and restoration of ecosystems for climate resilience.

One promising opportunity is to use green bonds to channel greater levels of private finance towards EbA. While the use of green bonds for EbA is still nascent, there are a number of new initiatives that seek to use bonds to generate finance to fund ecosystem-based initiatives (such as mangrove restoration, wetland conservation or reforestation projects) that can confer adaptation benefits to society. There is a need to grow awareness, interest and capacity on EbA among both bond issuers and bond investors and to develop more pilot initiatives that can demonstrate success and serve as examples for replication.

Debt relief could provide another important financial mechanism for fostering greater action on EbA. Many low- and medium-income countries are facing record high debt levels and are having difficulties servicing their debt payments; at the same time, many of these countries lack sufficient resources to invest in climate adaptation. There is growing momentum among economists and policymakers to offer debt relief to countries in exchange for special action on climate change and/or nature conservation. In these "debt for climate" or "debt for nature" swaps, instead of continuing to make external debt payments to the creditor in a foreign currency, the debtor nation makes payments in a local currency to finance climate projects or nature conservation actions based on agreed-upon terms with the creditor. As part of these green debt swaps, countries can commit to using the debt relief to finance the conservation, restoration and sustainable management of ecosystems that provide protection against climate hazards, thereby promoting greater EbA investment and implementation.

Another opportunity is to leverage COVID-19 stimulus and recovery funds in support of EbA. Investing stimulus and recovery funds in EbA initiatives could help countries recover from the unprecedented socioeconomic impacts of the pandemic by creating jobs and other economic benefits, and by improving the long-term resilience of communities, businesses and economies to climate change. In order to spur the use of EbA in economic recovery plans, governments, multilateral development banks, development agencies and other donors could directly provide grants, loans or other types of funding for priority EbA measures, such as investing in green infrastructure in cities to reduce heat exposure and urban flooding, or financing mangrove and wetland restoration to minimize coastal flooding.

Another way to accelerate action on EbA is to support the disclosure of risks to climate and nature among private sector actors, including businesses and financial institutions. There are currently two initiatives under way to promote greater transparency on climate- and nature-related risks to companies: the Task Force on Climate-related Financial Disclosures and the Task Force on Nature-related Financial Disclosures. The broad-scale adoption of these risk disclosure frameworks could spur greater use of EbA, as private sector actors become more aware of the risks they face from climate change and nature loss and the potential for ecosystem management to address these risks. Governments can support these risk disclosure efforts by creating national regulations that require companies to report their climate-related and nature-related financial risks and the actions they are taking to address these risks (including EbA).

There are opportunities to leverage more financial resources for EbA from the insurance sector. The insurance sector can incentivize the use of EbA among its clients by providing discounts for clients who use EbA to reduce their vulnerability, thereby reducing the cost of insurance. They could also support EbA by creating innovative insurance mechanisms that support the conservation, management and restoration of ecosystems that are important for adaptation. Finally, the insurance industry can invest directly in the restoration, conservation and sustainable management of ecosystems for climate resilience.

Targeting ecosystem-based adaptation implementation to the contexts where the greatest benefits will likely accrue

A fifth, and final, approach that holds promise for scaling up EbA is to prioritize EbA implementation in those contexts in which it will deliver the greatest and most significant adaptation benefits (i.e. where its implementation reduces the vulnerability or enhances the resilience of the greatest number of people). Decisions about whether, how, where and which EbA measures to include in adaptation initiatives for a given location should be based on a detailed, spatially explicit analysis of climate risks, stakeholder vulnerabilities and adaptation needs, potential adaptation measures, and numbers of potential beneficiaries. While the specific priority areas for EbA will differ from one country to the next, there are three contexts where EbA implementation holds particular promise for delivering adaptation benefits at scale.

Firstly, EbA should be prioritized in low-lying cities that are vulnerable to heat stress and flooding. As the world becomes urbanized, cities are increasingly at the forefront of climate change adaptation efforts. It is estimated that 55 per cent of the world's population (UNEP 2016) already lives in urban areas and the urban population continues to grow (United Nations 2018). Climate change poses significant risks to many cities because they are located in the floodplains of major rivers, on drained wetlands, along estuaries or along coastlines, and are therefore vulnerable to flooding and storm surges. An estimated 700 million people live in urban or peri-urban areas that are less than 10 m above sea level (Center for International Earth Science Information Network 2019). Flooding already causes an estimated US$ 120 billion of damage to urban property each year and this is expected to increase significantly in coming years (Browder *et al*. 2019). Urban residents are also threatened by rising temperatures and heat stress. EbA measures, such as the establishment and management of green roofs, street trees, urban parks and other green areas, can help manage heat and flooding risks in cities, while also providing additional benefits such as energy savings, recreation opportunities and improved health. In low-lying coastal cities, additional EbA measures are needed (see the next recommendation). To encourage widespread uptake of EbA in cities, national and local governments can mainstream EbA into urban development strategies, ensure urban planning and zoning include the use of green and blue infrastructure, update building codes and zoning restrictions, and create incentives for EbA uptake.

Secondly, the use of EbA should be prioritized in coastal communities that are vulnerable to the risk of sea level rise, storm surges and erosion. Coasts are home to more than 40 per cent of the world's population (UNEP 2016) and are vital economic hubs. Climate change poses a significant threat to coastal towns, villages and cities, with rising sea levels, increased storm surges, accelerated land erosion and increased flooding threatening the well-being and livelihoods of coastal residents, damaging coastal infrastructure and affecting trade. The widespread implementation of EbA (such as the conservation and restoration of mangrove forests, coral reefs, salt marshes and other coastal and marine ecosystems) can be a particularly effective means of protecting coastal communities, infrastructure and assets against climate hazards. National and local governments can encourage the use of EbA in coastal regions by updating coastal development regulations to protect ecosystems that provide critical protective functions by requiring that coastal defence projects consider EbA options, by increasing investment in the use of green and blue infrastructure and by prohibiting activities (such as sewage pollution, habitat damage and loss, overfishing and uncontrolled coastal development) that degrade existing coastal ecosystems and undermine their protective functions.

Finally, there are significant opportunities to scale up the use of EbA in key agricultural landscapes that are critical for food and water provision in a changing climate. Agriculture is a critical sector because it covers larger parts of the world, provides most of the world's food, and is an important source of employment. An estimated 2 billion people depend on agriculture for their livelihoods. Agricultural communities are often at the front lines of climate change, as higher temperatures, changes in precipitation patterns and increased frequency of extreme weather events directly threaten agricultural and livestock production, food security, and rural livelihoods. EbA measures such as the use of agroforestry to protect livestock from heat stress or the use of agroecological methods that improve soil health and resilience or the protection of forests within broader agricultural landscapes can help improve the resilience of these landscapes to the adverse impacts of climate change. EbA could enable farmers to continue to produce food for the world's rapidly growing population and ensure the provision of water in a changing climate, without undermining the ecosystems and natural resources on which society depends. To encourage greater implementation of EbA in agricultural landscapes, there is a need to build the capacity of farmers, agronomists, extension agents and farmer-led organizations to design and apply EbA measures, increase the funding of public extension and outreach services for agriculture and natural resource management, and facilitate access to finance for farmers so that they can adopt EbA measures. There is also an urgent need for governments to remove perverse agricultural subsidies that lead to deforestation, degradation and unsustainable agricultural practices and redirect these funds towards EbA and other sustainable management practices.

Conclusions

There is significant scope for EbA to play a much greater role in putting the world on a more climate-resilient and nature-positive pathway. In order to harness the full potential of EbA, it is critical to accelerate both the pace and scale of EbA action. This will require: creating more supportive policy and regulatory frameworks; applying innovative policy instruments in support of EbA; broadening the EbA constituency to include Indigenous Peoples and local communities, the business community and the finance sector; using innovative finance approaches to secure greater levels of private and public funding; and ensuring that EbA is targeted to the contexts in which it will provide the greatest adaptation benefits.

We recognize that these recommendations are ambitious and that their implementation will require tremendous effort, political will, and significant financial and human resources. Scaling up will take time and success is not guaranteed. However, inaction is not an option. Without rapid and significant adaptation action, climate change will have increasingly devastating impacts on human communities, natural ecosystems and economies worldwide. Ambitious and rapid action on EbA is needed on many fronts and by many stakeholders if we are to put the world on a more climate-resilient and nature-positive pathway.

Introduction

Climate change poses a serious and escalating threat to society. Across the world, rising sea levels, longer and more frequent droughts, record-breaking temperatures, stronger hurricanes, extreme rainfall events, and historic climate-driven floods are threatening people's livelihoods, disrupting economies and undermining global progress on sustainable development (United Nations Environment Programme [UNEP] 2021a; Intergovernmental Panel on Climate Change [IPCC] 2022). The impacts of climate change are already being felt by local communities, towns, cities, businesses and governments across all regions of the world. An estimated 85 per cent of the global population is already suffering from climate change impacts (Callaghan *et al*. 2021). Even if rapid progress is made to curb greenhouse gas emissions, the impacts of climate change are expected to intensify in future decades (Global Commission on Adaptation [GCA] 2019; UNEP 2021a). Urgent and ambitious action is needed to build the resilience of society to both current and future climate change impacts and to put the world on a more sustainable and climate-resilient pathway (GCA 2019).

In this report, we focus on the central role that EbA can play in helping society adapt to the adverse impacts of climate change and highlight opportunities for accelerating its use in global adaptation efforts. EbA refers to the use of biodiversity and ecosystem services as part of a broader climate adaptation plan, and involves the conservation, restoration and management of ecosystems to help people adapt to climate change (Convention on Biological Diversity [CBD] 2009; Ojea 2015). EbA is equivalent to the term "Nature-based Solutions (NbS) for adaptation", as recently defined by the United Nations Environment Assembly (UNEA 2022).

EbA has gained significant traction in policy, research and practice in recent years. Across the world, many countries have started to incorporate EbA measures into their National Adaptation Plans (NAPs) and their Nationally Determined Contributions (NDCs) (Seddon *et al*. 2019a; Seddon *et al.* 2020b; Terton and Greenwalt 2020). EbA initiatives are being implemented in a wide range of ecosystems and sectors, with support from United Nations organizations, bilateral and multilateral development agencies, multilateral development banks and funds, international NGOs, national and local governments, research organizations, local communities, civil society organizations and the private sector (Nalau and Becken 2018; Kapos *et al*. 2019). In addition, there is a rapidly growing and significant body of publications, reports and guidelines on the implementation and management of EbA initiatives, reflecting increasing interest in this approach (Nalau and Becken 2018; Swiderska, King-Okumu and Islam 2018; CBD 2019). However, despite growing this growing momentum, the current pace and scale of EbA implementation falls far short of its potential. The total number and size of EbA initiatives is still small, many national and local policies do not yet effectively integrate EbA, and the availability of public and private finance for EbA is far below what is needed (Roberts *et al*. 2012; Ojea 2015; Reid *et al*. 2019; Swann *et al*. 2021). In order to harness the full potential of EbA, greater action is needed.

The objective of this report is to explore why EbA is not yet being applied at the necessary pace and scale, and to identify opportunities and ways for rapidly scaling up its use in global adaptation efforts. By "scaling up", we refer both to replicating existing successful initiatives in new locations and geographies and increasing the number of EbA initiatives, as well as increasing the size, spatial extent and duration of EbA initiatives so that EbA initiatives are increasingly implemented at the landscape, watershed, national or regional scale as part of long-term development strategies.

The report consists of four chapters. In chapter 1, we introduce the concept of EbA, provide examples of the diverse array of EbA measures and highlight how EbA can form an important cornerstone of national and global adaptation efforts. In chapter 2, we assess the current status and trends of global EbA implementation by examining the extent to which policies, projects and investments are supporting ecosystem management for climate adaptation. In chapter 3, we examine the diverse set of barriers that are currently preventing the use and scaling up of EbA. Finally, in chapter 4, we provide a set of recommendations on how to promote the widespread and rapid uptake of EbA globally to help society better prepare for and adapt to the impacts of climate change.

The report draws on a detailed literature review and consultations with EbA experts. We examined more than 750 documents (including scientific and technical articles, websites, policy reports, case studies and blogs) related to EbA implementation, finance and policy development. We also solicited ideas and feedback from 59 EbA experts from 30 institutions[4] through interviews and a detailed peer review process. The full list of experts who contributed to the report can be found in the acknowledgements section.

The report is intended for the wide set of actors who stand to benefit from EbA and who can move action forward at scale. This includes national and local policymakers, multilateral and bilateral institutions, businesses, the private finance sector, non-governmental organizations, civil society groups, Indigenous Peoples and local communities, project developers, researchers and society at large. It is also intended to inform the implementation and future direction of the newly created Global EbA Fund[5] (funded by Germany's International Climate Initiative, and implemented by IUCN and UNEP) which aims to catalyse greater adoption of EbA globally.

4 Experts represented the following institutions (in alphabetical order): Alliance for Global Water Adaptation (AGWA), Asian Development Bank (ADB), Center for International Forestry Research (CIFOR), Conservation International (CI), Deutsche Gesellschaft für Internationale Zusammenarbeit (German Agency for International Cooperation, GIZ), Development Bank of Latin America (CAF), Eindhoven University of Technology (The Netherlands), eThekwini Municipality Government (Durban, South Africa), French Agricultural Research Centre for International Development (CIRAD), Global Environment Facility (GEF), Green Climate Fund (GCF), Griffith University (Australia), Inter-American Development Bank (IDB), International Climate Initiative (IKI), International Institute for Environment and Development (IIED), Institute for Global Environmental Strategies (IGES), International Union for Conservation of Nature (IUCN), Lund University (Sweden), Organisation for Economic Co-operation and Development (OECD), The Nature Conservancy (TNC), United Nations Development Programme (UNDP), United Nations Environment Programme (UNEP), United Nations Environment Programme – World Conservation Monitoring Centre (UNEP-WCMC), University of California – Santa Cruz (UCSC), United States Agency for International Development (USAID), University of Oxford (UK), Wildlife Conservation Society (WCS), World Bank, World Resources Institute (WRI) and World Wildlife Fund (WWF).

5 For more information, please visit https://globalebafund.org/.

Chapter 1. Ecosystem-based adaptation

Introduction

As stronger storms, extreme rainfall events, record-breaking temperatures and historic climate-driven floods become more frequent and affect large parts of the world, governments, businesses and communities are increasingly calling for society to better prepare for and adapt to the negative impacts of climate change or face serious costs, damages and losses. Recent high-level reports, such as the United Nations Adaptation Gap Reports (UNEP 2021a; UNEP 2021e), the Adapt Now report (GCA 2019), and the latest report from the Intergovernmental Panel on Climate Change (IPCC 2022), have stressed the urgent need for much more ambitious policies, programmes and investments to build societal resilience to climate change. These reports have also highlighted the critical importance of ecosystems and ecosystem services in helping people to adapt to the adverse impacts of climate change. EbA can play a central role in enhancing the overall resilience of society to climate change, while also ensuring the conservation of ecosystems and ecosystem services on which society depends (GCA 2020).

In this chapter, we explore what ecosystem-based adaptation (EbA) is and how it can help put the world on a more climate-resilient and nature-positive pathway. The overall aim of this chapter is to ensure that readers have a clear understanding of what EbA entails and how it can make a significant contribution to both local and global adaptation efforts. We first briefly introduce the concept of climate change adaptation and the main adaptation approaches, so that the broader context in which EbA can be applied is clear. Next, we provide a detailed overview of the concept of EbA and clarify how EbA relates to other concepts such as NbS, green infrastructure and community-based adaptation. We then provide specific examples of how EbA can be applied in different socioeconomic contexts, in order to demonstrate the wide applicability and diversity of EbA measures. Finally, we highlight some of the reasons why EbA is rapidly gaining traction within policies, programmes, investments and research, as well as some of the physical limitations to its use. An overview of the current status and trends of EbA implementation is provided in chapter 2, while subsequent chapters examine the barriers (chapter 3) and opportunities (chapter 4) for scaling up the use of EbA globally.

1.1. Climate change adaptation and different types of adaptation measures

As defined by the IPCC, adaptation is “the process of adjustment to actual or expected climate and its effects” (IPCC 2014). Climate change adaptation includes actions and decisions to help society prepare for and adjust to both the current effects of climate change and the predicted impacts in the future. The overall goal of adaptation is to reduce the vulnerability of people to climate change risks, and to enhance their capacity to respond to or manage these risks.

Adaptation can take many forms, including changes in behaviours, practices and knowledge to address the expected impacts of climate change. For example, adaptation can involve establishing early warning systems to protect vulnerable communities from severe storms, building larger reservoirs to deal with water shortages, switching to new drought-resistant crop varieties to help farmers better deal with changes in rainfall patterns, building sea walls to protect coastal areas from flooding, or managing forest undergrowth to prevent the risks of more severe, climate-fuelled fires (GCA 2019). Adaptation can be incremental, involving small adjustments to practices, behaviour or infrastructure (such as changing the locations where livestock are grazed, or raising the height of sea walls), or it can be transformative, leading to systematic changes in society and ecosystems (such as farmers switching to non-agricultural livelihood activities or migrating to other regions – Kates, Travis and Wilbanks 2012; Fedele *et al*. 2019). Adaptation can be pursued by all constituents of society – individuals, households, communities, businesses and national governments – and involves actors in both public and private sectors. It can be based on traditional knowledge, local knowledge, scientific knowledge and technologies, or a combination thereof.

While there is a diverse array of measures that can be undertaken to help society adapt to climate change, adaptation actions can be broadly categorized into three main approaches: conventional hard approaches, soft approaches and EbA (Sovacool 2011; Jones, Hole and Zavaleta 2012).

- **"Hard approaches"** refer to the use of specific technologies, engineering solutions or human-built infrastructure to reduce the impacts of climate change on society. Examples include using sea walls to protect vulnerable coastlines from coastal erosion and storm damage, building dams, storm drains and canals to protect cities from the risk of flooding, establishing irrigation systems to tackle climate-induced water scarcity, building water treatment plants to ensure the provision of clean water during climate change, and installing air-conditioning to help households cope with rising temperatures and heat stress (Sovacool 2011; Jones, Hole and Zavaleta 2012). These hard adaptation approaches (which are often also referred to as "conventional" approaches, "engineered" solutions, "grey infrastructure" or simply "grey" approaches) are typically very effective at addressing specific climate hazards (Browder *et al*. 2019). However, they tend to be expensive to build and maintain, have a finite lifespan, and often involve large and irreversible disturbances to surrounding natural ecosystems (World Wildlife Fund [WWF] and World Bank 2013).

- **"Soft approaches"** refer to the use of information, finance, knowledge generation, policy, human resources development, policies, and planning processes to build societal resilience to a range of climate change impacts (Jones, Hole and Zavaleta 2012; Goldstein *et al*. 2019). Examples include enhancing awareness of climate risks, building capacity on climate adaptation, creating disaster risk reduction strategies to deal with climate hazards, developing social safety nets that can help communities affected by climate hazards, improving weather forecasts and climate modelling, and developing early warning systems for droughts, floods and other extreme weather events (Sovacool 2011; Jones, Hole and Zavaleta 2012). In most cases, soft approaches are used in combination with hard approaches and EbA.

- **"Ecosystem-based adaptation"** (EbA) is defined as "the use of biodiversity and ecosystem services as part of an overall adaptation plan strategy to help people adapt to the adverse effects of climate change" (CBD 2009). As detailed in the following section (section 1.2), EbA includes the targeted conservation, restoration and management of ecosystems to deliver services that help people adapt to climate change. In some cases, EbA measures are implemented as stand-alone, discrete adaptation initiatives that serve as alternatives to hard approaches. However, in most cases, EbA measures are implemented in tandem with hard and soft measures, as part of a broader adaptation plan (Bertram *et al*. 2017; Browder *et al.* 2019).

Adaptation planners and practitioners can use a mix of these different adaptation approaches to address the specific climate risks arising in a particular location and to respond to the differentiated vulnerability and adaptation needs of different stakeholder groups. In many cases, adaptation practitioners combine hard and EbA approaches in so-called "green-grey" or "hybrid" approaches (Browder *et al*. 2019, Green-Gray Community of Practice 2020).

While all types of adaptation are important, necessary and appropriate for certain contexts, our report focuses specifically on the opportunity to increase the implementation of EbA to help society become more resilient to climate change. Throughout this report, we use the term "EbA initiatives" to refer both to the use of initiatives that consist solely of EbA measures, as well as hybrid or green-gray approaches in which EbA is used in tandem with hard adaptation measures.

Large scale ecosystem-based adaptation in the Gambia: developing a climate-resilient natural resource-based economy.
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1.2. Ecosystem-based adaptation: definition and principles

EbA is an approach that harnesses nature to reduce vulnerability and build resilience to climate change (International Union for Conservation of Nature [IUCN] 2017). As defined by the CBD (2009), an EbA initiative or approach is characterized by three key elements:

1. it is based on the active use of biodiversity and ecosystem services
2. it helps people adapt to the adverse impacts of climate change
3. it is implemented in the context of a broader adaptation strategy

EbA measures include actively conserving natural ecosystems, restoring degraded ecosystems, targeted management of natural and modified ecosystems, and/or creating new ecosystems (e.g. the planting of new vegetation in urban areas) as part of a broader climate adaptation strategy (Bertram *et al*. 2017; European Environment Agency [EEA] 2021).

EbA can enhance societal resilience to climate change in two main ways. Firstly, EbA can physically shield or buffer communities, infrastructure and assets against climate-related hazards such as floods, storm surges, heatwaves, droughts, fire, landslides and erosion (Ojea 2015; Seddon *et al*. 2020a; 2020b). For example, restoring mangrove forests, coral reefs and other coastal habitats has been proven to reduce wave energy, attenuate wave height, reduce storm surges and stabilize coastal shores, protecting coastal communities and infrastructure from climate change impacts (Arkema *et al*. 2013; Temmerman *et al*. 2013). Secondly, EbA can help communities improve their ability to cope with, respond to or recover from the impacts of climate hazards by maintaining the ecosystems and critical ecosystem services (e.g. providing food and timber or access to water) that can help people meet their diverse needs in a changing climate (Ojea 2015; Donatti *et al*. 2020). For example, the implementation of EbA measures (such as agroforestry or soil and water conservation practices) in agricultural systems can improve crops, increase farmers' income and enhance their food security, thereby improving farmers' ability to withstand the negative impacts of climate change (Vignola *et al*. 2015; Miralles-Wilhelm 2021).

EbA can be used to address a wide range of climate hazards, including not only extreme weather events but also slow-onset events such as sea-level and temperature rise. Depending on the context and measures deployed, EbA can be used to help mitigate the impacts of climate-induced high temperatures, heat waves, dust and sand storms, heavy rainfall events, strong storms, floods, sea level rise, droughts, water scarcity, coastal erosion and landslides (McVittie *et al*. 2018; Donatti *et al*. 2020). Examples of the adaptation benefits from EbA include reducing the risks from floods, droughts and other extreme weather events, maintaining food and water security in a changing climate, avoiding negative health outcomes (such as respiratory distress and heat stroke from high temperatures and fires), reducing the incidence of certain vector-borne diseases, reducing climate-related mortality and morbidity, maintaining and diversifying livelihoods in a changing climate, and protecting human life, property and assets from climate hazards (Secretariat of the Convention on Biological Diversity [SCBD] 2019; Donatti *et al*. 2020).

Many organizations have developed principles to inform the development and implementation of EbA initiatives. The EbA Assessment Framework developed by the Friends of EbA (FEBA) network, for example, includes five broad criteria and 20 quality standards for EbA implementation (Bertram *et al*. 2017). According to this framework, EbA should:

1. reduce social and environmental vulnerability
2. generate societal benefits in the context of climate change adaptation
3. restore, maintain or improve ecosystem health
4. be supported by policies at multiple levels
5. support equitable governance and enhance capacities by following a community-centred, participatory and gender-sensitive approach.

Additional guidance for EbA implementation is available from IUCN (Andrade Perez *et al*. 2011), the United Nations Development Programme (UNDP 2015a), the Convention on Biological Diversity (CBD 2019), Conservation International (CI – Donatti *et al*. 2021), and the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), the United Nations Environment Programme – World Conservation Monitoring Centre (UNEP-WCMC) and FEBA (Wicander 2020), among others. While the specific articulation of EbA principles and guidelines varies across these groups, all of them point to the need to maintain healthy and resilient ecosystems, the importance of collaboration and coordination among diverse stakeholder groups and sectors, the need to address the differentiated vulnerability and adaptation needs of different stakeholder groups (including women, Indigenous Peoples and other marginalized groups), the importance of integrating scientific, local and traditional knowledge, and the need for supportive policy and governance structures. In addition, most of these guidelines emphasize the need for EbA to support equitable and inclusive development.

1.3. How ecosystem-based adaptation differs from related concepts

The concept of EbA draws on a wide number of existing approaches to ecosystem management and is closely related to other concepts. Here we briefly explore the relationship of EbA measures with other conservation and sustainable development measures, as well as the relationship between EbA and related concepts which are prominent in ongoing policy discussions.

While the concept of EbA is still relatively new[6], many of the practices deployed under EbA have been used for decades by the conservation and sustainable development sectors (UNEP 2021a). For example, many of the EbA practices for agriculture (such as the use of agroforestry) have been widely promoted under the concepts of sustainable agriculture, agroecology, conservation agriculture, climate-smart agriculture, and, more recently, regenerative agriculture (Lipper *et al*. 2017; Vignola *et al*. 2015). Similarly, the use of forest conservation, restoration or sustainable management to address climate risks is common in forest landscape restoration, biodiversity conservation, integrated watershed management and integrated landscape management initiatives (Harvey *et al*. 2014; Reed, Deakin and Sunderland 2015; Stanturf *et al*. 2015; Bertram *et al*. 2017). Many of the EbA practices that are applied to protect coastal communities from climate-induced flooding or sea level rise have been widely supported as part of integrated coastal zone management, marine spatial planning and integrated water management initiatives (Giffin *et al*. 2020; Le Tissier 2020), while EbA measures for cities have been applied as part of green infrastructure, sustainable urban drainage systems, natural water retention measures and sustainable urban planning initiatives (Pauleit *et al*. 2017; EEA 2021). While EbA uses many of the same measures as these closely related approaches, the key difference is that under an EbA approach, these measures are selected, implemented and managed with the specific goal of helping society adapt to climate change, and are intended to address the identified climate adaptation needs of target stakeholder groups.

The concept of EbA is closely related to several other key concepts that are gaining traction in policy, practice and research, including NbS, Ecosystem-based disaster risk reduction (Eco-DRR), community-based adaptation (CbA), and green infrastructure:

6 The term was first used by IUCN and its member institutions at the United Nations Framework Convention on Climate Change Conference of Parties in 2008 (UNFCCC 2008) and was then formally defined by the Convention on Biological Diversity in 2009 (CBD 2009; Colls, Ash and Ikkala 2009).

- ***Nature-based Solutions (NbS)*** is a broader umbrella concept that encompasses actions designed to address major social, economic and environmental challenges such as biodiversity loss, climate change, land degradation, desertification, food security, disaster risks, urban development, water availability, poverty eradication, inequality and unemployment (Cohen-Shacham *et al.* 2016; Cohen-Shacham *et al*. 2019). The term was defined in a multilateral resolution at the UNEA in March 2022 as "actions to protect, conserve, restore, sustainably use and manage natural or modified terrestrial, freshwater, coastal and marine ecosystems, which address social, economic and environmental challenges effectively and adaptively, while simultaneously providing human well-being, ecosystem services, resilience and biodiversity benefits" (UNEA 2022). EbA refers to the subset of NbS that are specifically designed and implemented to achieve climate adaptation goals (IUCN 2020; Terton and Greenwalt 2021). The term "nature-based solutions for adaptation" (NbSA) is therefore synonymous with "EbA" and the two terms can be used interchangeably.

- ***Ecosystem-based disaster risk reduction (Eco-DRR)*** is defined as the "sustainable management, conservation and restoration of ecosystems to reduce disaster risk, with the aim to achieve sustainable and resilient development" (Doswald and Estrella 2015; Renaud *et al*. 2016; United Nations Office for Disaster Risk Reduction 2020). While Eco-DRR and EbA share some of (but not all) the same practices and are conceptually similar, EbA focuses specifically on helping people to adapt to climate change, while Eco-DRR focuses on reducing disaster risk not only from climate hazards but also from natural hazards such as earthquakes and tsunamis (Renaud *et al*. 2016). In addition, while EbA can be used to address both gradual onset events (such as rising temperatures) and acute climate hazards (extreme weather events), Eco-DRR focuses solely on acute threats from natural hazards.

- ***Community-based adaptation (CbA)*** aims to support the adaptation needs of vulnerable communities, empowering people to plan for and cope with the impacts of climate change (Reid *et al*. 2009). EbA and CbA are similar in that they are both focused on helping people to adapt to climate change; however, there is a difference in emphasis. EbA emphasizes the management, restoration and conservation of ecosystems to help people adapt to climate change, while CbA focuses on ensuring that adaptation is specifically tailored to the priorities, needs and capacities of the most vulnerable communities, without specifying the type of adaptation approach needed (Reid 2016). In practice, EbA and CbA are often implemented jointly (Girot *et al*. 2012).

- ***Green infrastructure*** refers to strategically planned networks of natural and semi-natural terrestrial habitats which are designed and managed to deliver a wide range of ecosystem services such as water purification, air quality, space for recreation and climate mitigation and adaptation, while "blue infrastructure" refers to the management of water bodies including ponds, lakes, streams and rivers to provide ecosystem benefits to people (EEA 2021). The use of green or blue infrastructure (also sometimes referred to as "nature-based infrastructure" or "green-blue infrastructure", Bassi *et al*. 2021) is similar to EbA in that it aims to restore, maintain and improve ecosystems to enhance the provision of services to society. However, whereas EbA is specifically designed to help people adapt to climate change and is based on assessments of climate vulnerability, climate hazards and risks to people, the use of green and blue infrastructure is typically intended to deliver on multiple broader goals, including but not limited to climate change adaptation (Pauleit *et al*. 2017; EEA 2021).

1.4. Examples of ecosystem-based adaptation in different socioecological settings

There is a wide range of EbA measures that can be used to address different climate hazards and risks in different contexts, ecosystems and geographies (Ojea 2015, Swiderska, King-Okumu and Islam 2018). To demonstrate the diversity and wide applicability of EbA measures, here we provide a high-level overview of EbA measures that can be implemented in six socioecological settings, namely urban areas, agricultural landscapes, forested landscapes, mountainous regions, freshwater systems and coastal areas. Additional examples of EbA measures and case studies of their application in different settings can be found in Table 1. Since there are overlaps and interlinkages across these settings (e.g. urban areas may occur in coastal zones or in mountain areas), individual EbA measures are often relevant to multiple settings. In practice, EbA initiatives are often implemented across large spatial scales (landscapes, watersheds or even transboundary river basins) that include multiple socioecological settings, and therefore involve a suite of different EbA measures (Hutchins *et al*. 2021).

- ***Urban areas:*** There is a wide number of EbA measures that can help urban residents and businesses cope with rising temperatures, heat waves, urban flooding, greater water scarcity and other climate impacts (Gaffin, Rosenzweig and Kong 2012; Geneletti and Zardo 2016; Hobbie and Grimm 2020). For example, urban parks, street trees, green roofs, community gardens and other green spaces provide shade and evaporative cooling, reducing the impacts of rising temperatures on the health and well-being of urban residents (Norton *et al*. 2015; Hobbie and Grimm 2020; Koch *et al*. 2020). Other EbA measures, such as the restoration of ponds, urban wetlands, and green spaces, can help reduce the risks of urban flooding by increasing water infiltration into the soil and reducing the amount and speed of surface run-off (Chu *et al*. 2019; Hobbie and Grimm 2020). These measures can also capture and store water, allowing aquifer recharge and reducing the risks of water insecurity under changing rainfall patterns (Chu *et al*. 2019). The use of EbA measures in common in cities around the world, with well-documented examples from Europe (Gill *et al*. 2007; Naumann *et al*. 2011; Brink *et al*. 2016; Geneletti and Zardo 2016; Frantzeskaki 2019; Kabisch *et al*. 2017; McVittie *et al*. 2018; EEA 2021; Zölch, Wamsler and Pauleit 2021), the United States of America (Young 2011; Chu *et al*. 2019), Latin America (Tellman *et al*. 2018), Africa (Thorn *et al*. 2021) and China (Zevenbergen, Fu and Pathirana 2018; UNEP 2021a). Guidance on the implementation of EbA within cities is available from the World Bank (2021), UNEP (2021) and the Green-Gray Community of Practice (2020).

- ***Agricultural landscapes:*** EbA measures can help farmers, pastoralists and other rural residents adapt to the impacts of climate change on farm productivity, food security and rural livelihoods (Vignola *et al*. 2015; Miralles-Wilhelm 2021). For example, the establishment of diverse agroforestry systems can help buffer crops from the impacts of higher temperatures, heavy rains, droughts or strong winds, reduce soil erosion and modify the microclimate in ways that improve crop yields (Verchot *et al*. 2007; Harvey *et al*. 2014; Schoeneberger, Bentrup and Patel-Weynand 2017). Agroecological practices (such as cover crops, mulching, no till, crop rotation and soil and water conservation practices) can be used to help improve soil structure and fertility, increase water infiltration, reduce soil loss and protect crops from water scarcity (Sinclair *et al*. 2019; Miralles-Wilhelm 2021). Crop diversification and the conservation of agrobiodiversity can help reduce the risks of crop failure from high temperatures, heavy rainfall events, droughts, or climate-induced pest and disease outbreaks or invasive species (Burgiel and Muir 2010; Lin 2011; Snapp *et al*. 2021). Adopting silvopastoral practices and restoring degraded pastures can help to sustain the livelihoods of pastoralists and ranchers under climate change (International Fund for Agricultural Development [IFAD] 2020; Bah *et al*. 2021). At the broader landscape level, restoring forests, wetlands, riparian areas and degraded lands across the agricultural landscape can increase water infiltration and slow the flow of water, thereby ensuring the continued provision of water to agricultural areas and buffering against water scarcity and drought (Pramova *et al*. 2012). EbA measures can be easily incorporated into integrated landscape management, forest landscape restoration or climate-smart landscape initiatives which contribute to climate adaptation, climate mitigation, biodiversity conservation and food security efforts (Harvey *et al*. 2014; Reed *et al*. 2015; Stanturf *et al*. 2015; Reed *et al*. 2020). Guidance on the implementation of EbA in agricultural systems is available from Abdelmagied and Mphesha (2021), Wilhelm-Miralles (2021) and Sonneveld *et al*. (2018).

- ***Forested landscapes:*** EbA measures can also help communities living in forested landscapes adapt to higher temperatures, more severe heat waves, increased likelihood and severity of forest fires, longer fire seasons, changes in the availability of water, prolonged droughts, increased soil erosion, more frequent landslides, and climate-induced outbreaks of forest pests (Swiderska, King-Okumu and Islam 2018). Potential EbA measures for forested landscapes include the active protection of intact forests from deforestation, degradation and human-induced fires to ensure that forests are healthy and resilient to climate change, the restoration of degraded forest lands to restore hydrological services, and the use of sustainable forest management practices (e.g. thinning and/or selective logging) in natural forest stands to maintain forest health and productivity in a changing climate (Colls, Ash and Ikkala 2009; Chausson *et al*. 2020). Careful management of fires within forests can also help enhance their resilience to climate change and their ability to provide timber, firewood, non-timber forest products, water regulation and climate regulation services to society (Colls, Ash and Ikkala 2009). At the landscape level, the large-scale protection of intact forest through protected areas, conservation agreements, or community-managed forests can help to stabilize soils and prevent the incidence of landslides and flash floods under extreme weather events, while also providing valuable biodiversity and climate mitigation benefits (Dudley and Stolton 2003; MacKinnon, Dudley and Sandwith 2011; Lopoukhine *et al*. 2012; Martin and Watson 2016). Conserving and restoring forests at the landscape or watershed level can also improve water infiltration and storage, helping to preserve water in the face of changing precipitation regimes and rising temperatures. This regulatory function is particularly important in regions where large cities and towns lie downstream of forested areas (Dudley and Stolton 2003; Tellman *et al*. 2018; Ozment *et al*. 2021). Guidance for the use of EbA in forested landscapes can be found in Swiderska, King-Okumu and Islam (2018).

- ***Mountainous regions:*** The deliberate management of mountain ecosystems (including grasslands, páramos, wetlands, alpine ecosystems and montane forests) can play a key role in helping mountain communities to adapt to the impacts of rising temperatures, changing precipitation patterns and more intense extreme weather events (Lo 2016; Swiderska, King-Okumu and Islam (2018). Conserving, restoring and sustainably managing vegetation in the upper slopes of mountains can stabilize slopes and prevent landslides and avalanches during extreme storms or precipitation events (Forbes and Broadhead 2013). The use of ecosystem restoration practices, contour planting or agricultural terraces can help stabilize fragile mountain slopes and reduce water run-off, reducing erosion and the risk of climate-induced floods (UNDP 2015b). In dry mountainous areas, the adoption of rainwater harvesting techniques and other traditional water management practices can help farmers and herders manage the uneven spatial and temporal distribution of water in a changing climate (Sonneveld *et al*. 2018; Swiderska, King-Okumu and Islam 2018). Restoring mountain springs and riverbank vegetation can also help regulate water flows and ensure the continued provision of fresh water supplies downstream for domestic use, lowland irrigation and other needs under climate change (Price and Egan 2014; UNEP 2014). The management, conservation and restoration of healthy mountain ecosystems can also help build resilience against disasters by providing food, shelter and other goods to local mountain communities and sustaining their livelihoods (UNDP 2015b). Guidance on the use of EbA in mountainous regions is available from UNDP (UNDP 2015b) and from Swiderska, King-Okumu and Islam (2018).

- ***Freshwater systems:*** Communities living adjacent to freshwater systems (such as rivers, streams and inland wetlands) are threatened by increased temperatures, changes in rainfall, and more intense droughts, flash floods and storms, which may reduce agricultural production in river floodplains, damage houses and community infrastructure, reduce domestic water supply and negatively affect fishing and other livelihoods. EbA measures can play an important role in providing resilience to these climate hazards. For example, conserving and restoring habitats along streams and rivers in upper catchments can protect downstream communities and infrastructure from flooding and erosion, while also improving water security and maintaining livelihoods (De Vriend *et al*. 2014; Seddon *et al*. 2020a). The restoration or renaturalization of stream and river structures can help enhance flood retention, improve downstream water quality and regulate water temperature and help support inland fisheries (Chausson *et al*. 2020). Conserving intact wetlands can help to limit the run-off from water catchments and thereby also increase water availability for agriculture (Kuma *et al*. 2020). Guidance on how to integrate EbA within freshwater systems is available in Dörendahl and Aich (2021), Bridges *et al*. (2021) and the Cities Finance Facility and eThekwini Municipality (2020).

- ***Coastal areas:*** Many coastal areas are vulnerable to climate-induced storm surges and rising sea levels, which can lead to coastal flooding, land erosion, saltwater intrusion (threatening water supplies), loss of life and significant damage to coastal settlements, infrastructure and other assets (Swiderska, King-Okumu and Islam 2018). Conserving and restoring near-shore ecosystems such as coral and oyster reefs, sea grasses, kelp forests and barrier islands can help reduce climate risks to coastal communities by dissipating water energy, attenuating wave heights and reducing storm surges (Hale *et al*. 2009; Temmerman *et al*. 2013; Narayan *et al*. 2016; Reguero *et al*. 2021). The careful management of mangrove forests, salt marshes, sand dunes and other coastal habitats can help to reduce the impact of wave intensity, lower risks of flooding and saltwater intrusion, reduce the erosion and loss of land, and protect human settlements and coastal assets from storm damage (Hale *et al*. 2009; Kumar *et al*. 2020). The establishment or expansion of marine protected areas, no-take zones or locally managed marine areas can enhance the resilience of marine ecosystems to climate change and support critical fisheries and coastal livelihoods (Roberts *et al*. 2017; Chausson *et al*. 2020). Reducing pressures on coastal ecosystems (such as overfishing, pollution, high sediment loads and unplanned and unsustainable coastal development) can help ensure that ecosystems are healthy, resilient and able to provide ecosystem services to people under climate change. Guidance on the deployment of EbA in coastal areas is available in Spalding *et al*. (2014), UNEP (2016), the United States Agency for International Development (USAID 2018), Swiderska, King-Okumu and Islam (2018), IUCN (2020a) and The Nature Conservancy (TNC 2021a).

1.5. Strengths of ecosystem-based adaptation

EbA has many qualities which make it a potentially attractive approach for policymakers, donors, investors and practitioners interested in enhancing the overall resilience of society to climate change.

First, EbA can potentially be applied in a wide range of socioecological settings and sectors, making it relevant to most adaptation initiatives. As highlighted in section 1.4, EbA holds the potential to help people adapt to climate change across a wide range of socioecological settings, from agricultural landscapes to coastal zones to cities, and can be used to address a wide range of climate hazards. In addition, EbA measures can meet the adaptation needs of a diverse set of sectors, including energy production, agriculture and food production, urban development, forestry, fisheries, water and sanitation, health, disaster relief, infrastructure and transportation, among others (Kapos *et al*. 2019;

Chausson *et al*. 2020). In the energy sector, for example, the use of EbA measures (such as forest conservation or restoration) in the upper catchments of watersheds can help to reduce run-off and siltation to downstream dams, helping to ensure the continued provision of hydropower production in a changing climate (Stickler *et al*. 2013). In the infrastructure and transportation sector, EbA measures can used to protect roads and train tracks from climate-induced landslides or flash flooding (Mandle, Griffin and Goldstein 2016; Browder *et al*. 2019). This widespread applicability and versatility of EbA makes it attractive to a broad suite of different stakeholders in diverse geographies.

Second, high-quality and carefully designed EbA initiatives can generate an array of short- and long-term benefits to society, above and beyond adaptation benefits. Depending on their design and management, EbA measures can potentially contribute to improved health, biodiversity conservation, food security, climate change mitigation, job creation, recreation, aesthetic enjoyment, tourism opportunities, livelihood opportunities and economic development (Ojea 2015; Lo 2016; Loehr *et al*. 2020). For example, the creation and retention of urban parks and street trees not only helps to reduce heat stress and urban flooding but can also provide other benefits such as improved health, recreation opportunities, energy savings, improved quality of life and a sense of belonging (Lee and Maheswaran 2010; Kabisch *et al*. 2016; McDonald *et al*. 2020; Diener and Mudu 2021). The establishment of diverse agroforestry systems not only reduces climate change impacts on crop production, but can also lead to enhanced food security, improved water quality, job creation and new economic opportunities from the sale of timber, fruits and firewood (Verchot *et al*. 2007). Many EbA practices also provide significant climate mitigation benefits by storing and sequestering carbon in soils and plant biomass and by reducing greenhouse gas emissions from deforestation and degradation (Griscom *et al*. 2017; Girardin *et al*. 2021; UNEP and IUCN 2021). In fact, the protection and restoration of forests, mangroves and other ecosystems could deliver emissions reductions and removals of at least 5 $GtCO_2e$ per year by 2030, making a significant contribution to climate change mitigation efforts (UNEP and IUCN 2021). These so-called “co-benefits” are an important and unique selling point for EbA (Ojea 2015), as other adaptation measures (such as hard infrastructure) only deliver the specific adaptation outcomes they are designed for and may not provide co-benefits.

Third, EbA is often (but not always) more cost-effective than alternative, engineered solutions, especially if the value of the multiple co-benefits of EbA is considered (Emerton 2017; GIZ 2017b). The construction, operation and maintenance of large, engineered projects (such as sea walls or dams) is expensive and typically requires significant maintenance, emergency repair and replacement costs (UNDP 2015a; Sutton-Grier *et al*. 2018). EbA options are often considerably cheaper to implement, may cost less to maintain over time and deliver additional co-benefits to society, making them more cost-effective over the long-term (UNDP 2015a; USAID 2017b; Organisation for Economic Co-operation and Development [OECD] 2021; Smith and Chausson 2021). For example, a study by Reguero *et al*. (2018) found that the restoration of marsh and oyster reefs was among the most cost-effective adaptation measures for preventing flooding. A global review of the costs and benefits of coastal defences similarly found that salt marshes and coral reefs were two to five times more cost-effective at protecting coastlines than engineered structures (Narayan *et al*. 2016). Another study in Sao Paulo, Brazil found that the restoration of 4,000 ha of forests in the city’s watershed was US$ 4.5 million cheaper than dredging reservoirs to improve water quality (GCA 2019). Green-gray approaches can also be cost-effective, as the integration of ecosystems with hard infrastructure can extend the lifetime of the costly hard infrastructure and enhance overall service provision (Green-Gray Community of Practice 2020).

Fourth, EbA is flexible and more sustainable in the long term than other adaptation approaches, as ecosystems can generally grow and adapt to changing climatic conditions (unless the changes are too great – see section 1.6). Unlike grey infrastructure approaches which are designed to provide protection against a particular level of a climate threat (e.g. wind speeds up to a certain level or flooding up to a certain height) and are not easily changed once they have been built, EbA measures are able to withstand and adjust to changing climatic conditions and can continue to deliver adaptation benefits in the long-term (Hallegatte and Dumas 2008; Jones, Hole and Zavaleta 2012). For example, mangroves and wetlands can migrate inward or upland in response to rising sea levels if the rate of sea level rise is not too high and if there is undeveloped coastal space for them to colonize (Borchert *et al*. 2018; Menéndez *et al*. 2020). Similarly, mangrove forests and other forests can regenerate following hurricane events and continue to provide protective functions into the future (Imbert 2018). In contrast, if sea walls or levees are destroyed by heavy storms or rising sea levels, they no longer deliver their intended protective function and become stranded assets that need to be replaced (OECD 2021).

A final reason why EbA is an attractive approach is that it allows policymakers, donors and practitioners to pursue multiple policy agendas simultaneously. Due to its ability to generate multiple societal benefits, EbA can help governments not only to meet their commitments under the United Nations Framework Convention on Climate Change (UNFCCC)[7], but also to achieve related policy goals under the Convention on Biological Diversity[8], the United Nations Convention to Combat Desertification (UNCCD)[9], the Sendai Framework for Disaster Risk Reduction[10], the United Nations Sustainable Development Agenda[11], the Bonn Challenge[12], the UN Decade on Ecological Restoration[13] and related policy initiatives (Ojea 2015; Seddon *et al*. 2020b). For instance, EbA implementation contributes to countries' national development strategies and sustainable development agenda by enhancing food, water and energy security, providing opportunities for training and empowerment, creating jobs, enhancing health outcomes, reducing disaster risks and generating local economic development (Vijtpan *et al*. 2018; Raes *et al*. 2021; Roe *et al*. 2021). In addition, EbA initiatives (particularly those involving the active restoration of degraded ecosystems) can play a potentially important role in helping countries recover from the current COVID-19 pandemic by providing a source of jobs and economic activity, and by enhancing the resilience of communities to both current and future climate shocks (Edwards, Sutton-Grier and Coyle 2013; OECD 2020; Beyer and Vandermosten 2021). Finally, if designed and implemented appropriately, EbA can also contribute to gender-sensitive, equitable and inclusive development, as EbA interventions can be intentionally designed to address the specific vulnerabilities of women and other marginalized groups and to ensure the equitable distribution of costs and benefits across different stakeholder groups (Angula *et al*. 2021; Dazé and Terton 2021).

1.6. Limitations of ecosystem-based adaptation

While EbA is a versatile approach and can potentially be used in myriad contexts, it is also important to consider the limitations to its application.

First, there are some contexts in which EbA may not be able to successfully address a particular climate hazard or combination of hazards. For example, in coastal areas where sea level rise is leading to saltwater intrusion into underground water supplies, there is no EbA management strategy that can directly solve this problem (Hobbie and Grimm 2020). Instead, communities will need to find alternative water supplies, begin desalinization processes or potentially relocate to unaffected areas. Similarly, in regions where rising temperatures are causing glaciers to rapidly melt and retreat, significantly reducing the water supply and threatening the livelihoods of adjacent and downstream communities, there are no ecosystem-based strategies that can directly prevent the reduction in water availability. However, EbA approaches can be helpful for more efficiently managing the water resources that remain (Mayville, Sanchez de Lozada and Shennum 2021). To assess the potential role of EbA within a particular adaptation plan, it is critical to have a good understanding of the expected climate impacts on people and ecosystems in the given region,

7 For more information, please visit https://unfccc.int/.
8 For more information, please visit https://www.cbd.int/.
9 For more information, please visit https://www.unccd.int/.
10 For more information, please visit https://unece.org/sendai-framework.
11 For more information, please visit https://www.un.org/sustainabledevelopment/.
12 For more information, please visit https://www.bonnchallenge.org/.
13 For more information, please visit https://www.decadeonrestoration.org/.

Building the resilience of Kune-Vaini Lagoon in Albania through ecosystem-based adaptation.
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the differentiated vulnerability of stakeholders to these impacts, and their specific adaptation needs, and to carefully consider the extent to which EbA measures can address these adaptation needs (Munroe *et al*. 2015; GIZ *et al*. 2019a; Donatti *et al*. 2021).

A second limitation is that EbA measures may take longer to implement than hard infrastructure approaches and may not be able to deliver adaptation benefits as quickly as needed. For example, while restoring degraded forests and native vegetation in mountainous areas is a viable option for stabilizing soils and preventing erosion and landslides from affecting mountain roads over the long term (Pramova *et al*. 2012), it may take years or even decades to restore a fully functioning forest ecosystem that can deliver the desired soil stabilization benefits. In contrast, grey infrastructure (such as retaining walls) provides protection from landslides as soon as it has been built but only delivers these benefits during the infrastructure's lifespan (Browder *et al*. 2019). Similarly, it can take several years before the planting or restoration of mangroves delivers coastal protection, as the mangroves need to grow sufficiently tall and dense to protect communities from the impacts of severe storms, flooding and coastal erosion; however, once the mangroves are sufficiently wide and well-established, they can provide protection over the long term (Spalding *et al*. 2014; del Valle *et al*. 2020). The fact that EbA measures often take longer to deliver visible adaptation benefits than grey infrastructure initiatives can make them less attractive to policymakers, donors and practitioners who want solutions that demonstrate immediate benefits (Sarabi *et al*. 2019; OECD 2021). Combining EbA measures with grey infrastructure approaches can sometimes help overcome this limitation (Green-Gray Community of Practice 2020).

A third limitation to the use of EbA is that there is sometimes insufficient physical space for their implementation. Many EbA measures entail the restoration or conservation of natural ecosystems and therefore space must be made available for these purposes (Nalau, Becken and Mackey 2018a). This is a particular constraint in coastal areas and floodplains where most land has been built on and where there is little remaining undeveloped land on which ecosystems could be actively restored or managed. There is also often restricted space for EbA measures in cities, most of which are densely populated and have little space that could be dedicated to ecosystem management. In other cases, land may be available but the price of land or the opportunity cost of securing land for EbA may be prohibitive.

A final limitation on the use of EbA is that ecosystems are themselves vulnerable to the impact of climate change, which means that their ability to continue to deliver the ecosystem services that underpin human resilience could be impaired as climate change intensifies (Hannah *et al*. 2002; Malhi *et al*. 2020). For instance, while mangroves can withstand slow rates of sea level rise, once the rate of sea level rise exceeds the capacity of mangroves to migrate inland, mangroves will slowly disappear from existing areas and their ability to protect communities from coastal flooding will decline (Menéndez *et al*. 2020). Similarly, many coral reefs are already being bleached by rising ocean temperatures and are likely to eventually die if temperatures continue to rise unabated, undermining their ability to provide coastal protection to coastal communities in the future (Thiele *et al*. 2020). The faster the climate changes, the greater the impacts will be on natural ecosystems and their ability to deliver key ecosystem services. In addition, many natural ecosystems are also facing significant pressure from unsustainable harvesting, agricultural production, animal grazing, oil and gas extraction, mining, contamination, pollution, wildlife hunting and other stressors, impairing their structure, function and delivery of ecosystem services (Grantham *et al*. 2021; Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services [IPBES] 2021). Urgent action is needed to reduce both climatic and non-climatic stressors on ecosystems and maintain ecosystem health and integrity, so that they can continue to serve as an important cornerstone of climate adaptation efforts into the future (IPBES 2021; UNEP 2021a).

Table 1. **Illustrative examples and case studies of EbA measures applied in different socioecological settings**

Context	EbA measures	Case studies
Urban areas	• Establishment and management of urban parks, street trees, green roofs, green façades, community gardens and other green spaces to provide shade and cool cities, mitigating the negative impacts of high temperatures and heat stress. • Conservation, management and restoration of parks, green roofs, rain gardens, bioswales, rivers, ponds and urban wetlands to increase water infiltration, reduce surface run-off, manage storm water and reduce flooding risks. • Renaturalization and restoration of riparian areas, rivers and floodplains in urban areas to improve water management and reduce flooding from extreme rainfall and severe storms. • Rainwater harvesting through urban gardens, rain gardens and other green spaces to capture and store water, allow aquifer recharge, and ensure water supply during climate-induced droughts. • Creation and management of parks and protected areas within and adjacent to cities to ameliorate heat stress and attenuate flood risks.	• China is promoting the widespread uptake of “sponge cities” in which open green spaces, green roofs, bioswales, ponds and urban wetlands are intentionally conserved to enhance water infiltration and reduce flooding risks under extreme rainfall events (Zevenbergen *et al*. 2018; Griffiths *et al*. 2020). Since 2014, more than 30 different pilot sponge cities have been implemented across China. • In Europe, the integration of street trees, green roofs and walls, parks, and other green spaces has been widely used to combat rising temperatures, heat stress and climate-induced flooding (Geneletti and Zardo 2016). The Urban Nature Atlas[14] contains more than one thousand case studies of the use of NbS for urban resilience, most of which come from Europe. • The CityAdapt project[15] is using EbA measures to build the resilience of urban systems in three Latin American and Caribbean countries (El Salvador, Jamaica and Mexico) and four Asian countries (Bhutan, Cambodia, the Lao People's Democratic Republic and Myanmar). EbA measures include using urban agriculture with drought-resistant seeds, restoring wetlands and mangroves to reduce the risk of flooding and saline intrusion and establishing urban forests, parks and gardens, as well as watershed management to increase water infiltration and storage.

14 For more information, please visit https://una.city/.
15 For more information, please visit https://cityadapt.com/wp-content/uploads/2021/08/EbA_CityAdapt_vf.pdf.

Agricultural areas

- Planting trees in crop fields and pastures in diverse agroforestry systems to buffer the impacts of high temperatures, heavy rains, droughts and extreme weather events on crops and livestock.
- Use of agroecological practices (e.g. cover crops, intercropping, mulching, reduced tillage, crop rotation or soil and water conservation practices) to increase water infiltration, reduce soil erosion and protect crops from climate-induced water scarcity.
- Conservation of agrobiodiversity and crop diversification to reduce the risk of crop failure in a changing climate.
- Adoption of sustainable livestock management practices (e.g. rotational grazing, transhumance, silvopastoral systems) to enhance the resilience of grazing lands and livestock production to climate change.
- Restoration of degraded cropland and pastures through natural regeneration or active replanting to improve water infiltration and reduce soil erosion.
- Use of traditional water harvesting practices to maximize water capture and to recharge groundwater for domestic and agricultural use during dry periods and droughts.
- Conservation or restoration of forests and wetlands in the broader agricultural landscape to regulate water flows, prevent flooding and minimize potential water scarcity.

- In El Salvador, efforts are under way to restore coffee farms and ecosystems in the watershed of San Salvador in order to increase water infiltration, prevent flooding downstream and reduce the risks of landslides.[16]
- In Humbo, Ethiopia, farmers have adopted the use of farmer-managed natural regeneration to regenerate trees on degraded agricultural and forest land to recharge groundwater, reduce flash flooding and soil erosion, and safeguard agricultural livelihoods (Hou-Jones, Roe and Holland 2021).
- In Bangladesh, the Climate-Resilient Ecosystems and Livelihoods project helped rural farming communities to adopt EbA measures (including the use of agroforestry, integrated pest management and the preservation of natural vegetation adjacent to farming plots) to strengthen the resilience of agricultural production and local livelihoods to climate change (USAID 2017a).
- The Great Green Wall Initiative[17] aims to build the resilience of vulnerable smallholder farmers and ecosystems to climate change across the African Sahel by scaling up land restoration with native species and supporting sustainable agricultural production (Goffner, Sinare and Gordon 2019; Green Climate Fund [GCF] 2021).
- In Uganda, smallholder farmers are being encouraged to diversify their cropping systems to increase their household income and food security under changing climatic conditions (Nanfuka, Mfitumukiza and Egeru 2020).

16 For more information, please visit https://cityadapt.com.
17 For more information, please visit https://www.greatgreenwall.org/about-great-green-wall.

Forest landscapes

- Protection of intact forests from deforestation, degradation and human-induced fires to ensure continued productivity of in a changing climate.
- Restoration of degraded forests through natural regeneration or reforestation to restore hydrological services and enhance the climate resilience of forest-based livelihoods (e.g. tourism, recreation, non-timber forest products).
- Use of sustainable forest management practices (e.g. thinning or selective logging) to make forest industries more resilient to climate change.
- Establishment of protected areas, conservation agreements and community-managed forests to protect forests, stabilize soils, prevent erosion and maintain critical ecosystem services in a changing climate.
- Conservation, management and restoration of forests across watersheds to improve water infiltration and storage, reduce the risk of flooding and ensure continued water supply under changing climatic conditions.
- Adoption of measures to reduce the loss or degradation of forests from agricultural expansion, unsustainable harvesting (e.g. firewood, timber and charcoal), mining and gas exploitation, new roads and other pressures.
- Conservation, restoration and management of forests and other vegetation on steep slopes to prevent landslides during extreme weather events.

- In Nepal, trees and shrubs were planted in degraded forest and agricultural lands to reduce the vulnerability of local communities to climate-induced droughts, floods and soil erosion (Mills *et al*. 2020).
- In the watersheds of Ameca-Mascota and Jamapa, Mexico, a GCF project is under way to rehabilitate and restore forests along rivers and springs, protect and conserve remaining cloud forests, and promote agroforestry and sustainable livestock management to help local communities adapt to climate change and protect them from flooding and landslides (GCF 2021).

Mountains

- Conservation, management and restoration of native vegetation to stabilize slopes and prevent the risks of landslides and avalanches during extreme rainfall events.
- Restoration of degraded areas (through natural regeneration, active planting, terracing or contour planting) to stabilize slopes and reduce run-off, erosion and landslides due to extreme weather events.
- Restoration and management of highland pastures to reduce soil erosion and maintain livestock productivity in a changing climate.
- Conservation and restoration of mountain springs and riverbank vegetation to regulate water flows and enhance water provision.
- Water conservation, management and harvesting to ensure continued water provision under changing climatic conditions.
- Conservation and rewetting of peatlands to lower ambient temperatures in nearby areas, reduce the risks of climate-induced fires, and help regulate water flows.
- Actions to reduce pressure on fragile mountain ecosystems (e.g. reduced grazing, mining, unsustainable firewood and timber extraction), thereby enhancing ecosystem resiliency.

- In mountainous regions of Nepal, adaptation practitioners have reinforced riverbanks with native vegetation and hard infrastructure to protect the community from climate-induced flash floods (UNDP 2015b).
- In Tanta, Peru, degraded natural pastures, wetlands and alpine ecosystems have been restored to enhance year-round water provision and improve forage for grazing animals under changing climatic conditions (UNDP 2015b).
- In Mount Elgon, Uganda, a broad range of EbA measures including soil and water conservation practices, reforestation, terracing and agroforestry were used to reduce the risks of flooding and landslides, while also increasing income generation and food security for local communities (UNDP 2015b).
- In the high Andes of Colombia, there have been various initiatives to restore native vegetation in upper watersheds, along rivers and in landslide areas in order to reduce the vulnerability of ecosystems and communities to climate change and ensure the continued provision of water to the city of Bogotá (Andrade Perez *et al*. 2010).

Inland waters

- Protection and restoration of native ecosystems along streams and rivers in upper attachment bars to reduce downstream flooding.
- Restoration and renaturalization of stream and river structures to enhance flood reduction, improve water quality, regulate water temperatures and support inland fisheries amid climate change.
- Restoration of degraded floodplains to regulate water availability, reduce flooding and provide livelihood opportunities.
- Conservation of intact wetlands to limit run-off from water catchments and increase water availability for agriculture and domestic use.
- Reduction of pressure on freshwater ecosystems by targeting issues such as overfishing, contamination and pollution from agricultural run-off and industries, and unsustainable development on flood plains.
- Reforestation and restoration of riparian vegetation along riverbanks to slow run-off and reduce downstream damage to communities, properties and livelihoods.

- In The Gambia, an ongoing project aims to restore and rehabilitate at least 10,000 ha of agricultural land and degraded ecosystems (including forest, mangroves and savanna) along the River Gambia to improve the health, food security and water security of communities and reduce the risk of climate-induced flooding (UNEP 2017).
- In the Philippines, the Ministry of Environment and local communities are using EbA measures along the Ilog-Hilabangan river basin and the Tagum-Libuganon river basin to protect biodiversity, improve water availability for local communities and reduce the risks of climate-driven flooding (GIZ 2020).
- The water component of the Thai-German Climate Programme[18] is using EbA measures to increase the adaptive capacity of local communities to floods and droughts in select watersheds in Thailand.
- In the Netherlands, the Dutch Government has deployed EbA as part of its Room for the River programme[19], an initiative that is focused on reducing the risks of river flooding by creating more room for the river to flow across the floodplains.

18 For more information, please visit https://www.thai-german-cooperation.info/en_US/thai-german-climate-programme-water/.
19 For more information, please visit https://www.dutchwatersector.com/news/room-for-the-river-programme.

- Conservation and restoration of near-shore ecosystems (such as coral and oyster reefs, sea grasses, kelp forests, and barrier islands) to reduce wave energy and damage from storm surges, prevent flooding and reduce coastal erosion.
- Conservation of onshore habitats (including mangrove forests, salt marshes, sand dunes and coastal vegetation) to reduce wave intensity, reduce risk of flooding and saline intrusion, reduce coastal erosion and protect human settlements and assets from storm damage.
- Establishment and management of marine protected areas, no-take zones, and locally managed marine areas to increase ecosystem resilience to climate change, support fisheries and maintain fisheries and tourism-related livelihoods.
- Restoration of natural hydrological functions of salt marshes and coastal wetlands and revegetation of sand dunes to protect coasts from storms.
- Actions to reduce pressure on coastal ecosystems (e.g. unsustainable harvesting of timber from mangroves, overfishing, pollution, sedimentation, unplanned coastal development) to maintain healthy, resilient ecosystems that can provide services to support people's livelihoods in a changing climate.

- In Bangladesh, the Community Based Adaptation to Climate Change through Coastal Afforestation project has restored and replanted mangroves and wetland areas to protect coastal communities from storms and tidal surges, while also increasing incomes and diversifying livelihoods in agriculture, aquaculture and livestock production (Swiderska *et al*. 2012).
- In Tanzania, EbA measures (such as the restoration of mangroves and coral reefs) are being used to provide flood defence for coastal communities and to support local fisher livelihoods (UNEP 2021a).
- The Reef Rescuers project is restoring damaged coral reefs in the Seychelles to reduce the risks of sea level rise and extreme weather events to coastal communities, and to protect marine ecosystems on which local communities depend for fishing and income generation (USAID 2018).
- In the USA, the conservation, management and restoration of coastal habitats ("living shorelines") are being promoted through policies, status and regulations as a means of stabilizing coastal areas against the effects of sea level rise and coastal erosion (Moorman, Myers and Carlin 2019).
- In Kenya, communities are restoring mangroves along the Kwale coastline to protect communities from coastal flooding, storm surges and coastal erosion and enhance the ability of local communities to withstand climate risks (Hou-Jones, Roe and Holland 2021).
- In the Seychelles, the EbA South project restored 400 ha of degraded wetland ecosystems, including mangroves, to protect local communities from the impact of sea level rise and flooding (Mills *et al*. 2020).

Example of green space and green roof use.

Chapter 2. Status and trends in the use of ecosystem-based adaptation

Introduction

To understand the opportunities for scaling up the use of EbA, it is helpful to first understand the extent to which EbA is already being deployed. In this chapter, we explore the current status and recent trends of EbA action, examining the extent to which EbA has been integrated into on-the-ground initiatives, mainstreamed into national and local policies, and supported by climate and development finance. Our analysis highlights the fact that while there is growing momentum to harness ecosystem conservation, restoration and management for climate change adaptation, EbA remains underused and falls far short of its potential. There is considerable scope to scale up the use of EbA globally and put the world on a more climate-resilient and nature-positive pathway.

The chapter is organized into six sections. First, we examine the availability of data on EbA practice, policy and finance, highlighting its dispersed and incomplete nature. Second, we explore what is known about the implementation of EbA on the ground using information from global databases, peer-reviewed publications, technical reports and case studies. Third, we examine the extent to which key actors (United Nations organizations, bilateral and multilateral funders, NGOs, etc.) are promoting and implementing EbA. Fourth, we examine the extent to which EbA has been integrated into international, national and local policy processes. Next, we examine what is known about the level and sources of finance for EbA. Finally, we summarize the key trends in EbA policy, finance and practice that emerge from our analysis.

2.1. Availability of data on global ecosystem-based adaptation practice, policy and investment

Despite the mounting interest in EbA, information on its implementation is limited, dispersed and incomplete. Currently there are no comprehensive databases that track the number of EbA initiatives, policies or investments at the global level, or even at the regional or national levels. This makes it difficult to get a detailed picture of the status and trends of EbA implementation worldwide.

There are several reasons why the data for a global stock take of EbA are not readily available. First, although there are clear definitions and principles for EbA (see CBD 2009; Bertram *et al*. 2017), it is a relatively new concept and there is still some uncertainty among policymakers, investors and practitioners about what counts as EbA (Doswald and Osti 2011; Milman and Jagannathan 2017). For example, a review of the UNFCCC database on EbA[20] highlighted that there is a lot of ambiguity surrounding what projects get classified as EbA and that many projects are misclassified (Milman and Jagannathan 2017). Similarly, a literature review on EbA effectiveness found a total of 164 papers that reported on the implementation of EbA measures but noted that none of these articles actually used the term "EbA"' (Doswald *et al*. 2014). This ongoing uncertainty about what interventions should be labelled EbA makes it difficult to accurately quantify and track its use.

A second reason why tracking EbA is difficult is that many interventions that fall under the umbrella of EbA are not labelled as such, leading EbA activities to be underestimated (Doswald and Osti 2011; Brink *et al*. 2016). In many cases, EbA measures are implemented

20 Now part of the Adaptation Knowledge Portal. Available at https://www4.unfccc.int/sites/NWPStaging/Pages/Home.aspx.

as part of larger biodiversity conservation or sustainable development initiatives and are not distinguished or tagged as a distinct category (UNEP 2021a). For example, the conservation of mangroves to provide protection from storm surges or sea level rise may be reported as a "biodiversity conservation" initiative, rather than an EbA initiative, even though it contributes towards both climate adaptation and conservation goals. Similarly, efforts to establish urban parks or plant street trees to prevent climate-induced flooding may be categorized as "green infrastructure" rather than EbA.

A third reason why compiling data on EbA is challenging is because it involves a diverse set of actions, stakeholders and sectors. As highlighted in chapter 1, EbA initiatives can encompass a diverse set of actions (from mangrove protection to agroforestry to wetland restoration), involve an array of stakeholder groups (from local communities to multilateral development banks), span diverse sectors (from agriculture to urban development) and be applied across different spatial scales (from individual households to national initiatives; Nalau *et al*. 2018a; Donatti *et al*. 2020). Information on individual EbA initiatives is therefore often dispersed among multiple government agencies, partner organizations and individuals, complicating data-collection efforts. In addition, since many EbA initiatives are long-term endeavours that span multiple years and even decades, tracking EbA activities, investments and outcomes can be complex.

A fourth challenge is that the financial investment in EbA is rarely tracked. Assessing how much finance flows towards EbA is tricky because finance can stem from both public and private sources, may involve multiple organizations, may be delivered using different mechanisms (e.g. grants, loans, equity or blended finance) and can be provided for different investment periods (GIZ 2017c; Hunzai *et al*. 2018; Swann *et al*. 2021). In addition, most governments, donors and implementing organizations do not track their investment in EbA as a separate funding category or include it in their funding statistics or annual reports (Swann *et al*. 2021). It is also often difficult to work out how much is spent specifically on EbA because EbA measures are often only a small component of larger adaptation or development investments (Swann *et al*. 2021; Tall *et al*. 2021). For example, a recent review of investments by the Inter-American Development Bank (IDB) was able to identify how many investments included the use of NbS (including EbA) but was unable to readily quantify how much investment went specifically to NbS because projects generally included both ecosystem and non-ecosystem-based activities (Ozment *et al*. 2021).

A final challenge is that information on many EbA projects is often only available in project reports, case studies or grey literature that are written in local languages or that are not accessible to the broader public. A review of marine and coastal EbA in Asia and Oceania, for example, found that 58 per cent of the EbA projects identified were only documented in grey literature (Giffin *et al*. 2020).

2.2. Current status of ecosystem-based adaptation implementation

While the lack of comprehensive and detailed data makes a global stock take difficult, it is still possible to gain some general insights into the extent of EbA implementation by pulling together disparate information from diverse sources. Here we highlight what is known about the current implementation of EbA initiatives[21] based on information from 1) global databases, 2) publications and analyses of global EbA action, and 3) publications on EbA implementation in specific contexts.

21 As in the rest of the report, we use the term "EbA initiatives" to refer both to the use of initiatives that consist solely of EbA measures, as well as hybrid or green-gray approaches in which EbA is used in tandem with other adaptation measures.

2.2.1. Global databases on ecosystem-based adaptation implementation

There are currently several databases that provide high-level, though incomplete, information on EbA implementation around the world. Of these, the most notable are the UNFCCC Adaptation Knowledge Portal, the PANORAMA – Solutions for a Healthy Planet online platform, the Compendium of Contributions – Nature-Based Solutions, the Nature-based Solutions Evidence Tool and the Urban Nature Atlas:

- The Adaptation Knowledge Portal[22], hosted by the UNFCCC, is a platform that enables policymakers, practitioners and researchers to voluntarily upload and share information on their adaptation work (including EbA activities). In 2015, there were 43 projects listed as EbA, with examples from multiple countries and sectors (Milman and Jagannathan 2017). By October 2021, the number of EbA case studies had increased to 72, with examples from Africa, America, Asia, the Caribbean and Central America, Europe, North Pacific/Oceania, the Polar region and South America.

- The PANORAMA – Solutions for a Healthy Planet is a partnership initiative that aims to document and promote examples of inspiring, replicable solutions across a range of conservation and sustainable development topics, including EbA. The partnership is jointly led by 10 organizations[23], with GIZ and IUCN serving as the Secretariat and is funded by the International Climate Initiative (IKI) of the German Government and the Global Environment Facility (GEF). As at March 2022, the database included a total of 169 self-reported EbA case studies from more than 60 countries, with examples of EbA across a wide range of contexts, from urban areas to agriculture to water management to community-based forest management (L. Richter pers. comm.).

- The Compendium of Contributions – Nature-Based Solutions was compiled by the Nature-Based Solutions Coalition in preparation for the Climate Action Summit in 2019 (UNEP 2019). This online compendium includes 196 examples of NbS for climate change (including both actions for adaptation and for mitigation), with examples from a diversity of ecosystems and geographic regions.

- The Nature-based Solutions Evidence Tool[24], led by the Nature-based Solutions Initiative at University of Oxford, aims to showcase the implementation of NbS for climate adaptation. As at November 2021, the platform contained information from 332 EbA case studies, with examples from 85 countries (Chausson *et al*. 2020). The majority of studies (57 per cent) come from high-income countries, while 27 per cent are from upper-middle-income countries, 10 per cent from low-income countries and 5 per cent from middle-income countries (Chausson *et al*. 2020).

- The Urban Nature Atlas[25] was developed as an output of the NATURVATION Project[26] that was led by the Central European University in collaboration with the Ecologic Institute and Durham University and funded by the European Commission. The atlas contains information on more than one thousand initiatives where ecosystems are being managed, restored or conserved either to help protect urban residents from the impacts of climate change or to help mitigate climate change. While most of the cases stem from European cities, the database is now going global, with examples from roughly 50 countries.

In addition to these existing databases, there are various ongoing initiatives that are compiling new data on EbA. For example, the Global Adaptation Mapping Initiative[27] is a global collective initiative that aims to gather and synthesize information on climate adaptation, including EbA. The Friends of EbA (FEBA) Urban EbA Working Group (chaired by IUCN and PlanAdapt)[28] is compiling

22 For more information, please visit https://www4.unfccc.int/sites/NWPStaging/Pages/Home.aspx.

23 The ten partner organizations are GIZ, GRID-Arendal, International Centre for the Study of the Preservation and Restoration of Cultural Property, International Council on Monuments and Sites, International Federation of Organic Agriculture Movements Organics International, IUCN, United Nations Development Programme (UNDP), UNEP, Rare and the World Bank.

24 For more information, please visit https://www.naturebasedsolutionsevidence.info/evidence-tool/.

25 For more information, please visit https://una.city/.

26 For more information, please visit https://naturvation.eu/.

27 For more information, please visit https://globaladaptation.github.io/.

28 For more information, please visit https://www.iucn.org/news/ecosystem-management/202009/urban-ecosystem-based-adaptation-call-survey-participation.

examples of EbA planning and implementation in urban areas. Another relevant initiative is the Nature-Based Infrastructure Global Resource Centre[29], led by the International Institute for Sustainable Development and funded by the Special Climate Change Fund of the GEF. This centre is developing a database on the economic valuation of nature-based infrastructure projects that will include data on the performance and costs of EbA initiatives.

In summary, it is not yet possible to know the full extent of EbA action because the existing databases are incomplete and scattered. While the databases reviewed above contain information on approximately 1,700 EbA initiatives[30], this figure is clearly an underestimate of global activity since many EbA initiatives are not labelled as such and are therefore not included in these databases. The current databases are too new to provide robust information on trends in EbA implementation. As these databases (and others) are maintained and updated over the next few years, a more comprehensive picture of the state of EbA action will likely emerge.

2.2.2. Publications, analyses and technical reports on ecosystem-based adaptation implementation

Another way to gain insights into EbA implementation is to analyse information available in published reports, scientific publications, cases studies and websites.

The most notable attempt to synthesize the overall state of EbA implementation was made by the UNEP Adaptation Gap Report (UNEP 2021a). In this report, researchers compiled data on EbA initiatives implemented from seven publicly available data sources including the GCF, the GEF, the AF, the IKI, the Natural Hazards – Nature-based Solutions platform (NH-NbS) hosted by the World Bank, the Climate-ADAPT[31] database and the Climate Disclosure Project[32]. The researchers recorded a total of 942 initiatives (from 1991 to 2019) that used EbA either as the main focus of the project or as a project element. This included 207 EbA initiatives documented by IKI, 202 by the Climate Disclosure Project, 182 in the NH-NbS platform, 192 by the GEF, 70 by the AF, 53 in the Climate-ADAPT database and 37 by GCF. EbA activities were recorded on all continents except Antarctica, with projects were distributed fairly evenly across Africa, Asia-Pacific, Latin America and the Caribbean, and Western Europe and Other States (UNEP 2021a). EbA initiatives were particularly common in a handful of countries (Brazil, Colombia, Indonesia, Peru, United Kingdom and United States of America). There were 40 countries, however, that had no records of EbA initiatives. Worldwide, an estimated 52 per cent of the EbA initiatives were located in rural regions, 29 per cent in urban areas (including coastal cities) and 19 per cent in non-urbanized coastal areas (UNEP 2021a). The total number of EbA initiatives in the databases increased over time: the number of initiatives increased exponentially between 2005 and 2015 and then appeared to plateau thereafter at approximately 70 new initiatives per year.

Several other reports have also synthesized information related to EbA implementation using case studies from the literature:

- A systematic literature review on the effectiveness of EbA found a total of 81 case studies of EbA, of which 51 were peer-reviewed, and the remainder were in grey literature (Munroe *et al*. 2012).
- A review of the constraints and barriers to the implementation of EbA identified 65 papers documenting EbA experiences, with case studies from around the world (Nalau, Becken and Mackey 2018a).
- Donatti *et al*. (2020) examined all the EbA projects listed in the UNFCCC, UNEP and GEF database from January 2005 to August 2016. Of the 58 EbA projects identified, 15 were implemented in Africa, 11 in Asia, 9 in South America, 6 in Central America, 6 in Europe, 5 in Oceania, 4 in North America, 1 in the Caribbean and 1 in the Middle East.
- A review of NbS to climate change by Chausson *et al*. (2020) identified 386 papers that reported on the effectiveness of NbS for climate change adaptation.

29 For more information, please visit https://nbi.iisd.org/database/.
30 It is likely that some of these initiatives are included in multiple databases, leading to double counting.
31 For more information, please visit https://climate-adapt.eea.europa.eu/.
32 For more information, please visit https://www.cdp.net/en.

- An online survey by the Global Adaptation Network (GAN) obtained information from 90 EbA practitioners from around the world, with 53 per cent of the projects occurring in Africa, 34 per cent in Asia and the Pacific, 3 per cent in Latin America and the Caribbean, 3 per cent in North America, 2 per cent in Europe and the remainder occurring in multiple regions (UNEP unpublished data). The projects occurred in a wide variety of settings, of which the most common were agricultural lands (18 per cent), forests (14 per cent), coastal zones (10 per cent), wetlands (8 per cent), urban areas (8 per cent) and freshwater systems (8 per cent; UNEP unpublished data).

- A study of 190 small-scale adaptation projects in the South Pacific from 1995 to 2006 by the GEF Small Grants Programme found that 115 projects were ecosystem-based, while an additional six projects combined ecosystem-based approaches with engineered structures (Hasan *et al*. 2021).

- Finally, a review of more than 26,000 scientific publications found that the term "ecosystem-based adaptation" appeared among the top 50 key words used in climate change adaptation publications published between 2016 and 2020, indicating the growing profile of this research area (Nalau and Verrall 2021).

In addition to the growing number of scientific papers, there has also been a dramatic increase in the number of guidelines, references and tools for EbA. The EbA Tools Navigator[33], developed by the International Institute for Environment and Development (IIED), UNEP-WCMC, IUCN and GIZ, contains more than 240 tools and publications that are suitable for helping practitioners, planners and decision makers design and implement EbA (Bjerre *et al*. 2021).

Key documents for EbA implementation include guidance on:

- assessing stakeholder vulnerability and climate risks for EbA (Munroe *et al*. 2015; Hagenlocher *et al*. 2018)

- selecting, designing and implementing EbA initiatives (Travers *et al*. 2012; SCBD 2019; Garstecki *et al*. 2020; Donatti *et al*. 2021)

- designing and implementing EbA for specific contexts, such as agricultural landscapes (Abdelmagied and Mphesha 2020; Miralles-Wilhelm 2021; Miralles-Wilhelm and Iseman 2021), coastal zones (Spalding *et al*. 2014; UNEP 2016; USAID 2017; Swiderska, King-Okumu and Islam 2018), mountain ecosystems and drylands (Swiderska, King-Okumu and Islam 2018) and urban contexts (Green-Gray Community of Practice 2020; UNEP 2021b; UNEP 2021e; World Bank 2021a)

- designing and implementing gender-responsive EbA (Dazé and Terton 2021)

- monitoring and evaluating EbA initiatives and outcomes (Donatti *et al*. 2020; Wicander 2020; Donatti *et al*. 2021; European Commission 2021)

- assessing the costs, benefits and effectiveness of EbA (Emerton 2017; European Commission, Directorate-General for Research and Innovation 2021)

- integrating EbA into NAPs (FAO 2021b, Terton and Greenwalt 2021; UNEP 2021c)

- mainstreaming EbA into policy, regulatory and budgetary planning (Ilieva and Amend 2019)

- ensuring supportive governance arrangements for EbA (Hunzai *et al*. 2018)

- identifying finance options and instruments for EbA (Hunzai *et al*. 2018; Roth, Thiele and von Unger 2019)

- applying conservation standards to EbA (Garstecki *et al*. 2020)

- integrating EbA with hard infrastructure in green-gray infrastructure approaches (Green-Gray Community of Practice 2021; UNEP 2021e)

- integrating EbA with Integrated Water Resources Management (Dörendahl and Aich 2021)

- combining EbA and insurance for risk reduction (Beck *et al*. 2019).

33 For more information, please visit https://toolsnavigator.friendsofeba.com/about.

Trees surrounding coffee crop.

In summary, the large body of scientific publications, analyses and technical guidance suggests growing interest and use of EbA but does not directly provide information on the overall status of EbA implementation. The detailed analysis of EbA implementation by UNEP (2021a) which recorded more than 900 initiatives is probably the most comprehensive analysis of EbA action to date, but is still an underestimation of the number of global EbA activities, given that it only focused on a handful of data sources and did not contain information on initiatives funded by national governments, development organizations, international and national NGOs or the private sector.

2.2.3. EbA implementation in different socioecological contexts

Another way to get a sense of how much EbA is being implemented is to look at its reported use in particular socioecological contexts. While EbA is applicable to a wide number of contexts, the best documented examples of EbA are in cities and coastal areas.

In cities, numerous studies suggest that the conservation, restoration and management of ecosystems for climate resilience is widespread:

- A study by Brink *et al*. (2016) documented 139 case studies of EbA being used in 112 different urban areas. The case studies came predominantly from eastern Asia, Europe and North America, with the most studied cities being Beijing, Manchester, London and Toronto, but cases were also reported in Africa and South America. Commonly used EbA measures included green space (mentioned by 36 per cent of the articles), trees and shrubs (26 per cent), wetlands (24 per cent) and parks and gardens (15 per cent).
- A study by the Carbon Disclosure Project found that of the 210 cities around the world that disclosed their adaptation actions, just under half (101 cities) reported planting trees and creating green spaces to adapt to climate change (Kapos *et al*. 2019). Data from the Carbon Disclosure Project suggest that the implementation of NbS (including EbA) has grown significantly in recent years, increasing from 7 per cent of the cities in 2017 to nearly 12 per cent in 2019 (UNEP 2021a).
- A review of the urban adaptation plans of 14 cities in Europe found that there was general awareness and incorporation of EbA measures in all these plans, with 85 per cent of the plans including maintaining and enhancing urban green spaces for flood retention and water storage, 57 per cent promoting green walls and roofs, and 29 per cent of plans including the renaturalization of river systems (Geneletti and Zardo 2016), although the authors emphasized that it is not clear if the high prevalence of EbA in these cities is representative of adoption levels across European cities.
- The new, previously mentioned, Urban Nature Atlas[34] contains information on more than one thousand NbS (including EbA) applied in cities worldwide, with examples from more than 50 countries.

In coastal areas, there is also ample evidence of EbA being used to protect coastal communities from climate change impacts:

- A study in Asia and Oceania identified a total of 79 EbA projects that were being implemented in marine and coastal ecosystems, including a mix of conservation, restoration, awareness-raising, management and planning activities (Giffin *et al*. 2020). Projects were located in 24 countries, with the majority (75 per cent of projects) occurring in developing countries, and the remainder in least developed (24 per cent) and developed countries (1 per cent). Countries with a high number of coastal EbA projects included Vietnam (14 projects), the Philippines (9), India (8) and Pakistan (7). Projects were also reported in Australia, Fiji, Samoa and the Solomon Islands.
- The UNEP (2016) report on the use of EbA in coastal environments includes examples of implementation in India, Malaysia, Mozambique, the Pacific Islands, Solomon Islands, Thailand and West Africa and Vietnam, among others.

34 For more information, please visit https://una.city/.

- A systematic review of the inclusion of EbA into coastal planning along mangrove coasts in the tropics documented 13 cases, with examples from Africa, Asia, the Caribbean Islands, Latin America and Oceania (Sierra-Correa and Kintz 2015).

In other socioecological settings, there is less information available. For example, while there are studies documenting the use of EbA by coffee farmers in Central America (Harvey *et al*. 2017), smallholder farmers in the drylands of sub-Saharan Africa (Kloos and Renaud 2016), farmers in the Pacific Islands (Hills *et al*. 2013), smallholder farmers in Vietnam (Tran and Brown 2019), agropastoral farmers in Uganda (Mfitumukiza, Barasa and Ntale 2017), and subsistence farmers with household gardens in Vanuatu (Buckwell *et al*. 2020), there have not yet been any systematic reviews that quantify the full extent of EbA implementation in agricultural settings. EbA has also been promoted in several other contexts, including mountainous areas (Andrade Perez *et al*. 2010; Park and Alam 2015; UNDP 2015b; Klein *et al*. 2019), inland wetlands and floodplains (Opperman *et al*. 2011; Iacob *et al*. 2014) and grasslands (Mfitumukiza, Barasa and Ntale 2017; Nanfuka, Mfitumukiza and Egeru 2020), but information on the global extent of implementation in these contexts does not yet exist.

In summary, the data on the use of EbA in specific contexts is incomplete and highly variable across different contexts. EbA use is fairly well-documented in cities and coastal areas, but information from other contexts is much more limited and fragmented.

2.3. Ecosystem-based adaptation implementation by different types of organizations

Another way to gauge the level of EbA action is to examine information from organizations that are leading or funding EbA initiatives, as these organizations sometimes have publicly available information on the number, location and size of their initiatives. Here we provide an overview of EbA actions by key groups including the United Nations, bilateral funders, multilateral development banks, multilateral environmental and climate funds, international NGOs, the private sector and collaborative networks. Given the limited and dispersed nature of data on EbA implementation, this is a selection of relevant organizations, rather than an exhaustive list.

2.3.1 United Nations system

Within the United Nations system, various organizations are actively promoting the use of EbA in their strategies, programmes and activities.

UNEP is a major champion and supporter of EbA. UNEP is currently supporting 53 EbA projects in Africa, Asia, the Caribbean, Central America and Eastern Europe[35]. Of these projects, 30 per cent are in forest ecosystems, 28 per cent in agricultural land, 27 per cent in coastal areas, 8 per cent in savanna and rangelands, 5 per cent in urban areas and 1 per cent in coral reefs (S. Yang pers. comm.). UNEP's portfolio of EbA projects aims to restore approximately 113,000 ha of land, enhance the awareness of climate risks among 75,000 people, and benefit up to 2.5 million people (S. Yang pers. comm.).

UNDP is also promoting EbA initiatives around the world. The UNDP website[36] highlights the implementation of 38 EbA projects in 31 countries since 2008, with actions comprising the replanting of 1.3 million ha of mangroves and forests, the protection of 145,800 ha of marine protected areas and 2 million ha of protected land, and 873,771 ha of agricultural land

35 For more information, please visit https://www.unep.org/explore-topics/climate-action/what-we-do/climate-adaptation/ecosystem-based-adaptation.

36 For more information, please visit https://www.adaptation-undp.org/ecosystem-based-adaptation.

under improved management for adaptation benefits (as at Oct 2020).

Other United Nations organizations that are featuring EbA in their strategies and initiatives include FAO[37] and the World Food Programme (WFP) (Kapos *et al*. 2019). For example, as part of its efforts to build the resilience of vulnerable communities to climate change, the WFP promotes the restoration of degraded ecosystems as natural buffers against climate change impacts (WFP 2022). From 2016–2020, WFP worked with governments, partners and communities to restore more than 900,000 ha of degraded land and forests (WFP 2022).

2.3.2 Bilateral funders

EbA is also receiving significant support from a handful of key bilateral and multilateral donors.

Of the bilateral donors, the most prominent champion of EbA is the German Government. A report by the World Resources Institute (WRI) estimates that the German Government invested between US$ 920 million and US$ 1,510 million in NbS for adaptation in 2018 through its official development assistance (Swann *et al*. 2021). Within the German Government, the International Climate Initiative (IKI), funded by the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV), has been a particularly strong proponent for EbA. From 2008 to July 2021, IKI funded 56 EbA projects globally, investing approximately €299.5 million in total (E. Philipp pers. comm). These projects include implementing EbA in diverse ecosystems and sectors (e.g. water, agriculture, land use and finance), integrating EbA into NAPs, and promoting private sector engagement in EbA. Many of the more recent IKI projects are designed to promote the use of EbA at large spatial scales and have longer durations and higher funding levels (E. Philipp pers. comm.). IKI has also been providing long-term support for networks (such as FEBA and the EbA Community of Practice) and knowledge platforms and tools such as the EbA Tools Navigator and the EbA Support Facility. In addition, IKI is also supporting the Caribbean Biodiversity Fund's EbA Facility[38] (supported by the German Government through the German Development Bank – KfW) which is providing €45 million in seed funding for EbA measures in select Caribbean small island developing nations (Hunzai *et al*. 2018). In 2021, IKI funded the creation of the Global EbA Fund[39] (co-managed by IUCN and UNEP) and indicated that it would allocate €30 million in seed funding to this fund to catalyse the implementation of EbA worldwide.

Another major donor for EbA is the United Kingdom (UK). From 2016 to 2021, the UK allocated 18 per cent (more than £1 billion) of the £5.6 billion it had made available for international climate finance (ICF) to programmes that support NbS for climate change, including both adaptation and mitigation efforts (United Kingdom 2021). From 2021 to 2026, the UK has committed to spend £11.6 billion on ICF of which £3 billion will contribute to protecting and restoring nature, including mangrove restoration and forest projects that seek to protect communities from flooding and other climate impacts (United Kingdom 2021).

Other major bilateral donors for EbA include Japan, Sweden and the USA (Swann *et al*. 2021). A publication by WRI, for example, estimates that in 2018 Sweden invested between US$ 260 million and US$ 360 million in NbSA, Japan invested between US$ 230 million and US$ 450 million, and the USA invested between US$ 110 million and US$ 220 million (Swann *et al*. 2021). Additional details on key bilateral funds established by developed countries to finance climate change adaptation in developing countries can be found in Timilsina (2021).

2.3.3 Multilateral development banks

EbA is also gaining traction within multilateral development banks who are the main distributors of international climate finance and the main agencies to implement or execute adaptation financing in their client countries (Hunzai *et al*. 2018; Timilsina 2021). In 2018, for example, multilateral development banks are estimated to have committed almost US$ 13 billion to climate change adaptation (Timilsina 2021). Although it is not yet clear how much of this funding went to EbA, there are signs that multilateral development banks

37 For more information, please visit https://www.fao.org/in-action/naps/adaptation-planning/topics/ecosystem-based-adaptation/en/.
38 For more information, please visit https://www.adaptationcommunity.net/ecosystem-based-adaptation/the-eba-support-facility/
39 For more information, please visit https://globalebafund.org/.

are progressively becoming much more important EbA actors and committing more of their funds towards this approach.

One multilateral development bank that is actively promoting nature-based initiatives for climate change adaptation is the Inter-American Development Bank (IDB; Ozment *et al*. 2021). A recent review of the IDB's investments found that the bank had invested in 28 nature-based initiatives (including EbA) in 15 countries within the Latin America and the Caribbean region from 2015 to mid-2020 (Ozment *et al*. 2021). These investments represented a total value of nearly US$ 1.25 billion (of which US$ 813.12 million came from IDB funds and US$ 436.77 million was leveraged from external donors and counterpart governments; Ozment *et al*. 2021); however, the exact amount that was targeted towards NbS is not known, as these figures represent the funds for the entire project, including non-ecosystem-based interventions. IDB projects included investments in multiple EbA practices such as adopting best management practices for farmland, establishing urban parks, and conserving and restoring intact wetlands, grasslands, riverbeds, riparian areas and forests, as well as investments in coastal habitats (e.g. coral and oyster reefs, coastal wetlands, sandy beaches and dunes, mangroves and forests).

The World Bank and the Global Facility for Disaster Reduction and Recovery (GFDRR, a grant-funding mechanism managed by the World Bank) are similarly supporting the use of natural ecosystems for climate change adaptation and disaster risk reduction. According to Kapos *et al*. (2019), just over 1 in 10 of the World Bank's disaster risk management projects include some form of NbS. The World Bank has invested nearly US$ 5 billion in NbS projects that contribute to climate resilience since 2012, and these investments have grown significantly recently, with the total number of NbS lending projects rising by 35 per cent from 2018 to 2020 (GFDRR 2021). The World Bank has also recently established a Global Program on Nature-based Solutions for Climate Resilience[40] (under GFDRR) that aims to support the World Bank team and their government counterparts in identifying, preparing and implementing NbS for climate resilience.

Other multilateral development banks are also supporting the implementation of EbA measures. For example, Swann *et al*. (2021) estimate that the Asian Development Bank invested up to US$ 1.58 billion in nature-based adaptation efforts in 2018. Information on the investment of other multilateral development banks in EbA or NbS more generally is hard to find. However, the recent "MDB Joint Statement on Nature, People and Planet", that was signed at COP26 (November 2021) by the major multilateral development banks (MDBs, including the Asian Development Bank, African Development Bank, Asian Infrastructure Investment Bank, Caribbean Development Bank, European Bank for Reconstruction and Development, European Investment Bank, IDB, IDB Invest, Islamic Development Bank, and World Bank Group) points to growing support for NbS, including EbA (MDB Joint Statement 2021[41]). In this statement, the MDBs acknowledged the value of nature for climate adaptation and mitigation and agreed to take significant steps to support countries in their development of policies that promote nature-positive solutions, step up the financing of nature, and mainstream nature into their institutional analyses, advice, investments, and operations by 2025.

2.3.4 Multilateral climate and environmental funds

The use of EbA is also strongly supported by the various multilateral climate and environmental funds that have been established to help channel funding for climate action, particularly in developing countries.

The GEF was one of the first dedicated multilateral funds to pioneer EbA projects. The GEF has been a key supporter of EbA action globally through its leadership of the Least Developed Countries Fund (LDCF)[42] and the Special Climate Change Fund (SCCF[43]; GEF 2021). As at November 2021, the LDCF and SCCF had supported 170 projects that had an explicit focus on EbA, with an investment of more than US$ 900 million (GEF 2021). Of these projects, the majority (59 per cent) have been located in Africa, with 27 per cent of the EbA projects being implemented in Asia, 9 per cent in Latin America and the Caribbean, 3 per cent in East and Central Asia

40 For more information, please visit https://naturebasedsolutions.org/about-ushttps://naturebasedsolutions.org/about-us.
41 For more information, please visit https://www.iadb.org/en/news/idb-leads-multilateral-development-banks-boost-nature-based-investments.
42 For more information, please visit https://www.thegef.org/what-we-do/topics/least-developed-countries-fund-ldcf.
43 For more information, please visit https://unfccc.int/topics/climate-finance/resources/reports-of-the-special-climate-change-fund.

and 1 per cent at the global level (GEF Secretariat pers. comm.). The high number of projects in Africa reflects the fact that many of the EbA projects were funded by the LDCF and most of the least developed countries are in Africa. In addition to these EbA-specific projects, the GEF has also supported EbA measures in some of its other projects related to agriculture, forestry, coastal management, and disaster risk management, but specific data on EbA use within these projects is difficult to extract. The GEF plays a key role in promoting EbA globally as it funds the majority of the EbA projects implemented by United Nations organizations. It has also been a pioneer in supporting EbA and NbS for adaptation projects that have strong private sector engagement and aims to unlock their innovation and financing for EbA interventions (GEF Secretariat pers. comm.).

Of the multilateral funds, the GCF is the largest and has the most significant resources for climate action (Timilsina 2021). The GCF has given EbA a high profile by including "ecosystems and ecosystem services"[44] as one of the eight results areas of the fund. It is also scaling up investments in EbA by supporting large-scale measures that protect, restore and manage ecosystems to enhance adaptation (such as the Amazon Bioeconomy Fund,[45] the Global Fund for Coral Reefs[46] and the Great Green Wall initiative[47]), with a focus on the management of terrestrial and freshwater ecosystems and ecosystem-based management of coastal and marine zones (GCF 2021; V. Galmez pers. comm.). As at February 2022, the GCF had funded 60 projects (totalling US$ 1.05 billion) under the ecosystems and ecosystem services results areas, accounting for 10 per cent of the US$ 10 billion total GCF financing (V. Galmez pers. comm.). However, since EbA projects may also be funded under other results areas (e.g. health, food and water security, forests and land use), the total funding being channelled towards EbA is likely much larger (A. Grobicki pers. comm.).

Other multilateral funds that are relevant for EbA include the AF,[48] the Adaptation for Smallholder Agriculture Programme (ASAP) that was set up by IFAD, and the Pilot Program for Climate Resilience (PPCR) (Hunzai *et al*. 2018; Swann *et al*. 2021), among others. A summary of the numerous multilateral funds established by developed countries to facilitate adaptation initiatives in developing countries can be found in Timilsina (2021).

2.3.5 International conservation organizations

EbA is being widely promoted by international conservation organizations and features prominently in the strategies, initiatives and policies of these organizations.

For example, IUCN, a membership organization comprising both governmental and civil society organizations) has been a champion of EbA for many years and has significantly ramped up its EbA work in recent years. In 2015, IUCN had a total of 45 projects in 58 countries which conserve, restore or sustainably manage ecosystems with the goal of climate change adaptation (Bjerre *et al*. 2021). By 2020, IUCN's portfolio of EbA projects had increased to 100 projects in 109 countries (Bjerre *et al*. 2021). Of these 100 projects, 30 were implemented in Asia (across 16 countries), 24 at a global level, 12 across eastern and southern Africa (11 countries), 12 across West Africa (18 countries), 6 in Europe (11 countries) and 7 in South and Central America and the Caribbean. Of the EbA projects, 25 per cent were located in coastal and marine areas, 20 per cent across multiple ecosystems, 8 per cent each across wetlands, drylands and forests, 4 per cent each across agricultural landscapes and river basins, 3 per cent in urban areas, 2 per cent in mountainous regions and 18 per cent in other ecosystem types. IUCN's EbA work has been supported by a total of 59 donors (including governments, intergovernmental and non-governmental organizations, multilateral agencies, and foundations) who provided financial support totalling €230,222,288 (Bjerre *et al*. 2021). Of these donors, the IKI (based in Germany) is the largest donor (accounting for 34 per cent of IUCN's EbA funding and 17 projects). Other key donors included: the European Commission (accounting for 14 per cent of the funding across 9 projects); the GCF (accounting for 7 per cent of the funding across 4 projects); the Swedish International Development Cooperation Agency (SDIA, accounting for

44 For more information, please visit https://www.greenclimate.fund/results/ecosystems-ecosystem-services.
45 For more information, please visit https://www.greenclimate.fund/project/fp173.
46 For more information, please visit https://www.greenclimate.fund/document/global-fund-coral-reefs-investment-window-gfcr.
47 For more information, please visit https://www.greenclimate.fund/news/great-green-wall-spotlight-cop.
48 For more information, please visit https://www.adaptation-fund.org/.

5 per cent of the funding across 4 projects); the World Bank (accounting for 4 per cent of the funding across 4 projects); the Norwegian Agency for Development Cooperation (NORAD, accounting for 3 per cent of the funding for 1 project); USAID (accounting for 3 per cent of the funding across 2 projects; Bjerre *et al*. 2021).

Many of the large international conservation NGOs are also championing the conservation, restoration and management of ecosystems for climate resilience. For example, CI has invested an estimated US$ 215 million in 66 EbA projects since 2015, aiming to provide a total of 1.3 million people with increased resilience to climate change (G. Fedele pers. comm.). Of these projects, 14 were implemented in Latin America, 30 in Africa, 20 in the Asia-Pacific region and 2 in multiple locations, with an average project size of US$ 3 million (ranging from US$ 50,000 to US$ 8 million). Activities have included EbA initiatives in rangelands (approximately 25 per cent of the projects), agricultural landscapes (approximately 25 per cent of the projects), coastal areas (approximately 25 per cent of the projects), forests (approximately 15 per cent of the projects) and wetlands (approximately 10 per cent of the projects). Funding for these projects has come from a wide range of donors including the GCF, GEF, IKI and other bilateral funding.

Multiple other international conservation organizations (e.g. BirdLife International, TNC, Wetlands International, WWF, and many others) similarly promote EbA in their strategies, initiatives and investments, but data on the number of projects and the funds invested are not readily available.

2.3.6 Private sector

Action on EbA among the business community is still understood to be minimal (Kapos *et al*. 2019; Tall *et al*. 2021). A review of more than 1,600 corporate adaptation strategies found that only 54 companies had included EbA measures within their adaptation strategies, with the most common application being in sustainable agriculture, watershed protection and restoration and sustainable management (Goldstein *et al*. 2019). Similarly, a review of adaptation strategies among 44 companies selling coffee, cocoa and cotton found that only seven of them were using EbA to manage climate change risks (Goldstein 2019).

However, there are some indications that the private sector is starting to show more interest in EbA and NbS more broadly (Cooper and Tremolet 2019; Seddon *et al*. 2021). For example, there are nascent but growing efforts among the insurance sector to use EbA as an approach for climate adaptation (Hunzai *et al*. 2018; Beck *et al*. 2019). The insurance sector is starting to develop innovative insurance schemes for insuring intact ecosystems or for taking EbA measures into account in insurance premiums (Hunzai *et al*. 2018; Beck *et al*. 2019). There are also nascent efforts to develop “green bonds” to finance climate adaptation and resilience initiatives that can protect communities from climate hazards while also generating returns for investors, and to use the bond proceeds to finance EbA measures (Chahine and Liagre 2020; Jones 2020; Louman *et al*. 2020). Private sector interest in the use of green and blue infrastructure is also growing, providing a potential means for promoting ecosystem management for climate resilience (Browder *et al*. 2019). There are multiple recent corporate funding pledges for nature and climate change action from major corporations such as Amazon, Apple, Delta Airlines, Mastercard and others (see Seddon *et al*. 2021), many of which include actions to restore or conserve forests, wetlands and peatlands. While these corporate funding pledges focus primarily on ecosystem management for climate change mitigation, the actions they are proposing could also provide significant adaptation benefits, if designed and managed carefully. Finally, there is a growing number of initiatives by multilateral funds (such as the GEF and GCF) to stimulate greater private investment in climate change adaptation which could potentially lead to greater involvement in EbA (see, for example, the GCF CRAFT project – Catalytic Capital for First Private Investment Fund for Adaptation Technologies in Developing Countries)[49].

2.3.7 Collaborative networks

A final indication of the degree of institutional support for EbA is the growing number of collaborative networks that support EbA action, research and knowledge-sharing.

49 For more information, please visit https://www.greenclimate.fund/project/fp181.

One of the most important networks is FEBA[50], a collaborative network that aims to share experiences and knowledge, improve implementation of EbA activities on the ground and influence the development of EbA polices. To date, FEBA has more than 90 members, including government ministries and subagencies (e.g. KfW, the UK Department for Environment, Food and Rural Affairs and USAID), United Nations organizations and convention secretariats (e.g. CBD Secretariat, UNDP, UNEP, UNFCCC, and WHO), major international development organizations (e.g. CARE International and Mercy Corps), international conservation organizations (such as BirdLife International, CI, IUCN, TNC and WWF), prominent universities (e.g. Stockholm Resilience Centre and Wageningen University & Research), and international think tanks and research consortia (such as the CGIAR, IIED and WRI).

In addition to the FEBA network, there are an increasing number of collaborative networks of organizations that are promoting the use of adaptation measures more broadly (including EbA measures). Examples include the GAN and associated regional networks[51], the NAP Global Network[52], the Partnership for Environment and Disaster Risk Reduction (PEDRR)[53] ICLEI – Local Governments for Sustainability[54], the GIZ-hosted international EbA Community of Practice[55], C40 Cities[56], and the Green-Gray Community of Practice[57], among others.

In summary, our review of institutions engaging in EbA suggests that this approach is being promoted by a diverse suite of organizations, especially by United Nations organizations, bilateral and multilateral development agencies, multilateral climate and environmental funds, international NGOs and collaborative networks. Since most EbA initiatives also involve government agencies, research organizations, universities, local civil society groups (such as farmer organizations or women's groups) and local communities, the number of organizations involved in EbA is clearly much greater than what is noted above. Many of the key organizations promoting EbA work together (for example, most of the United Nations organizations' projects are funded by the GEF, while a significant number of IUCN work is funded by IKI). This can make it difficult to ascertain the true number of initiatives under way, since some EbA initiatives are reported by multiple organizations and can easily be double counted. Nonetheless, the large number and diversity of actors involved in EbA initiatives highlights the extent to which different sectors of society have embraced the importance of healthy ecosystems for fostering climate resilience and points to the opportunity to achieve EbA implementation at scale.

2.4. Current status of ecosystem-based adaptation in policies

Another way of gauging the uptake of EbA is to consider the extent to which it has been integrated into policies at different governance levels. Here we summarize what is known about the current status of EbA in 1) the international policy arena, 2) national-level policies, and 3) local policies.

2.4.1. Ecosystem-based adaptation in the international policy arena

EbA has gained prominence in the international policy arena due to its ability to deliver on multiple global policy goals, including not only climate change

50 For more information, please visit https://friendsofeba.com/.
51 For more information, please visit https://www.unep.org/gan/.
52 For more information, please visit https://napglobalnetwork.org/.
53 For more information, please visit https://pedrr.org/.
54 For more information, please visit https://www.iclei.org.
55 For more information, please visit https://www.adaptationcommunity.net/ecosystem-based-adaptation/international-eba-community-of-practice/.
56 For more information, please visit https://www.c40.org/.
57 For more information, please visit https://www.conservation.org/projects/global-green-gray-community-of-practice.

Large scale ecosystem-based adaptation in the Gambia: developing a climate-resilient natural resource-based economy.

adaptation, but also climate change mitigation, biodiversity conservation and sustainable development (Epple *et al*. 2016). Within the UNFCCC, EbA has been promoted in numerous workstreams, decisions and mechanisms, including the Cancun Adaptation Framework[58], the Nairobi Work Programme[59], the AF, REDD+ planning, NAPs and NDCs (Reid *et al*. 2016; Seddon *et al*. 2019; 2020b). NbS (including EbA) were also prominently featured at UNFCCC COP26, with numerous announcements and commitments related to the use of ecosystem restoration and conservation to help society adapt to and mitigate climate change (United Nations Economic and Social Commission for Asia and the Pacific [ESCAP] 2021). EbA and other NbS are also likely to become an important component of the CBD post-2020 global biodiversity framework[60] that is currently under discussion. There is also increasing political interest in and commitment to investing in ecosystem conservation, restoration and management to achieve the goals of the Sendai Framework for Disaster Risk Reduction[61], the Global Mangrove Alliance[62], the Sustainable Development Agenda, the Ramsar Convention on Wetlands[63], the New Urban Agenda[64], the UNCCD[65]. the Bonn Challenge[66], the UN Decade on Ecosystem Restoration[67] and related international agreements and initiatives (Epple *et al*. 2016; Seddon *et al*. 2021; Sudmeier-Rieux *et al*. 2021).

Another indication of the growing political traction of EbA is the large number of high-level policy reports, declarations and initiatives that have highlighted the importance of EbA and other NbS for addressing global challenges. The following are some key examples of key EbA-related policy initiatives:

- NbS (including EbA) were included as one of the nine action tracks of the 2019 United Nations Climate Action Summit, convened by the United Nations Secretary-General.
- The Nature-based Solutions for Climate Manifesto[68], which was launched at the 2019 United Nations Climate Action Summit, calls for countries to mainstream NbS within national governance, climate action and climate policies and scale up the conservation and restoration of forests and other terrestrial ecosystems, freshwater systems, marine and coastal systems in support of climate change adaptation and mitigation. This manifesto was signed by 32 countries, the European Commission, 21 civil society organizations and 8 private sector groups (Seddon *et al*. 2021).
- The Least Developed Countries 2050 Vision (LDC 2050 Vision) highlights the importance of ecosystems for climate resilience. One of the three overarching goals of the LDC 2050 Vision is that "climate-resilient landscapes and ecosystems are sustainably managed, less vulnerable to shocks and stresses, and use NbS" (LDC Initiative for Effective Adaptation and Resilience 2019).
- The Leaders' Pledge for Nature[69], agreed at the United Nations Summit on Biodiversity in September 2020, calls for countries to "step up global ambition for biodiversity and to commit to matching our collective ambition for nature, climate and people with the scale of the crisis at hand" and to "put nature at the heart of national and international development strategies" (Leaders' Pledge for Nature 2020; Roe *et al*. 2021). It was signed by leaders from 92 countries from all world regions, and the President of the European Commission on the behalf of the European Union.

58 For more information, please visit https://unfccc.int/process/conferences/pastconferences/cancun-climate-change-conference-november-2010/statements-and-resources/Agreements.
59 For more information, please visit https://unfccc.int/topics/adaptation-and-resilience/workstreams/the-nairobi-work-programme-the-unfccc-knowledge-to-action-hub-for-climate-adaptation-and-resilience.
60 For more information, please visit https://www.cbd.int/conferences/post2020/wg2020-03/documents.
61 For more information, please visit https://www.undrr.org/publication/sendai-framework-disaster-risk-reduction-2015-2030.
62 For more information, please visit https://www.mangrovealliance.org/.
63 For more information, please visit https://www.ramsar.org/.
64 For more information, please visit https://uploads.habitat3.org/hb3/NUA-English.pdf.
65 For more information, please visit https://www.unccd.int/actions/achieving-land-degradation-neutrality.
66 For more information, please visit https://www.bonnchallenge.org/.
67 For more information, please visit https://www.decadeonrestoration.org/
68 For more information, please visit https://wedocs.unep.org/xmlui/bitstream/handle/20.500.11822/29705/190825NBSManifesto.pdf?sequence=1&isAllowed=y.
69 For more information, please visit https://www.leaderspledgefornature.org/.

- At the UNFCCC COP26 in November 2021, leaders from more than 130 countries (representing nearly 90 per cent of the world's forests) signed the Glasgow Leaders' Declaration on Forests and Land Use[70] in which they pledged to halt and reverse forest loss and land degradation by 2030 and promote more sustainable use of ecosystems in support of climate adaptation and mitigation goals (Butler 2021).
- The Environment Ministers Communiqué[71] from the G20 Environment Ministers' meeting in September 2020 acknowledges the crucial role of NbS and ecosystem-based approaches for tackling climate change and biodiversity loss, while providing additional benefits to people (Commonwealth Secretariat 2021). It also calls for enhancing investment in ecosystem-based approaches for ecosystem conservation and restoration as a means of increasing the resilience of people and ecosystems.
- The G7 Environment and Climate Ministers' Communiqué in May 2021 emphasizes the important role of NbS for delivering climate adaptation and mitigation goals and contributing to the Sustainable Development Goals, and calls for greater deployment and increased finance for NbS (G7 2021).
- The Glasgow Climate Pact (UNFCCC 2021a) from COP26 urges developing countries to at least double adaptation finance for developing countries from the 2019 level by 2025, which could potentially lead to greater finance for EbA (ESCAP 2021).
- The Glasgow Climate Pact recognizes "the critical role of protecting, conserving and restoring nature and ecosystems in delivering benefits for climate adaptation and mitigation" (UNFCCC 2021a).
- Finally, multiple high-level reports have emphasized the importance of ecosystems for climate adaptation and the urgent need to scale up adaptation action. Prominent examples include the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services Global Assessment Report on Biodiversity and Ecosystem Services (IPBES 2019), the United Nations Compendium of Contributions: Nature-based Solutions (UNEP 2019), the Climate Change and Land report of the IPCC (2019), WEF's Nature Risk Rising report (WEF 2020), the Adaptation Gap reports in 2020 (UNEP 2021a) and 2021 (UNEP 2021d), and the Adapt Now report of the GCA (2019).

2.4.2. Ecosystem-based adaptation in national and regional policies

There are also signs that EbA is gaining traction in national and regional policies. As part of the Paris Agreement, countries who are party to the UNFCCC are required to submit NDCs which outline the actions they will take to reduce their national emissions and adapt to the impacts of climate change. A recent analysis of the NDC submissions found that 133 governments (the equivalent of 66 per cent of all nations that have signed the Paris Agreement) have committed to restoring or protecting ecosystems in their climate targets (Seddon *et al*. 2020b). This includes 104 governments that have included EbA or conservation action in the adaptation components of their NDCs, 77 countries that have included them both in their adaptation and mitigation components and 27 governments that have included them in their mitigation targets (Seddon *et al*. 2020b). Interestingly, EbA was most frequently mentioned by poorer countries: 28 of the 30 nations that are classified as "low income" included NbS in their adaptation plans (including 22 that specifically mention EbA), as did 43 of the 47 least developed countries. In contrast, only 9 of the 34 high-income nations mention EbA (Seddon *et al*. 2020b). While these results suggest that governments recognize the importance of ecosystems for adaptation, the authors point out that these high-level intentions are still only rarely translated into specific, measurable actions or targets. For example, only 30 of the 104 countries who included EbA in their NDCs provided measurable targets for action (Seddon *et al*. 2020b).

Another important indication of the national-level uptake of EbA can be found in the NAPs of individual countries.

70 For more information, please visit https://ukcop26.org/glasgow-leaders-declaration-on-forests-and-land-use/.
71 For more information, please visit https://www.env.go.jp/press/files/jp/115068.pdf

The NAPs are a strategic means of identifying medium- and long-term adaptation needs and developing and implementing strategies and programmes to address those needs (Hammill, Dekens and Dazé 2020; UNEP 2021c). The NAP Global Network[72] tracks how EbA is being integrated into NAPs (Terton and Greenwalt 2020). As at March 2020, all 19 of the NAPs that had been submitted to the UNFCCC included some consideration of ecosystems and the services they provide, and most had specifically included EbA measures in their plans, especially in forests, freshwater, and coastal ecosystems (Terton and Greenwalt 2020).

A study of the NAPs and national adaptation strategies being used by 13 of the G20 countries also points to the increased attention being paid to EbA (Prabhakar, Scheyvens and Takahashi 2019). The study found that almost all the countries are promoting ecosystem protection and conservation to foster adaptation, and several key countries (such as Brazil, Italy, Mexico and the USA) used ecosystem-based approaches as a guiding principle for adaptation efforts (Prabhakar, Scheyvens and Takahashi 2019). The G20 countries differed in the types of EbA approaches they emphasized, with China and Japan prioritizing the importance of EbA for resilient infrastructure, and Germany, Indonesia, Japan and South Africa identifying land-use planning and spatial approaches as key for integrating EbA into their adaptation strategies. However, while these countries had policy goals related to EbA, some of these adaptation plans did not identify concrete steps for implementing and monitoring EbA, suggesting a gap between policy ambition and on-the-ground action.

There are also examples of regional policies supporting EbA approaches, especially within the European Union. Multiple European Union policies place a strong emphasis on the use of EbA, including the recently updated EU Climate Adaptation Strategy (European Commission 2021)[73], the EU Green Infrastructure Strategy (European Commission 2013)[74] and the EU Biodiversity strategy for 2030[75] (European Commission 2020) among others (World Business Council for Sustainable Development [WBSCD] 2017).

2.4.3. Ecosystem-based adaptation in local policies

At the local level, evidence on the integration of EbA into subnational or municipal policies, regulations and plans is sparse, scattered and hard to find. The handful of case studies that have examined the mainstreaming of EbA in local action have tended to highlight the fact that EbA has not yet been successful mainstreamed into local adaptation plans. For example, Huq *et al*. (2017) reported that, in Bangladesh, there was little mainstreaming of EbA into key sectors that were pertinent to EbA, such as agriculture, forestry, water, biodiversity, urban, and livelihood sectors, among others. Of the 329 climate change adaptation projects under way in Bangladesh, only 38 were related to EbA (Huq *et al*. 2017). A study in Portugal similarly found little uptake of the EbA approach by municipalities (Cousiño and Penha- Lopes 2021). A study of eight municipalities in the Western Cape of South Africa found that most municipalities had little understanding of EbA and were not implementing EbA measures (Pasquini and Cowling 2015). In Sweden, the use of EbA approaches among municipalities was much lower than that of grey approaches (Wamsler *et al*. 2016). A study of 14 European cities found some evidence that the EbA approach was being considered in local climate adaptation plans, but concrete details and plans on how EbA would be implemented were missing (Geneletti and Zardo 2016).

In summary, the integration of EbA into the policy agenda is uneven. While there is significant (and growing) attention being paid to EbA in the international policy arena and a growing number of countries are integrating EbA into national-level commitments (e.g. NAPs and NDCs), progress varies across countries. In addition, the extent to which this national support for EbA is being effectively translated into local policies, plans and strategies is not yet clear, as there are only a handful of studies that have examined the mainstreaming of EbA into local policy frameworks. However, the existing studies suggest EbA is still often only a fringe component of local policies and plans, rather than a central element (Reid *et al*. 2019; OECD 2021).

72 For more information, please visit https://napglobalnetwork.org/
73 For more information, please visit https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2021:82:FIN.
74 For more information, please visit https://ec.europa.eu/environment/nature/ecosystems/strategy/index_en.htm.
75 For more information, please visit https://ec.europa.eu/environment/strategy/biodiversity-strategy-2030_en.

2.5. Current level of funding for ecosystem-based adaptation

A final way to understand the extent to which EbA is being adopted globally is to track the investment in EbA. Finance for EbA can come from different sources including international public sources (such as multilateral climate and environmental funds, multilateral development funds, bilateral financial cooperation), domestic public sources (such as national funds and budgets) and private sources (including non-profit organizations, market debt and business investments; Hunzai *et al*. 2018). However, as noted in section 2.1, it is difficult to estimate the total finance that is being allocated to EbA due to the lack of centralized data on EbA projects, the large number and diversity of actors involved, the lack of a standard way of tagging and reporting finance and funding sources, and the fact that EbA activities are often blended or integrated with other adaptation activities. Some information on the levels of investment in EbA investments by MDBs, multilateral climate funds, bilateral funders, and other individual organizations has already been provided in section 2.3. Here we provide additional information on the overall level of international public funding for EbA using information from two key synthesis reports.

First, a study led by the WRI and the GCA estimated the amount of public international funding flowing towards NbSA (Swann *et al*. 2021). Using publicly available data from the OECD, the authors estimated that US$ 3.8 billion to US$ 8.7 billion were provided to EbA in 2018, up from an estimated US$ 2.1 billion to US$ 4.1 billion in 2012 (Swann *et al*. 2021). This funding represents approximately 0.6 to 1.4 per cent of total climate finance flows and 1.5–3.4 per cent of public finance flows in this area (Swann *et al*. 2021). Most of this funding was provided by a handful of bilateral donors (Germany, Japan, Sweden, the UK and the USA) and by multilateral donors, the biggest of which were the Asian Development Bank, the European Union, the GCF, IFAD, the GEF and the AF (Swann *et al*. 2021). Most of this funding was provided in the form of grants, which accounted for as much as 85 per cent of funds deployed to developing countries (Swann *et al*. 2021). Funding for EbA was mainly directed towards activities in countries in sub-Saharan Africa and South and Central Asia, which together have received approximately 50 per cent of total public EbA funding. However, the authors note that their results likely underestimate the total flows for EbA because their analysis only covers international public funding (not domestic public funding) and because estimates are based on the imperfect tagging within the data sets analysed. The authors conclude that the overall level of international public funding for EbA is low and that there is significant scope to improve overall public finance flows to ensure that developing countries can implement EbA at scale.

A second source of information on the level of available international public finance for EbA is the United Nations Adaptation Gap Report 2020 (United Nations 2021a). In this report, the authors reviewed the investments of four institutions that support climate and NbS action, including the GEF, the GCF, the AF, and the IKI of the German Government. Together, these organizations have invested US$ 18.8 billion in climate mitigation and adaptation over the last 30 years. Of this climate funding, projects that included NbS for adaptation (or EbA) accounted for only 13 per cent of these funds. The amount of funding and percentage of climate funds dedicated to NbS was variable across funds: the GEF spent US$ 8.61 billion on NbS funding from 1991–2020, representing an estimated 13 per cent of their total climate financing; the GCF invested US$ 2.02 billion from 2015–2020, which represented 9 per cent of their climate funds; the AF dedicated US$ 0.504 billion to NbS (or 68 per cent of its climate funds), while IKI invested US$ 0.92 billion (or 26 per cent) of their climate funds (United Nations 2021a). According to the report, funding for EbA remains inadequate.

In addition to these two analyses of public finance for EbA, multiple other reports have suggested there is a significant funding gap for NbS and climate adaptation more broadly. For example, the GCA's 2019 flagship report "Adapt Now: A Global Call for Leadership on Climate Resilience" stressed the importance of increasing the scale of public and private finance to safeguard nature to help foster climate resilience (GCA 2019). The "State of Finance for Nature" report (UNEP 2021f) similarly highlighted the massive financial gap in NbS and called for more than tripling the funding available for this approach: according to this report, current investment in NbS (including but not limited to EbA) is estimated to be US$ 133 billion annually (of which 86 per cent stems from public funds and 14 per cent from private funds), but investment needs by 2050 are estimated to reach more than US$ 536 billion per year. The recent "State of the Finance for Nature in the G20" report concluded that current investments in nature by G20 are insufficient and called for the G20 to increase their annual spending on NbS from US$ 120 billion per year to US$ 285 billion by 2050 to tackle the intertwined climate, nature and land degradation challenges (UNEP 2022). The United Nations Secretary-General has also called for multilateral donors to channel more of their funds towards NbS, including EbA (UNFCCC 2021b).

There are also numerous reports that have stressed the large gap in adaptation finance more generally. For example, the Adaptation Gap Report 2021 (UNEP 2021e) estimated that adaptation costs in developing countries were five to 10 times greater than the available public adaptation finance and called for urgent, more ambitious action to fill this widening funding gap. The lack of sufficient funding for climate adaptation (including EbA) was a major point of discussion at the UNFCCC COP26 (November 2021), as developing country leaders emphasized the need for greater funding to enable more ambitious and rapid action on climate adaptation. To address this challenge, the Glasgow Climate Pact includes a goal for developed countries to double the adaptation funding provided to developing countries by 2025, which could lead to greater funding for EbA initiatives (ESCAP 2021; UNFCCC 2021a).

In summary, while the extent of funding available for EbA is not known, there is general agreement that the amount of money being invested in EbA is low and insufficient to fully harness the adaptation potential of nature and foster resilience at scale (Bapna and Fuller 2021).

2.6. Conclusions and the scope for scaling up ecosystem-based adaptation action in practice, policy and finance

As highlighted in this chapter, it is difficult to provide a comprehensive assessment of the current extent of and trends in EbA implementation because the data on EbA are incomplete, insufficiently detailed and scattered across multiple institutions, geographies and sectors. In addition, since most EbA initiatives are in early stages of implementation, it is too early to determine clear trends in implementation. Nevertheless, our analysis provides some key insights into the current state and trends of EbA action.

First, our analysis suggests that there is already substantial action on EbA practice, policy and finance at the global scale. EbA initiatives are being implemented across the world with support from a diverse suite of actors, including United Nations organizations, bilateral and multilateral development agencies, MDBs and multilateral development funds, national and local governments, international NGOs and academia, among others. Several thousand EbA initiatives have been documented in databases, scientific publications, case studies and reports, with examples from various countries, socioecological settings and sectors, and in both developing and developed contexts. Since many initiatives are not labelled as such or are not included in the existing database, the total number of EbA initiatives under way is likely somewhat higher. EbA also has significant traction in the international policy arena. EbA features prominently in the NAPs and NDCs of many (but not all) countries (Seddon *et al*. 2019; 2020b). Numerous high-level policy initiatives, reports and declarations call for greater uptake and finance of EbA and other NbS, signalling high-level support. In addition, EbA is currently being funded by a small number of key bilateral donors, multilateral donors and climate and environment funds, with an estimated US$ 3.8 billion to US$ 8.7 billion of public finance provided to EbA in 2018 (Swann *et al*. 2021).

Second, there are some signs that the pace of EbA activity is slowly increasing. The overall amount of international public finance being allocated to EbA grew from estimated US$ 2.1 billion to US$ 4.1 billion in 2012 to between US$ 3.8 billion and US$ 8.7 billion EbA in 2018 (Swann *et al*. 2021), but it is not yet clear if this trend will continue. The World Bank increased the number of its NbS projects by 35 per cent from 2018 to 2020 (World Bank 2021a), though it is not clear how many of these projects were specifically EbA activities. The UK has committed to spending £3 billion from 2021 to 2026 to protect and restore nature as part of its ICF (United Kingdom 2021). IUCN has more than doubled the number of its EbA projects from 2015 to 2020 (Bjerre *et al*. 2021). There have also been a growing number of policy declarations and commitments by multilateral development banks (such as the "MDB Joint Statement on Nature, People and Planet" and the Glasgow Climate Pact) that aim to increase the amount of finance directed towards NbS and climate change adaptation, which could lead to greater finance for EbA in the future. Finally, the burgeoning number of publications, case studies and guidelines likely reflects both greater implementation and rising interest in EbA (Chausson *et al*. 2020; Nalau and Verrell 2021).

However, while there is clearly significant action on the ground and a trend of growing support, it is also clear that the level of EbA activity, finance and policy implementation falls far short of its potential (Kapos *et al*. 2019; Seddon *et al*. 2020a; United Nations 2021a). The number of EbA initiatives under way, while significant, is far fewer than what could be achieved (Roberts *et al*. 2012; Dorst *et al*. 2019; UNEP 2021a). Even if the actual number of EbA initiatives is in the tens of thousands (which is likely a high estimate), rather than the several thousand currently documented, this is still too little to have a meaningful impact on the hundreds of millions of people who are threatened by climate change. In addition, many of these initiatives are small, short-term and stand-alone projects, rather than being integral components of long-term development policies (Roberts *et al*. 2012; Cohen-Shacham *et al*. 2019; Bhattarai *et al*. 2021). EbA is not yet systematically integrated into all national climate change policies, national development plans, sectoral plans and local regulations where it is relevant, and EbA measures are often overlooked in favour of conventional infrastructure approaches for adaptation (Browder *et al*. 2019; Reid *et al*. 2019). The amount of available funding for EbA also falls short of what is needed (Hunzai *et al*. 2018; GCA 2019; Swann *et al*. 2021; UNEP 2021a). Public finance for EbA, for example, still makes up less than 2 per cent of total climate finance flows (Swann *et al*. 2021) and is far below the amount that is needed to protect, manage and restore ecosystems at the scale needed to confer resiliency to climate change globally (Kapos *et al*. 2019).

In short, there is scope for EbA to play a much greater role in global adaptation efforts. There are significant opportunities to strengthen EbA-enabling policies across all governance levels, to deliver greater levels of both public and private finance, and to scale up the number and size of initiatives on the ground, so that the full potential of EbA can be harnessed (Kapos *et al*. 2019; Cook 2021). Accelerating the pace and scale of EbA action would not only help to significantly enhance the resiliency of society to climate change but would also be beneficial for tackling the intertwined challenges of climate change, biodiversity conservation and sustainable development and putting the world on a more climate-resilient and nature-positive trajectory. The remainder of the report explores why EbA is falling short of its potential and what actions could help accelerate EbA action. In chapter 3, we take a detailed look at the barriers that are currently constraining the widespread implementation and scaling up of EbA measures, policies and finance. In chapter 4, we explore potential avenues for addressing these barriers and scaling up EbA action.

Chapter 3.
Barriers preventing the use of ecosystem-based adaptation: a review of the literature

Introduction

EbA is increasingly recognized by governments, civil society, the scientific community and the private sector as being an important means of increasing societal resilience to climate change. However, despite its potential to deliver significant adaptation and socioeconomic benefits, EbA remains underused and falls far below its potential (Ojea 2015; Kapos *et al*. 2019; Sarabi *et al*. 2019). In this chapter, we explore the barriers that are currently hindering the widespread adoption and scaling up of EbA, using a detailed review of more than 750 scientific and technical documents. The overall aim of the chapter is to provide a better understanding to policymakers, practitioners, donors and other interested stakeholders of the types and diversity of barriers facing EbA initiatives, so that they can anticipate potential barriers that may impede or delay EbA implementation and can take action to address or circumvent these challenges. This analysis of barriers also serves as a starting point for the discussion in chapter 4 on how to devise strategies for scaling up the use of EbA.

First, an overview of the existing literature on barriers to EbA is provided, highlighting the types of studies that have been conducted and the information that is available. We then summarize the eight main types of barriers that have been identified in the literature and provide examples of the different contexts in which these barriers have been reported. While the term “barriers” has been defined in many ways, for the purpose of this report we define barriers broadly as factors that make it harder to plan or implement adaptation options, or that make adaptation less efficient, less effective, or more expensive (Moser and Eckstrom 2010; IPCC 2014). These barriers may occur at different stages of the project cycle (from design to implementation to monitoring) and may affect EbA policies, on-the-ground interventions and/or investments.

3.1. Overview of the literature on barriers to ecosystem-based adaptation

In contrast to the extensive literature on the barriers to the use of climate adaptation measures more generally (e.g. Moser and Eckstrom 2010; Biesbroek *et al*. 2013; Eisenack *et al*. 2014; IPCC 2014; Future Climate for Africa 2015), the understanding of barriers to the use and scaling up of EbA is nascent and still evolving. This is in part because the concept of EbA is still relatively new and because most EbA initiatives are still in the early phases of design and implementation (Reid *et al*. 2018). However, as the use of EbA has gained traction, researchers have started to document experiences of implementing EbA in different sectors, ecosystems and geographic settings and to identify the various barriers that are slowing down or hindering its use.

Information on the barriers to EbA has emerged from three types of studies. First, there are many studies that have focused specifically on identifying the barriers to EbA implementation or policy development in a particular location or geography. Examples include studies from Nepal (Mills *et al*. 2020; Bhattarai *et al*. 2021), Samoa (Chong 2014), Cambodia (Chong 2014), Bangladesh (Huq *et al*. 2017; Mustafa Saroar *et al*. 2019), Australia (Lukasiewicz, Pittock and Finlayson 2016), the Seychelles (Khan and Amelie 2015; Mills *et al*. 2020), Peru (Ilieva 2018), Mauritania (Mills *et al*. 2021), Portugal (Cousiño and Penha-Lopes 2021), Viet Nam (Mills *et al*. 2020), the Philippines (Ramos 2018), Sweden (Wamsler *et al*. 2016; 2020; Wamsler and

Pauleit 2016), Mexico (Vázquez Vela and Amend 2018) and South Africa (Knowles and Bragg 2018).

Second, in other studies, researchers have uncovered barriers in the process of documenting EbA implementation in particular sectors. For example, information on potential obstacles to EbA policy development and implementation has been generated through studies in coastal ecosystems (e.g. Grantham *et al*. 2011; Donner and Webber 2014; Giffin *et al*. 2020), in smallholder agricultural landscapes (e.g. Harvey *et al*. 2017; Miralles-Wilhelm and Iseman 2021) and in urban contexts (e.g. Brink *et al*. 2016; Geneletti and Zardo 2016; Sarabi *et al*. 2019; 2020), among others.

Third, there is a growing number of papers that have synthesized information on barriers across multiple EbA projects and studies from different geographies. For example, Naumann *et al*. (2011) analysed the implementation of 161 EbA projects in Europe and identified the key technical, capacity, organizational, policy, social and behaviour challenges facing individual projects. Brink *et al*. (2016) reviewed research on urban EbA experiences in 112 initiatives and highlighted key obstacles preventing EbA uptake. Ojea (2015) reviewed EbA literature to identify the challenges to mainstreaming EbA into the international policy agenda. Kabish *et al*. (2016) highlighted barriers experienced in the implementation of urban EbA initiatives. Sarabi *et al*. (2019; 2020) identified and classified barriers that occur in the implementation of EbA in urban environments across Europe. Nalau, Becken and Mackey (2018a) used a systematic literature review of more than 60 papers to identify the key obstacles affecting EbA implementation. A study commissioned by the European Commission reviewed lessons learned from the implementation of 125 EbA initiatives in Europe and identified both the factors that led to – or hindered – successful implementation (McVittie *et al*. 2018). Kapos *et al*. (2019) summarized common barriers documented in the literature as an input for the GCA. Smith and Chausson (2021) identified barriers experienced by practitioners and policy experts in implementing NbSA in the UK. Finally, the GAN recently completed an online survey among 90 EbA practitioners and experts from around the world about the key types of barriers affecting the implementation of EbA (UNEP unpublished data).

Across these studies, researchers have deployed a variety of methods for identifying and understanding barriers. The most common methods include detailed analyses of existing policies, strategies and regulations (e.g. Ojea 2015; Zölch, Wamsler and Pauleit 2018; Cousiño and Penha-Lopes 2021), careful reviews of project documents and evaluation reports of on-the-ground implementation (e.g. Doswald and Osti 2011; McVittie *et al*. 2018), interviews or expert workshops with planners, policymakers and practitioners leading EbA initiatives (e.g. Kabish *et al*. 2016; Mills *et al*. 2020), online surveys (e.g. Donatti *et al*. 2017) and extensive literature reviews (e.g. Brink *et al*. 2016; Nalau *et al*. 2018a). Some researchers have used a mixed method approach, combining policy analysis, survey data, interviews, expert workshops and literature reviews to get a more complete understanding of the barriers encountered in a particular context (e.g. Mills *et al*. 2020; Sarabi *et al*. 2020; Wamsler *et al*. 2020; Bhattarai *et al*. 2021). Researchers have discussed the barriers from different perspectives, with some focusing more on governance and policy challenges (e.g. Ojea 2015; Wamsler *et al*. 2016; Ilieva and Amend 2019), some focusing on financial barriers (e.g. Hunzai *et al*. 2018; Toxopeus and Polzin 2021) and others highlighting key knowledge gaps (e.g. Rizvi and van Riel 2014; Rizvi, Baig and Verdone 2015; Donatti *et al*. 2017).

3.2. Main barriers impeding the implementation and scaling up ecosystem-based adaptation

Our review of the scientific and technical literature suggests that there are eight broad categories of barriers that can potentially constrain EbA policy development, planning and implementation in different contexts. These broad categories are: 1) limited awareness and understanding, 2) knowledge and evidence gaps, 3) technical capacity constraints, 4) insufficient public and political support, 5) governance challenges, 6) policy and regulatory challenges, 7) finance challenges, and 8) limited space for EbA. For each of these categories, we explain why this category is important, identify the specific barriers that fall within the category, and provide examples of how these barriers have arisen in EbA initiatives in different contexts. The list of specific barriers to EbA implementation is provided in Table 2.

While we present the specific barriers individually, it is important to note that many of these barriers are linked and EbA initiatives may therefore experience multiple barriers either at the same time or sequentially. In addition, while some barriers will likely apply to many types of EbA initiatives (e.g. difficulties securing funding for EbA), others may be specific to a particular context or initiative.

Table 2. **Summary of the potential barriers to EbA implementation that have been highlighted in the literature**

Barrier category	Specific barriers
Limited awareness and understanding	• Limited awareness and understanding of EbA among national and local policymakers, preventing its inclusion in policies, regulations and budgets • Limited awareness and understanding of EbA among private sector actors, hindering its integration in risk management strategies and investments • Limited understanding of EbA among local authorities, technicians and professionals tasked with implementing EbA
Knowledge and evidence gaps	• Insufficient data on climate change, vulnerability and ecosystem extent to inform policy and investment decisions • Incomplete evidence on the costs, benefits and effectiveness of different EbA measures • Limited knowledge on how to most effectively integrate EbA measures with conventional engineering solutions • Uncertainty about the biophysical limits to ecosystems in a changing climate

Technical capacity constraints	• Limited institutional capacity and expertise among policymakers and local authorities to mainstream EbA into policies, plans and investments • Limited technical experience of professionals in EbA initiatives
Insufficient public and political support	• Lack of political leadership and support for EbA • Limited public support for EbA, due to lack of awareness, cultural constraints and entrenched preferences
Governance challenges	• Unclear institutional arrangements and decision-making procedures • Lack of cross-sectoral and inter-institutional collaboration • Challenges establishing effective multi-stakeholder partnerships for EbA
Policy and regulatory challenges	• Unsupportive policies and strategies • Lack of supportive regulations or inadequate enforcement of regulations • Difficulty of mainstreaming EbA across sectors • Lack of coherence across national and local policies and regulations
Finance challenges	• Insufficient availability of public and private finance • Lack of financial incentives and business models for EbA • Existing financial instruments and policies (such as perverse subsidies, incentives and tax breaks) often undermine EbA
Limited space	• Limited space or land for EbA implementation, due to lack of undeveloped land or high opportunity costs

3.2.1. Limited awareness and understanding

One of the most commonly reported types of barriers to the use of EbA is a lack of awareness and understanding of the role of ecosystem conservation, restoration and management in fostering climate resilience (Kapos *et al*. 2019; OECD 2021). Because EbA is still a fairly new concept, there is still some uncertainty among certain stakeholders about what EbA entails, the benefits it can deliver and how it can be best pursued (Nalau *et al*. 2018a). This lack of understanding can prevent or slow down the inclusion of EbA measures in relevant policies, programmes and investments.

While different stakeholder groups vary in their level of awareness, the literature suggests that there are three key constituencies among whom this lack of understanding of EbA is a particular concern. First, national and local policymakers are often unfamiliar with EbA and may therefore ignore or overlook opportunities to integrate this approach into relevant policies, regulations, plans and budgets (Kapos *et al*. 2019; Terton and Greenwalt 2021). A study in South Africa, for instance, found that local authorities were unaware of the potential role of ecosystems in delivering adaptation benefits, complicating efforts to promote the use of EbA (Pasquini and Cowling 2015). A study in Bangladesh similarly reported that policymakers at both the national and sectoral levels were largely unfamiliar with the role of EbA in fostering climate resilience (Huq *et al*. 2017). In Sweden, municipal authorities often lacked a basic understanding of EbA and therefore had difficulties incorporating this approach into municipal planning (Wamsler *et al*. 2020). A survey of EbA policymakers and practitioners by the GAN found that the lack of understanding and awareness was the most frequently mentioned barrier to EbA implementation (reported by approximately half of the 90 respondents; UNEP unpublished data). Even in countries where national policies are supportive of EbA, knowledge of ecosystem-based approaches is often limited to select actors within ministries and institutions tasked with environmental and climate change issues and does not always extend to the broader suite of decision makers (such as the Ministry of Finance or Economy) overseeing the development of national development, economic or sectoral plans (Kapos *et al*. 2019). As a consequence, opportunities for integrating EbA into national development plans or using EbA to enhance the resiliency of key sectors such as infrastructure, transport, energy and agriculture are often missed (Nelson *et al*. 2020).

Second, many actors in the private sector, including both businesses (e.g. micro-, small- and medium-sized enterprises, and corporations) and the private financial sector (commercial banks, insurers, investment funds, retail investors, and institutional investors), have a limited awareness of the importance of ecosystems for climate change adaptation (United Nations Global Compact 2011; OECD 2021). Many companies are unaware of the extent to which their businesses depend on ecosystems or the potential value of ecosystems in helping them protect their businesses from the impacts of climate change, and therefore fail to consider EbA in their risk management strategies, business decisions and investments (United Nations Global Compact 2011; Dasgupta 2021). For example, a study of 1,600 corporate adaptation strategies found that while nearly half of the companies reported using hard adaptation approaches (such as capital investments in technology, engineered infrastructure and built structures), only 3.3 per cent of the companies reported using EbA (Goldstein *et al*. 2019). In the private finance sector, the limited understanding and awareness of EbA is a key factor (together with the lack of clear business models) that discourages investment in EbA (Stoll *et al*. 2021; Tall *et al*. 2021).

The third set of actors who often lack sufficient understanding of EbA are the local authorities, professionals and technicians tasked with translating policies into local plans and on-the-ground action. In most places, it is the city planners, engineers, water management authorities, property developers, construction workers, landscape planners and local authorities who are responsible for implementing and managing adaptation programmes, together with local communities, NGOs and civil society organizations (Sarabi *et al*. 2020; Wamsler *et al*. 2020). While these technical staff are generally familiar with engineering options for addressing climate change risks and have been trained to follow detailed guidelines and standards for grey infrastructure, they often lack comparable expertise and experience in ecosystem-based approaches (Browder *et al*. 2019; Kapos *et al*. 2019). Local authorities and project implementors may also be unaware of existing evidence or technical guidance on the effectiveness and multiple benefits

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of EbA and therefore turn to grey infrastructure as the default option for preventing flooding, reducing heat risks or addressing other climate risks (Browder *et al*. 2019). A study of multiple European cities, for example, found that city planners and engineers were generally averse to implementing urban EbA measures because they were unfamiliar with these approaches and wary about their potential effectiveness (Sarabi *et al*. 2020). A report by the WBSCD similarly highlighted the need for more specialized training in the design, implementation, monitoring and permitting of natural infrastructure approaches for engineers, city planners and other key technical staff, in order to help catalyse greater interest and demand in EbA (World Business Council for Sustainable Development [WBCSD] 2017). The limited knowledge of EbA among technical staff reflects, in part, the fact that current training programmes, educational systems and certification processes often overlook the importance of ecosystems as a risk management intervention in favour of more conventional infrastructure-based approaches (Kapos *et al*. 2019; OECD 2021).

3.2.2. Knowledge and information gaps

A second commonly cited set of barriers is the lack of knowledge and information to inform decision-making for EbA planning and implementation (Travers *et al*. 2012; GAN 2021). Policymakers, practitioners and investors need to have access to accurate, up-to-date and detailed information about future climate scenarios, climate risks and vulnerabilities, as well as the costs, benefits and effectiveness of different EbA measures, so that they can readily identify opportunities for using ecosystems to foster adaptation (Andrade Perez *et al*. 2011). Decisions about EbA design and implementation need to be based not only on scientific and technical information, but also on relevant local and traditional knowledge (Mercer *et al*. 2012; Nalau and Becken 2018). If there are key knowledge or information gaps, this can prevent or discourage the use of EbA in policies, plans and investments or result in the ineffective use of available technical and financial resources (UNEP 2012; Nalau *et al*. 2018a).

According to the literature, there are four main types of knowledge and information gaps that can constrain the use of EbA.

First, the implementation of EbA is often hindered by the lack of robust information on future climate projections, climate risks, social vulnerability, and ecosystem extent and condition (Doswald and Osti 2011; Kapos *et al*. 2019; UNEP 2021a). In many countries, this information is either missing, out-of-date, not available at the relevant spatial scale or time frame, or not accessible in a manner that policymakers, project implementers and local communities can understand (Mercer *et al*. 2012; Donatti *et al*. 2017). For example, the lack of detailed, high-quality and spatially explicit data on future climate projections and risks was noted as a constraint for EbA initiatives in Cambodia (Chong 2014), Peru (Ilieva 2018) and South Africa (Roberts *et al*. 2012). In many cases, there is also a need for more detailed information on the specific climate risks faced by different stakeholder groups, the socioeconomic and ecological context in which the initiative will take place, and existing local practices (such as rainwater harvesting, indigenous crop rotation, seed conservation practices) that can contribute to adaptation, so that EbA initiatives can be tailored to local concerns, needs and aspirations (Mercer *et al*. 2012; Nalau *et al*. 2018b). Local and traditional knowledge can be an important source of this information, but numerous studies have noted that EbA initiatives often overlook this information (Doswald *et al*. 2014; Nalau *et al*. 2018b). For example, a review of adaptation initiatives in the Caribbean Small Island Developing States found that few EbA initiatives had actively integrated local knowledge into project design and implementation (Mercer *et al*. 2012). Finally, in some instances, more detailed information is needed on the distribution and condition of terrestrial and coastal ecosystems and the ecosystem services they provide, so that interventions can be targeted to those ecosystems and locations which are most likely to provide the greatest adaptation benefits (Bourne *et al*. 2016; Kasecker *et al*. 2018). An analysis of the climate adaptation plans for 14 European cities, for example, concluded that better baseline information on the existing stock and distribution of green and blue infrastructure and their ability to provide climate change adaptation services was needed to better target the design and implementation of urban EbA initiatives (Geneletti and Zardo 2016).

A second commonly cited knowledge barrier is the limited evidence base on the costs, benefits and effectiveness of EbA in different contexts (Ojea 2015;

Chausson *et al*. 2020; UNEP 2021a). In order to design successful adaptation initiatives, policymakers, planners and practitioners require detailed information on the costs and benefits of different EbA measures (including not only adaptation benefits, but also co-benefits such as climate mitigation, biodiversity conservation and economic development), how the costs and benefits compare to alternative, infrastructure-based measures, and the distribution of these costs and benefits across different stakeholder groups (Travers *et al*. 2012; Emerton 2017; Richerzhagen *et al*. 2019). Although the evidence base for EbA is rapidly growing, more information is needed on which EbA measures (or combination of measures) will be the most cost-effective and deliver the greater level of adaptation and co-benefits for a particular context (Doswald *et al*. 2014; Ojea 2015; Reid *et al*. 2018; Seddon *et al*. 2020a). Multiple studies have highlighted the need for a more robust evidence base, standardized metrics and agreed-upon methodologies for measuring the costs, benefits and effectiveness of EbA in different contexts, including in cities, agricultural landscapes, coastal environments, mountain ecosystems and urban areas in order to better inform the design of EbA investments, policies and programmes (e.g. Colls, Ash and Ikkala 2009; Harvey *et al*. 2017; Milman and Jagannathan 2017; Swiderska, King-Okumu and Islam 2018; Keeler *et al*. 2019; Sarabi *et al*. 2020). Another major knowledge gap that constrains the use of EbA is the lack of information on how the costs, benefits and effectiveness of EbA measures compares to alternative grey infrastructure measures (Narayan *et al*. 2016; Keeler *et al*. 2019). Other studies have emphasized the importance of having more information on the distribution of EbA costs and benefits across different social groups (particularly among women and men) or across time (i.e. across different generations) in order to facilitate the design of more inclusive and gender-responsive initiatives (Brink *et al*. 2016; Angula *et al*. 2021; Hagedoorn *et al*. 2021). In addition, there is a need to ensure that these analyses of costs, benefits and effectiveness take into account both the adaptation benefits (e.g. reduced flood risks or reduced property damage) as well as co-benefits (such as food security, water security, carbon sequestration), and account for potential trade-offs between interventions, ecosystem services and stakeholder groups (Seddon *et al*. 2020a).

A third critical knowledge gap is the limited knowledge and technical guidance on how to most effectively integrate EbA approaches with conventional, engineering solutions and other adaptation measures. Ecosystem-based measures are often used in combination with hard infrastructure and other adaptation strategies, yet there is still limited understanding of how these hybrid approaches should be designed to deliver the desired adaptation outcomes (Browder *et al*. 2019; Green-Gray Community of Practice 2020). For example, in smallholder farming systems, researchers have noted the need to have more information on how to most effectively integrate the use of EbA approaches (such as agroforestry systems and soil and water conservation practices) with other adaptation strategies such as the use of irrigation systems, agricultural technology (e.g. improved seeds), climate information systems and insurance (Harvey *et al*. 2017). In coastal systems, there is a need for better information on how to most effectively combine EbA measures such as the restoration of coral reefs with the more conventional construction of sea walls or embankments (Narayan *et al*. 2016). Guidance on how to integrate EbA with hard infrastructure approaches is also a common challenge in urban development and infrastructure initiatives (e.g. Browder *et al*. 2019; Green-Gray Community of Practice 2021).

A final knowledge gap is the need for a better understanding of how ecosystems provide adaptation services and the extent to which ecosystems will continue to provide these services under climate change (Jones, Hole and Zavaleta 2012; Buckwell *et al*. 2020). Despite significant advances in ecosystem science, there is still some uncertainty about how the extent, location and condition of different ecosystems impact their ability to provide the ecosystem services that help society adapt to climate change, and the limits and thresholds under which ecosystems might no longer be able to deliver adaptation benefits (Nalau *et al*. 2018a; Buckwell *et al*. 2020). For example, researchers have noted that it is critical to understand whether coral reefs will continue to provide significant protection to coastal communities if they are affected by climate-driven bleaching events, or whether mangroves will continue to buffer the impacts of storm waves under increasingly strong storm events and rapidly rising sea levels (Jones, Hole and Zavaleta 2012). More information is also needed on how quickly the restoration of degraded land or the planting of trees in cities can result in the provision of flood protection or heat stress benefits, how much of an area will need to restored, how many and which tree species need to be planted, how these areas should be managed, how quickly the cooling benefits will be provided, and how long these benefits will last in a changing climate (Milman and Jagannathan 2017; Seddon *et al*. 2020a). Uncertainties around how climate change will impact ecosystems and how the continued degradation of ecosystems will affect their ability to provide adaptation services has been shown to dampen enthusiasm for the use of ecosystems as part of adaptation strategies. For example, a study in Bangladesh highlighted the need for better information on how both climate and non-climatic stressors will affect coastal ecosystems in the future, so that this information can inform the design of adaptations strategies for improving the resilience of coastal communities (Mustafa Saroar *et al*. 2019). A review of EbA literature by Nalau *et al*. (2018a) also highlighted significant knowledge gaps regarding the capacity of ecosystems to continue to provide ecosystem services and adaptation in a changing climate.

3.2.3. Technical capacity constraints

A third broad set of barriers that is frequently mentioned in the literature is the lack of adequate technical capacity to successfully design and implement EbA measures at scale (Travers *et al*. 2012; Kapos *et al*. 2019). The planning, implementation and management of EbA initiatives requires significant technical expertise and know-how, including skills in climate change modelling, vulnerability analyses, assessment of the costs and benefits of different adaptation measures, participatory stakeholder engagement processes, project design, finance and adaptive management, among others (Lo 2016; Swiderska, King-Okumu and Islam 2018; Kapos *et al*. 2019). If this technical capacity is not available, this can slow down or even impede EbA action.

The literature suggests that two types of capacity gap play a particularly important role in preventing the adoption and scaling up of EbA. First, in many countries (especially in developing countries), governments lack staff with the diverse set of scientific skills and knowledge needed to effectively plan and implement EbA policies and initiatives. To be successful, government ministries, departments and agencies need staff who can understand climate scenarios and vulnerability assessments, rigorously assess the advantages or disadvantages of different adaptation options, bring together stakeholders to prioritize adaptation actions and manage the rollout of existing policies and initiatives (Lo 2016; Knowles and Bragg 2018; Kapos *et al*. 2019). They also need staff who can develop fundable projects and identify and secure finance to support EbA (Ilieva 2018; Swann *et al*. 2021). Finally, it is helpful for governments to have staff or partners who are “knowledge brokers” who can relay EbA-relevant information and analyses to decision makers and end users, and who can bring together stakeholders across different disciplines and departments and facilitate collaboration among policymakers, scientists and practitioners (Brink *et al*. 2016; Bednerek *et al*. 2018; Sarabi *et al*. 2020). However, in many cases, this technical expertise is often either missing, incomplete or unevenly distributed across different government departments, slowing EbA action. For example, the limited technical capacity and know-how of governments and national institutions was identified as a major constraint to the implementation of EbA initiatives in Nepal (Bhattarai *et al*. 2021), Peru (Ilieva 2018), South Africa (Knowles and Bragg 2018) and Sweden (Wamsler *et al*. 2020), among others. The lack of technical capacity and skilled knowledge brokers has also been identified as a key barrier to the implementation of urban EbA initiatives (Brink *et al*. 2016; Sarabi *et al*. 2020).

A second key capacity gap is the lack of adequate technical knowledge and know-how among the professionals and technicians involved in implementing and monitoring EbA interventions. To ensure success, it is critical that engineers, contractors, planners and regulators working in key sectors (e.g. agriculture, forestry, water and sanitation, infrastructure, urban development and planning) have the appropriate skills for designing and implementing EbA measures. However, in many cases, these technical staff lack EbA-relevant knowledge and skills because EbA are not included in their formal training or certification programmes (Browder *et al*. 2019; Kapos *et al*. 2019; OECD 2021; Terton and Greenwalt 2021). A global review of 139 EbA case studies in urban areas, for example, found that the lack of technical skills and know-how was one of the most common barriers to implementation (Brink *et al*. 2016). Other studies have similarly noted the urgent need to provide specialized training on how to effectively implement NbS to the engineers, contractors and other technical staff in charge of designing, implementing and regulating adaptation measures (WBCSD 2017; Sarabi *et al*. 2020). Another key consideration is that many technical professionals lack experience of the complex and participatory multi-stakeholder engagement processes that are typically used in EbA initiatives and this can be a barrier for its implementation (Swiderska, King-Okumu and Islam 2018). For example, service providers who are tasked with designing green infrastructure for urban flood control may need to build relationships with non-traditional development partners and engage with a much more diverse set of actors than if they were developing hard infrastructure projects, and this may require them to acquire new skills and training (Browder *et al*. 2019).

3.2.4. Insufficient political and public support

A fourth frequently mentioned challenge is the need to ensure robust support and leadership for EbA (Kabish *et al*. 2016; Sarabi *et al*. 2020). Although it is important for EbA to be broadly supported by a diverse coalition of stakeholder groups, the literature highlights two constituencies that are particularly critical for mobilizing action and support for EbA: policymakers and the general public.

First, in many instances, progress on EbA is stymied by the lack of political leadership. Political support and will are needed to raise the profile of EbA, advocate for its broad inclusion in relevant policies, regulations and investments, and mobilize action and collaboration across the diverse actors and governance levels needed for successful implementation (GIZ 2017a; Ilieva and Amend 2019). Political leadership is particularly important because EbA is often a new approach for government officials and partners and scaling up its implementation requires a range of different changes to existing practices and procedures. If political support for EbA is weak, lacking or inconsistent, it is unlikely that EbA will be prioritized or mainstreamed into national and local-level planning or that adequate funds and resources will be allocated to its implementation. For example, researchers in Sweden found that the lack of political will to address climate change adaptation was an important barrier to the adoption of EbA by local municipalities (Wamsler *et al*. 2016). They also noted that the ability of municipalities to mainstream EbA was dependent on individual officials' level of commitment to EbA, pointing to the importance of local champions in mobilizing action. A review of experiences with EbA in multiple European cities similarly found that weak political support prevented the mainstreaming of EbA in municipal policy agendas (Sarabi *et al*. 2021). In the case of the Philippines, the lack of political will and motivation of leaders, combined with the lack of buy-in among some local government units, were important constraints to mainstreaming EbA into policy and practice (Ramos 2018).

Policymakers may be reluctant to champion the use of EbA for multiple reasons, including unfamiliarity with the approach, uncertainties about EbA costs and effectiveness, entrenched preferences for engineered approaches, and reluctance to initiate EbA interventions that will deliver benefits beyond their political terms (Sarabi *et al*. 2020; Terton and Greenwalt 2020). In addition, the fundamental mismatch between the short-term nature of governmental policy and funding cycles versus the long-term horizon for EbA benefits to accrue often discourages its use, as policymakers are keen to undertake actions that will deliver tangible and visible benefits in the short term to demonstrate success and get reelected (Ojea 2015; Sarabi *et al*. 2020). For example, in Bangladesh, policymakers supported the use of hard infrastructure solutions for protecting communities from floods, cyclones and river erosion because they preferred the quick risk-reduction benefits of built infrastructure to the longer-term, more sustainable benefits of EbA (Huq *et al*. 2017). EbA measures that involve the restoration of degraded ecosystems may have particular difficulty in attracting political support, as they are often slow to deliver their adaptation benefits in full (Roberts *et al*. 2012; OECD 2021).

In other situations, the lack of strong public support is an important obstacle to the use of EbA. Securing the buy-in and long-term commitment of local stakeholders and champions who can be "change agents" is critical for successful EbA implementation, especially in initiatives that include actions on private lands managed by local landowners or that require active community participation (Lo 2016; Nalau *et al*. 2018a). In places where public support is mixed or weak, it is difficult to speed up the progress of ecosystem management for adaptation goals. For example, in an EbA initiative along the Uruguayan coast, public support for coastal revegetation and sand dune management measures for coastal protection was mixed, with some stakeholders viewing the measures positively because of their low cost relative to hard coastal protection measures and others being sceptical of their ability to effectively protect coastal communities; this lack of public support initially delayed the projects' design and implementation (Carro *et al*. 2018). In Europe, negative stakeholder perceptions were a major obstacle to implementing EbA in coastal zones, as local communities were concerned about the effectiveness of nature-based approaches (compared to hard structures) and angry at potentially losing land for ecosystem restoration and conservation (Doswald and Osti 2011). A lack of citizen awareness and interest in EbA was also reported as an obstacle to the mainstreaming of EbA in municipal plans in Sweden (Wamsler *et al*. 2020). Negative public perceptions of EbA have also been reported to delay the realization of large-scale, ecosystem-based flood defence programmes, as local stakeholders are often opposed to allowing reclaimed land to be returned to wetlands (Temmerman *et al*. 2013).

The lack of wide public support for EbA is linked to limited public awareness and understanding of EbA, cultural preferences for certain land uses and landscape types, and, in some cases, entrenched preferences for hard infrastructure, especially among urban and coastal stakeholders who are accustomed to using grey infrastructure to address climate challenges and using construction to stimulate economic growth and job creation (Sarabi *et al*. 2019). For example, in Samoa, local stakeholders preferred the use of hard infrastructure (such as groynes and seawalls) as solutions to sea level rise, flood and coastal erosion over EbA solutions because they were more familiar with engineered approaches and were confident in their ability to protect them from climate risks (Nalau *et al*. 2018b). There may also be trade-offs involved with the use of EbA which may dampen enthusiasm for this approach: for example, setting aside land for EbA in cities may conflict with urban development plans (Lo 2016).

3.2.5. Governance challenges

The fifth category of barriers – governance challenges – are one of the most frequently reported barriers to achieving the efficient and successful use of EbA at scale (Ojea 2015; Nalau and Becken 2018; Amend 2019). In the context of EbA, governance refers to the norms, institutions and processes that determine how society distributes the power, responsibilities and decision-making processes to protect, restore and sustainable manage ecosystems as part of an overall strategy for climate change adaptation (Iza 2021).

As EbA involves multiple sectors, governance levels, institutions and stakeholders and is often implemented at broad geographic scales that cross political or administrative boundaries, the potential challenges of successfully planning and governing EbA interventions are significant.

The literature has identified three governance factors that are of particular relevance. First, in many places, there is a lack of clear institutional arrangements, decision-making structures or procedures for EbA that lay out who has the authority or mandate to advance this approach. Because of its multisectoral and multidisciplinary nature, EbA lies at the interface of multiple departments and policy sectors and does not easily fit into the existing decision-making structures and procedures. Often, it is not clear which government departments or institutions are responsible for planning, leading or funding EbA interventions, especially in cases where interventions cover several sectoral, geographic or administrative boundaries (Ojea 2015; Reid *et al*. 2019). The lack of clear institutional arrangements (within institutions, across institutions and across municipalities) and streamlined decision-making procedures has been found to complicate the delivery of EbA in multiple locations (Kabish *et al*. 2016; Nalau and Becken 2018; Amend 2019). For example, a study of adaptation initiatives in European cities found that the different responsibilities and visions of multiple agencies and departments and the lack of clear decision-making processes were a barrier to incorporating EbA in planning and management processes (Sarabi *et al*. 2019). In Australia, the complexity of multi-agency cooperation and decision-making across the various state and regional bodies involved in freshwater management of the Murray-Darling Basin complicated the planning and implementation of ecosystem approaches and required significant time and investment to be overcome (Lukasiewicz, Pittock and Finlayson 2016). In the case of Peru, mandates for climate change adaptation and ecosystem management were clear at the national level, but not at the local government levels where EbA implementation actually takes place, slowing action (Ilieva 2018).

A second governance challenge for EbA is the insufficient collaboration and coordination among the multiple government departments, institutions and sectors that are involved in ecosystem conservation, restoration and sustainable management (Nalau *et al*.

2018a; Kapos *et al*. 2019). EbA measures cut across different government departments, institutions and sectors, as well as across different spatial scales, and therefore require both significant horizontal (i.e. across government departments and sectors) and vertical collaboration (e.g. from local to national levels) within governments (Lo 2016; Amend 2019). Ensuring the successful collaboration across these different entities and scales is often tricky because government departments and institutions tend to work as silos, with each focusing on its own set of goals, priorities and resources (Brink *et al*. 2016; Sarabi *et al*. 2019). This compartmentalization of government institutions can undermine the ability of governments to deliver on EbA, especially when different government entities prioritize competing actions in the same geographical area, or when adaptation priorities conflict with development or other priorities. A study in Sweden, for example, found that municipal departments promoting an increase in urban green spaces for climate adaptation benefits clashed with other departments focusing on promoting urban densification (Wamsler *et al*. 2016). At the municipal level, local authorities often face the challenge of reconciling competing policies and priorities. In the United States of America, for instance, local officials in vulnerable flood-prone coastal areas who are eager to adopt green infrastructure approaches for flood control face the dilemma that expanding the area of restored wetlands and floodplains and converting developed sites back to undeveloped land will significantly reduce their tax revenues, thereby affecting their capacity to provide other key services like education, housing and water (Shi 2020).

Finally, EbA faces the challenge of building effective cross-sectoral, multi-stakeholder and inclusive partnerships that can support initiatives over the long-term horizons needed to deliver adaptation benefits to society (Nalau *et al*. 2018a; Amend 2019). As most initiatives involve diverse sets of actors (e.g. local landowners, Indigenous Peoples and local communities, women, youth, business owners, citizen groups, NGOs, private companies, municipal departments, and national authorities) and involve activities on multiple spatial scales, it is critical that EbA practitioners build cross-sectoral, multi-stakeholder partnerships that enable effective participation and can reconcile diverse perceptions and priorities. In many cases, EbA proponents will need to engage with new or non-traditional partners, and coordinate activities over much large spatial scales (e.g. watersheds, landscapes or coastal regions) than they are accustomed to, and this is a challenge (Lukasiewicz, Pittock and Finlayson 2016; Amend 2019). Identifying and effectively engaging key stakeholders is often complex. In Bangladesh, many EbA projects were deemed unsuccessful because they were organized top-down and failed to ensure the participation of relevant stakeholders (Mustafa Saroar *et al*. 2019). A study of the use of EbA by German and Swedish municipalities noted that the municipalities often lacked clear strategies for increasing citizen participation in the co-development of EbA policies (Wamsler and Pauleit 2016). The failure to effectively engage with Indigenous Peoples, women and other marginalized groups is also often a constraint on EbA implementation (Lo 2016).

A related challenge is the need to ensure that EbA initiatives carefully consider gender-differentiated vulnerabilities and adaptation needs and address the power dynamics across diverse stakeholder groups, institutions and actors (Nalau and Becken 2018; Angula *et al*. 2021; Dazé and Terton 2021). Women are often disproportionately vulnerable to climate change and have limited adaptive capacity because of cultural and traditional norms; their roles as primary providers of food and water; their dependence on natural resources for their livelihoods and survival; limited access to education, capital and information; and the inequitable distribution of roles, resources and power (Angula *et al*. 2021; Hagedoorn *et al*. 2021). To be successful, EbA projects need to be carefully designed to address these gender-differentiated needs and to promote more equitable and inclusive development. However, many EbA initiatives have faced challenges in effectively engaging women and other marginalized groups in the design and implementation of EbA (Lo 2016).

3.2.6. Policy and regulatory challenges

A sixth major category of barriers to EbA are policy and regulatory factors. Because EbA involves multiple sectors, actions at multiple geographic scales and multi-stakeholder processes, it is critical that this approach be backed by strong and consistent policies, laws and regulations (Ilieva and Amend 2019). Creating a supportive and coherent policy framework is important because it sends a strong signal to both the public and private sector about the importance of ecosystems in protecting society from adverse climate impacts and encourages greater investment in this approach (Ilieva and Amend 2019).

According to the literature, there are several potential policy and regulatory barriers to EbA. The first challenge is that many national policies and strategies do not explicitly promote the use of EbA approaches or provide detailed plans or resources for its application. Since national policies provide the framework for the operation of lower levels of government and sectors and guide the allocation of technical and financial resources, if EbA is not clearly integrated into and prioritized within policies at the national level, it is unlikely that it will be reflected in local climate adaptation policies, programmes and budgets (Ilieva and Amend 2019). A study in Viet Nam, for example, found that there was only weak integration of EbA consideration into climate change policies, and highlighted the fact that a lack of strong national-level policies on EbA prevented its integration at lower governmental levels and into sectoral policies (Nguyen, Pittock and Nguyen 2017). In Cambodia, the lack of integration of EbA into the broader legal and policy framework for climate change was a barrier to its uptake (Chong 2014). However, even when EbA approaches are supported in national-level policies, this support is not necessarily reflected in local-level policies or in the actions of local organizations tasked with policy implementation on the ground. The European Union Adaptation Strategy, for example, explicitly encourages the use of EbA by member countries, but a study in Portugal found that this mandate has not been transposed into municipal plans and strategies (Cousiño and Penha-Lopes 2016). In England, national policies for dealing with the impacts of flooding are increasingly supportive of EbA measures, yet at the local level, flood management is dominated by structural development, construction and pipeline management (Huq 2016). In Samoa, the lack of supportive institutional and legal frameworks at the local level was similarly reported as an important barrier to EbA implementation (Chong 2014).

Another policy constraint highlighted in the literature is the difficulty of mainstreaming EbA into other sectoral and national strategies beyond those that focus specifically on climate change and environmental issues. Mainstreaming refers to the systematic integration of EbA considerations at the local, institutional and inter-institutional levels and includes changes in policy, regulations, planning tools, workings structures, mandates, finances and human resources (Ilieva and Amend 2019; Wamsler *et al*. 2020). Because EbA has the potential to reduce climate change impacts on a wide range of sectors, including agriculture, forestry, coastal planning, infrastructure, transportation, energy and health, it is critical that ecosystem-based approaches be mainstreamed across the wide set of policies, operations, planning and decision-making mechanisms related to these sectors (Wamsler *et al*. 2014; Ilieva and Amend 2019). However, in practice, the mainstreaming of EbA into sectoral policies and plans has been difficult. For example, a study in Peru found limited alignment between climate adaptation policies and sectoral action, preventing EbA action (Ilieva *et al*. 2018). In Viet Nam, there has been little integration of EbA into key sectoral strategies, such as those for forestry, fisheries, water, coastal zone management, disaster management and biodiversity conservation (Nguyen, Pittock and Nguyen 2017). In Bangladesh, sectoral policies and plans for water resources and rural development largely ignore EbA and instead focus on hard structural approaches for adaptation (Huq *et al*. 2017). A study of Swedish municipalities similarly found that mainstreaming EbA was difficult because municipal departments work in silos and because EbA is considered too late in the planning process (Wamsler *et al*. 2020). Interestingly, a study of Swedish and German municipalities found that mainstreaming EbA was more successful in those municipalities that already had experience in mainstreaming other environmental policy issues (Wamsler and Pauleit 2016).

In some cases, the lack of supportive regulations (or inadequate enforcement of these regulations) is also a major constraint. There is a wide set of national and local regulations which can potentially promote or hinder the planning, implementation and financing of EbA. For example, regulations related to land and resource use, coastal development, water management, infrastructure development and disaster risk reduction, among others, can potentially discourage the implementation of EbA if they promote activities that undermine the ability of ecosystems to provide adaptation services or restrict the consideration of ecosystem-based approaches. In the case of the UK, for instance, marine restoration projects such as the restoration of seagrass beds or oyster reefs face high licensing fees and heavy administrative burdens, making them difficult for environmental groups to implement (Smith and Chausson 2021). In many Pacific Islands, the absence of a coherent legal framework for protected areas complicated the implementation of EbA in both terrestrial and marine environments (Boer and Clarke 2012). In urban settings, engineering standards, permitting processes, environmental impact

Building climate resilience of urban systems through ecosystem-based adaptation (EbA) in Latin America and the Caribbean.
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assessments, zoning ordinances or building codes for developing new infrastructure (housing, roads, bridges, ports, energy systems, hydropower) or retrofitting and upgrading existing infrastructure can prevent or prohibit the application of EbA measures by both public and private sector actors (Watkins *et al*. 2019). For example, a study of Swedish municipalities found that the lack of supportive legislation for incorporating green roofs and other EbA measures into building requirements hindered their broad adoption (Wamsler *et al*. 2016). Landscape planning and zoning across urban, rural and coastal areas can also undermine EbA efforts, if it permits the construction of new infrastructure on coastal areas, wetlands or river floodplains where the vegetation is critical for protection from storms, or if it fails to protect natural ecosystems that provide critical adaptation benefits (Kabish *et al*. 2016; Browder *et al*. 2019; Kapos *et al*. 2019). A related issue is that even in cases where regulations and laws are designed to support EbA, the lack of compliance or enforcement of these regulations may limit EbA application (Chong 2014; Pasquini and Cowling 2015; Sarabi *et al*. 2019).

Finally, the lack of coherence across policies, laws and regulations (at both national and lower levels) that affect ecosystem conservation, restoration and use is often a major challenge for EbA implementation (Ilieva and Amend 2019). In essence, any policy that affects natural resource use, land use, forests, agriculture, coastal areas, watershed management or urban landscapes, or that involves sectors where EbA could be applied, is potentially of relevance to EbA and could either promote or hinder its uptake. In Europe, for example, the lack of consistency in both the intention and implementation of different policy areas, such as agriculture, biodiversity, fisheries and transport, is often an important detriment to the use of EbA (Naumann *et al*. 2011). In Sweden, efforts to increase the extent of green areas in cities to manage stormwater often run counter to policy initiatives that promote urban densification (Wamsler *et al*. 2016). The lack of coherence across policies at different levels or in different sectors has also been noted as a major challenge to the mainstreaming of EbA in Peru (Ilieva *et al*. 2018). In addition, the lack of coherent policy and regulatory frameworks is also a major constraint to private sector investment in adaptation, as it sends mixed signals to the private sector about the importance of considering ecosystems in business decisions (Dougherty-Choux *et al*. 2015).

3.2.7. Finance challenges

Many of the most common and most important barriers to the implementation and scaling up of EbA are financial in nature (Nalau *et al*. 2018a; Kapos *et al*. 2019; Swann *et al*. 2021). Like other adaptation measures, EbA requires significant financial resources for planning, implementation and management, as well as for related capacity-building and stakeholder engagement efforts (Hunzai *et al*. 2018; Swann *et al*. 2021). In addition, since implementing EbA is typically a long-term endeavour, small amounts of finance must also be available for maintaining the intervention over multiple years and for monitoring its outcomes. If the levels of finance available to support EbA interventions are insufficient or unsustainable over the long term, this can be a major obstacle to achieving adaptation goals (Doswald and Osti 2011; Hunzai *et al*. 2018).

According to the literature, there are several financial barriers that affect the delivery of EbA. The overarching (and most common) barrier is the lack of available funds for EbA action, whether in the form of public funds (e.g. government budgets, bilateral or multilateral aid, or climate funds) or finance from the private sector (Nalau *et al*. 2018a; Kapos *et al*. 2019; UNEP 2021a). Researchers have reported the lack of sufficient funding or difficulties in accessing finance as major challenge to EbA action in Australia (Lukasiewicz, Pittock and Finlayson 2016), multiple European countries (Doswald and Osti 2011; Brink *et al*. 2016), Nepal (Bhattarai *et al*. 2021), Oceania (Grantham *et al*. 2011), Samoa (Chong *et al*. 2014), the Seychelles (Khan and Amelie 2015), South Africa (Guerbois *et al*. 2019), the UK (Smith and Chausson 2021), Viet Nam (Wolf *et al*. 2021), and urban EbA initiatives across the world (e.g. Brink *et al*. 2016; Kabish *et al*. 2018; Sarabi *et al*. 2020). Indeed, a recent survey of EbA practitioners by the GAN found that 73 per cent of practitioners cited the lack of finance as the key barrier to EbA implementation (UNEP unpublished data). In some cases, project leaders are able to secure funds to cover initial planning and stakeholder engagement costs but are unable to obtain funds for implementation or to cover ongoing operational costs, thereby delaying action on the ground (Doswald and Osti 2011).

The EbA funding shortage is due to the lack of sufficient public funding from both domestic and international sources, as well as the lack of private finance (Swann *et al*. 2021). Domestic funding for EbA is often limited because national and/or local governments are underresourced, have constrained budgets and need to balance EbA with competing priorities, as is the case in Nepal (Bhattarai *et al*. 2021) and South Africa (Roberts *et al*. 2012). In Europe, cities often have limited budgets for green development and the maintenance of green spaces, reducing the options for EbA (Kabish *et al*. 2016). Many developing countries, eligible for adaptation funding from multilateral or bilateral sources, encounter problems accessing ICF for EbA because the application process is onerous (requiring significant paperwork and detailed modelling requirements) and because governments often lack the capacity to apply for and manage these funds (Smith and Chausson 2021). For example, an adaptation project in Kiribati that aimed to protect coastal areas from sea level rise by building seawalls and restoring mangrove forests faced significant challenges in meeting the heavy reporting and management demands of international funding, due to limited personnel and capacity, undermining their ability to deliver results (Donner and Webber 2014). The limited amount of private finance reflects a combination of limited awareness or interest of the private sector in EbA, the lack of clear investment opportunities, the complexities of securing finance for activities that generate a mix of private and public goods, and the fact that many EbA investments are of limited attractiveness to private investors due to their long-term payback times and revenue flows, low returns, small size, and perceived high-risk profiles (Cooper and Tremolet 2019; WWF 2020; Tall *et al*. 2021; UNEP 2021a).

A second and closely related challenge is the lack of financial incentives and business models that could spur greater investment in EbA by the private sector. Numerous studies have suggested that the use of innovative financial tools and approaches could help to catalyse a greater flow of private sector investment towards ecosystem conservation, restoration and management (WBCSD 2017; Louman *et al*. 2020). The financial tools that could potentially be deployed to stimulate private sector finance include concessional loans, tax credits, green bonds, grants, payment for ecosystems services, subsidies, government guarantees, extension of credit lines, credit guarantees, blended finance, seed capital, pricing guarantees, novel insurance schemes, resilience bonds and other risk-sharing mechanisms (United Nations Global Compact 2011; GCA 2019; Earth Security 2020; Tall *et al*. 2021). However, while there are increasing examples of the innovative application of tools to spur private sector investment, the adoption of these tools is still limited and has not yet generated finance for EbA to the necessary degree (Swann *et al*. 2021). For example, a review of EbA implementation in urban areas found that the lack of financial incentives is a major barrier for collaboration between the public sector and entrepreneurs from the private sector (Sarabi *et al*. 2020).

A final financial challenge to EbA is the fact that existing subsidies, tax breaks and other financial instruments and policies may serve as a disincentive for businesses or private citizens to implementing EbA. In many countries, governments provide subsidies and/or tax breaks to activities that undermine the condition of ecosystems and their ability to deliver adaptation benefits – for example, providing incentives for the development of agriculture in wetland areas which could instead be managed for adaptation purposes (Sarabi *et al*. 2021). Subsidies for oil and gas production, mining, fishing, forestry, and agricultural (including oil palm) expansion are all examples of perverse incentives that lead to ecosystem loss and degradation and undermine the ability of ecosystems to provide adaptation and other services (Dempsey, Martin and Sumaila 2020; Ding *et al*. 2021). Unless these perverse financial incentives are removed or shifted to support the conservation, restoration and sustainable management of ecosystems, efforts to channel higher levels of finance towards ecosystem-based approaches are unlikely to produce the intended results.

3.2.8. Limited space for ecosystem-based adaptation

A final challenge for EbA initiatives is the need to secure land or space for long-term interventions. Most EbA initiatives require that there be space for conservation, restoration and/or sustainable management to provide the ecosystem services that underpin adaptation (Colls, Ash and Ikkala 2009; Nalau *et al*. 2018a). Increasingly, EbA is implemented at the broader landscape, seascape or watershed level and requires a mix of interventions at different locations across the landscape, often including actions on a complex mosaic of lands with different ownership and tenure characteristics (Swiderska, King-Okumu and Islam 2018). If the key areas that need to be restored, managed or conserved are not available or fall under the ownership and management of multiple actors (potentially including both private and public actors), or if acquiring this space incurs high opportunity costs, this can significantly delay or prevent progress (Colls, Ash and Ikkala 2009). Only in cases where EbA focuses on changing the management of existing ecosystems (e.g. changing agricultural practices on farms or rewetting peatlands to foster greater resiliency) is space not necessarily a limiting factor.

There are many documented examples of the difficulty of securing land for EbA implementation, including cases in Australia (Lukasiewicz, Pittock and Finlayson 2016), Mauritania (Mills *et al*. 2020), Nepal (Mills *et al*. 2020), Peru (Ilieva *et al*. 2018) and Thailand (GIZ-ECOSWat 2017). In some landscapes, there is limited land available for EbA because most of the land has already been urbanized or used for other activities. For example, efforts to provide storm and coastal flood protection by restoring or conserving mangroves, tidal wetlands and other coastal vegetation are often constrained by the lack of remaining undeveloped land (Temmerman *et al*. 2013). Similarly, efforts to restore rivers and floodplains are often stymied by the presence of housing and infrastructure within the floodplains. In other landscapes, project proponents may encounter difficulties in obtaining permission to implement adaptation measures because much of the land is privately owned and landowners are not willing to participate, or because municipal governments have limited abilities to act on or influence private land. For example, a study in the Murray-Darling catchment in southeastern Australia highlighted the difficulties of implementing catchment-scale programmes on private property as a major constraint to the implementation of EbA measures (Lukasiewicz, Pittock and Finlayson 2016). Private landownership is a particular challenge for EbA uptake in urban contexts, given that most land and real estate in cities belongs to private owners and acquiring this land is prohibitively expensive (Sarabi *et al*. 2020). In some countries, customary landownership practices can also limit the opportunities for women to implement EbA practices; Nigeria is an example (Oloukoi *et al*. 2014). A final reason why it can be difficult to obtain space for implementing EbA measures is that most land is already being used by local communities for agriculture, fishing or other productive uses, and communities are often sceptical of proposals to replace their current land use with ecosystem-based activities. For example, one study found that in Mauritania, local community members preferred to continue their traditional livelihoods on degraded lands, rather than restoring the ecosystems to provide adaptation benefits (Mills *et al*. 2020).

3.3. Conclusions

Our review of the scientific and technical literature indicates that there are many barriers that can potentially slow down or prevent the implementation of EbA. The major types of barriers identified in the literature include limited awareness and understanding of EbA, knowledge and evidence gaps, technical capacity constraints, insufficient political and public support, governance challenges, policy and regulatory challenges, finance challenges and limited space for EbA implementation.

However, beyond identifying potential obstacles to EbA implementation, the literature does not yet provide a comprehensive understanding of how, where and when different barriers emerge or how these barriers can be overcome (Davies *et al*. 2020; Ishtiaque *et al*. 2020). The evidence base is still too incomplete to enable the identification of which specific barriers – or combinations of barriers – are most likely to arise in a particular type of intervention, in a particular context, or at a particular stage of an EbA intervention (e.g. planning, design, implementation, management; Sarabi *et al*. 2021). In addition, while most initiatives face multiple barriers (either simultaneously or sequentially), the relationships between different types of barriers and the relative importance of individual barriers are not yet well understood. This makes it hard for adaptation practitioners to know which barriers are the most critical to address, or which strategies are likely to be most effective at overcoming these challenges. However, as more EbA initiatives get under way and existing initiatives evolve and mature, our understanding of the barriers that EbA interventions face in different contexts is likely to become more sophisticated and nuanced. Over time, there will also be more examples of how initiatives have successfully overcome different sets of barriers in different contexts, as well as guidance on how to best anticipate, plan for and address potential challenges.

Yet, even with our current, incomplete knowledge, it is already clear that there are numerous aspects and dimensions that EbA planners and practitioners must consider as they design and implement EbA interventions, in order to improve their chance of success. The evidence to date suggests that, like conservation and sustainable development initiatives more broadly, the successful implementation of EbA depends on having supportive policies, an enabling governance context, appropriate knowledge and technical capacity, increased awareness and understanding, strong public and political support, sufficient and sustainable finance, and available space. In the next chapter (chapter 4), we explore potential actions that we think could help address many of the current barriers to EbA and thereby spur greater uptake of EbA globally.

Chapter 4. Recommendations for scaling up the use of ecosystem-based adaptation

Introduction

EbA has the potential to play a central and crucial role in putting the world on a climate-resilient and nature-positive pathway. However, as highlighted in the previous chapters, the current use of EbA falls short of its potential and remains far below the scale necessary to respond to the impacts of both existing and future climate change. The number and size of EbA initiatives is still small, many national and local policies do not yet effectively integrate EbA, and the availability of public and private finance for EbA falls far below what is needed (Roberts *et al*. 2012; Ojea 2015; Swann *et al*. 2021). A wide range of factors (including policy and regulatory constraints, knowledge and awareness gaps, capacity gaps and lack of finance) has been shown to potentially slow or impede the implementation of EbA measures (see chapter 3). These potential barriers will need to be quickly addressed, circumvented or overcome in order to harness the full potential of ecosystems for climate resilience.

In this chapter, we examine opportunities for rapidly scaling up the use of EbA across all regions of the world, in support of climate adaptation and other policy goals. By "scaling up", we refer both to increasing the number of EbA initiatives[76] globally (i.e. replicating successful EbA approaches in new locations) as well as significantly enhancing the spatial scale and coverage of existing and future initiatives, making them bigger, more sustainable and more impactful.

Although there are no silver bullets for harnessing the full potential of ecosystems for climate resilience, there are many promising avenues for scaling up EbA action and overcoming the barriers which often restrict its widespread use. In this chapter, we provide a broad list of recommendations which, if implemented, could help tip the scales in favour of EbA and accelerate its implementation at scale. These recommendations are based on an extensive review of more than 750 documents, as well as discussions and input from 59 EbA experts from 30 organizations with experience in EbA policy, implementation and finance (see the acknowledgements section for experts' names and affiliations). Rather than attempting to provide an exhaustive list of all potential actions that could help advance EbA, or a systematic plan for scaling up, we suggest a set of recommendations which, in our judgment, hold the greatest potential for success. These include actions which already have some support or momentum from policymakers, investors or practitioners, actions which address specific barriers to the use of EbA, and actions that build on existing opportunities. Some of these actions will directly spur the use of EbA (e.g. creating regulations that mandate its use), while others may advance EbA more indirectly by creating larger constituencies of support and greater momentum for action. The list of recommendations is intended to be a starting point for more detailed consideration, rather than a prescriptive list of actions that must be followed. It is likely that some of these recommendations will only apply to certain contexts or initiatives, while others may be more broadly applicable. Indeed, we anticipate that these recommendations will evolve over time as more information and experiences on EbA are shared.

Our recommendations are organized into five broad categories: 1) developing a supportive policy and regulatory framework for EbA; 2) using innovative policy instruments and approaches; 3) working with key groups that can spur greater uptake of EbA; 4) using innovative approaches to increase EbA finance; and 5) targeting EbA to the contexts where the greatest adaptation benefits will accrue. For each of these broad categories, we provide a set of specific recommendations (see Table 3 for the full list of recommendations). For each of the recommendations, we highlight why this action is important, explain what specific steps can be undertaken and specify the role of different actors. Where possible, we also provide successful examples of EbA implementation that could be built on or replicated in other locations. While the

76 As in the rest of the report, we use the term "EbA initiatives" to refer broadly to initiatives that include actions to actively conserve, manage or restore ecosystems with the intent of helping people adapt to climate change. This includes both initiatives that consist solely of EbA measures, as well as initiatives in which ecosystem-based approaches are used in combination with hard infrastructure or engineering approaches (e.g. green-grey or hybrid approaches).

recommendations are presented individually, almost all these recommendations are closely linked. Action on many fronts – and by many actors – will be needed if we are to harness the full adaptive benefits of nature and achieve impact at scale.

Table 3. Summary of the main recommendations for scaling up EbA action

Category	Recommendation
4.1. Creating a supportive policy and regulatory framework for EbA	**4.1.1.** Raise the profile of EbA in national-level commitments for climate, biodiversity and sustainable development **4.1.2.** Mainstream EbA in policy, planning and budgeting processes
4.2. Using innovative policy and regulatory instruments to promote EbA	**4.2.1.** Encourage the use of natural capital accounting **4.2.2.** Use green public procurement processes to increase the use of EbA **4.2.3.** Promote the integration of green and blue infrastructure in infrastructure projects **4.2.4.** Use building codes and zoning regulations to support EbA
4.3. Working with key groups that can spur greater action on EbA	**4.3.1.** Support EbA action by Indigenous Peoples, local communities and women **4.3.2.** Promote greater involvement by private businesses **4.3.3.** Stimulate greater investment by the financial sector
4.4. Using innovative approaches to finance EbA	**4.4.1.** Use green, blue and resilience bonds to secure finance for EbA **4.4.2.** Support the use of debt-for-nature and debt-for-climate swaps **4.4.3.** Use COVID-19 stimulus and recovery funds to support EbA action **4.4.4.** Support risk disclosure by businesses in the private sector **4.4.5.** Create innovative insurance mechanisms to protect and restore ecosystems

4.5. Targeting EbA to the contexts where the greatest benefits will likely accrue	**4.5.1.**	Prioritize the use of EbA in low-lying cities that are vulnerable to flooding and heat stress
	4.5.2.	Prioritize the use of EbA in coastal areas that are vulnerable to sea level rise, storm surges and erosion
	4.5.3.	Prioritize the use of EbA in agricultural landscapes that are critical for food and water security

Note: The numbering of recommendations refers to the section in which the recommendation is explained.

4.1. Creating a supportive policy and regulatory framework for ecosystem-based adaptation

One of the most important ways to stimulate greater adoption of EbA is to ensure it is backed by a supportive policy and regulatory framework. Creating a conducive policy framework is a critical, and often foundational, step for mobilizing action on EbA, as the policy framework determines which actions can be undertaken, guides the allocation of technical and financial government resources, and communicates the importance of ecosystem management for climate adaptation to both the public and private sectors (UNDP 2015c; Ilieva and Amend 2019; Kapos *et al*. 2019). Here we highlight two aspects that are particularly critical for ensuring a supportive policy environment for EbA: 1) raising the profile of EbA in national-level commitments for climate, biodiversity and sustainable development; and 2) mainstreaming EbA into policy, planning and budgeting processes.

4.1.1. Raising the profile of ecosystem-based adaptation in national-level commitments for climate, biodiversity and sustainable development

One important opportunity for increasing EbA action is to raise the profile of EbA in national commitments to international policy processes related to climate change, biodiversity conservation and sustainable development. Across the world, most countries have already committed to taking ambitious action to meet the global goals of the UNFCCC Paris Agreement, the Land Degradation Neutrality target of the UNCCD, the United Nations Sustainable Development Agenda, the United Nations Decade on Ecological Restoration and other related initiatives. Countries are also currently negotiating the goals and targets of the post-2020 Global Biodiversity Framework of the CBD and are expected to make ambitious pledges in 2022 to value, conserve and restore biodiversity, maintain ecosystem services, sustain a healthy planet, and deliver essential benefits for people (IUCN 2021b). As discussed in chapter 1, EbA could be a powerful approach for addressing these interlinked policy goals simultaneously, as EbA measures not only contribute to climate change adaptation, but also to climate change mitigation, biodiversity conservation and sustainable development more broadly.

In order to harness the contribution of EbA to these interlinked policy agendas, national governments need to explicitly incorporate EbA activities into their climate, biodiversity and sustainable development commitments, and develop specific, ambitious and measurable targets for the use of EbA measures to achieve their stated goals. Many national governments have already included EbA as a key component of their NAPs and their NDCs under the UNFCCC: a detailed review of 19 NAPs, for example, found that all countries had included EbA actions to reduce the threats of climate change to people (Terton and Greenwalt 2020), while another report found that a total of 91 countries (out of 114 countries which had submitted NDCs by October 2021) had included EbA within their NDCs (Bakhtary, Haupt and Elbrecht 2021). There is, however, scope for more ambitious action. For example, in both existing and future rounds of NDCs, governments could set more ambitious, measurable and time-bound targets for how, when and where EbA will be deployed and how many people will benefit from EbA initiatives. They could also ensure that NDCs cover all relevant ecosystem types (not only forests, but also grasslands, wetlands, coral reefs, mangroves, etc., depending on national circumstances) and create more specific plans for how they will design, implement and fund EbA implementation (Seddon *et al*. 2020b; Martin, Bartlett and Marcella 2020). Detailed guidance is available on how to integrate EbA into the formulation, implementation and review of NAPs (UNEP 2021d) and NDCs (Martin, Bartlett and Marcella 2020; Bakhtary, Haupt and Elbrecht 2021; Terton and Greenwalt 2021).

In addition to raising the profile of EbA within the climate agenda, governments should also seek to integrate EbA into their national-level commitments for biodiversity, sustainable development and related policy initiatives, and foster linkages across these commitments. For example, governments could highlight the role of ecosystems in fostering climate adaptation in their National Biodiversity Strategies and Action Plans and prioritize the conservation and restoration of healthy, intact ecosystems that are critical for both current and future adaptation efforts (SCBD 2019). Such a commitment would help protect healthy, intact ecosystems that are critical for both current and future adaptation (Martin and Watson 2016). Similarly, national governments could integrate EbA actions into their national plans for sustainable development, Land Degradation Neutrality and disaster risk reduction, as well as into their commitments to large-scale environmental initiatives such as the United Nations Decade on Ecosystem Restoration[77] (UNEP 2020), the Bonn Challenge[78] (Dave *et al*. 2018) and the Global Mangrove Alliance,[79] all of which have the potential to have impact at a meaningful scale. Raising the profile of EbA within these interlinked policy agendas and demonstrating the synergies across these agendas should help to catalyse greater investment and implementation of EbA on the ground.

While the development and implementation of national policy commitments is the responsibility of policymakers and requires strong political leadership, other actors can also support these efforts. Academic institutions, research organizations and think tanks can ensure that EbA targets are robust and based on the best available knowledge from science and practice (Seddon *et al*. 2020b). They can also develop and apply methods for documenting EbA implementation, policy integration and budget allocations, and for tracking progress towards national-level commitments. Local government agencies, NGOs, civil society organizations, Indigenous Peoples, local communities and other practitioners can share their knowledge and experiences with EbA implementation, helping to identify the most promising interventions for a given location or context and prioritizing ecosystems for adaptation action (Nalau *et al*. 2018; Swiderska, King-Okumu and Islam 2018). Organizations that provide international public funding (e.g. bilateral donors, multilateral organizations and climate and environmental funds) can support governments in developing ambitious national-level commitments, by providing technical expertise for the design and implementation of national commitments and related policies; helping to strengthen institutional capacity on EbA; funding research, demonstration and monitoring efforts to further strengthen the EbA evidence base; and funding EbA knowledge exchange and information hubs (Ng'etich 2021). Perhaps most importantly, international public funders need to significantly step up the level of finance they provide for EbA, so that developing governments can access the necessary funds to deliver on their national commitments and implement EbA at scale (Murphy and Parry 2020; United Nations 2021). The recent commitment by the world's major multilateral development banks (MDB Joint Statement on Nature, People and Planet, endorsed in November 2021 at COP26[80]) to help countries to secure high ambition

77 For more information, please visit https://www.decadeonrestoration.org/about-un-decade.
78 For more information, please visit https://www.bonnchallenge.org.
79 For more information, please visit https://www.mangrovealliance.org.
80 For more information, please visit https://thedocs.worldbank.org/en/doc/e523c9386dd95f2ec59613310611e1de-0020012021/mdb-joint-statement-on-nature.

in implementing NbS across their relevant plans and strategies, and to allocate more funds towards NbS, could be an important step for accelerating EbA action (Bennet 2021). The Glasgow Pact from COP26 similarly calls on developed countries to double their 2019 level of funding for climate change adaptation by 2025, in order to help developing countries quickly ramp up their adaptation efforts. Securing more international funding for adaptation and NbS is essential for helping countries to deliver on the EbA actions they have outlined in their NAPs and NDCs.

4.1.2. Mainstream ecosystem-based adaptation in policy, planning and budgeting processes

While national-level policy commitments signal the intent of countries to conserve, manage and restore ecosystems for adaptation goals, the goals and visions of these national policy commitments will only be achieved if EbA is systematically embedded into all relevant policy, planning and budgeting processes (Ilieva and Amend 2019; Terton and Greenwalt 2020). Mainstreaming includes revising, updating and developing policies, regulations and incentives so that they promote the use of EbA, allocating funds for EbA in national and local budgets, and ensuring alignment between national, local and sectoral policies that affect ecosystem management and conservation (UNEP 2021d). Mainstreaming the consideration of EbA into all levels and stages of decision-making (from policy formulation to implementation to evaluation) will help align policies and decision-making within governments, facilitate planning and implementation of ecosystem-based initiatives, promote cross-sectoral collaboration across different ministries, departments and institutions, and reduce the cost of adaptation planning, ultimately resulting in the greater use of EbA (Ilieva and Amend 2019; SCBD 2019). Strong political leadership will be needed to mobilize action and synergize efforts across different governance and sectoral levels.

To achieve impact at scale, EbA must become a standard feature of government decision-making (Huq *et al*. 2017; Ilieva and Amend 2019; GIZ 2019b). At the national level, there is need to mainstream EbA not only into national climate adaptation and related environmental policies, but also into economic development plans (e.g. national development plans, poverty reduction strategies, national budget allocation processes and other long-term strategies). This is important because economic development policies often determine government priorities, actions and funding allocations and also provide the impetus for municipalities, communities and the private sector to consider ecosystems in their own development planning (USAID 2017b; Amend 2019). EbA should also be systematically mainstreamed into the national strategies, policies, plans and budgets of key sectors (e.g. agriculture, water, forestry, health, energy, infrastructure and transportation) where its use can support sectoral goals (UNDP 2016; Ilieva and Amend 2019). Some sectors are already embracing the use of EbA as a means of enhancing their climate resilience (e.g. ministries of agriculture often include ecosystem conservation, management and restoration as a means of protecting water supplies for farm irrigation); however other sectors (such as transportation or energy) may be less familiar with the potential contribution of EbA to their sectoral goals and may require additional awareness-raising, capacity-building and technical information (e.g. on the benefits of ecosystem management for preventing landslides on mountain roads or the value of forest conservation for ensuring water flow to hydroelectric dams) before embracing the use of EbA (Mandle, Griffin and Goldstein 2017; Prabhakar, Scheyvens and Takahashi 2019). At the subnational and local levels, EbA should similarly be mainstreamed into policies, regulations, strategies, plans and budgets, especially those related to municipal adaptation, land-use planning and zoning, infrastructure and transportation planning, hazard mitigation, stormwater management, and planning of parks and open spaces (Wamsler *et al*. 2014; Ilieva and Amend 2019).

Policymakers can foster the mainstreaming of EbA into relevant policies, plans and budgets in various ways. They can actively encourage (or mandate) the integration of EbA by different ministries, departments or government institutions, provide targeted financial resources for mainstreaming efforts across long-term and sectoral strategies, and ensure there is sufficient human and technical capacity for EbA across all levels of government (Ilieva and Amend 2019). Governments can also set up new formal or ad hoc institutional arrangements or working groups to facilitate the coordination of EbA-related policy, planning and budgeting processes across ministries, institutions and sectors, and to ensure there are clear plans for who will do what, where, when and how (Wamsler *et al*.

2020; Tall *et al*. 2021). At both national and local levels, governments can put in place financial instruments to generate public funding for EbA, including allocating revenue from targeted taxes (e.g. property taxes, carbon taxes), tradable permits, development rights, water-use fees, payments for environmental services, and national climate and development funds, among other possible sources (Dougherty-Choux *et al*. 2015; GCA 2020). National governments can also issue green bonds (see section 4.4.1), green credit lines and insurance schemes to channel funding towards EbA actives (Hunzai *et al*. 2018). Since mainstreaming is an iterative and often multi-year process, a high level of political support and long-term budgeting are critical for success.

Other actors can also play a role in mainstreaming EbA. MDBs, climate funds, bilateral donors and other funders can provide valuable technical expertise and funding to support mainstreaming efforts. In addition, public funding agencies can themselves commit to mainstreaming the use of EbA in their investments and operations or include EbA considerations as criteria in their public funding allocations, thereby creating additional impetus for national governments to embrace the use of EbA (Ng'etich 2021). Civil society organizations, communities and the general public can work with policymakers to mainstream the use of EbA and actively engage with governments in the planning, implementation and monitoring of EbA initiatives (Kapos *et al*. 2019; Wamsler *et al*. 2020). EbA practitioners and researchers can build the capacity of policymakers and technical staff to design and implement EbA initiatives, through training programmes, workshops, site visits and peer exchanges with other policymakers who are already leading the way on EbA (Kapos *et al*. 2019). EbA practitioners can also drive greater mainstreaming of EbA by documenting and disseminating information on the costs, benefits and performance of different EbA measures in diverse contexts, and by facilitating access to relevant EbA tools, methods and knowledge platforms (Paquin and Cowling 2015; Sarabi *et al*. 2020). Finally, the establishment of multisectoral partnerships, communities of practice or policy-based networks that include diverse stakeholder groups can help facilitate knowledge-sharing, strengthen public and private sector support for EbA and spur action on the ground (SCBD 2019). Prominent examples of global collaborative networks that are promoting the deployment of EbA measures include the Friends of EbA,[81] the GAN and associated regional networks,[82] the NAP Global Network,[83] the International EbA Community of Practice,[84] the Partnership for Environment and Disaster Risk Reduction,[85] AdaptationCommunity.net,[86] ICLEI – Local Governments for Sustainability,[87] and C40 Cities,[88] among others. Guidance, case studies and tools for mainstreaming EbA within policy, planning and budgeting processes can be found in Ilieva and Amend (2019) and SCBD (2019).

81 For more information, please visit https://friendsofeba.com.
82 For more information, please visit https://www.unep.org/gan/.
83 For more information, please visit https://napglobalnetwork.org.
84 For more information, please visit https://www.adaptationcommunity.net/ecosystem-based-adaptation/international-eba-community-of-practice/.
85 For more information, please visit https://pedrr.org.
86 For more information, please visit https://www.adaptationcommunity.net/ecosystem-based-adaptation/.
87 For more information, please visit https://iclei.org.
88 For more information, please visit https://www.c40.org.

4.2. Using innovative policy instruments and approaches to promote ecosystem-based adaptation

A second major category of actions that can help spur EbA interventions is the use of innovative policy instruments. With careful design and implementation, policy instruments can be used to increase awareness about the importance of EbA, channel greater levels of funding and encourage greater implementation by both the public and private sectors. Here we highlight four policy instruments and approaches that hold particular promise for accelerating the use of EbA: 1) encouraging the use of natural capital accounting, 2) using green public procurement procedures to support EbA, 3) promoting the use of green and blue infrastructure, and 4) revising building codes and zoning regulations to support EbA.

4.2.1. Encourage the use of natural capital accounting

The use of natural capital accounting by national governments could help to spur greater action on EbA over the long term. Numerous high-profile reports – such as the Global Assessment Report on Biodiversity and Ecosystem Services (IPBES 2019), the Future of Nature and Business (WEF 2021), The Economics of Biodiversity: the Dasgupta Reivew (Dasgupta 2021) and Making Peace with Nature (UNEP 2021) – have highlighted the fact that the world's economic development and well-being depend directly on healthy ecosystems and the services they provide. However, our existing social, economic and financial systems do not value the many benefits that society gets from nature and therefore often result in the overexploitation, destruction and degradation of natural ecosystems and their essential services (Fujita *et al*. 2013; Dasgupta 2021). Existing markets not only fail to value nature and the services they provide, but also fail to capture and value the benefits of climate change adaptation action (Pauw *et al*. 2021), hindering progress on EbA. In order to address these market failures and scale up the use of EbA, it is crucial that governments and institutions fundamentally shift the way in which they value and use nature, and transform the way in which nature and adaptation are considered in decision-making and fiscal policies.

Natural capital accounting is an important tool for integrating the value of ecosystems and their services into government accounting systems, reports and decision-making, and could be used to promote greater conservation, management and restoration of ecosystems for adaptation goals (Agarwala *et al*. 2014). Natural capital accounting involves, among other things, measuring the extent, condition and economic value of ecosystems; assessing the status and trends in the flows of ecosystem services (including services that contribute to climate change adaptation); and analysing whether the overall stock of ecosystems and the flow of ecosystem services are increasing, decreasing or staying stable (Guery *et al*. 2015; Keating 2021). Although there are multiple ways of implementing natural capital accounting (Bagstad *et al*. 2021), the United Nations has recently developed a standardized approach, called the System of Environmental Economic Accounting Ecosystem Accounting (abbreviated as SEEA EA), which is now being used by more than 80 countries (United Nations, Statistical Commission 2022).

The widespread adoption of natural capital accounting by governments could lead to greater awareness and use of EbA among policymakers, technicians and other decision makers, as it provides them with valuable information on the value of nature and its critical role in delivering adaptation (and other) services, and enables them to systematically track changes in the extent, condition and value of ecosystems and ecosystem services (Guerry *et al*. 2015; Bagstad *et al*. 2021). The adoption of natural capital accounting takes time. However, if done successfully, it can change the basic parameters for decision-making in a way that will favour the adoption of EbA and other NbS and help improve ecosystem management. For example, natural capital accounting can help decision makers to identify the specific geographic areas where the conservation, management or restoration of ecosystems is critical for

River running through forest demonstrating forests' role in regulating water flows.

delivering key adaptation services (e.g. which areas of forest may be important for ensuring the water security of downstream cities during periods of climate-induced drought; United Nations 2020). It can also help countries more carefully manage the potential trade-offs between different economic activities (e.g. intensive agriculture, bioenergy production, industrial production) and ecosystem services like flood protection, or between different development trajectories (Bagstad *et al*. 2021). In addition, information generated by natural capital accounting can be a valuable input for government investment and budgeting decisions and can potentially help guide public finance towards activities that maintain or enhance natural capital (and ensure the continued delivery of ecosystem services) and away from activities that undermine ecosystem functioning (Bagstad *et al*. 2021).

In order for natural capital accounting to help move forward action on EbA, however, it is critical that governments commit to implementing natural capital accounting over the long term and using the results to inform decision-making in key policy areas (e.g. agriculture, environment, economy, trade). In addition, governments need to dedicate the necessary technical and financial resources and set up mechanisms for incorporating the results of accounting exercises into relevant policy and investment decisions. To ensure that natural capital accounting informs adaptation planning, governments could also include natural capital accounting as part of climate vulnerability assessments and adaptation planning processes. Research organizations, academic institutions and think tanks can provide valuable technical and scientific support to natural capital accounting efforts, helping with data collection, analysis, interpretation and application. International public donors can provide critical financial support to cover the costs of natural capital accounting, encourage its use by national governments, and also facilitate valuable networking and learning opportunities. One prominent example of such support is the World Bank-led Wealth Accounting and Valuation of Ecosystem Services (WAVES) partnership,[89] which brings together United Nations organizations, governments, international institutes, NGOs and academics to support the use of natural capital accounting by countries and share knowledge and experiences.

4.2.2. Use green public procurement to support ecosystem-based adaptation

Public procurement offers another important, and often underappreciated, policy instrument for encouraging the use of EbA. "Public procurement" refers to the process by which governments purchase goods, services and works from the private sector (Boscio and Djankov 2020). This can include equipping schools, managing forests, building new infrastructure, maintaining public transportation and energy systems, and much more. The purchasing power of public procurement is enormous: in 2018, a total of US$ 11 trillion, or 12 per cent of global gross domestic product (GDP), was spent via public procurement (Bosio and Djankov 2020). In the European Union, government expenditure on goods, services and public works is estimated to be €2.3 trillion annually, the equivalent of 19 per cent of Europe's GDP (Pouikli 2021).

Many countries across the globe have already established "green" public procurement policies that aim to leverage the money that governments spend on large contracts to achieve environmental and climate policy goals (OECD 2015; Hasanbeigi, Becqué and Springer 2019; World Bank 2021). "Green public procurement" refers to the public purchase of products and services that are less environmentally damaging than alternatives, when taking into account the whole life cycle of the product or service (OECD 2015). While the scope of these programmes varies, most address a wide range of environmental issues from climate change mitigation to energy efficiency to the protection of ecosystems, water and biodiversity (Hasanbeigi, Becqué and Springer 2019). The number of green public procurement programmes is growing rapidly: a recent study documented green procurement programmes in 22 countries across Asia, Europe, North and South America, Africa and Oceania, as well as within multiple MDBs and the United Nations (Hasanbeigi, Becqué and Springer 2019). Another study highlighted that almost all OECD countries are reportedly using green public procurement programmes and 69 per cent of OECD member countries are tracking the results and impacts of these programmes (OECD 2015).

89 For more information, please visit https://www.wavespartnership.org/en/about-us.

There are significant opportunities to harness the power of green public procurement to support EbA. Governments with existing green public procurement policies could review and update their technical standards and procedures to ensure that EbA measures are always included as options in the assessment of any adaptation-related initiatives and require that procurement procedures compare the long-term effectiveness, costs and benefits (including both adaptation benefits and co-benefits) of EbA to conventional hard infrastructure approaches (Kapos *et al*. 2019; SCBD 2019). In addition, governments could include requirements that EbA measures be considered in the early stages of all infrastructure projects (e.g. new roads, coastal development, energy infrastructure, agricultural infrastructure), either as a stand-alone option or to complement hard infrastructure options (Kapos *et al*. 2019; Watkins *et al*. 2019). They could also require that any purchase of goods and services from the agricultural, forestry and fishery sectors come from sustainably-managed ecosystems that meet voluntary sustainability standards (e.g. Fairtrade, Organic, Rainforest Alliance – Lernoud *et al*. 2018) to ensure that their purchases do not contribute to ecosystem degradation or disrupt the flow of critical ecosystem services (OECD 2015). In addition, technical procurement plans that involve the restoration of degraded ecosystems could provide guidance on the selection of climate-adapted species, avoidance of alien invasive species, and management of ecosystem processes, to ensure that the restoration efforts are well-designed and able to deliver the desired adaptation benefits (UNEP 2021a). Governments also have the potential to ramp up the use of existing green procurement policies by mandating that a certain percentage of public procurement be "green" and that this percentage increase over time (as is being discussed in European Union legislation), and carefully tracking implementation (Pouikli 2021). Countries that have not yet adopted green public procurement policies can draw on the existing experiences and methodologies from the OECD (OECD 2015), the European Union (Pouikili 2021), UNEP (2021g) and the World Bank (2021b), among others, to design robust and effective procurement policies that support EbA while also ensuring transparency, integrity, cost-effectiveness and financial sustainability (Hasanbegi, Becqué and Springer 2019; Pouikli 2021). Multilateral organizations, international development agencies, climate funds and other providers of international public finance could also use their own procurement procedures as a means of stimulating greater adoption of EbA, for example, by requiring that countries that receive funding for new infrastructure or development projects consider the use of EbA as part of their activities or have green procurement policies in place.

4.2.3. Promote the integration of green and blue infrastructure in infrastructure projects

Another approach that could significantly accelerate action on EbA is to ensure that new infrastructure developments include the use of "green" and "blue" infrastructure (e.g. ecosystems such as forests, parks, wetlands and mangroves; Green-Gray Community of Practice 2020; Bassi *et al*. 2021). Countries around the world are investing heavily to build new infrastructure to meet the needs of their citizens. In many developing countries, major investments are being undertaken to develop new infrastructure to meet the transportation, energy, water, sanitation and housing demands of rapidly growing populations (Oxford Economics 2017). In other regions, such as the USA and Europe where much of the current infrastructure was built 40–60 years ago, the focus is on upgrading or replacing infrastructure that is ageing, in poor condition or vulnerable to climate impacts (Stefanakis, Calheiros and Nikolaou 2021). The scale of ongoing infrastructure investment is enormous – a recent report found that an estimated US$ 94 trillion of investment (or 3 per cent of the world's GDP) will be needed globally between 2016 and 2040 (Oxford Economics 2017). An estimated 1.2 million km^2 of land will be urbanized between 2000 and 2030, and an additional 3–4.7 million km of roads will be added to the global network by 2050 (zu Ermgassen *et al*. 2019). Seventy per cent of the infrastructure investment is expected to occur in low- and middle-income countries whose societies and economies are typically more exposed to climate risks (Carmody and Chavarot 2021). The way in which these new infrastructure investments are planned – and the extent to which they rely solely on grey infrastructure or also take into account green and blue infrastructure – will have a significant impact on the resilience of communities and ecosystems worldwide (Browder *et al*. 2019; Hallegatte, Rentschler and Rozenberg 2019).

There is an important opportunity to integrate the use of green and blue infrastructure into all future infrastructure investments, in order to increase the resilience of communities and infrastructure to climate change, while ensuring the provision of other critical services (Green-Gray Community of Practice 2020). The careful integration and management of green infrastructure (e.g. green roofs, street trees, parks and urban gardens) and blue infrastructure (e.g. rivers, ponds, floodplains and wetlands) into infrastructure planning can provide a range of benefits to society (Thiele *et al*. 2020; Liberalesso *et al*. 2020; TNC 2021a). These benefits can include climate adaptation benefits such as protection from flooding, reduced heat stress, and reduced risks from sea level rise and landslides, but also potentially other benefits such as biodiversity conservation, reduced energy consumption in buildings, improved air quality, carbon storage, health benefits and recreational opportunities (Zuniga-Terran *et al*. 2020; Green-Gray Community of Practice 2021). The use of green and blue infrastructure has rapidly gained traction among national decision makers, urban professionals, city leaders and MDBs who recognize its ability to deliver multiple benefits (Quintero 2012). Prominent examples of the broad uptake of green and blue infrastructure include the EU Strategy on Green Infrastructure (European Commission 2021), the Netherlands Government's "Building with Nature" approach that incorporates the use of ecosystems for managing flood risks (de Vriend *et al*. 2014), the Chinese Government's Sponge City programme (Zevenbergen *et al*. 2018), the IDB's support for green infrastructure programmes in Latin America (Watkins 2014; Watkins *et al*. 2019; Ozment *et al*. 2021), and the World Bank's work on green infrastructure (Hallegate *et al*. 2019), among others. The recent creation of the Coalition for Climate Resilient Infrastructure (CCRI), a private sector-led coalition of institutional investors, banks, insurers, rating agencies and governments representing over US$ 20 trillion in assets, also highlights the growing momentum and interest in enhancing the climate resilience of infrastructure and could result in greater investment in blue and green infrastructure in the future (Carmody and Chavarot 2021).

There are multiple potential avenues for scaling up the use of green and blue infrastructure and making this the default option for infrastructure development. National and local governments can include green and blue infrastructure in national guidelines, standards or regulations (e.g. for stormwater management, flood control, wastewater treatment, urban development or infrastructure development) and require that key service providers (e.g. water utilities, municipal stormwater departments, flood management agencies, irrigation agencies, power companies) consider the application of green approaches from the planning stage onwards (Browder *et al*. 2019; Watkins *et al*. 2019). For example, the Government of Peru has developed public investment policy guidelines on biological diversity and ecosystem services, which promote the use of green infrastructure in public investments at the local, regional and national levels and encourage the restoration of Andean ecosystems (Ilieva and Amend 2019). In the USA, at least 13 states have developed policies and regulations that promote the conservation, management and restoration of coastal habitats ("living shorelines"), instead of the use of hard armouring structures, as a means of equipping coastal areas to mitigate the effects of sea level rise and coastal erosion (Moorman, Meyers and Carlin 2019). For example, the Living Shoreline Protection Act of 2008 in the state of Maryland promotes the use of living shorelines as the preferred method for shore protection and only allows hard infrastructure measures under specified circumstances (Moorman, Meyers and Carlin 2019). In addition to establishing supportive regulations for EbA, governments can also develop procurement standards (see section 4.2.2) for government-funded infrastructure projects that mandate the consideration of green infrastructure approaches in tenders and requests for proposals (Browder *et al*. 2019).

Governments can also require that climate risks and green infrastructure be considered in local and regional planning initiatives, land and coastal zoning, master land-use plans, or territorial plans (see section 4.2.4). National governments can use financial incentives (e.g. rebates, stormwater fee discounts, tax reductions, subsidies) to make use of green and blue infrastructure more appealing to homeowners, business and developers (see WBCSD 2017; Beck *et al*. 2019; Liberalesso *et al*. 2020; Stefanakis, Calheiros and Nikolaou 2021). In Mexico City, for example, property owners that have installed green roofs can obtain a reduction of 10–25 per cent on their property taxes (Mexico, Legislative Assembly of Mexico City 2015). In the cities of Minneapolis and Portland (USA), property owners can get stormwater fee discounts of up to 100 per cent by installing green roofs and using permeable materials that enhance rainwater infiltration (Liberalesso *et al*. 2020). In Nagoya, Japan, the government is encouraging private landowners to increase the amount of green space on their properties, preserve existing trees, and establish green rooftops and walls by giving them discounted bank home loans, among other preferential treatment (Liberalesso *et al*. 2020). The private sector can also play a role in promoting green and blue infrastructure, by providing both technical expertise and capital to design and structure infrastructure investments that incorporate green and blue infrastructure in support of adaptation goals (Carmody and Chavarot 2021). MDBs, development agencies and other public investors can encourage the use of green and blue infrastructure by requiring that proposals for major infrastructure development carefully identify climate risks to infrastructure investments, assess the importance of ecosystems in providing risk protection, and integrate green and blue infrastructure. They can also provide loans with better rates or use conditional finance to support infrastructure initiatives that include ecosystem-based approaches (Browder *et al*. 2019; Ozment *et al*. 2021). Finally, academic organizations, research groups and project implementors can document the costs, benefits and effectiveness of green and blue infrastructure initiatives in delivering adaptation and other benefits, thereby strengthening the evidence base. They can also update and strengthen educational and training curricula, so that engineers, planners and other infrastructure specialists have the requisite knowledge to successfully integrate ecosystem management into infrastructure developments and are able to design and build for a changing climate (Browder *et al*. 2019; UNEP and International Ecosystem Management Partnership 2019).

4.2.4. Use building codes and zoning regulations to support ecosystem-based adaptation

Building codes and zoning regulations could be potentially powerful policy tools for promoting the widespread use of EbA, especially in areas where new infrastructure development is planned. Building codes and standards provide guidance to engineers, builders, architects, contractors and regulators on how to design, build and operate homes, schools, workplaces and other buildings to ensure the health, welfare and safety of building occupants (Vaughan and Turner 2013). They also influence the ability of buildings and infrastructure to withstand natural disasters and the impacts of climate change, including extreme heat conditions, more intense storms, rising sea levels and more frequent flooding (Vaughan and Turner 2013; World Bank 2021a). A related set of policy instruments are zoning regulations (e.g. land-use regulations, zoning ordinances, coastal zoning, territorial planning or master land-use plans) which describe how different areas may be used, how these areas are managed, and which areas may be developed with new roads, ports, houses or other infrastructure (Dougherty-Choux *et al*. 2015; Chu *et al*. 2019). Zoning regulations for terrestrial, freshwater and marine areas have profound implications for the use of EbA, as they influence where (and which) natural ecosystems are conserved, how ecosystems are managed and used, and whether they will be able to continue to provide the ecosystem services needed for climate adaptation into the future.

Both building codes and zoning regulations can be designed (and enforced) in such a way that they promote the conservation, management or restoration of ecosystems that are critical for climate change adaptation. For example, national and local governments can develop or update building codes and standards so that they require the consideration of both medium- and long-term climate risks to both new and retrofitted buildings, roads, ports and other infrastructure, and mandate the consideration of EbA options as a means of addressing climate risks. This could entail, for example, developing regulations that require the maintenance of green spaces within urban commercial, institutional and residential developments to reduce the risk of urban flooding, or that regulate the planting of street trees to provide shade and ameliorate heat stress (Urbanek 2018; Hill and Martinez-Diaz 2019; Liberalesso *et al*. 2020). Governments can also set clear targets and minimum design standards for green roofs to ensure that green roofs are biodiverse and cover sufficient area in order to deliver the desired cooling and drainage services. In Canada, for example, the city of Toronto now requires green roofs to cover 20–60 per cent of the rooftop area depending on the size of the building (Stefanakis, Calheiros and Nikolaou 2021). Governments can also mandate the inclusion of green spaces in urban drainage systems. For example, in Wales, all new developments (over 100 m^2 in size) are required to use sustainable urban drainage systems (SuDS) that incorporate green roofs, street trees, infiltration ponds and green areas to improve water filtration and reduce the risk of surface flooding during heavy rains, following the Statutory SuDs standards (Wales 2019; Smith and Chausson 2021). National and local governments can also revise and improve land and coastal zoning regulations so that they seriously consider the important role of ecosystems in enhancing societal resilience to climate change (Dougherty-Choux *et al*. 2015; Chu *et al*. 2019). For example, regulations can be updated to prohibit new developments in ecosystems that are critical for coastal protection or require that new developments are set back a certain distance from the coastline or from critical coastal ecosystems. Where possible, the development (or revision) of zoning regulations and/or land-use plans should be based on a spatially explicit analysis of the extent and condition of the region's ecosystems and the ecosystem services (e.g. flood protection, food provision) they provide, so that the regulations can be designed in such a way as to conserve, restore and manage those ecosystems that are most critical for buffering communities from the impacts of climate change (Iza 2021). In Colombia, for example, the government is systematically mapping climate risk to communities within individual watersheds, assessing the flood risk reduction capacity of ecosystems, and identifying ecosystems which require additional conservation, restoration or management to enhance their flood regulation capacities (UNEP 2021a).

To take advantage of the potential of building codes and zoning regulations to promote EbA, the broad range of actors involved in construction, land zoning, urban planning and coastal development must have the necessary skills and core competencies to comply with stricter zoning regulations that include ecosystem management (American Society of Landscape Architects no date; OECD 2020; Terton and Greenwalt 2021). Research organizations, NGOs and EbA practitioners can play a key role by carrying out capacity-building on EbA and on ecosystem management more generally among local decision makers, regulators, and professionals in civil engineering, urban planning, landscape architecture, building, disaster relief, environmental impact assessment, coastal planning and related sectors (OECD 2020). Professional training and licensing programmes related to building codes, zoning and infrastructure development should be updated to include training in EbA, with equal study time dedicated to green approaches as is currently dedicated to conventional gray approaches (Kapos *et al*. 2019; Sarabi *et al*. 2019). In addition, licensing processes and permit processing for EbA projects should be made easier, to encourage greater use of ecosystem-based approaches (Smith and Chausson 2021). Governments will also need to establish clear mechanisms for ensuring compliance with building codes and land zoning policies, so that ecosystems are effectively managed for adaptation goals.

4.3. Working with key groups that can spur greater action on ecosystem-based adaptation

A third broad approach for accelerating action is to broaden the constituency of actors who are actively promoting and implementing EbA initiatives. As highlighted in the earlier chapters, the effective design and implementation of EbA requires collaboration among a large and diverse suite of stakeholders and entails both bottom-up and top-down action (Swiderska, King-Okumu and Islam 2018; SCBD 2019). However, to date, most of the action on EbA has been led by national and local governments, international public funders, international and national NGOs, and the research community. For EbA to be implemented at scale, it will be necessary to more actively engage a much wider and more diverse set of actors. Here we identify three stakeholder groups who have the potential to play a much more active and significant role in promoting EbA: 1) Indigenous Peoples, local communities and women, 2) the business community, and 3) actors in the finance sector.

4.3.1. Support locally led action by Indigenous Peoples, local communities and women

Indigenous Peoples and local communities (including women) can potentially play a leading global role in planning and delivering EbA, as they manage large areas of the world's land and seas, have livelihoods that are dependent on ecosystems, and stand to directly benefit from effective EbA action (Mfitumukiza *et al*. 2020; Townsend and Craig 2020). As much as 65 per cent of the world's land is thought to be under customary, community-based tenure systems, though precise data are lacking (Rights and Resources Initiative 2015). The amount of land that is owned managed or occupied by Indigenous Peoples is enormous: although Indigenous Peoples represent less than 5 per cent (approximately 370 million) of the world's population, they manage or have rights to an estimated 37.9 million km^2 (or 28.1 per cent) of the world's land area, including 7.8 million km^2 within protected areas (Garnett *et al*. 2018). Much of this indigenous land is ecologically intact and of higher conservation and adaptation value than surrounding non-indigenous lands (Fa *et al*. 2020). In addition, indigenous lands generally experience lower levels of deforestation and degradation than non-indigenous lands (Sze *et al*. 2022). While Indigenous Peoples and local communities have a wide range of political, cultural and economic aspirations, many depend on terrestrial, freshwater and marine ecosystems for their livelihoods (e.g. for agriculture, hunting or fishing), have a long history of managing climate variability and changes in the environment, and have valuable local and traditional knowledge of ecosystems and natural resource management that can be incorporated into the design of EbA initiatives (Nalau *et al*. 2018b; Schlingmann *et al*. 2021). Local communities are often uniquely positioned to understand the particular climate-related vulnerabilities and risks they face and can help guide the development of EbA initiatives that are culturally appropriate and tailored to the local context. For example, in many developing countries where communities lack access to potable water, women are responsible for securing water for household consumption and have valuable knowledge of which springs or streams are the first to run dry under drought conditions (Ali and Grobicki 2016). In addition, many local communities have knowledge of indigenous plant species, seed collection and planting methods that are crucial for ecosystem restoration efforts (Reyes-Garcia *et al*. 2019; Hosen, Nakamura and Hamzah 2020).

Many Indigenous Peoples and local communities are already implementing EbA practices to adapt to climate change, such as changes in crop cultivation practices or in the management of natural ecosystems (Nalau *et al*. 2018b; Schlingmann *et al*. 2021). Indeed, EbA measures are thought to be particularly well-suited to the adaptation needs of Indigenous Peoples and local communities because they are less capital intensive than grey infrastructure approaches, take advantage of local materials, and often build on traditional ecological knowledge and practices (Vignola *et al*. 2015). However, to date, the potential role of local and indigenous actors (including women, youth and other marginalized groups) in designing and implementing EbA initiatives has often been overlooked (Tye and Suarez 2020). Most adaptation planning and implementation continues to be led by actors at the national and international level, with little meaningful participation of Indigenous Peoples, local communities and women (Tye and Suarez 2020; Dazé and Terton 2021). A recent global analysis, for example, estimated that less than 10 per cent of total global climate finance flows to local actors (Soanes *et al*. 2017).

There are several ways in which governments, development agencies, donors and civil society organizations can support the greater leadership of Indigenous Peoples, local communities and women in EbA. One key step is to ensure that Indigenous Peoples and local communities (including women, youth and other marginalized groups) have the necessary information, knowledge and capacity to actively lead EbA initiatives, including not only expertise in technical matters but also knowledge of best practices for project management, finance, business plan development, project evaluation and adaptive management (Tye and Suarez 2020). Local capacity on EbA can be strengthened by organizing peer-to-peer exchanges, site visits, knowledge exchange workshops and other active learning opportunities, and by building transdisciplinary partnerships on EbA between local communities, local governments, academia and NGOs (Cockburn *et al*. 2016). Governments can also facilitate the engagement and leadership of indigenous and local community representatives in broader adaptation policy and planning processes, to ensure that their ideas, knowledge and needs are taken into account (Garnett *et al*. 2018; Fa *et al*. 2020). It is also important that more governments take action to establish or recognize clear land rights to land managed by Indigenous Peoples and local communities, along with the rights to access, manage and extract natural resources, since secure land tenure is critical for the long-term success of ecosystem-based initiatives (Fa *et al*. 2020).

Other actors can also support greater leadership on EbA by Indigenous Peoples, local communities and women. For example, researchers and practitioners can work closely with Indigenous Peoples, local communities and women to codesign more holistic EbA projects that build on local, traditional and scientific knowledge and are carefully tailored to local contexts and needs (Nalau and Becken 2018). International public funders (including MDBs, multilateral and bilateral organizations, and climate funds) can significantly increase the amount of finance they provide to locally led action and make these funds more flexible and accessible to local actors, by simplifying onerous application processes and requirements (Soanes *et al*. 2017; Soanes *et al*. 2020). They can also set targets for how much funding will be delivered to local communities and how much will go towards EbA. The group of Least Developed Countries, for example, has made a commitment to dedicate 70 per cent of their climate fund to locally led climate action by 2030 (Soanes *et al*. 2020) which, if achieved, could significantly enhance the implementation of adaptation measures – including EbA – by local stakeholders. The recent announcement by global leaders at COP26 that they would mobilize US$ 450 million[90] for initiatives and programmes to enhance locally led approaches is another important step for elevating EbA and other local adaptation solutions.

As governments, donors and other organizations engage with Indigenous Peoples, local communities and women on EbA, it is critical that they apply the "Principles for Locally Led Adaptation Action" that were designed to ensure local actors have greater power and resources to build resilience to climate change (GCA 2020).[91] These principles were developed by the GCA and have already been endorsed by more than 70 organizations, governments and funders (Coger 2021). All actors that that are developing, funding or implementing EbA actions should also adopt a gender-responsive approach to EbA that recognizes gender differences in adaptation needs and capacities, promotes gender-equitable participation and influence in decision-making processes, and ensures gender-equitable access to finance and other benefits (Angula *et al*. 2021; Dazé and Terton 2021). The GCF is already emphasizing gender responsiveness in its programming prerequisites and operations (Angula *et al*. 2021), while other multilateral climate funds (such as the GEF, the LDCF, the SCCF and the AF) have similarly established gender policy and action plans (Schalatek 2020; Angula *et al*. 2021). Detailed guidance on how to effectively integrate gender considerations into EbA design, implementation and evaluation is available from the International Institute for Sustainable Development (Dazé and Terton 2021).

4.3.2. Promote greater use of ecosystem-based adaptation by private businesses

A second constituency that could play a much larger role in planning and delivering EbA is the business community (defined here as enterprises in the real economy including micro, small and medium enterprises, as well as large corporations; Fayolle *et al*. 2019), which accounts for the majority of the world's economic output, investment and employment (Stoll *et al*. 2021). According to the World Economic Forum's annual survey of business and government leaders, "failure to act on climate change mitigation and adaptation" and "biodiversity losses" were among the top three perceived global risks facing the world's businesses and economy in 2020 (WEF 2020). Climate change can pose a significant risk to business in multiple ways, including through physical damage to assets and infrastructure (such as damage from hurricanes, floods or sea level rise), disruptions to supply chains, changes in downstream market conditions, regulatory and policy risks, and disruption of internal production (Dougherty-Choux *et al*. 2015; Fayolle *et al*. 2019; WEF 2020). The loss and degradation of natural ecosystems similarly threatens businesses operations (WEF 2020). However, despite the significant risks that climate change and biodiversity loss pose to their operations, corporate supply chains, employees and customers, many businesses are unaware of these risks and are not taking action to address them (Goldstein 2019). A study of more than 1,600 corporation, for example, found that only 3.3 per cent of the corporations included EbA measures in their corporate adaptation strategies, despite its potential to

90 For more information, please visit https://ukcop26.org/uk-cop-presidency-cop-president-daily-media-statement-and-latest-announcements-8th-november/.

91 For more information, please visit https://www.wri.org/initiatives/locally-led-adaptation/principles-locally-led-adaptation.

effectively address both climate change and biodiversity risks (Goldstein *et al*. 2019).

There is an urgent need to rapidly scale up the use of EbA by businesses to improve the resilience of businesses and national economies to climate change, while conserving the natural ecosystems and services on which society depends (Stoll *et al*. 2021). Research suggests that businesses are likely to be willing to invest in EbA under three circumstances. First, businesses will invest in EbA if it is in their interest to do so, that is, if the actions reduce the risks and costs of climate change impacts on their operations, corporate supply chains, employees and customers, and if these actions improve their bottom line (Stoll *et al*. 2021; Tall *et al*. 2021). For example, agrobusinesses may be willing to invest in EbA measures (such as soil and water conservation practices) if these measures help to ensure the continued provision of agricultural commodities in a changing climate, supporting business continuity and profitability. Second, businesses may be willing to invest in EbA measures if this represents a new business opportunity for them (Stoll *et al*. 2021). For instance, there may be opportunities for companies to develop new goods or services that support EbA action, such as new spatial modelling tools, novel risk insurance products, drought-resistant seeds or nurseries for landscape restoration (Dougherty-Choux *et al*. 2015; Tall *et al*. 2021). Third, businesses may be spurred into investing in EbA solutions in response to government regulations or policies, or market demand (Tall *et al*. 2021). For instance, businesses may take action on EbA if government policies, regulations or procurement procedures require the consideration or use of EbA options. Public demand for greater EbA action (such as public requests for the disclosure of climate and nature-related financial risks or stakeholder resolutions on climate change action) may also lead companies to take a closer look at their operations and identify ways of using EbA to address climate-related risks (Goldstein *et al*. 2019; Seddon *et al*. 2021).

There are multiple ways in which national and local governments can help spur greater uptake of EbA by businesses. Governments can design policies and regulations that support EbA use, for example, by requiring the consideration of EbA in public sector procurement of goods and services (see section 4.2.2), mandating climate and nature risk financial disclosures by private businesses (section 4.4.4) and creating building code and zoning regulations that incentivize the conservation and restoration of ecosystems (section 4.2.4; Dougherty-Choux *et al*. 2015; Sarabi *et al*. 2020). If governments demonstrate a clear policy commitment to EbA, this sends a clear signal to the business community and can help drive market shifts, empowering the private sector to invest in adaptation without compromising their competitiveness (Tall *et al*. 2021). In addition, governments can use innovative ways to incentivize businesses to adopt EbA measures, such as through public-private financing programmes, local tax discounts, reduced storm water utility fees, rebates and faster permitting processes (Liberalasso *et al*. 2020; EEA 2021). Government investments in data analytics, and technical knowledge on climate scenarios and ecosystems, can also help provide the data businesses need for their risk modelling exercises and decision-making processes (Kabich *et al*. 2016; Kapos *et al*. 2019; Tall *et al*. 2021). Engaging the private sector more directly in multi-stakeholder consultation programmes for designing and implementing national adaptation strategies or planning large-scale EbA interventions could also create opportunities for greater involvement by both businesses and the finance sector (United Nations Global Compact 2011; Tall *et al*. 2021). Research organizations and academia can also push businesses to do more by compiling and disseminating data on EbA costs, benefits and effectiveness, and sharing examples of successful interventions so that businesses can better understand the business case for EbA (Kapos *et al*. 2019). Businesses can also enhance their own capacity to use EbA to address climate risks by hiring in-house climate and biodiversity experts, developing internal policies and procedures for assessing climate risks and identifying adaptation options, and sharing successful experiences with EbA with others in their industry.

4.3.3. Stimulate greater investment in ecosystem-based adaptation by the financial sector

A third stakeholder group that needs to be much more engaged in promoting EbA is the financial sector. As noted in chapter 2, most EbA funding comes from public sources, including national government budgets and international funding from bilateral cooperation, multilateral institutions and specific climate funds (Swann *et al*. 2021). However, these public funds fall far short of what is needed to promote EbA at

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scale (Swann *et al*. 2020; UNEP 2021a). In order to significantly increase the amount of funding for EbA, it will be necessary to do a much better job of unlocking and enabling private capital from the financial sector, including investments from banks, pension funds, microfinance institutions, impact investors, insurance companies, hedge funds and private equity funds (Fayolle *et al*. 2019; Miller and Swann 2019; Tall *et al*. 2021).

To date, leveraging private sector finance for EbA and other resilience-building projects has proven to be challenging (Fayolle *et al*. 2019; Stoll *et al*. 2021; Tall *et al*. 2021). Many EbA actions have high transaction and development costs, require long-term investments, and often deliver benefits over time frames that are much longer than typical investment cycles (UNEP 2021a). The lack of predictable and quantifiable revenue flows from EbA initiatives often makes them unappealing to investors who are looking for "bankable" projects with attractive returns on their investments (WWF 2020; Tall *et al*. 2021). Investors are often deterred from investing in EbA because of the considerable uncertainty about future climatic conditions, how climate change will impact their business operations and assets, and how EbA could help address these risks (WWF 2020). In addition, because most investors focus primarily on short-term results and profits, they are often averse to investing in EbA initiatives in which benefits materialize over the long term and include a combination of monetary and non-monetary benefits (UNEP 2021a). Another important challenge to leveraging more finance is that many EbA initiatives generate public goods (i.e. goods that benefit the broader society, rather than being the exclusive property of any one person or group) such as the protection of communities from flooding, the reduction of heat stress in cities or the protection of coastal areas from storm surges or sea level rise (Fujika *et al*. 2018; Seddon *et al*. 2020a; Tall *et al*. 2021). This means that there is often no immediate incentive for the financial sector to invest in EbA because they cannot capture all the benefits of their adaptation investments (Hallegatte, Rentschler and Rozenberg 2019).

National governments and other actors can help overcome these market failures and facilitate greater investment in EbA by the finance sector in several ways. As highlighted earlier, one the most important things governments can do is to create a supportive policy and regulatory framework for EbA (United Nations Global Compact 2011; Sarabi *et al*. 2020). Governments can also encourage (or mandate) the finance sector to systematically screen their business investments for exposure to climate risks as part of their standard investment appraisal process and consider EbA measures to address these risks (see section 4.4.4; GCA 2019). Governments can also facilitate greater access to public information on projected climate change, impacts and associated costs, thereby helping to address some of the uncertainty around the magnitude and likelihood of different climate risks (Kapos *et al*. 2019). Governments, NGOs, researchers and EbA practitioners can also provide proof-of-concept and research on the cost-effectiveness of implementing EbA to build confidence within the finance community and justify new investments and long-term funding; they can also highlight and promote investment opportunities (Kabich *et al*. 2016; Miller and Swann 2019; WWF 2020). Finally (as discussed in the next section), the public sector can help improve the risk profile of EbA investments by applying public finance instruments that reduce the risks of private sector investments (United Nations Global Compact 2011; Miller and Swann 2019; Tall *et al*. 2021).

4.4. Using innovative approaches to finance ecosystem-based adaptation

A fourth broad set of actions that can help accelerate EbA action is the use of innovative finance mechanisms to generate funding at the scale that is needed. While most funding for EbA continues to stem from public budgets and international assistance, there are increasing opportunities to use new innovative mechanisms to attract greater public and private investment. These innovative finance mechanisms may tap into new sources of funds, blend different sources of funds, de-risk private sector investments or develop novel ways to unlock funds for the conservation, management and restoration of ecosystems for climate resilience (Deutz *et al*. 2018; Louman *et al*. 2020). The design of innovative finance mechanisms for climate change adaptation, nature conservation, and sustainable management of landscapes and seascapes is a rapidly emerging field (Deutz *et al*. 2018; Louman *et al*. 2020). Here we highlight five innovations that we think hold particular promise for quickly increasing the pace and scale of EbA finance: 1) using green bonds to secure finance for EbA, 2) supporting the use of debt-for-nature or debt-for-climate swaps, 3) leveraging COVID-19 stimulus and recovery funds towards EbA action, 4) supporting climate and nature risk disclosure by businesses, and 5) creating innovative insurance programmes.

4.4.1. Use green bonds to secure finance for ecosystem-based adaptation

One finance approach that holds significant potential to attract and leverage finance for EbA is the development of “green bonds”. These are debt instruments that can be used by governments, organizations and companies to generate capital to finance projects that have positive environmental and climate impacts (Tuhkanen 2020). In these bonds, some or all of the proceeds of the bonds are allocated to investments that support specific environmental or climate change goals, such as energy efficiency, green infrastructure, low-carbon development or climate resilience. “Blue bonds” are a subset of green bonds which are used to finance environmental projects in marine and coastal environments, while “resilience bonds” or “green bonds for climate resilience” are a subset of green bonds in which the proceeds are specifically designed to help manage the financial risk from climate change impacts or catastrophes (Deutz *et al*. 2018; Bascuñan, Molloy and Sauer 2020a; Qadir and Pillay 2021). Here we use the term green bonds broadly to include both blue bonds and resilience bonds.

The first green bond was issued by the European Investment Bank in 2007 (Qadir and Pillay 2021). Since then, the green bond market has grown rapidly, with an estimated cumulative total of US$ 1.002 trillion in green bonds being issued from 2007 to 2020 (Jones 2020). Across the world, green bonds are now being issued by multilateral organizations, sovereign countries, municipalities, national development banks, financial institutions and corporations. Demand for green bonds continues to grow as investors aim to fulfil their green mandates (Qadir and Pillay 2021).

While green bonds hold tremendous promise for channelling private finance towards environmental and climate action, their application to EbA initiatives is only now beginning to be explored. To date, most of the proceeds from green bonds have been directed towards climate mitigation projects (rather than to climate adaptation efforts), with 95 per cent of the current green bond funding supporting projects in renewable energy, low-carbon buildings, energy efficiency and low-carbon transportation (Tuhkanen 2020; Mejía-Escobar, González-Ruiz and Franco-Sepúlveda 2021). However, there is growing momentum to use green bonds to finance climate adaptation and resilience initiatives that can protect communities from climate hazards while also generating returns for investors (Chahine and Liagre 2020; Louman *et al*. 2020). One example comes from Fiji. In 2017, Fiji was the first developing country to issue a sovereign green bond (the Fiji Sovereign Green Bond) to mobilize funding to help build climate resilience, with over 90 per cent of its proceeds allocated to adaptation projects, including reforestation and conservation activities (IFC 2017; Ng’etich 2021). Another example is the Netherlands’ €5.98 billion green bond (issued in 2019) which will fund coastal and river ecosystem projects to protect the country from flood risks in coastal and low-lying areas (Mauroner 2019). In Norway, the Nordic Investment Bank has recently issued a SEK 2 billion (US$ 200 million) blue bond to protect and rehabilitate the Baltic Sea, with proceeds being used both for ecosystem-based measures (such as the protection and restoration of wetlands, rivers, lakes and coastal areas), as well as for more conventional infrastructure approaches for storm water management, flood protection and wastewater management (Roth, Thiele and von Unger 2019). There are also efforts under way to create a Municipal Mangrove Bond Fund which could be used as a means of increasing finance for the conservation and restoration of mangroves in support of climate adaptation (Earth Security 2021).

In order to stimulate the greater use of green bonds as a financing mechanism for EbA, there is a need to grow awareness of and interest in EbA among both bond issuers and bond investors. Since the use of green bonds for climate resilience – and EbA specifically – is still nascent, there is also a need for more pilot initiatives that can demonstrate success and serve as examples for replication. Partnerships between international NGOs, multilateral development organizations and governments (such as the partnership between International Finance Cooperation, the World Bank and the Government of Fiji to develop the Fiji Sovereign Green Bond; International Finance Cooperation 2017) can be helpful for developing and testing innovative finance mechanisms that use ecosystems to foster climate resilience. At the same time, it is important that municipalities, companies and other bond issuers adopt robust frameworks that clearly outline how bonds are structured, how proceeds will be used (including which specific EbA actions will be undertaken) and how these investments lead to specific adaptation outcomes. The use of voluntary standards such as the Green Bond Principles from the International Capital Market Association (ICMA 2021),[92] the Climate Bond Standards[93] from the Climate Bond Initiative, and the European Green Bonds Standard which will soon enter the European Union market,[94] can spur greater confidence and investment in the use of green bonds for climate resilience. Governments can also support the development of a robust green bond market by adopting policies, regulations and legal frameworks that support the issuance of green bonds, by strengthening the creditworthiness of institutions willing to issue green bonds, and by requiring rigorous monitoring on their implementation and performance. Finally, there is an urgent need for local governments, NGOs, civil society organizations and other adaptation practitioners to develop a pipeline of EbA projects that can be financed through the proceeds of green bonds, so that there are immediate opportunities for investment (Deutz *et al*. 2018).

4.4.2. Use debt-for-nature and debt-for-climate swaps to support ecosystem-based adaptation

Debt relief could provide another important financial mechanism for fostering greater action on EbA (Fenton *et al*. 2014; Singh and Widge 2021). Many low- and medium-income countries are facing record high debt levels and are having difficulties servicing their debt payments, especially with the unprecedented economic impacts of the COVID-19 pandemic (Thomas and Theokritoff 2021). It is estimated that at least US$ 1.1 trillion in debt service payments will be owed by low- and middle-income countries in 2021, and that as many as 72 countries have high debt vulnerabilities (Jensen 2021). At the same time, many countries lack sufficient resources to invest in adaptation measures at the speed and scale required to enhance their resilience to climate change. Public allocation to climate action has decreased since the pandemic started, as many governments have experienced declines in tax revenue, foreign exchange earnings and employment, and have allocated their limited public resources towards health, social programmes, national defence and economic recovery plans, rather than towards their climate or sustainable development commitments (Caldwell, Alayza and Larsen 2021; Thomas and Theokritoff 2021).

There is growing momentum among economists and policymakers (including the leaders of the World Bank, the IMF, and the United States Department of the Treasury) to offer debt relief to countries in exchange for special action on climate change and/

92 For more information, please visit https://www.icmagroup.org/sustainable-finance/.
93 For more information, please visit https://www.climatebonds.net/standard.
94 For more information, please visit https://ec.europa.eu/info/business-economy-euro/banking-and-finance/sustainable-finance/european-green-bond-standard_en.

or nature conservation (McDonnell 2021; Shalal and Lawder 2021; Singh and Widge 2021). In these "debt-for-climate" or "debt-for-nature" swaps, instead of continuing to make external debt payments to the creditor in a foreign currency, the debtor nation makes payments in a local currency to finance climate projects or nature conservation actions based on terms agreed upon with the creditor (Essers, Cassimon and Prowse 2021; Singh and Widge 2021). As part of these green debt swaps, countries can commit to using the debt relief to finance the conservation, restoration and sustainable management of ecosystems that provide protection against climate hazards. One example of this approach is an innovative climate debt swap for the Seychelles in which the country agreed (among other things) to use debt relief funds to restore coral reefs, improve management of mangroves and protect marine conservation areas in order to provide key climate adaptation and biodiversity benefits (Deutz *et al*. 2018; Silver and Campbell 2018). Another more recent example is the restructuring of US$ 553 million of Belize's debt to reduce its external debt and secure long-term financing to support marine conservation and climate goals, including mangrove and coral reef restoration, improved coastal zone policies, sustainable marine fisheries and enhanced resilience of coastal communities to climate change (Landers and Lee 2021; Winter 2021; TNC 2021b). Similar debt-for-climate swaps are being explored for small islands in the Caribbean (Thomas and Theokritoff 2021) and in several African countries (Patel *et al*. 2021). If designed and structured appropriately, green debt swaps could significantly reduce the strain on the budgets of indebted countries and enhance their financial stability while also promoting EbA and other environmental actions that contribute to countries' adaptation and nature conservation goals.

Governments, MDBs and other creditors should actively explore both debt-for-nature and debt-for-climate deals for low-income countries that are in or at risk of debt distress (Steele and Patel 2020). In cases where such debt swaps are appealing to both creditors and debtor countries, it will be important to ensure that the debt swaps consider the wide range of EbA measures which could be used to enhance climate resilience, that the EbA measures are designed to address local adaptation needs, and that sufficient and sustainable funding is allocated to ecosystem management. EbA practitioners, researchers, local communities and other stakeholders could also help enhance the effectiveness of these swaps by providing knowledge of which areas and ecosystems provide the greatest adaptation and biodiversity benefits, allowing governments to target their debt relief funds towards conservation, restoration and sustainable management activities in the places of highest value. Recent announcements by the World Bank and the IMF suggest that both institutions are considering more ambitious action on green debt swaps (Shalal and Lawder 2021; Volta *et al*. 2021), potentially providing an important window of opportunity for promoting EbA through debt relief.

4.4.3. Leverage COVID-19 stimulus and recovery funds for ecosystem-based adaptation action

There is an immediate (but time-bound) opportunity to leverage COVID-19 stimulus and recovery funds for EbA action. The ongoing COVID-19 pandemic has had profound and catastrophic impacts globally, causing the illness and death of millions of people, creating mass unemployment, upending livelihoods and communities, and disrupting local and global economies (Mofijur *et al*. 2021). These impacts are likely to continue to reverberate for years to come. In response to this unprecedented health, social and economic crisis, many governments, development agencies, multilateral organizations and bilateral agencies have allocated – or are in the process of allocating – unprecedented levels of public funding towards programmes and initiatives that can stimulate economic recovery and help communities to recover from the impacts of the pandemic. While the full extent of economic stimulus and recovery packages is not yet clear, a July 2021 study found that global stimulus funds were reported to be worth at least US$ 17.2 trillion (Beyer and Vandermosten 2021).

As countries navigate their recovery from the pandemic, there is a unique opportunity to steer a significant portion of the stimulus and recovery spending towards NbS, including EbA, that will help strengthen the overall resilience of society and economies (OECD 2020; Beyer and Vandermosten 2021; IUCN 2021a). Investing stimulus and recovery funds in EbA could help countries to recover from the unprecedented socioeconomic impacts of the pandemic in two ways. First, many EbA initiatives (particularly those that involve active restoration of degraded ecosystems) can create jobs and other economic benefits for communities, thereby helping to spur economic recovery (Edwards *et al*. 2013; WWF and International Labour Organization 2020; Raes *et al*. 2021). A recent report, for example, found that every dollar spent on ecological restoration generated at least nine dollars of economic benefits (UNEP and Food and Agriculture Organization of the United Nations [FAO] 2020). Public works programmes that have a strong focus on ecosystem restoration, land and water management and soil conservation (such as the Working for Water[95] and Working for Wetlands[96] programmes in South Africa, the Mahatma Gandhi National Rural Employment Guarantee Act[97] in India, and the Productive Safety Net Programme[98] in Ethiopia) have been shown to provide important employment and training opportunities to local communities, while also stimulating local economies (Pasquini and Cowling 2015; Norton *et al*. 2020). Second, the implementation of EbA initiatives by governments as part of their economic recovery plan can help to improve the long-term resilience of communities, businesses and economies to climate change, while also providing valuable climate mitigation, biodiversity and sustainable development benefits (Saghir *et al*. 2021; Murti and Sheikholeslami 2021; Tall *et al*. 2021). Investing in the active conservation, management and restoration of ecosystems now could enhance community resilience to future climate and other shocks and significantly reduce the cost of future adaptation action (FEBA 2020; WRI 2020). At the same time, investments in NbS could help countries make progress on their biodiversity and sustainable development commitments (Murti and Sheikholeslami 2021).

In order to place EbA at the heart of COVID-19 recovery plans, governments, MDBs, development agencies and other donors could directly provide grants, loans and other types of funding for priority EbA measures, for example financing mangrove and wetland restoration to minimize coastal flooding and protect the livelihoods of fishing communities, improving watershed management to ensure continued availability of water to communities and businesses, restoring degraded agricultural land to enhance the resilience of food systems and rural livelihoods, and investing in green infrastructure in cities to reduce heat exposure and urban flooding (Cook and Taylor 2020; OECD 2020; Beyer and Vandermosten 2021). Many of these EbA initiatives are shovel-ready and the practical work can be done by vulnerable and local populations, even under social distancing regulations (OECD 2020). National governments, multilateral organizations and other public funders could also prioritize the use of stimulus funds to incentivize developers, construction companies and other infrastructure developers to integrate EbA into new and existing infrastructure investments by providing subsidies, tax relief, faster permitting processes or other incentives to those businesses that build resilience (and consider EbA options) in their development plans, or by developing regulations that mandate the integration of EbA measures (WBCD 2017; OECD 2020; Beyer and Vandermosten 2021). In addition, government bailouts or support for companies in industries that have been negatively affected by the pandemic could be made contingent on these companies assessing future climate risks and adaptation needs, and examining the role of EbA in building in climate resilience (Beyer and Vandermosten 2021). Governments could also allocate funds for long-term research in and demonstration and monitoring of EbA initiatives to strengthen the scientific evidence base for using EbA in different sectors and contexts. Finally, they could also allocate a portion of recovery funds towards updating and improving long-term development strategies so that they are more aligned with climate adaptation and other societal goals.

4.4.4. Support risk disclosure by the private sector

Another way to accelerate action on EbA is to support the disclosure of risks related to climate and nature among private sector actors, including businesses and financial institutions. As the financial impacts of climate change become more visible and more acute, there is growing momentum for companies to disclose both the actual and potential impacts of climate change on their businesses, as well as their processes and action to manage these risks (Goldstein *et al*. 2019; Hill and Martinez-Diaz 2019; Tall *et al*. 2021). At the same time,

95 For more information, please visit https://www.dffe.gov.za/projectsprogrammes/wfw.
96 For more information, please visit https://www.dffe.gov.za/projectsprogrammes/workingfowetlands.
97 For more information, please visit https://nrega.nic.in/Nregahome/MGNREGA_new/Nrega_home.aspx.
98 For more information, please visit https://europa.eu/capacity4dev/project_psnp_ethiopia.

Building resilience of communities living in degraded forests, savannahs and wetlands of Rwanda.

growing concern over the unprecedented loss and degradation of ecosystems is also leading to calls for businesses to disclose their dependencies on nature and the risk that nature loss or degradation pose to their operations (IPBES 2021; Task Force on Nature-related Financial Disclosure [TNFD] 2021). Investors, lenders, insurers and other market participants are increasingly demanding robust and comparable information on how companies will be affected by climate change and the loss of nature, and how they are preparing to deal with these risks, so that they can make informed investment decisions about which companies will be most resilient into the future (Tall *et al*. 2021).

There are two related initiatives under way to require greater transparency on the climate-related and nature-related risks to companies, both of which could spur greater action on EbA. First, the Task Force on Climate-related Financial Disclosure (TCFD),[99] created by the G20's Financial Stability Board, has developed voluntary recommendations for business to disclose their climate-related risks. The TCFD recommendations (TCFD 2017) require that organizations disclose the actual and potential impacts of climate-related risks and opportunities on their business strategy, explain how they assess and manage climate-related risks, and identify the metrics and targets they use to assess and manage these risks (Hallston 2018; TCFD 2021). Already, more than 1,500 organizations have supported the TCFD guidelines, including 1,340 companies with a market capitalization of US$ 12.5 trillion and financial institutions responsible for assets of US$ 150 trillion (TCFD 2021). In addition, more than 110 regulatory and government entities, including the governments of Belgium, Canada, Chile, France, Japan, New Zealand, Sweden and the UK, have encouraged the use of TCFD, and a number of national governments (e.g. New Zealand) have announced government plans to make these climate-related disclosures mandatory for certain publicly listed companies and large financial institutions (TCFD 2021).

The second, more nascent, initiative is to get businesses to disclose their dependencies on nature and the risks that nature loss or degradation pose to them. Launched in June 2021, the new Task Force on Nature-related Financial Disclosures (TNFD) aims to create a risk management and disclosure framework for organizations to report and act on evolving nature-related risks. Specifically, this new initiative aims to get companies to disclose their dependences on nature, their impacts on nature and how the loss or degradation of ecosystems and their services could affect their businesses, so that this information can be incorporated into strategic planning, risk management and asset allocation decisions, and ultimately shift global financial flows away from nature-negative to nature-positive outcomes (TNFD 2021). Of particular relevance to EbA, the TNFD highlights that it will employ an integrated approach to climate- and nature-related risks, in order to help scale up finance for NbS (TNFD 2021).

The large-scale adoption and use of TCFD and TNFD recommendations could potentially spur much greater use of EbA initiatives, as private sector actors become more aware of the risks they face from climate change and nature loss, and the potential of ecosystem management to address these risks. To encourage the uptake of risk disclosure, policymakers can create national regulations that mandate companies to report both their climate-related financial risks and their nature-related risks as part of their annual financial disclosure. They could go even further by requiring companies to consider whether there are EbA options that could help address their climate-related and nature-related risks, and to report on their use of and investment in EbA. Governments could also make public support (e.g. subsidies, incentives, and public funds for COVID-19 recovery) for businesses and financial institutions contingent on the assessment and disclosure of climate and nature risks (Bascuñan, Molloy and Sauer 2020b; WRI 2020). Finally, both the public sector and the research sector could also help businesses better understand the climate and nature risks they face by providing spatially explicit data on climate risks, ecosystem extent and condition, and provision of key ecosystem services (including adaptation services), and by updating risk modelling tools to enable the quantification of the risk reduction benefits for ecosystems (Beck *et al*. 2019).

99 For more information, please visit https://www.fsb-tcfd.org.

4.4.5. Create innovative insurance mechanisms to protect and restore ecosystems

Another important opportunity for accelerating the use of EbA is to encourage greater action by the insurance industry (Beck *et al*. 2019; Bascuñan, Molloy and Sauer 2020b; Máñez-Costa *et al*. 2020). Although interest in EbA is still nascent in the insurance sector, insurance providers are very aware of the growing risks that climate change poses to homes, businesses and other assets and the associated rise in the costs of providing insurance, and are interested in finding ways to reduce these risks and thereby reduce the cost of payouts for climate hazards (Beschaf 2020; Máñez-Costa *et al*. 2020). In 2017 alone, private insurers paid out more than US$ 133 billion for weather-related damages, mainly from coastal storms, and this amount is expected to grow significantly unless comprehensive adaptation measures are put in place (Beck *et al*. 2019).

The insurance sector could potentially support action on EbA in three ways (Beck *et al*. 2019). First, the insurance sector can incentivize the use of EbA among its clients by providing discounts for clients who use EbA to reduce their vulnerability, thereby reducing the cost of insurance (Beck *et al*. 2019; Máñez-Costa *et al*. 2020; Reguero *et al*. 2020). For example, the National Flood Insurance Program of the Federal Emergency Management Agency (FEMA) in the United States of America uses a voluntary community rating scheme in which communities that restore or conserve natural features that reduce flood risk such as wetlands, green spaces or living shorelines are rewarded with discounted flood insurance premiums for their residents, with reductions ranging from 5 to 45 per cent (TNC 2019). Private sector insurers could similarly incentivize greater use of EbA by offering discounts to individuals, businesses or other customers who invest in EbA activities (e.g. establishing green roofs or conserving wetlands on their property) to reduce their vulnerability to climate risks, or conversely by establishing higher premiums for clients who do not undertake adaptation actions (Beck *et al*. 2019; Kapos *et al*. 2019). Insurance providers could also refuse to provide insurance to new infrastructure development in coastal wetlands, mangroves or other ecosystems that are critical for protecting communities from intense storms and other climate hazards.

A second way in which the insurance industry can support EbA is by creating innovative insurance mechanisms that support the conservation, management and restoration of ecosystems that are important for climate adaptation. In Mexico, for example, the large reinsurance company Swiss Re (together with TNC, the hotel owners' association and the National Commission of Natural Protected Areas[100]) has recently developed a first-of-its kind insurance mechanism to insure the Mesoamerican Reef and beaches along a 160 km coastal line of the Yucatán Peninsula, and protect the region's US$ 10 billion tourism industry (Reguero *et al*. 2019; Secaira Fajardo *et al*. 2019; Swiss Re 2020). The parametric insurance is designed so that payments are automatically triggered if wind speeds exceed a certain limit (as high wind speeds are known to severely damage the coral reefs and beaches on which tourism and local livelihoods depend), and payments are then used to fund the rapid restoration of coral reef following these extreme weather events (Peterson 2018). This approach facilitates the rapid release of payouts following storm damage, enabling community members to rapidly start restoration activities and minimize coral damage. Moving from indemnity-based insurance (where the insurance is based on the assessed losses and damage) to parametric-based insurance (where payouts occur if a hazard reaches a predetermined level) can be very beneficial for insuring ecosystems, since the assessment of ecosystems following hurricanes or other extreme weather events is time-consuming and costly. If this innovative approach to insuring ecosystems can be scaled up and replicated in other ecosystems which are critical for sustaining regional economies and protecting society from climate hazards, the impact could be huge (Brahin 2021). Already, there are efforts to replicate this approach along the coasts of Florida and Hawaii (Berg *et al*. 2020).

A third and final way in which the insurance industry can strengthen the use of ecosystems for climate change resilience is to invest directly in nature-based and climate-resilient infrastructure projects (Beschaf 2020). The insurance sector is one of the largest investors

100 For more information, please visit www.cakex.org/community/directory/organizations/national-commission-natural-protected-areas-mexico-la-comisi%C3%B3n.

in the global capital market as it needs to invest its premium payments to earn revenue for later payouts (Beck 2019). In 2020, the global insurance community collected an estimated US$ 6.3 trillion in premiums.[101] If even a fraction of this capital were channelled towards the restoration, conservation and sustainable management of ecosystems for climate adaptation, this would greatly increase both the financial and physical resilience of communities globally.

EbA practitioners (whether in the government, private sector or civil society) can help the insurance sector to become more familiar with EbA and its risk reduction benefits by sharing information and evidence on its effectiveness and highlighting successful examples where insurance payouts have been reduced due to the use of EbA measures. Governments can develop policies, laws and regulations that encourage the insurance sector to look more closely at the ways in which they can support EbA, and conservation and adaptation efforts more generally. The research community could also help facilitate the incorporation of EbA into the insurance sector by developing new risk modelling tools which quantify the risk reduction benefits of ecosystems, and by systematically assessing the empirical evidence base of case studies, thereby enabling the insurance sector to consider the importance of ecosystem management in its risk analyses and investments (Beck *et al*. 2019).

4.5. Targeting ecosystem-based adaptation to the contexts where the greatest benefits will accrue

A fifth and final broad approach that holds promise for scaling up EbA is for decision makers and investors to prioritize EbA implementation in those contexts in which it will deliver the greatest and most significant adaptation benefits (i.e. where its implementation reduces the vulnerability or enhances the resilience of the greatest number of people). Decisions about whether, how, where and which EbA measures to include in adaptation initiatives for a given location are often based on an analysis of climate risks, stakeholder vulnerabilities and adaptation needs, potential adaptation measures, and numbers of potential beneficiaries (Swiderska, King-Okumu and Islam 2018; Donatti *et al*. 2021). Increasingly, there are sophisticated spatial modelling and planning tools that allow decision makers to identify which specific ecosystems hold the greatest potential to deliver climate adaptation benefits to the greatest number of vulnerable people, or alternatively, which ecosystem "hotspots" deliver the greatest combination of adaptation and other benefits, such as climate mitigation or biodiversity conservation (e.g. Rao *et al*. 2015; Bourne *et al*. 2016; Kasecker *et al*. 2018; Van Coppenolle and Temmerman 2020). The specific priority areas for EbA will differ from one country to the next, reflecting differences in the climate hazards faced, the ecosystems present and the particular socioeconomic conditions. However, we suggest that in many countries there are three contexts where EbA implementation could deliver significant adaptation benefits at scale: 1) low-lying cities that are vulnerable to heat stress and flooding, 2) coastal areas that are vulnerable to sea level rise, storm surges and erosion, and 3) agricultural landscapes that are critical for food security and water provision in a changing climate.

4.5.1. Prioritize the use of ecosystem-based adaptation in low-lying cities that are vulnerable to flooding and heat stress

As the world becomes urbanized, cities are increasingly at the forefront of climate change adaptation efforts. It is estimated that 55 per cent of the world's population

101 For more information, please visit https://www.iii.org/publications/insurance-handbook/economic-and-financial-data/world-insurance-marketplace.

already lives in urban areas and that more than two-thirds will live in cities by 2050, with 90 per cent of this urban growth occurring in low- and middle-income countries that already have large vulnerable populations (United Nations 2018; Chu *et al*. 2019). Many cities are at significant risk from climate change because they are located in the floodplains of major rivers, on drained wetlands, or along estuaries or coastlines, and are therefore vulnerable to flooding, storm surges and sea level rise (McGranahan, Balk and Anderson 2012; Hobbs and Grimm 2020). An estimated 700 million people live in urban or peri-urban areas that are less than 10 m above sea level (Center for International Earth Science Information Network 2019). Flooding already causes an estimated US$ 120 billion of damage to urban property each year and this is expected to increase significantly in coming years (Browder *et al*. 2019). Many low-lying cities are also especially vulnerable to the impacts of rising temperatures and heat waves because the of the large amounts of concrete, asphalt and metal in urban structures which readily absorb and re-radiate heat, making urban areas significantly warmer than surrounding areas and leading to adverse health outcomes (Koch *et al*. 2020). Urban residents who are poor and lack access to basic social services and resources, such as secure housing, energy, water and sanitation, education, health care and employment, are particularly vulnerable to climate change impacts (Chu *et al*. 2019). Adaptation action is urgently needed not only to enhance the climate resilience and well-being of rapidly growing urban populations, but also to protect critical assets such as infrastructure, and facilities used for manufacturing and financial services which are concentrated in cities (Chu *et al*. 2019).

EbA has the potential to significantly enhance the climate resilience of low-lying cities. There is a robust (and rapidly growing) evidence base on the successful use of EbA practices to manage heat and flooding risks in cities (e.g. Chu *et al*. 2019; Hobbs and Grimm 2020; Koch *et al*. 2020). The establishment and management of green roofs, street trees, urban parks and other green spaces can significantly lower temperatures and reduce the threat of heat stress through shading and evapotranspiration (Norton *et al*. 2015; Koch *et al*. 2020). For cities threatened by flooding, the integration of EbA practices such as street trees, green roofs and walls, urban parks, rain gardens, bioswales, urban ponds and impervious surfaces can help increase the infiltration of water into the soil and reduce run-off during heavy rain events, thereby reducing the risk of flooding while also providing important energy savings, recreational and health benefits (Hobbs and Grimm 2020; McDonald *et al*. 2020). At the larger watershed scale, the targeted conservation, restoration and management of upland forests and other native vegetation can significantly reduce the risks of urban flooding downstream and also prevent landslides from occurring during extreme weather events (Reid *et al*. 2016; GCA 2019). EbA options to prevent the flooding of coastal cities are discussed in the following section (section 4.5.2).

In order to encourage the widespread implementation of EbA in low-lying cities, a mix of policy, regulatory and financial incentives is needed. As highlighted earlier in the chapter, national and local governments can mainstream the use of EbA into national and local development policy, planning and budgeting (section 4.1.2) and procurement processes (section 4.2.2), and ensure urban planning and zoning consider the use of green and blue infrastructure (section 4.2.3). Urban building codes, zoning restrictions, and local spatial planning (including hazard mitigation planning, storm water management, land-use and infrastructure planning) can be designed to promote the conservation, restoration or sustainable management of urban ecosystems, such as parks, rivers and wetlands, to enhance resilience to climate change (Browder *et al*. 2019; section 4.2.4). Robust zoning regulations which indicate which areas within low-lying cities can be built on, how far businesses or local communities should be located from rivers or estuaries, and which areas should be conserved or restored to natural floodplains or wetlands, will be key for protecting businesses and local communities from the risk of flooding (Dougherty-Choux *et al*. 2015). If done correctly, urban planning can operationalize the implementation of EbA and also help identify potential trade-offs across adaptation and other goals (Bush and Doyon 2019). Local governments can use a diverse suite of incentives for individuals, companies and other stakeholders to support and implement urban EbA measures, including reduced taxes or tariffs, subsidies and rebates for the installation of EbA measures (Liberalasso *et al*. 2020). In Europe, for example, many cities provide incentives for developers or homeowners for the voluntary installation of green roofs, green walls and permeable payments that reduce stormwater run-off and the risk of urban flooding (Liberalesso *et al*. 2020; Stefanakis, Calheiros and Nikolaou 2021).

4.5.2. Prioritize the use of ecosystem-based adaptation in coastal areas that are vulnerable to sea level rise, storm surges and erosion

There are also significant opportunities to use EbA to significantly enhance the resilience of coastal communities that are vulnerable to sea level rise, storm surges and erosion. Coastal areas are home to more than 40 per cent of the world's population, including many of the world's most vulnerable communities (UNEP 2016). Coastal zones are vital economic hubs, housing critical infrastructure (e.g. ports, energy transportation) and generating an estimated 61 per cent of the world's GDP through tourism, shipping, commercial and subsistence fishing, shellfish harvesting and related activities (UNEP 2016; TNC 2021a). Climate change poses a significant threat to coastal towns, villages and cities, with rising sea levels, increased storm surges, accelerated land erosion and increased flooding undermining the well-being and livelihoods of coastal residents, damaging coastal infrastructure and affecting trade (USAID 2018). Currently, an estimated 40 million people and US$ 3 trillion of assets are located in flood-prone coastal cities, and these figures are expected to increase to 150 million people and US$ 35 trillion by 2070 (Temmerman *et al*. 2013). Unless adaptation measures are quickly put in place to protect coastal communities and assets, studies predict that annual coastal flooding will directly affect 5 per cent of the world's population and cost up to 20 per cent of GDP per year by 2100 (Hinkle *et al*. 2014; Fairchild *et al*. 2021). Climate change is also threatening the survival of coral reefs, mangroves and fisheries, with enormous impacts on the coastal fishing communities who depend on them for their food security and livelihoods (Fujita *et al*. 2013).

The widespread implementation of EbA can be a particularly effective means of increasing the resilience of both coastal communities and coastal ecosystems (Hale *et al*. 2009). Integrating natural ecosystems into coastal defence plans or adaptation plans (often in combination with existing gray infrastructure such as seawalls, bulkheads and dikes) is known to provide effective protection against climate hazards, is cost-effective and delivers multiple benefits beyond climate adaptation, including biodiversity conservation, fish production, recreation and other economic benefits (e.g. Temmerman *et al*. 2013; Narayan *et al*. 2016; Beck *et al*. 2019; Young, Cunniff and McDow 2021). For example, conserving and restoring coastal habitats (e.g. sand dunes, mangrove forests, saltmarshes) and offshore habitats (e.g. coral reefs, oyster reefs, kelp forests and sea grasses) can buffer against sea level rise, reduce storm surges, attenuate wave energy, reduce erosion and protect human settlements from flooding (Temmerman *et al*. 2013; Hobbie and Grimm 2020; Menéndez *et al*. 2020; Fairchild *et al*. 2021). A recent global study estimated that mangroves currently protect more than 15 million people from flooding worldwide and prevent US$ 65 billion of damage to property and infrastructure each year (Menéndez *et al*. 2020). Coral reefs are estimated to protect more than 100 million people from coastal storms and flooding (Beck *et al*. 2018). The creation of marine protected areas or locally managed marine areas can help to enhance the resilience of fish communities, coral reefs and mangroves, making them less vulnerable to the impacts of climate change and helping to protect the livelihoods and food security of fishing- and tourism-dependent communities (Roberts *et al*. 2017). EbA measures are also often more sustainable and cost-effective than conventional coastal engineering and are often less expensive to maintain over the long-term (Temmerman *et al*. 2013; Sutton-Grier *et al*. 2018). For example, coral reefs are up to two to five times more cost-effective at protecting coastal communities than conventional engineered structures (Ferrario *et al*. 2014; Narayan *et al*. 2016). Ecosystem-based approaches are also more resilient in the long term, as coastal mangroves and wetlands can, up to a point, migrate inland as sea levels rise and continue to provide protection into the future even in the face of changing conditions (Jones *et al*. 2020).

A range of actions could be used to encourage the broad-scale application of EbA in coastal areas that are vulnerable to flooding, storm surge and erosion (TNC 2021a). National-level policies can be developed or updated to encourage the use of EbA measures in coastal planning and coastal defence strategies, for example by providing clear guidance for the use of natural infrastructure for coastal protection (such as the "living shoreline" guidelines developed by FEMA; Moorman, Meyers and Carlin 2019) or mandating that public and private coastal defence projects consider EbA as the default option. Coastal development regulations can also motivate the inclusion of ecosystem restoration and conservation in longer-term planning by restricting new development in coastal ecosystems that are important for protecting communities from storms, prohibiting activities (such as sewage pollution, habitat damage and loss, overfishing and uncontrolled coastal development) that degrade existing coastal ecosystems and undermine their protective functions, or establishing marine protected areas or locally managed marine areas to protect vulnerable ecosystems (Fujita *et al*. 2013; USAID 2018; OECD 2020). The use of EbA can also be encouraged through increased investment of public and private funds to green and blue infrastructure projects in coastal areas (section 4.4.1). From 2004 to 2013, investment in coastal green infrastructure represented only 3.4 per cent of the global amount spent on coastal gray infrastructure (McCreless and Beck 2016), so there is clearly significant scope for greater investment. Novel incentives can be developed to promote greater use of EbA by homeowners, companies and land managers, for example by decreasing property taxes or reducing insurance premiums for coastal homeowners who implement EbA measures on their properties and enhance their resilience to climate change (Hill and Martinez-Díaz 2019; FEMA 2020).

4.5.3. Prioritize the use of ecosystem-based adaptation in agricultural landscapes that are critical for water and food security

There are also important opportunities to scale up the use of EbA in agricultural landscapes to improve the resilience of rural communities and economies and ensure the continued provision of food and water in a changing climate. Enhancing the resilience of the agriculture sector is a priority for many countries: of the 165 NDCs submitted to UNFCCC, 85 per cent of those that mention climate change adaptation include agriculture as a priority area (Carter, Ferdinand and Chan 2018). Agriculture is a critical sector because it covers large parts of the world, provides most of the world's food and is an important source of employment, export earnings and rural development, especially in developing countries (FAO 2017). Approximately 5 billion hectares (or 38 per cent of the global land surface) are currently used for crop cultivation or animal grazing (FAO 2020a), and an estimated 2 billion people depend on agriculture for at least part of their livelihoods, including Indigenous Peoples, local communities, women, youth and other vulnerable and marginalized populations (Searchinger *et al*. 2019). Farmers and pastoralists are often on the front line of climate change, as higher temperatures, changes in precipitation patterns and the increased frequency of extreme weather events, flooding and droughts directly threaten their agricultural and livestock production, food security, income generation, and livelihoods (Howden *et al*. 2007; Morton 2007; Harvey *et al*. 2014). Smallholder farmers are often particularly vulnerable to the impacts of climate change and have low adaptive capacity due to their dependence on rain-fed agriculture and limited access to capital, technology and technical assistance (Harvey *et al*. 2017; Holland *et al*. 2017). In addition to being exposed to climate hazards, farmers across the world are also increasingly facing problems of degraded land and declining yields: an estimated 52 per cent of the world's agricultural land is classified as moderately or severely degraded and is in need of restoration (UNCCD 2014). The rapidly growing global population and increased demand for food are also putting pressure on rural landscapes, leading to agricultural expansion, deforestation and the loss of biodiversity and critical ecosystem services (Searchinger *et al*. 2019).

EbA can play a key role in shifting agriculture onto a more resilient pathway in which food security and rural livelihoods are maintained in a changing climate, without undermining the ecosystems on which people depend (USAID 2017a). There is a wide range of EbA measures that can be successfully applied in farms and agricultural landscapes, often as part of larger landscape-level initiatives such as integrated landscape management initiatives (Louman *et al*. 2020), climate-smart landscapes (Harvey *et al*. 2014; Shames and Scherr 2019) or forest landscape restoration initiatives (Stanturf *et al*. 2015), that seek to create landscapes which aim to deliver a range of ecological, social and economic benefits, including resilience to climate change. For example, the use of diverse agroforestry systems can help protect crops and animals from heat stress and the impacts of extreme weather events, while also enhancing agricultural productivity, sequestering carbon and providing habitats for biodiversity (Schroth *et al*. 2004; Verchot *et al*. 2007; Schroth *et al*. 2009). The implementation of EbA measures such as soil and water conservation practices, intercropping and crop diversification can improve the overall health and resiliency of agricultural systems, while also helping to protect water resources (Holt-Giménez 2002; Sinclair *et al*. 2019). The conservation, management and restoration of forest and wetlands within the upper areas of agricultural landscapes can ensure continued water flow downstream, providing benefits to communities and industries downstream (Harvey *et al*. 2014; Shames and Scherr 2019). While EbA can be applied across a wide range of different agricultural systems, it is particularly well-suited for smallholder farmers who often lack the resources to invest in alternative adaptation measures such as improved seed varieties, fertilizers and pesticides, irrigation systems and insurance schemes (Vignola *et al*. 2015).

In order to scale up the use of EbA within agricultural systems and landscapes globally, a diverse set of actions is needed. One key aspect is to build capacity of farmers, agronomists, extension agents and farmer-led organizations so that they can design and apply EbA measures that address the specific vulnerabilities and adaptation needs of local stakeholders and build on local, traditional and scientific knowledge (Harvey *et al*. 2018). Building local capacity can be achieved by integrating the EbA approach in both formal and informal curricula (including universities, technical training and farmer field schools), strengthening agricultural network extensions and farmer-based organizations, and organizing farmer-to-farmer exchanges (Braun, Thiele and Fernández 2000; Harvey *et al*. 2018). In many developing countries, there is also an urgent need to increase funding to extension and outreach services for agriculture and natural resource management, as many of the government agencies tasked with providing this technical expertise are chronically underfunded.

In addition to building capacity on EbA, the government and private sector can help farmers access the financial resources needed to invest in EbA measures, for example by facilitating access to credit or loans or providing financial incentives for good stewardship of their land (Harvey *et al*. 2018). In some cases, payment for ecosystem services schemes could be used to promote the adoption of EbA practices, especially in agricultural landscapes that are part of watersheds that are critical for providing water to major urban areas downstream (Pagiola *et al*. 2007; GCA 2019). In Costa Rica for example, the national Payment for Ecosystem Services Programme[102] pays farmers and landowners to conserve forests, reforest degraded areas, establish agroforestry systems and sustainably manage forests in order to ensure the continued provision of key ecosystem services (water regulation, biodiversity protection, carbon sequestration and landscape beauty; Sánchez-Azofeifa *et al*. 2007). The broad application of sustainability standards for agricultural production (including both third party certifications such as Fairtrade, organic and Rainforest Alliance, and private industry standards such as the Coffee and Farmer Equity [CAFE] practices of Starbucks) could also potentially help promote the use of EbA, as these standards typically require that farmers avoid clearing or degrading forests and other critical ecosystems, minimize land and soil degradation and apply sustainable agricultural practices, many of which also confer resilience to climate change (Milder *et al*. 2014; Lenoud *et al*. 2018). Finally, there is an urgent need for governments to remove perverse agricultural subsidies that lead to deforestation, degradation and unsustainable agricultural practices and redirect them towards EbA and other sustainable practices (Ding *et al*. 2021). It is estimated that up to US$ 100 billion is spent each year on subsidizing agricultural practices that lead to deforestation, land and water degradation, biodiversity loss, and the disruption of critical ecosystem services such as water regulation and flood protection (Karouskis *et al*. 2017; Rodríguez Echandi 2021). If this money were redirected towards the implementation of EbA and other sustainable agriculture practices, this would enable farmers to continue to produce food for the world's rapidly growing population and ensure the provision of water in a changing climate, without undermining the ecosystems and natural resources on which society depends (Ding *et al*. 2021).

102 For more information, please visit https://onfcr.org/psa-2.

4.6. Conclusions

EbA has the potential to play a key role in helping society adapt to climate change and putting the world on a more climate-resilient and nature-positive pathway. While EbA may not be applicable in every instance, it has the potential to meet many of society's diverse adaptation needs and priorities, while also conserving and restoring the ecosystems on which our world depends. It can also help the world meet multiple global objectives including not only climate change adaptation, but also climate change mitigation, biodiversity conservation and sustainable development more broadly.

However, in order to harness the full potential of EbA, it will be important to significantly increase the pace and scale of EbA implementation across the world. There is a need for much greater implementation of EbA, backed by supportive policies and regulations and significant financial resources. There are significant opportunities both to ramp up the number of EbA initiatives globally and to implement larger, longer-term and more impactful initiatives in support of climate adaptation goals.

The recommendations we have laid out here are intended to push EbA to the next level, and to harness the power of nature to help people adapt to climate change at a pace and scale that is commensurate with the magnitude of the climate challenge. We recognize that these recommendations are ambitious and that their implementation will require tremendous effort, political will, and significant financial and human resources. Scaling up will take time and success is not guaranteed. However, inaction is not an option – the world cannot afford to wait. Without rapid and significant adaptation action, climate change will have increasingly devastating impacts on human communities, natural ecosystems and economies worldwide. Ambitious and rapid action on EbA is needed on all fronts and by all stakeholders if we are to accelerate the transition towards a climate-resilient and nature-positive pathway that is better for both people and nature.

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