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Nature-based Solutions to Emerging Water Management Challenges in the Asia-Pacific Region

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ABBREVIATIONS

ADB	Asian Development Bank
AWP	The Australian Water Partnership
CDD	Consortium for DEWATS Dissemination Society India
CTCN	Climate Technology Centre and Network
DEWATS	Decentralised Wastewater Treatment System
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
GIS	Geographic Information System
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (German development agency)
GWh	Gigawatt hours
ICRAF	World Agroforestry Centre
IFAD	International Fund for Agricultural Development
IIED	International Institute for Environment and Development
IKI	The International Climate Initiative
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
IWA	International Water Association
MFF	Mangroves for Future
NAP	National Adaptation Plan
NbS	Nature-based solutions
NDCs	Nationally Determined Contributions
PPP	Public-private Partnership
SDGs	Sustainable Development Goals
SIDS	Small Island Developing States
TNC	The Nature Conservancy
UN	United Nations
UNEP	United Nations Environment Programme
UNEP-DHI	United Nations Environment Programme - DHI Centre on Water and Environment
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organization
UNPFA	United Nations Population Fund

Foreword

On behalf of the UN Climate Technology Centre & Network (CTCN), I am proud to present this regional knowledge brief, the product of a fruitful collaboration with its Consortium Partner, the UNEP-DHI Centre, and several other partners, highlighting trends and best practice examples of nature-based solutions (NbS) for water management in the Asia-Pacific region. This publication aims to showcase relevant success stories and solutions, building on previous publications by UNEP-DHI, CTCN, UNEP and the CTCN's Network Member, IUCN, that address integrated water resources management and NbS.

The Asia-Pacific Region has experienced a flurry of economic growth and expansion in recent decades, alongside the myriad of challenges that accompany this type of development. The global COVID-19 pandemic has exacerbated adversity across the board, causing cross-sectoral economic devastation in several Asia-Pacific countries. Following the pandemic, many actors in the region have recognized that there is an opportunity to rebuild in a greener and more sustainable manner, following the trajectory of a 'green recovery.' Indeed, the CTCN has seen an increase globally in the number of technical assistance requests from countries with such a focus.

The pandemic has highlighted the importance of investing in technology solutions that are cross-cutting and capable of achieving benefits across several sectors. NbS can be considered technologies: the Intergovernmental Panel on Climate Change definition of climate technologies incorporates practical knowledge, skills, or techniques that can be used to address climate change. Recently, NbS have been increasingly touted as 'win-win' solutions that can promote both human well-being and ecosystem protection. Water management is an issue that has rapidly increased in importance, rising to become part of the dominant discourse encompassing climate change and developmental challenges, and requiring technical solutions that address complex issues in rural, urban and coastal environments. This knowledge brief showcases NbS from an immensely diverse region that address critical water management issues while simultaneously meeting climate change objectives and delivering a wide range of environmental and social benefits.

NbS often cross physical and administrative boundaries, stretching across watersheds and even across water sector operators and functions. We must recognize the importance of mainstreaming these technologies into national policies and strategies to both raise awareness and help generate the funding that is crucial to the implementation and scale-up of NbS initiatives. Examples of mainstreaming are featured in this brief, providing a useful snapshot of success in mainstreaming NbS into national-level action.

It is important to emphasize the wisdom in considering solutions that already exist in nature, which are on offer if we can prudently and deftly harness their potential. In many cases, NbS are the most cost-effective solutions, but need more upfront investment. Further investment is only possible when investors and stakeholders are informed about the diverse array of NbS benefits through publications such as this one, which describe specific ways in which NbS can help to address problems ranging from urban and peri-urban expansion and infrastructure necessary for clean water delivery and sanitation to the mitigation of urban flooding and storm surges.

This brief illustrates the potential of NbS to meet the diversity of critical needs that have been exacerbated by climate and COVID. It provides an illuminating and inspiring overview of the use of NbS technologies from which we can borrow as we move forward in adopting and implementing holistic solutions that exploit synergies wherever possible to tackle climate change and water management challenges in rural, urban and coastal areas.

Rose Mwebaza, Director of the CTCN

Executive Summary

Economic growth in the Asia-Pacific region over recent decades has contributed to lifting millions of people out of poverty and has spurred growth in many important industries. Progress on improved water management has followed suit: more people than ever now have access to clean water and sanitation. Yet despite these improvements, the region is increasingly vulnerable to climate changes that impact both water quantity and quality, which are exacerbated by population growth, urbanisation, and rising water demand. Adding to concerns is the alarming degradation of critical natural assets, such as the wetlands, forests, rivers, and lakes upon which so many depend.

Climate technologies are considered by the Intergovernmental Panel on Climate Change (IPCC) to be any piece of equipment, technique, practical knowledge or skills for performing a particular activity that can be used to address climate change. Nature-based solutions (NbS) are part of the wide range of climate technologies and are increasingly being adopted to address climate change challenges. In February 2022, the United Nations Environment Assembly (UNEA-5) declared a resolution formally adopting the definition of NbS as 'actions to protect, conserve, restore, sustainably use and manage natural or modified terrestrial, freshwater, coastal and marine ecosystems, which address social, economic and environmental challenges effectively and adaptively, while simultaneously providing human well-being, ecosystem services and resilience and biodiversity benefits' (UNEP 2022). At their core, they are about recognizing and harnessing the power of nature to provide valuable ecosystem services to humans and nature alike. These include the provision of clean water and air, raw materials and safe habitats for birds and animals; reduction of greenhouse gas (GHG) emissions; and the bolstering of adaptation to the impacts of climate change through the mitigation of disaster risks. NbS are sometimes described as win-win solutions, as they not only address societal challenges, but also promote human well-being and ecosystem protection – often at a lower cost than their built alternatives.

This knowledge brief seeks to highlight the potential of NbS in the Asia-Pacific region as a response to emerging climate-related water management challenges by presenting a collection of case studies and lessons learned.

At the time of writing, the world is still contending with the impacts of the unprecedented COVID-19 pandemic, requiring an urgent response to the biggest public health crisis of the last century. In addition to the serious public health toll, the pandemic has also caused economic contraction to many economies in the region. As part of recovery efforts, there is a need and indeed an opportunity to invest in solutions that can yield benefits across sectors. NbS offer such an opportunity through infrastructure solutions that address important water management and climate change challenges, while delivering a wide array of environmental and socioeconomic benefits.

This collection of carefully chosen case studies and lessons learned demonstrates the variety of types and scales of NbS that have been applied in the region as a response to climate change and exhibits the significant potential for further utilization and upscaling of NbS in cost-effective and sustainable ways. From urban greening projects and coastal protection initiatives to local wastewater treatment and community eco-engineering projects, all confirm the versatility of NbS options for a region as diverse as the Asia-Pacific. Findings also confirm that the nature of NbS allows for flexible and innovative implementation that can draw on international, national, or local-level mechanisms for implementation and financing.

The inherent diversity and flexibility of NbS, along with its broad contribution to sustainable development objectives, makes it a crucial mechanism for building the region's climate change resilience within the water resources domain while making an important contribution towards the achievement of numerous Sustainable Development Goals (SDGs).

Cheonggyecheon stream,
City of Cheonggyecheon , South Korea

1. Introduction

In 2015, the world set an ambitious course towards a more sustainable future through the adoption of the United Nations 2030 Agenda and its 17 Sustainable Development Goals (SDGs). The 2030 Agenda contains a dedicated goal on water – SDG 6 – but it is widely recognized that the goals and targets of the 2030 Agenda are closely interlinked and call for efforts and investment across sectors to meaningfully address the complex challenges we face today. The challenges are numerous and pressing – ranging from the mounting impacts of the changing climate to population growth, urbanization and deterioration of our ecosystems which are the bloodline of food security, health and, ultimately, peace and human wellbeing.

Indeed, climate change is largely revealed through changes in the water cycle, and during the last 25 years water-related events such as floods and droughts have caused 90 per cent of major weather-related disasters (United Nations Global Climate Action and Marrakech Partnership 2020). Climate change poses serious threats to the management of water resources, as it is predicted to increase drought and flooding frequency, alter rainfall patterns both temporally and spatially, and affect snow cover in mountainous areas reliant upon the snowpack. The United Nations Framework Convention on Climate Change (UNFCCC) Paris Agreement commits countries to limit warming to 1.5 degrees, and indeed projections suggest that a failure to meet this target could have dire consequences on water quality and availability.

As our understanding of these potential climate impacts and the importance of ecosystem services and their vital role for safe and prosperous communities increases (IPCC 2022), so does the focus on nature-based solutions (NbS) as one of the tools to address the challenges of climate change and sustainable development. In February 2022, the United Nations Environment Assembly (UNEA-5) declared a resolution formally adopting the definition of NbS as 'actions to protect, conserve, restore, sustainably use and manage natural or modified terrestrial, freshwater, coastal and marine ecosystems, which address social, economic and environmental challenges effectively and adaptively, while simultaneously providing human well-being, ecosystem services and resilience and biodiversity benefits' (UNEP 2022). Thus, at its core, the concept of NbS focuses on targeted protection, restoration and use of natural ecosystems for human and environmental benefits. NbS in the context of water resources management involve planned and deliberate use of ecosystem services to improve water quantity and quality and to increase resilience to climate change.

The concept is not new by any means but has gained traction over the past decades as communities, governments, and organizations at various levels have become more aware of the unbreakable link between human wellbeing and healthy ecosystems. It has also become more apparent that conventional infrastructure alone cannot solve the multitude of challenges, which demand more thoughtful integration of natural ecosystems in our infrastructure networks.

A note on NbS and technology. NbS include activities, practices or measures encompassing a diverse array of ecosystem-related approaches. Thus, NbS is used broadly as a term including practices that maximize synergies, often between climate mitigation and adaptation, or that capture other ecosystem benefits, and which address a broad range of interlinked societal challenges.

As defined by the IPCC, climate technologies can be any piece of equipment, technique, practical knowledge or skills for performing a particular activity that can be used to address climate change. Thus, NbS are considered 'technologies,' as they support us in solving problems at the nexus of nature, climate change, and natural disasters, while providing a multitude of tangential benefits. NbS often tap into techniques, methods or services that are enabled by, or even provided by nature and the

Mangrove edge on Koh Rong Island, Sihanoukville, Cambodia

inherent functions of particular ecosystems. They may capitalize on the use of an indigenous practice, or a function (i.e. carbon sequestration) of a living organism (e.g. trees, soils). They often represent opportunities for innovation, even though they may be based on techniques that are perceived as traditional, perhaps having existed for many years.

On the other hand, new technologies are also spurring development of NbS. A case in point, digital and data solutions are advancing rapidly, gaining momentum, and are considered to be game changers in several sectors, including NbS. For example, technologies that protect and maintain biodiversity are increasingly important, given the fact that biodiversity is fundamental for human survival and a functional society, and that healthy ecosystems contribute to the provision of clean air and water while also combating climate change and capturing benefits for people and industry. In this context, digitalization contributes to the improvement of biodiversity with enhanced data management and constantly evolving digital solutions that support biodiversity monitoring, raise awareness, and facilitate the implementation and enforcement of measures and regulations.

With regard to water, satellite data can detect changes in vegetation and water quality. New datasets are being developed to map the distribution of global water surfaces and provide new information, thereby supporting water resource management and biodiversity conservation while informing governments and citizens about water issues using a public interface. Sensor and cloud-based systems can enhance farmer productivity by providing information on environmental conditions, which enables better water management while improving yields (IUCN 2016a).

NbS are proven and cost-effective technologies that achieve a holistic and cross-cutting host of benefits. We trust that readers of this publication will remain flexible in their understanding of what comprises technological innovation involving nature-based methods. After all, nature has provided us with the tools to innovate, thus laying the foundation for solutions to our most pressing problems.

Swamp area in outskirts of Shanghai, China

Of the multitude of ecosystem services, the availability of and access to clean and sufficient water is one of the pillars of sustainable growth and, indeed, the continued existence of our societies. The Asia-Pacific region is home to 60 per cent of the world's population, or approximately 4.3 billion people (United Nations Population Fund [UNPFA] 2021). The region has experienced remarkable growth in recent decades. Food production, growing populations, energy production and manufacturing of goods and services all remain fundamental to development in the region and rely heavily on the availability of needed water resources. As the thirst for water has grown, Asia-Pacific has also been the region most battered by climate-related disasters, which are often water-related, such as floods and droughts. NbS are especially important to countries in the region, as they provide approaches to improve water quantity and quality, and to increase resilience to climate change (UN Environment-DHI, UN Environment [UNEP] and IUCN 2018) while delivering a range of significant benefits to growing communities.

This knowledge brief seeks to highlight the potential of NbS in the Asia-Pacific as a response to emerging climate-related water management challenges. Its overarching aim is to raise awareness on the importance of NbS for implementing integrated climate, water, and sustainable development interventions, and for supporting wider sustainable development objectives. In particular, it targets policy and decision makers in the Asia-Pacific region with the objective of supporting enhancement and implementation of Nationally Determined Contributions (NDCs), formulating and strengthening policies and regulations on ecosystem protection and sustainable utilization, and supporting NbS mainstreaming into policies and regulations relating to water resources management and climate change adaptation. Integration of NbS into National Adaptation Plans (NAPs) will be an increasingly important part of the mainstreaming process. Ecosystem-based adaptation, a complementary strategy for adapting to climate change that harnesses NbS and ecosystem services (UNEP 2022a), is being integrated into NAPs and can serve as an example.[1]

This knowledge brief is a result of a collaborative effort between the Climate Technology Centre and Network (CTCN) and UNEP-DHI Centre on Water and Environment. Its preparation was supported by NbS experts from experienced international and regional partner organizations with a strong track record of working with NbS in the region, represented in the NbS expert panel. Drawing on their experiences from the region, the expert panel provided important inputs and reflections.

Ultimately, this knowledge brief seeks to share the experiences and lessons learned from the important work that has been done toward implementing NbS in the region to date, to strengthen the case for NbS and help identify avenues for upscaling implementation as part of the sustainable development agenda.

About the CTCN

The CTCN is the operational arm of the UNFCCC Technology Mechanism, hosted by the UN Environment Programme (UNEP) in partnership with the UN Industrial Development Organization (UNIDO). The CTCN has been promoting accelerated transfer of environmentally sound technologies for low carbon and climate resilient development at the request of developing countries since 2013. The CTCN delivers technology solutions, capacity building and advice on policy, legal and regulatory frameworks tailored to the needs of individual countries by harnessing the expertise of a global network of technology companies and institutions.

More on CTCN's work in the Asia-Pacific region can be found at: https://www.ctc-n.org/

1 In 2021, UNEP developed guidelines on integration of EbA into NAPs as a supplement to the UNFCCC NAP Technical Guidelines.

2. Asia-Pacific: existing and emerging challenges

The Asia-Pacific region is diverse not only culturally, but also demographically and ecologically. It is home to the most populated countries in the world – including India and China, but also some of the world's smallest nations, such as the Small Island Developing States (SIDS) in the Pacific. The specific water challenges facing these communities are subsequently just as diverse, calling for an innovative mix of solutions.

Access to water and sanitation remains an important work in progress in many countries across the region, especially in rural areas. In South and South-East Asia, rapid urbanization and city growth has put a strain on existing water infrastructure, requiring more investment in new infrastructure for a clean water supply, sanitation and stormwater management. In Central Asia, water stress is projected to increase as the resource is scarce and naturally available surface water and groundwater resources are limited.

The agriculture sector remains the main water user in the region, but for several countries the limited availability of domestic energy supply has exerted considerable pressure on the need to further expand the hydroelectric power production capacity (Russell 2018). In the Pacific Islands, the limited availability of freshwater combined with high exposure to climate variability, sea level rise and impacts of storm surges pose major challenges in supplying water and protecting vulnerable populations. It is estimated that 71 per cent of the SIDS face a risk of water shortage (United Nations Educational, Scientific and Cultural Organization [UNESCO] 2019), especially in the low-lying states. The Pacific Island states are also among the most vulnerable to climate-related disasters such as tropical cyclones, floods and droughts, all of which have caused extensive damage in the past - a trend set to continue.

Water-related disasters are a concern and a sober reality in much of the region, with riverine, coastal and urban flooding causing significant damage to people's livelihoods and economic assets regularly. At the same time, water stress is expected to increase in many parts of the region – a threat to both economic development and livelihood security.

The inherent diversity of NbS mirrors the variety of ecosystems and ecosystem services these solutions rely upon, and therefore offers valuable opportunities to build the region's resilience to the changing climate. NbS have proven their potential in, among other areas, improving water quality, mitigating floods and droughts, and strengthening coastal protection. Importantly, applications of NbS have been shown to provide a wide range of additional benefits that strengthen the case for NbS as a critical part of our future water management infrastructure within the broader sustainable development and climate change adaptation frameworks.

The following sections summarize key pressures on the region's water resources. Understanding the broader context within which NbS could potentially be applied is crucial to fully realize the importance of the co-benefits that NbS deliver, and how NbS can contribute towards the broader socioeconomic and environmental objectives of the region.

Forested River Catchment in the Danum Valley Conservation Area, Sabah, Malaysia

Population growth and urbanization

The population of the region is expected to grow from 4.3 billion to 5.3 billion within the next decade, and to a further 5.7 billion by 2050 (United Nations Department of Economic and Social Affairs [UN DESA] 2019). While the growth rate is projected to slow down in most of the region before the end of the century, 25 per cent of global population growth between 2019 and 2050 is expected to be concentrated in Central and Southern Asia (UN DESA 2019).

Urbanization has continued in the region. The year 2019 marked the first year during which a majority of people in the region - more than 2.3 billion - lived in urban areas (United Nations Economic and Social Commission for Asia and the Pacific [UN ESCAP] and UN-HABITAT 2019). There were only 5 megacities[2] in the region in 1990, while the number grew to 20 in 2020, and is expected to reach as high as 33 by the year 2035 (UN DESA 2018). The associated expansion of urban and peri-urban areas exerts pressure on water resources and infrastructure necessary for sanitation, clean water delivery and storm-water management.

Cities will continue to play a vital role in shaping the region's future as centres for innovation and economic growth, and by providing opportunities for improved quality of life to people across all socioeconomic groups. Providing access to basic services such as water, sanitation and electricity is only part of the task at hand. As urban centres expand, local governments need to address issues related to housing, infrastructure, access to education and health services, and fundamental dimensions of quality of life such as environmental health through tackling air pollution, urban heat island effects and lack of access to green spaces. Climate change impacts further exacerbate the complexity of challenges, imposing serious threats to people and urban economic assets.

Mitigating urban flooding impacts through improved infiltration and natural floodwater storage, reducing urban heat island effects and rejuvenating urban waterways are just some of the ways in which NbS can contribute to sustainable and inclusive urban development. The co-benefits of improved air quality, recreational opportunities and maintenance of urban biodiversity are equally important contributions. The case studies in Chapter 4 demonstrate how NbS have already proven their potential in transforming the cities of the region.

2 Cities with more than 10 million people.

Gaomei Wetlands is to the south of the mouth of Dajia River, Taichung, Taiwan

Rapid economic growth

The economies of the Asia-Pacific region accounted for over two-thirds of global economic growth in the year 2019 alone, and the rapid economic growth of the region has contributed to bringing 1.1. billion people out of extreme poverty since 1990. This does, however, mean that the thirst for water is growing for domestic use, as well as for vital water-dependent resources, including industry, food and energy.

Energy demand in the region is also projected to increase considerably over the next decade. Due to increasing ambition for a transition to a greener energy mix, more attention will inevitably be directed towards renewable energy sources, including hydropower. In fact, hydropower has been the dominant driver of renewable energy growth in the region, and the amount of electricity generated from hydropower sources in the region grew from 417 GWh in 1990 to nearly 1800 GWh in 2018 (International Energy Agency [IEA] 2020) – more than fourfold. Countries such as China, Laos, and Indonesia in East and South-East Asia, and Bhutan and Tajikistan in South and Central Asia, have been leading the expansion of hydropower generation capacity in recent years (International Hydropower Association [IHA] 2020). It is estimated that future expansion potential is restricted due to land area limitations and topographical requirements (Asia Pacific Energy Research Centre (APERC) 2019), meaning that the competition over water resources between the energy sector and other users within basins is likely to intensify.

At the time of writing, economic growth has been stunted by the global COVID-19 pandemic, but the past decades have been a clear indication of the region's potential for rapid growth. The Asian Development Bank (ADB) estimates that 27 out of 49 ADB members face serious water constraints due to economic development (Asian Development Bank [ADB] 2020). The recovery from this unprecedented global crisis therefore calls not only for a renewed pace of economic growth, but also for growth that can further the region's development agenda without compromising environmental health. NbS will have a particularly important role to play in these efforts to 'build back better,' as these solutions protect and maintain vital ecosystem services on which economic activity relies, and provide protection from natural disasters.

Climate change impacts and disaster risk

When it comes to livelihoods and food security, it is impossible to separate the challenges of water management from those of a changing climate. More than 30 per cent of the population in the region rely on agricultural activities for their employment, with the percentage highest in South Asia (41 per cent). Agriculture is a vital source of income for the poor, making them particularly vulnerable to the impacts of climate change. The average temperatures in the region have been higher and rainfall patterns less predictable (Thomas et al. 2013). Many of the crop varieties grown are water-intensive and therefore stand to be highly impacted by changing rainfall patterns and water allocations for irrigation.

The Asia-Pacific is also considered to be the most vulnerable region to water-related disasters (UN ESCAP 2019). The size of the region and the breadth of its ecosystems render it vulnerable to floods, storms, tsunamis, droughts and landslides, amongst others. It is estimated that nearly half of the 30 countries that are most vulnerable to climate change globally are in the Asia-Pacific.

About 50 per cent of Asia's population (2.4 billion people) already reside in low-lying coastal areas (UNESCO, World Water Assessment Programme (United Nations) and UN-Water 2020). Population growth, combined with urbanization and the rising sea level, will intensify the flood-related vulnerabilities of coastal areas, resulting in required investment in coastal protection measures and infrastructure across the region.

In the last two decades, nearly 5 billion people have been affected by water-related disasters, with approximately 500,000 lives lost (Centre for Research on the Epidemiology of Disasters [CRED] 2021). Pacific islands have been especially impacted by the rising sea levels and continued damage to coastal areas from cyclones. Between 2018 and 2019, cyclone Fani affected 20 million people in India, while cyclones Kammuri and Phanfone impacted 5.1 million people in the Philippines in a single month. Meanwhile in Afghanistan, the drought lasting from April 2018 to July 2019 affected more than 10 million people (International Federation of Red Cross and Red Crescent Societies [IFRC] 2020).

The projected climate impacts in the region on future water availability differ depending on location. Climate change impacts on water security span a wide range from a general decreased availability and seasonal fluctuations to glacial melt to increased frequency and intensity of droughts. It is also possible that some rainstorms will be heavier, prompting increased surface runoff, which can cause water pollution as rainwater picks up waste, fertilizers, and other toxic chemicals and deposits them in rivers and lakes, possibly contaminating drinking water.

The Asian Water Development Outlook (Asian Development Bank 2020) cites the following as the main risks in the region:

- increased water stress in Central and West Asia and East Asia;
- severe water scarcity in Central and West Asia, East Asia, India, and Bangladesh;
- continued poverty in areas of Central and West Asia and the Pacific;
- lack of financial and human resources in all regions.

NbS offer a variety of opportunities to build climate resilience, including urban flood mitigation, attenuation of coastal storm effects and the bridging of water availability between the wet and dry seasons. Regional case studies in Chapter 4 help demonstrate how investment in NbS as climate change adaptation and disaster risk management measures also bring about valuable co-benefits to livelihoods and ecosystem health.

Increasing water scarcity and water stress

Significant progress has been made to increase the region's water security.[3] The fatality rate of water-related disasters was also reduced by 67 per cent over the last decade (ADB 2020). The proportion of the population using basic sanitary facilities has meanwhile expanded rapidly, especially in rural areas. For example, in the rural areas of Cambodia, India and Nepal, the proportion of the population with access to basic sanitation increased by more than 20 per cent between 2010 and 2017. In Cambodia, Lao PDR, Mongolia and Myanmar, access of rural populations to basic drinking water increased by more than 10 per cent (Organisation for Economic Cooperation and Development [OECD] and World Health Organisation [WHO] 2020).

The combination of growing populations, socioeconomic development requirements and climate change will further increase pressures on water supply. It is estimated that by 2050, 40 per cent of world's population will live under severe water stress, including almost the entire population of South Asia and significant parts of China (UNESCO, World Water Assessment Programme (United Nations) and UN-Water 2020). The growing gap between supply and demand is expected to manifest itself gravely even within the coming decade and is expected to be as high as 50 per cent in India and 25 per cent in China by the year 2030 (Asia-Pacific Water Ministers' Forum [APWMF] 2010).

Recent estimates also indicate depletion of groundwater resources from which countries draw for irrigation and drinking water to offset lacking surface water sources. The global groundwater depletion rate doubled between 1960 and 2000, and research shows that many large and vital aquifer systems are already highly depleted (including in India and Pakistan) (European Goesciences Union 2016).

The SIDS are especially vulnerable to water stress due to the limited availability of freshwater resources and their high exposure to sea level rise and storm hazards. It is estimated that most SIDS will experience dwindling freshwater supply due to reduced rainfall, salt-water intrusion from rising seas and increased demand from growing populations and tourism (UNESCO, World Water Assessment Programme (United Nations) and UN-Water 2020).

The already limited freshwater resources are further strained by pollution, over abstraction and salinity. Based on a global assessment, ADB reported that pollution increased in 50 per cent of the major rivers in Asia between 1990 and 2010, salinity increased by more than one-third, and 80 per cent of wastewater still lacks adequate treatment (ADB 2020). This presents challenges not only to the availability of water for human consumption, but also for ecosystem health.

Recognizing this growing gap between supply and demand, more attention is needed to further implement water management interventions that focus on the health of our existing water resources, bridge the availability gap between dry and wet seasons, and prevent further degradation of our limited sources. NbS can play a particularly important role in source water protection and rejuvenation of urban waterways (both groundwater and surface water sources), as will be exemplified by the case studies in this brief.

3 ADB defines water security as "the availability of adequate water to ensure safe and affordable water supply, inclusive sanitation for all, improved livelihoods, and healthy ecosystems, with reduced water-related risks toward supporting sustainable and resilient rural–urban economies in the Asia and Pacific region" (ADB 2020, p.7).

Ecosystem degradation

The Asia-Pacific region is exceptionally rich in biodiversity and ecosystems of intrinsic value for economic development, livelihoods, and spiritual and cultural activity. The region covers a vast array of ecosystems – forests and woodlands, grasslands and savannahs, alpine ecosystems, deserts and semi-deserts, freshwater wetlands, and unique coastal and marine ecosystems in the island states. The islands in the region, including New Zealand, Australia, and the smaller archipelago island states, represent unique ecosystems and are home to many endemic species. In addition, the region harbours 17 of the 36 global biodiversity hotspots (UNEP 2018).

However, ecosystem health has been decreasing overall, with species populations in a steady decline since the 1970s. For some species the average decline has been as high as 45 per cent (World Wildlife Fund [WWF] 2020). Forests, alpine ecosystems, inland freshwater ecosystems, wetlands and coastal ecosystems are the most threatened.

Many of the world's most significant river basins, including the Yangtze, Ganges and Brahmaputra, Indus, and Mekong can be found in the region. These river basins are substantial contributors to the region's economy through fisheries, transport of goods, hydropower generation and water supply for farming at large and small scales. The coastal areas of the region, including the island states, also serve as hubs of significant economic activity. About 90 per cent of global aquaculture production takes place in the region, while freshwater ecosystems support more than 28 per cent of aquatic and semi-aquatic species globally. Yet 37 per cent of these species are threatened, affecting not only the region but also the global supply (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services [IPBES] 2018). In addition, nine out of the 10 worst polluted large rivers in the world are in the Asia-Pacific region (World Business Council for Sustainable Development [WBCSD] 2020).

The key drivers of environmental degradation include agricultural land expansion, natural hazards, climate change, pollution, over-exploitation of natural resources, and invasive alien species. Many of these stem from economic activities that have driven the region's economic growth. Access to vital water services, a healthy resource base for economic activities, human health and well-being, and climate change resilience go hand in hand and require integrated approaches to achieve the goals of truly sustainable development.

The key pressures on water resources in the region summarized in this chapter are closely interlinked with the call for coordinated and integrated approaches to achieve future sustainable growth. NbS have considerable potential, not only to address the immediate water management and climate change adaptation aspects of regional challenges, but also to contribute to the wider objectives of the region's sustainable development agenda.

3. Why focus on NbS?

NbS: ecosystem-based approach with cross-cutting societal benefits

Healthy ecosystems have supported prosperous communities for millennia, and ecosystem services, including those derived from water, are fundamental to societies. Therefore, the rapid loss of these vital ecosystems requires renewed attention to the critical role of nature as the most essential of all 'infrastructure.'

Countries in the region have all committed to the SDGs through adoption of the 2030 Agenda - an ambitious vision for greener, more inclusive and integrated sustainable development. This vision cannot be achieved without addressing the loss of our ecosystems, which underpin the very existence of our communities. Investing in sustainable development therefore requires investing in nature. Strategically planned and executed NbS can deliver benefits well beyond conservation and protection: natural and nature-based infrastructure, for example, can replace or complement conventional "grey" infrastructure in delivering a wide range of services.

Within the water and climate change context, NbS offer one of the most effective and cost-efficient ways to address the complex challenges of clean water provision, climate change adaptation and livelihood resilience in an integrated way.

Within the domain of water management, NbS support a multitude of water management functions (UNEP-DHI, UNEP and IUCN 2018):

- Vegetation and forests reduce soil erosion and help slow runoff in heavy rains, reducing flood risks;
- Surface water bodies and groundwater reservoirs provide clean water for drinking and productive use;
- Green urban spaces facilitate infiltration of rainwater, helping to filter pollutants and recharge groundwater;
- Forests help regulate temperature, water flows in events of floods and droughts, and sediment flows - this has immediate impacts on downstream activities such as clean water supply for urban centers and hydropower facilities;
- Wetlands are highly diverse habitats, and depending on their location and type, can facilitate uptake of excess water during heavy rains and floods, provide storage of water for use in droughts, and attenuate wave impacts in coastal areas. The rich plant cover and soils of wetlands have also proven to be of significant value for water purification, and for removing excess nutrients and suspended solids; and
- Mangroves, coral and oyster reefs, and other coastal habitats mitigate impacts of coastal storms and reduce risks of saltwater infiltration in coastal aquifers.

These examples cover only a fraction of the ways that NbS support water management and adaptation objectives. The scope for NbS applications is further broadened when considering applications that do not build on existing ecosystems, but rather mimic ecosystem services, as included in the EU Commission's definition of NbS: "Solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience" (European Commission 2021). Examples of such 'hybrid' solutions include green roofs, permeable pavements and bioswales – solutions that are human-made but intend to support or replicate natural ecosystem functions for water infiltration.

Importantly, most NbS provide at least one significant benefit for water management, and usually produce a host of co-benefits for people and nature:

- Urban green spaces and forests provide flood mitigation, but also cool down cities, create more space for biodiversity, improve air quality and provide recreational spaces for communities, significantly improving the urban quality of life;
- Rejuvenation of water sources provides cleaner water for communities and is often accompanied by much broader benefits through new recreational areas and economic opportunities for vendors and tourism, cleaner air and spaces for urban biodiversity;

– Upstream ecosystem protection and restoration provides cleaner water for downstream users, but also can be a new source of income for upstream ecosystem users, e.g. farmers, by providing an incentive to transform existing farming practices into more sustainable activities; and
– Mangroves mitigate impacts of coastal surges, but are also vital breeding ground for many fish, crustaceans and molluscs. They are a source of wood and livelihoods for surrounding communities and are fundamental to coastal economies relying on fisheries and tourism.

This list is not exhaustive, as the full breadth of ecosystems and their specific benefits to communities in the region is beyond what can be captured in this publication. The potential benefits of NbS can be further expanded when considering a combination of nature-based and conventional engineered solutions. In addition to their immediate contribution to healthier ecosystems, water resource protection and climate change resilience, there are also economic benefits to be gained from cost-efficient NbS.

Barriers to NbS upscaling

Despite the broad acknowledgement that NbS have untapped potential, the upscaling of NbS as a central element of infrastructure has not been fully successful.

The ability to deliver a broad range of vital benefits is a key strength of NbS as an infrastructure solution. It is, however, this very ability that often complicates straightforward cost-benefit assessments of NbS when compared with alternatives. Cost-benefit assessments of conventional, built and engineered infrastructure solutions are conducted under well-established sets of rules and procedures often governed by a limited number of responsible authorities. The value of nature-based infrastructure solutions is often difficult to quantify since appraising ecosystem services is not easy. Furthermore, it is difficult to manage natural infrastructure when the asset is an entire ecosystem covering a broad and complex geographical area, as compared to a grey asset that is essentially a closed system.

Broad stakeholder involvement is necessary for targeted NbS implementation and management. However, beneficiaries are often located across geographic and administrative boundaries. Water managers and their respective agencies often operate somewhat independently within these complex systems. Divisions may exist even within water management such as among water delivery, treatment, and protection operators, creating a lack of coordinated management channels. It is necessary then to cut across this institutional complexity to plan, finance and implement NbS in a coordinated manner.

Working with and reshaping ecosystems also takes time. It may take years or even decades for ecosystems to deliver the full desired suite of benefits, whereas grey solutions are often able to produce anticipated results immediately after completion. A broader long-term vision that recognizes the value of NbS in sustainable development is therefore required to make the case for investing in nature.

Mainstreaming NbS into future infrastructure development can help expand awareness and contribute to water and climate adaptation infrastructure portfolios. Implementing infrastructure solutions that contribute to a multitude of sustainable development dimensions significantly increases the efficiency of investments – a critical need if the region is to stay on track to reach its Agenda 2030 ambitions in the aftermath of the global COVID-19 pandemic.

4. NbS application examples from the Asia-Pacific region

NbS exhibit great potential for building resilience and water security in the Asia-Pacific region. With the mounting investments needed for water infrastructure to meet the needs of growing populations, NbS present a clear opportunity to maximize investment benefits. NbS can address immediate water challenges while delivering on a wide array of other strategic and policy objectives, including those of environmental conservation, increased quality of life, air quality, climate resilience and livelihood security.

There is even greater potential when integrating NbS with conventional infrastructure and within wider planning strategies to address issues at various scales. The mainstreaming of NbS into national strategies and policies is important, as it helps create the necessary enabling environment to raise awareness and funding for NbS projects and initiatives.

This chapter contains a diverse selection of NbS application examples from the Asia-Pacific region. Cases were selected to demonstrate the variety of ways in which NbS have been applied. One criterion for case selection was a degree of implementation maturity that would ensure that key lessons learned to date could be distilled. The case studies are organized in three thematic groups, covering sustainable water management in urban, rural, and coastal settings. The case studies contain key information on each project, including geographic location, timeframe, relevant funding and implementation partners, as well as an overview of the type of NbS applied and the co-benefits achieved through their implementation. The narrative sections seek to summarize and highlight key challenges addressed, actions taken, and lessons learned.

FIGURE 1

Example cases by location, with page references

NbS for designing cities of the future

Cities of the Asia-Pacific region will remain important centres for regional socioeconomic activity now that they are home to more than half of the population. With a high concentration of human and economic assets and increasing climate change vulnerability, these cities are natural focal points for multidimensional NbS interventions.

The rapid expansion of urban and peri-urban areas exerts pressure on water demand and infrastructure necessary for sanitation, clean water delivery and stormwater management. Urban NbS vary in scale from national policies and programs on sustainable water management in cities to local and neighbourhood level projects. NbS can mitigate urban flooding and storm surges by increasing infiltration and have proven effective in reducing runoff and preventing combined sewer overflows, all while increasing access to green areas, reducing urban heat island effects, improving air quality, and enhancing urban biodiversity, which in turn contribute to the urban quality of life.

NbS for cities often cross physical and administrative boundaries, extending to the broader watersheds that provide clean water for other areas downstream. NbS can help improve water quality by implementing measures for protection of water sources, including reduced use of fertilizers and sediment control measures.

There are many valuable examples of urban NbS from the region. This chapter contains just a small selection of the implemented diversity of interventions, demonstrating solutions that can strengthen urban resilience and quality of life.

THAILAND

Building Bangkok's climate change resilience through NbS

LOCATION
Bangkok, Thailand

IMPLEMENTED BY
Landprocess (Private Company)

FINANCING SOURCES
Thammasat University and Chulalongkorn University, Thailand

IMPLEMENTATION TIMEFRAME
2017-2019

TYPE OF NBS APPLIED
Urban wetlands, green rooftops

BENEFITS
Flood control, runoff slow down, water storage, water purification, mitigation of heat island effect, increased urban biodiversity, urban food production, recreational benefits

IMPLEMENTATION CHALLENGES
Ensuring complementary initiatives across the city

SCALE-UP
Communities involved in planning and design can continue to promote NbS

Bangkok is a southeast Asian mega city facing increasing pressure from the impacts of climate change. To address the city's increasing vulnerability to climate change, Bangkok has recently embarked on several urban redevelopment projects to green the city. They aim to increase the number of carbon-sequestering urban spaces using urban forests, environmentally productive parks, green roofs, and urban wetlands. These investments will facilitate water infiltration, increase the public health and well-being of residents, mitigate the heat island effect and enhance urban adaptability to climate change.

Flood water storage and distribution through green spaces. Opened in 2017, Chulalongkorn Centenary Park was one of the first natural infrastructure investments designed to reduce Bangkok's urban flood risk. The Chulalongkorn Centenary Park sits at a 3-degree angle, which can slow runoff up to 20 times more than regular concrete surfaces. Excess water is stored in underground tanks while the rest is sent through a series of ecological components, including detention lawns and a wetland which filters, aerates and purifies the water. The excess water then flows down to a retention pond that is capable of doubling in size to handle severe floods, where it completes the cycle. The water is then available for irrigation and distribution to surrounding facilities. With on-site water management, the park can collect, treat and store up to one million gallons of water, alleviating the overwhelmed public sewerage system during heavy rainfall.

In 2019, a second green investment was opened, the Thammasat Urban Rooftop Farm, which is Asia's largest urban rooftop farm (22,000 m2). The university's unused roof area was repurposed into a public space that draws its design from traditional rice terraces and combines elements of green space, urban organic farm, water management, solar energy, and outdoor classroom. The cascading farm levels help slow down and absorb rainwater while also irrigating the food gardens. The runoff is filtered through each layer of soil and collected in four retention ponds (total of roughly 3.1 million gallons) used for rooftop irrigation and other purposes.

Involving vulnerable communities in designing their future neighbourhoods. An important focus of the projects has been a participatory design process that involves local communities and future generations, including over 100 student designers from 5 universities. Additionally, insights and ideas were collected from women and vulnerable households in local communities to inform the design.

Sources: (United Nations Framework Convention on Climate Change [UNFCCC] 2020) and (World Landscape Architect 2020)

SRI LANKA

Transforming Kurunegala into a climate-smart city

LOCATION
Kurunegala City, Sri Lanka

IMPLEMENTED BY
CTCN, Korea Environment Institute

FINANCING SOURCE
Pro bono support from the Republic of Korea (USD 106,910)

IMPLEMENTATION TIMEFRAME
2018-2019

TYPE OF NBS APPLIED
Recommendations include rainwater harvesting, gravity driven membrane filters, and natural infrastructure solutions

BENEFITS
Solutions to address water scarcity, mainstreaming of climate change considerations and low carbon technologies into local agendas and city development plans; strengthened adaptive capacity of Kurunegala's urban population; enhanced capacity to develop action plans for other climate issues

IMPLEMENTATION CHALLENGES
Residents understand risk, but lack awareness on concrete actions needed; lagging government willingness, budget availability, limited data availability for quantitative climate risk assessment

SCALE-UP
N/A

In recent years, the Sri Lankan city of Kurunegala has been experiencing a boom in economic development, but has also endured severe droughts, floods and devastating landslides. Like other cities in Asia, it is highly vulnerable to the impacts of climate change, particularly heat stress and water scarcity. Temperatures have been rising while rainfall patterns have increasingly fluctuated, gradually extending the dry season and altering agricultural productivity.

Addressing critical adaptative capacity issues for water resources. The CTCN matches requests from developing countries with implementing partners who can support the provision of innovative water resource technologies. The CTCN contributed to the development of a low emission transition pathway for Kurunegala city to address climate mitigation. A sectoral roadmap was drafted for the Kurunegala Municipal waste sector.

In a second phase of the project addressing climate adaptation, the Korea Environment Institute developed an adaptation action plan to build overall resilience against natural disasters with a specific focus on water scarcity and heat stress, which have been largely exacerbated by climate change. Vulnerability and risk assessments were conducted to identify priority areas and lay the foundation for a capacity building workshop to guide city planners and policymakers in transforming Kurunegala into a 'climate-smart city.' The recommended NbS approaches outlined in the plan included rainwater harvesting and gravity driven membrane filters to improve access to clean drinking water and cooling and natural infrastructure solutions like green roofs, vegetative swales, permeable pavement, and infiltration trenches to reduce heat stress and flood risk. Indicators for the water scarcity risk assessment were developed, including drought vulnerability, risks to drinking water, water quality, aquatic ecosystems, sanitation, health and temperature humidity.

Eliciting a host of beneficial impacts. These plans directly benefit the 40,000 people living in Kurunegala city. This project was successful not only in addressing water scarcity, but also in mainstreaming climate change considerations into local agendas and incorporating climate resilience and low carbon technologies into city development plans. The risk assessment guidelines, adaptation planning manual, and indicators can be used for cities in similar situations throughout the region experiencing water scarcity issues and a need for enhanced resilience.

These products are also contributing to the achievement of SDGs 2, 5, 6, 11 and 13, and to Sri Lanka's NDC, which emphasizes increasing resilience in human health, water, food security, urban infrastructure, and settlement sectors. With regard to gender, recommendations were provided on maintaining employee gender balance in key stakeholder organizations, enabling gender aspects to be mainstreamed into further projects and policymaking. For the water sector specifically, the NDC recommends addressing domestic water use through groundwater monitoring, climate-resilient water supply schemes, promotion of wastewater use, management of salinity, and capacity building for adaptation. For irrigation water, Sri Lanka is targeting restoration, rehabilitation and augmentation of irrigation systems, introducing alternative water sources, improving irrigation efficiency and early warning for river flooding.

Source: (Climate Technology Centre and Network (CTCN) 2019)

INDIA

Combining NbS and regulatory measures for lake rejuvenation in Coimbatore

LOCATION
Coimbatore, Tamil Nadu, India

IMPLEMENTED BY
Oasis Designs Inc. and Consortium for DEWATS Dissemination (CDD) Society

FINANCING SOURCES
Smart City Fund and private sector financing

SIZE OF THE FUND
INR 350 Crores (USD 50 Million) for implementation

IMPLEMENTATION TIMEFRAME
2017 – 2018 (Planning and Design Phase), 2019-Present (implementation)

TYPE OF NBS APPLIED
Floating and free surface flow urban wetlands (including designated conservation areas, active edges and bird islands)

BENEFITS
Flood control, groundwater recharge, increased water storage, increased water quality, enhanced biodiversity, public place-making (reconnecting communities with waterbodies)

IMPLEMENTATION CHALLENGES
Limited understanding and capacities among private contractors to implement the proposed NbS

SCALE-UP
Project covers all major lakes within the city. Depending on success, it may be replicated in similar cities

An industrial hub looking to regulate pollution and transform into a vibrant smart city. Coimbatore, the second largest city in the Southern Indian state of Tamil Nadu, is located on the banks of Noyyal river. The eight lakes connected to the river, all located in the city, were selected to be revitalized and restored using NbS to combat the growing pressure of pollution following rapid urbanization. In addition to rejuvenating the lakes to improve the natural environment and biodiversity, the project aimed to create recreational facilities in the surrounding neighbourhoods to reconnect communities with waterbodies.

NbS: cost-effective solution for waste-water treatment and urban place-making. To tackle the growing issues of the quality and quantity of waste-water inflow to the lakes, several NbS were used. These included using meandering arrangements and wetlands along the drains; floating and free water surface wetlands inside the lakes; and interception, diversion and offline treatment through ecological greywater treatment plants. Coupling these NbS with biodiversity enhancing activities including designated no-go zones to allow nature to thrive and creating bird islands within the lakes, the project is creating green areas for pedestrians and cyclists while improving habitat for indigenous fauna and flora. The expected co-benefits include improved flood management, groundwater recharge and increased water storage. The project is also working to increase public awareness and participation on issues relating to pollution control and management.

Dedicated management systems are needed to ensure sustainability. A detailed environmental and social (E&S) impact assessment study was undertaken, and an E&S Management Plan proposed to facilitate adherence to E&S safeguards setup up by State and National Policies. To coordinate this complex project spanning eight lakes in the city, a dedicated institution will be created to provide continuous and focused management. The Coimbatore Lakes and Catchment Management Authority has been proposed to ensure the operation and management of the project is sustained after completion, with dedicated funding earmarked from the conception of the project to ensure its sustainability.

Source: (Consortium for DEWATS Dissemination (CDD) Society India 2020)

CHINA

Harnessing benefits of public-private partnerships (PPPs) for sustainable water supply

LOCATION
Dongjiang River, Jiaquan river catchment, China

IMPLEMENTED BY
IUCN, Danone, Guangdong Academy of Forestry, South China Agriculture University

FINANCING SOURCES
EU, Danone Ecosystems Fund, Danone Waters China

IMPLEMENTATION TIMEFRAME
2013-2016

TYPE OF NBS APPLIED
Source water protection through eco-farming, improved agroforestry and native vegetation

BENEFITS
Pollution reduction, improved water quality, sustainable livelihoods, and additional income generation

CHALLENGES
N/A

SCALE-UP
Successful local pilot scaled up to catchment level, with further opportunities for scale-up in the basin

Securing clean water supply for cities and businesses by protecting the watershed. The Dongjiang River, whose basin covers an area of over 35,000 km2, is a critical natural resource for communities in the Pearl Delta. It provides water to more than 400 million people including the cities of Hong Kong, Guangzhou and Shenzhen. Economic activity in the basin had caused significant water quality degradation from discharge of sewage and industrial wastewater. This, combined with the changing climate's impact on available water resources including changes to sediment flows, created an urgent need to protect and restore the watershed to ensure a sustained supply of sufficient and clean water. Danone Waters China (DWC) has used water from the Jiaquan river (upstream catchment of Dongjiang River) for its bottled mineral water products since the late 2000s. DWC, in partnership with IUCN and the Longmen County Government, initiated a pilot scheme in the Jiaquan catchment to implement conservation practices to protect the flow and quality of the water.

Improving water quality through better technologies and improved farming practices. A three-staged plan was developed in collaboration with the local government to restore the catchment. The activities included improving agricultural and forestry practices, leasing land from farmers and converting it back to natural and native vegetation, and providing technological support to farmers to transition to more ecological agricultural practices. DWC also supported farmers in packaging and marketing their sustainable produce to increase value and ensure the profitability of eco-farming practices. As a result, monthly water samples in the Jiaquan catchment have shown a significant reduction in pollutants.

PPPs harness the investment needed to upscale NbS. One of the key success factors of the project was ensuring benefits to all involved parties – the local government, businesses and farmers –while demonstrating the potential of PPPs to upscale NbS. It also highlighted the vital role of local farmers as ecosystem service users and guardians. Further to the immediate local benefits, there were also important downstream benefits, given the strategic location of the Jiaquan catchment.

Source: (IUCN 2016b) and (The Nature Conservancy [TNC] 2016)

Rural NbS for healthy ecosystems and livelihood security

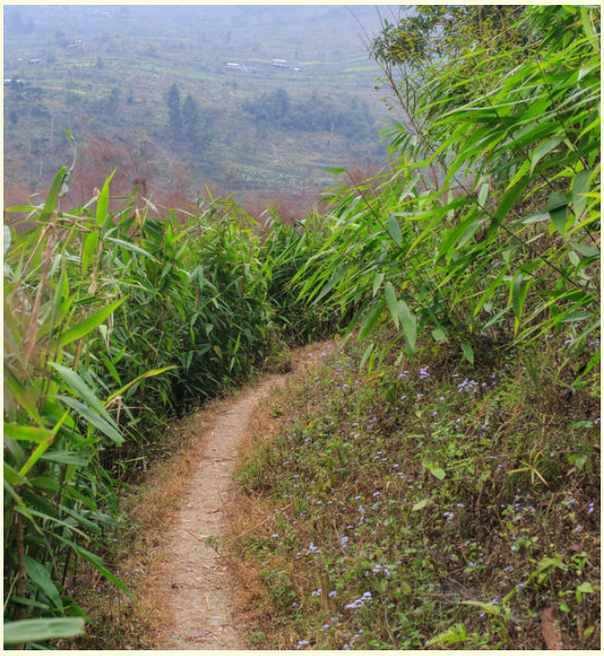
Society at large depends on healthy functioning ecosystems and ecosystem services. The effects of degradation are felt acutely by smallholder farmers, fishermen and other communities deriving their livelihoods from nature. It is estimated that nearly 200 million people in the region depend directly on forests as a source of food, medicine, non-timber forest products and fuel, as well as for other subsistence needs (UNEP 2018). In South Asia alone, smallholder agriculture employs over 40 per cent of the population (ADB 2020). These workers and their families are directly dependent on healthy ecosystems and clean water.

NbS can help strengthen the resilience of these communities to climate impacts through protection and restoration of the ecosystems on which they depend. Examples from the region show that many of the rural interventions are cost-effective, protecting lives and infrastructure while creating additional sustainable livelihood incomes. Agroforestry, wetland restoration and management, improved farming and forest management practices, and planned reforestation all are potential NbS that can help build livelihood security and climate resilience.

The following case studies have been selected to demonstrate the diversity of interventions that directly contribute to sustainable livelihoods while combating climate and disaster risks in predominantly rural areas.

NEPAL

Community-based bioengineering for disaster risk reduction in the Himalayas



LOCATION
Western Department, Nepal

IMPLEMENTED BY
IUCN Nepal and University of Lausanne

FINANCING SOURCES
German Ministry for the Environment: International Climate Initiative (IKI)

IMPLEMENTATION TIMEFRAME
2012-2017

TYPE OF NBS APPLIED
Slope stabilization through planting of native grasses, drainage and dry wall construction

BENEFITS
Reduced risk of landslides and flash floods, additional livelihood benefits from the use of native plants

IMPLEMENTATION CHALLENGES
N/A

SCALE-UP
The lessons learned have been incorporated into the new National Watershed Management Policy

Reducing disaster risk of landslides and flash floods in mountain areas through low-cost NbS. Communities in the mountainous regions of Nepal are prone to landslides and flash floods. These hazards are exacerbated by climate change and the predicted increase in precipitation and more frequent extreme events. Coupled with poorly engineered rural roads, landslides frequently cause injuries, and even death, as well as economic losses to agriculture fields and forests. The Ecosystems Protecting Infrastructure and Communities (EPIC) initiative in Nepal demonstrated that community-based, low-cost and environmentally friendly soil bio-engineering measures along roadsides can be both cost-effective and efficient in reducing these hazards.

Locally adapted solutions implemented by the communities. Three pilot areas were selected in the Western Development Region of Nepal to test the effectiveness of low-cost community-based roadside bio-engineering measures. Measures implemented included planting of local plant species such as broom grass and soil bioengineering techniques, such as drainage and dry wall construction. All measures were implemented and maintained in partnership with the local community and provided multiple co-benefits. For example, in addition to stabilizing the slopes, the plants were used as animal fodder, firewood and raw materials for hand-crafted goods.

Influencing policy change at regional and national levels. The project also contributed to building the capacity of local stakeholders, while bringing together actors from environmental protection, disaster management, land use planning, community development and civil society. The pilot projects were such a success that scale-up was planned across the country. It also catalysed regional and national discussions on the potential for implementing additional ecosystem-based disaster risk reduction methods in Nepal. As a result of these discussions, local governments have increasingly encouraged environmental protection: the Department of Soil Conservation and Watershed Management of Nepal drafted the National Watershed Management Policy, incorporating the lessons learned from the project.

Source: (IUCN 2017)

VIET NAM

Cost-benefit assessment of mitigation options in rice production

LOCATION
Viet Nam

IMPLEMENTED BY
CTCN, IRRI, Institute of Policy and Strategy for Agriculture and Rural Development, and UNIQUE LanduseGmbH

IMPLEMENTATION TIMEFRAME
2019

TYPE OF NBS APPLIED
Alternate wetting and drying, mid-season drainage, straw and stubble management, site-specific nutrient management

BENEFITS
Reduced GHG emissions, water conservation, carbon sequestration

SCALE-UP
Progress made will enable upscaling of mitigation practices nationally

The impacts of rice production on climate and water are significant. Rice production demands a great deal of water. Continuous flooding is traditionally used to ensure an adequate water supply and to control weeds. This is especially true of lowland rice, for which it takes about 1,400 liters of water to produce 1 kg of rice in an irrigated lowland production system (International Rice Research Institute [IRRI] Rice Knowledge Bank 2021). Rice paddy fields are also a significant source of GHG emissions, being one of the greatest anthropogenic sources of methane (CH4) and nitrous oxide (N2O) emissions (Win et al. 2020). Rice production offers an opportunity to scale up NbS in response to these issues. Methane emissions can be reduced by up to 70 per cent through innovative agricultural practices when compared to traditional rice production. Practices such as alternate wetting and drying can conserve water, therefore achieving water management goals in water scarce locations while also reducing emissions. Rice producing countries like Viet Nam are increasingly focused on choosing production options that reduce GHG emissions as part of sustainable development strategies. Decision-makers at various levels need information regarding options for mitigation in rice production.

A tool for better decision-making among NbS options. The government of Viet Nam requested the CTCN's assistance to enable a wide range of stakeholders, from farming communities to policy makers, to assess the costs and benefits of various mitigation options as a means of prioritizing suitable technologies and defining investment portfolios and policies for Viet Nam's rice production.

The CTCN, International Rice Research Institute (IRRI), Institute of Policy and Strategy for Agriculture and Rural Development, and UNIQUE LanduseGmbH developed an interactive and dynamic cost-benefit analysis (CBA) tool to identify the suitability and calculate the co-benefits and mitigation impacts of low emission development technologies for rice production systems.

The partners also created a geographic information system (GIS) analysis and mapping system to facilitate the incorporation of socioeconomic suitability for rice-producing areas into already existing GIS maps. They provided capacity building on the application of the CBA tool and GIS assessment for officials from Viet Nam's Ministry of Agriculture and Rural Development (MARD), experts from international and local research institutes, and representatives from various local governments. The workshop focused on four technologies, highlighting the benefits of alternate wetting and drying, mid-season drainage, straw and stubble management, and site-specific nutrient management.

Benefits to the achievement of Viet Nam's NDC goals and SDG targets. It is expected that the provision of reliable GHG emissions data and cost-benefit assessments of mitigation options will enable better targeting and upscaling of mitigation practices that can also reduce emissions and save water. The recommendations provided by the tool will contribute to reaching Viet Nam's NDC, which emphasizes rice production as a key target for emissions reductions in the country's critical agriculture sector. At farm level, the mitigation packages embedded in the tool consider factors that reduce costs and women's labor, provide access to more productive resources, and increase women's decision-making power in households. In addition, the tool will help to improve future national communications submitted to the UNFCCC relating to the agriculture sector and contribute to the achievement of SDG 2 (Zero hunger), SDG 9 (Industry, Innovation and Infrastructure), and SDG 13 (Climate action).

Source: (CTCN 2019a)

INDONESIA

NbS to reduce sediment loads affecting hydropower plant operation

LOCATION
Sumberjaya, Indonesia

IMPLEMENTED BY
GIZ, Helmholtz Centre for Environmental Research (UFZ) and Conservation Strategy Fund (CSF)

FINANCING SOURCES
IFAD

IMPLEMENTATION TIMEFRAME
2006-2012

TYPE OF NBS APPLIED
Reforestation, forest conservation, soil conservation practices (check dams, grass strips)

BENEFITS
Cost-efficient hydropower generation, land tenure for farmers, reduced soil erosion and sedimentation

IMPLEMENTATION CHALLENGES
Convincing farmers to change their practices

SCALE-UP
N/A

Unsustainable land management practices upstream compromise efficient hydropower plant operation downstream. The Way Besai watershed is in Sumberjaya on the west coast of Sumatra. Coffee plantations are the predominant agricultural activity in the watershed, covering some 70 per cent of the area. Forest clearing and short-term intensive use of land for coffee cultivation contributed to increased sediment loads in the Way Besay River, impacting the costs of hydropower generation. The Rewarding Upland Poor for Environmental Services (RUPES) project targeted upstream farmers to change their land use practices and move away from using measures that contributed to excessive sediment runoff. Before the project, the PLTA Way Besai hydropower company was removing sediment from the reservoir of the hydropower dam at a cost of up to 1 million USD per year.

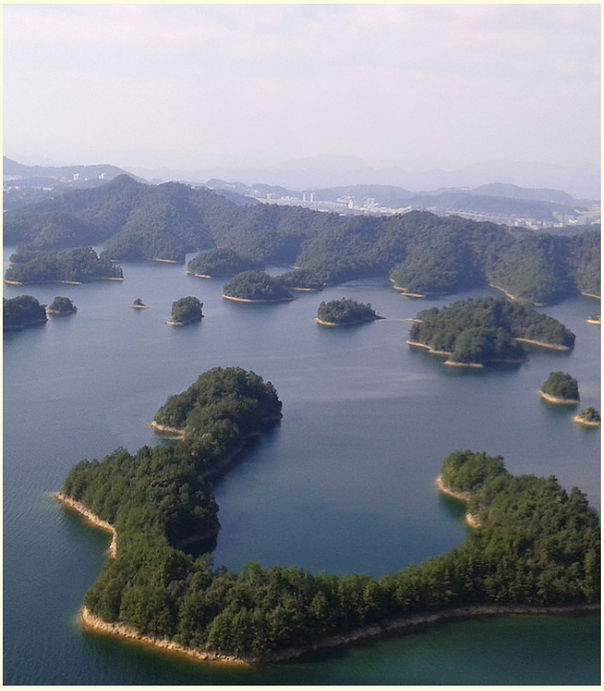
Payments for ecosystem services driving change in farming practices. To reduce excess sedimentation in the river, a payment for ecosystem services mechanism was developed between the hydropower company and the upstream communities focusing on forest conservation and enhanced soil management. Farmers would receive payments if they achieved a 30 per cent reduction in sediment loads, paid in the form of micro-hydropower units for electricity production in small villages, as well as cash payments. The farmers were also given training on water and soil conservation techniques, including setting up check-dams, planting grass strips in areas prone to landslides, and removing excess sedimentation from the check dams. An additional incentive was the opportunity to gain a conditional land tenure of 25 years for lands where farmers could actively plant trees or provide forest protection.

Setting tangible goals and ongoing monitoring of intervention impacts. Quantifying the impacts of interventions by monitoring sedimentation rates was important for successful implementation and for negotiations between farmers and the hydropower company. This monitoring and reporting process ensured transparency and motivated participation. The mix of incentives and support to diversification of land use practices as well as support to negotiations with the company were important factors in establishing buy-in for the project activities.

Source: (Gesellschaft für Internationale Zusammenarbeit [GIZ], Helmholtz Centre for Environmental Research [UFC] and Bundesministerium für Umwelt, Naturschutz, nukleare Sicherheit und Verbraucherschutz [BMUB] 2017)

CHINA

Innovative eco-compensation scheme for cleaner water in Qiandao Lake



LOCATION
Qiandao Lake and Xin'an River Basin, China

IMPLEMENTED BY
World Bank, The Nature Conservancy, Wanxiang Trust

FINANCING SOURCES
World Bank, Alibaba Foundation, Minsheng Life Insurance Foundation

SIZE OF THE FUND
10 million Chinese Yuan (approx. 1.5 M USD)

IMPLEMENTATION TIMEFRAME
2018-present

TYPE OF NBS APPLIED
Eco-farming practices

BENEFITS
Income generation, increased water quality

IMPLEMENTATION CHALLENGES
Convincing farmers to change their practices

SCALE-UP
N/A

Reducing agricultural non-point source pollution through payments for ecosystem services scheme. Qiandao Lake is a vital drinking water source in the Yangtze River Delta region that supplies the Hangzhou metropolitan area. Despite being located within a priority biodiversity conservation area, the lake has suffered from non-point source (NPS) pollution due to agricultural activity. A study identifying several hotspots of NPS pollution in the watershed followed by the forging of a partnership between the World Bank, private sector investors and The Nature Conservancy led to the creation of the Qiandao Lake Water Fund. The fund targets smallholder farmers, particularly tea plantations, who are looking to curb excessive nitrogen, phosphorus and sediment loading in the water through a payment for ecosystem services scheme.

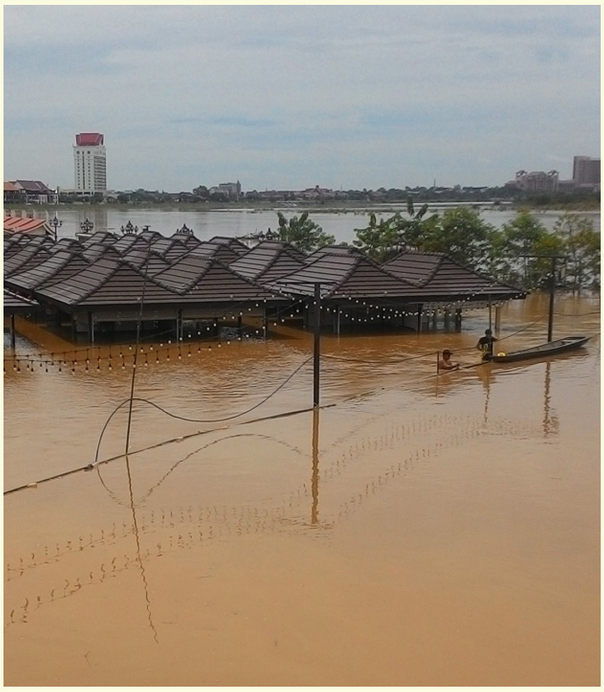
Coordinated efforts and the "Three Nos" approach. For smallholder farmers and collective tea cooperatives, the fund promotes voluntary commitment to the "Three 'No'" principle - saying 'no' to use of herbicides, pesticides, and fertilisers. Farmers are encouraged to adjust the use of fertilizers and pesticides in accordance with best management practices, including mulching and burying fertilizers in their fields to reduce the risk of NPS pollution from tea cultivation. For the larger farms, the fund promotes improved practices such as mulching and planting nectar source plants and cover crops among larger scale crops (typically rice, corn, rapeseed). Monitoring data show that mulching measures have helped reduce the losses of total nitrogen by 36.55 per cent, phosphorus by 38.11 per cent, and ammonia and nitrate nitrogen by 48.7 per cent and 61.59 per cent, respectively.

Simplifying farmer participation through innovative technologies and a better enabling environment. The Fund has developed a smart IT system for subsidy and compensation distribution and identification of best practices – a costly and inefficient process in the past – by reducing the administrative and transaction costs and providing additional incentive to farmers. The platform uses blockchain and artificial intelligence to improve its efficiency. As a result, the farmers increased their income by 30-40 per cent. An important success factor involved building on existing institutional capacities in the region (village-based tea collectives and NPS pollution reduction programmes) by strengthening and expanding them with strong institutional partners.

Source: (Iseman and Miralles-Wilhelm 2021)

MEKONG REGION

Regional initiative builds climate resilience by harnessing the benefits of wetlands



LOCATION
Cambodia, Lao PDR, Thailand and Viet Nam

IMPLEMENTED BY
IUCN

FINANCING SOURCES
International Climate Initiative (IKI) of the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB)

IMPLEMENTATION TIMEFRAME
2017-2020

TYPE OF NBS APPLIED
Wetland restoration and protection measures

BENEFITS
Mitigation of land erosion, flood control, reduced risk from tsunamis and landslides, water storage and control

SCALE-UP
Lessons learned were shared with 18 established and potential Ramsar sites and supported the development of a regional platform for dialogue and cooperation

The wetlands of the Lower Mekong region are in decline. Human activities, including urban expansion, infrastructure development, deforestation and expansion of agriculture, have had a detrimental impact on the wetlands of the Lower Mekong region and their ability to provide ecosystem services. This in turn has serious impacts on biodiversity and water quality. Farmers began to feel the impacts of climate change when the wetlands were no longer able to protect their livelihoods from salt-water intrusion, landslides, or floods.

A regional initiative to ensure that the benefits of wetlands are integrated into planning. The Mekong WET project aims to build wetland resilience in the Lower Mekong region across four countries. The initiative sought to bring together actors from across the basin to ensure that wetlands, and their ability to contribute to climate mitigation, adaptation, and disaster risk reduction, were duly integrated into planning. Based on regional best practices, an effective and replicable framework for sustainably managing wetlands was developed, which also contributed to capacity development for 150 wetland managers and more than 300 community representatives from across the region. This framework has enabled them to better manage wetlands to ensure the continued delivery of ecosystem-based adaptation and mitigation benefits, including the regulation of water flows, provision of clean water and carbon storage.

Governments were supported to implement other important planning processes, demonstrating the cross-cutting benefits of NbS. National Biodiversity Strategies and Action Plans (NbSAPs), as well as countries' respective climate change commitments for adaptation and mitigation under the UNFCCC, derive benefit from improved wetland management, attesting to the inherent value in regional collaboration and experience sharing. The project therefore helped to establish the Indo-Burma Ramsar Regional Initiative (IBRRI), which provides a platform for regional dialogue and learning focused on regional governance and the implementation of the Ramsar Convention.

Source: (IUCN 2019)

NbS for coastal protection and resilience

The coastal areas of the Asia-Pacific are particularly exposed to water-related climate hazards, such as sea level rise, coastal storm surges, water salinization and freshwater scarcity. Bolstering resilience in these areas is important, as a significant share of coastal socioeconomic activity in the region depends upon fisheries, tourism, and aquaculture.

Implementing NbS can yield benefits beyond physical coastal and shoreline protection and the creation of healthier ecosystems. It can help to ensure that human activities in coastal areas do not cause further degradation and enable the maintenance of traditional sources of income while providing new alternative livelihood sources.

Managing pollution in the coastal zones, protecting and restoring mangrove forests, and ensuring that communities maintain income from small-scale aquaculture are all ways in which NbS have shown their potential in building sustainable and safe coastal communities. In addition, these NbS interventions have reduced costs compared to built protection measures. In some countries, they have contributed to the mainstreaming of NbS considerations into national legislation.

Case studies selected for this chapter aim to demonstrate the diversity of coastal NbS applications while showing that the full potential for NbS upscaling in the region's coastal areas has yet to be entirely realized.

PAKISTAN

Using NbS for wastewater treatment and reducing coastal water contamination

LOCATION
Karachi, Pakistan

IMPLEMENTED BY
IUCN MFF, Pakistan Navy

FINANCING SOURCES
Mangroves for the Future (MFF)
(Danida, SIDA, Norad)

IMPLEMENTATION TIMEFRAME
2016–2018

TYPE OF NBS APPLIED
Constructed wetland (reed bed system)

BENEFITS
Water quality through pollution reduction, cost savings, water recycling/saving, reduced costs

IMPLEMENTATION CHALLENGES
N/A

SCALE-UP
The NbS will be scaled up across the country by the Pakistan Navy in other coastal settings

A prime coastal recreational spot contaminated by pollution. The small peninsula of Manora, southwest of Karachi, contains mangrove forests in the Western Bay and is a prime tourism location and popular destination for day-trippers, attracting an estimated 150,000 people per year. The practice of dumping untreated wastewater into the coastal areas surrounding the city of Karachi was leading to seawater contamination, while the increasing levels of floating debris were posing a threat to island inhabitants, the tourism industry and ecosystems. This site was therefore selected for piloting constructed wetlands for water treatment.

Constructed coastal wetlands to produce clean water and reduce costs of treatment. A constructed wetland system in the form of a reed bed was selected for NbS piloting. The system was designed to provide biological treatment of the wastewater produced on the island in order to reduce the amount of sewage and pollution from Manora island entering into the sea. The intervention is a natural, low-cost initiative, which is not energy intensive, as it uses the natural gradient to facilitate the flow of wastewater through various filter beds. The treated water is used for the greening of a local sports field enjoyed by naval cadets and local residents for recreational activities. As a result, an estimated 10.8 million gallons (or approximately 41 million litres) of water is saved, which would otherwise have been transported to the island. This equates to a monetary savings of approximately USD 45,000.

Using the pilot success to scale up initiatives on the national level. The relatively small project had a big impact in terms of cost reduction, reducing the amount of freshwater imports required to Manora island and reducing pollution in coastal waters. This success motivated the government and relevant ministries to consider further application of similar NbS in coastal areas and influenced policies and practices to control land-based pollution. The Pakistan Navy (a branch of Pakistan's Armed Forces), the main project implementors, will now employ this NbS in additional camps and facilities across the country.

Source: (Mangroves for the Future 2021)

THE PHILIPPINES

Living breakwaters contribute to mangrove restoration, enhanced fisheries and flood regulation

LOCATION
Iloilo, Philippines

IMPLEMENTED BY
Conservation International, Bechtel

FINANCING SOURCES
French Facility for Global Environment

IMPLEMENTATION TIMEFRAME
Since 2015 (on-going)

STATUS OF PROJECT
On-going

TYPE OF NBS APPLIED
Living breakwaters and mangrove restoration (shallow, low profile rock breakwaters collecting sediment for mangroves)

BENEFITS
Shoreline protection, mangrove ecosystem restoration, sustainable livelihoods

IMPLEMENTATION CHALLENGES
N/A

SCALE-UP
Inspired the creation of the Global Green-Grey Community of Practice which advocates for scaling up interventions that couple green (NbS) and grey infrastructure investments

Coastlines and communities threatened by increased wave energy. The project in Lo-ong and Bacjawan Norte on Iloilo Island aimed to build the resilience of coastal communities in the Philippines by reducing wave energy, which was causing severe coastal and cliff erosion, while encouraging sediment accumulation where mangrove seedlings and marine life could thrive. The project constructed shallow, low profile rock breakwaters that were colonized with shellfish. In Lo-ong, two living breakwater sections were placed in a location where severe beach and cliff erosion had occurred. In Bacjawan Norte, a living breakwater made of a shallow rock mound (approximately 80 meters long) was constructed.

Community benefits incentivizing sustainability of the project. The living breakwaters temper wave energy to help prevent coastal erosion while supporting mangrove rehabilitation. The livelihoods of surrounding communities employed in shellfish harvesting were enhanced, while the shellfish and rock structures also attracted larvae build-up over time and formed a complex and hard surface to dissipate wave energy and protect the coast. Livelihood enhancement was an important incentive, especially for the women and children who harvest shellfish, to ensure local ownership of the project and compel the community to take responsibility for the long-term maintenance of the living breakwaters, therefore strengthening the project's longer-term sustainability.

Partnership paving the way for innovation. This case demonstrated the benefits of partnering between an environmental organization and a private sector engineering and construction company. The initiative was supported by multiple public and private funders, the government and local communities. It has demonstrated an innovative approach to tackling immediate coastal protection issues in ways that are beneficial not only to coastal integrity, but also to ecosystems and livelihoods. It also inspired the creation of the Global Green-Grey Community of Practice, which advocates for additional consideration and inclusion of combined green (NbS) and grey investments to combat climate change and reduce the risk of disaster.

Source: (Conservation International 2019)

VIET NAM

Protecting coastlines and enhancing sustainable livelihoods through payment for ecosystem services and REDD+

LOCATION
Ca Mau province, Viet Nam

IMPLEMENTED BY
IUCN and Stichting Nederlandse Vrijwilligers (SNV)

FINANCING SOURCES
International Climate Initiative (IKI) of the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU)
Implementation timeframe: 2012–2020

TYPE OF NBS APPLIED
Mangrove restoration, eco-farming practices (organic shrimp farming)

BENEFITS
Coastal protection, carbon sequestration, increased shrimp yields

SCALE-UP
The successful project has informed policies at the provincial level for mangrove protection and payment for ecosystem services, and produced a mangrove shrimp development plan and vision to 2020–2030

Shrimp farming as a major driver of mangrove clearing and degradation. Viet Nam is the second largest exporter of shrimp in the world, hosting roughly 30 per cent of production in its southern Ca Mau province. The growing demand for and production of shrimp has led to the clearing of vast areas of mangrove forests, damaging mangrove ecosystem health and shrimp production. This loss of mangroves has increased GHG emissions, coastal erosion and climate vulnerability in coastal communities. Saltwater intrusion has also increased, while the loss of natural habitat and increased sea temperatures (due to loss of shade) have led to reduced shrimp growth.

Coupling mangrove restoration with sustainable aquaculture. The Mangroves and Markets (MAM) project established a payment for ecosystem services scheme aiming to create a sustainable shrimp value chain that would protect and increase mangrove coverage while simultaneously improving farmer yields through application of eco-farming processes. Training was provided to 5,500 farmer households on mangrove ecosystems, international organic shrimp certification standards, and organic shrimp farming practices. The initiative rewarded farmers who farmed shrimp organically, facilitating access to organic certification of the produce. These mangrove protection and organic farming practices improved the farmers' yields and allowed them to sell shrimp at a higher cost since the organically farmed shrimp were bigger and healthier. Pesticide costs were also reduced. The project resulted in protection of 12,600 hectares and replanting of 80 hectares of mangrove forest.

Providing a favourable legal framework for payment for ecosystem services to be used in future upscaling. The project piloted innovative financing mechanisms that promoted NbS through carbon financing and shrimp certification, making mangrove protection and restoration financially attractive to farmers while delivering ecosystem and coastal protection benefits. Further provincial policies and regulations were developed and piloted, aimed at creating a better legal environment for payment for ecosystem services schemes both in the province and nationally.

Source: (SNV, 2019)

5. Mainstreaming NbS in national level multisector policies and strategies

The mainstreaming of NbS into national strategies and policies is important, as it helps create the necessary enabling environment to raise awareness and funding for initiation and scale-up of NbS projects and initiatives.

There are already many positive examples from the region demonstrating this mainstreaming. For example, consideration for NbS has been integrated into the development of National Adaptation Plans (NAPs), which identify medium and long-term adaptation needs and elaborate strategies to address those needs. Other cases demonstrate conscious efforts to mainstream the understanding of NbS into national-level efforts for climate proofing and resilience building. The selected cases in this chapter present a snapshot of various ways and scales in which NbS can be highlighted, mainstreamed, and actively supported by governments.

FIJI

Embedding NbS in national adaptation planning

LOCATION
Fiji, nation-wide

IMPLEMENTED BY
Fijian Ministry of Waterways and Environment

FINANCING SOURCES
Government of Fiji, Republic of Korea

IMPLEMENTATION TIMEFRAME
Since 1950 (on-going)

TYPE OF NBS APPLIED
Vetiver grass plantation, restoration, enhancement and conservation of coastal mangroves, seagrasses and coral reefs, sustainable fisheries

BENEFITS
Flood defence, slope stabilization, shoreline management, erosion control

SCALE-UP
Inspire global climate action by demonstrating best practices and lessons learned

A Small Island Developing State strives to lead by example and promote NbS best practice in planning. Fiji is a country highly vulnerable to climate change risks. Erosion, flooding, storms and rising sea levels are among its major threats. Rising sea levels have already forced communities to relocate. Recognizing the urgent need for adaptation, Fiji has been leading the way on integrating NbS into national adaptation planning and strategies by utilizing techniques that have been part of local conservation measures since the 1950s. Now the government, with funding assistance from the Republic of Korea, is scaling up traditional soil conservation practices that were used as coastal defence mechanisms and mainstreaming them into national adaptation plans.

Utilizing traditional practices in new ways to combat rising seas. Vetiver grass, a resilient species with deep roots, has been used locally for decades primarily to protect in-land slopes and stabilize riverbanks. The grass also reduces contaminants in freshwater and provides a multi-purpose material that communities use to feed their livestock, thatch their roofs, and produce handicrafts. These benefits are now being extended to combat climate change. Grass nurseries are being established to provide flood protection. To date, three grass nurseries have been established and fields have been planted in more than 30 communities for flooding protection. Vetiver grass is also being used in part of a sea wall in Vanua Levu, complementing the use of boulders and mangroves to protect the shoreline.

A clear roadmap for NbS scale-up to inspire global action. The NAP process was important in providing a mandate and policy basis for national adaptation measures. Through the integration of these activities into the NAP, the scale-up of NbS has been greatly facilitated. The NAP includes a suite of further NbS for adaptation such as restoration, enhancement and conservation of coastal ecosystems such as mangroves, seagrasses and coral reefs, sustainable aquaculture in coastal areas, landward migration of coastal fish habitats and the expansion of freshwater habitats.

Sources: (Ledwell 2021) and (Government of the Republic of Fiji 2018)

CHINA

Sponge Cities - changing the national paradigm of urban water management

LOCATION
China, 30 pilot cities

IMPLEMENTED BY
Local governments

FINANCING SOURCES
Chinese State Government, local governments, private sector

IMPLEMENTATION TIMEFRAME
since 2013 (on-going)

TYPE OF NBS APPLIED
Urban green spaces, green roofs, water retention and storage

BENEFITS
Flood management, water storage, water recycling, mitigation of urban heat island effect, urban space rehabilitation, recreational opportunities, enhancement of urban biodiversity

IMPLEMENTATION CHALLENGES
Lack of standardization across interventions, monitoring success of the interventions, accessing adequate financing, coordination across bureaus, involvement of local communities in planning

SCALE-UP
By 2030, Sponge Cities concept to be integrated into all regional development plans in China

Climate change and urbanisation are increasing the risks of flooding in China's cities. The combined pressures of urbanisation, insufficient infrastructure and climate change have increased water shortages and flooding in China and have exerted immense pressure on urban infrastructure. The ambitious Sponge Cities programme was established in 2013 to mainstream climate adaptation action in cities into national-level planning. Piloted across 30 cities during two phases, the programme aims to implement a holistic approach to urban water management in China, while considering or integrating NbS to absorb, store and filter water, and enabling the building of future 'eco-cities' that account for the urban water cycle in their planning.

Combining NbS with conventional urban infrastructure. The Sponge Cities concept aims to combine grey and natural infrastructure, tailored to each pilot city's needs. Measures implemented include expansion of green spaces and green roofs, recycling of water and water filtration using urban wetlands, collection and use of rainwater and rehabilitation of degraded environments. These measures seek not only to mitigate the impacts of water-related disasters, but also to improve the city microclimate and collaborate with socio-economic systems to create future 'eco-cities.' Green spaces are combined with built infrastructure measures, such as porous design interventions and drainage systems, connected greenways and waterways, to achieve better resource management through water savings and recycling. Public-private-partnership financing arrangements have been encouraged, although the implementation of such arrangements has been limited to date.

Changing the urban water governance and planning paradigm nationally. Historically, there has been a lack of standardization and clear guidelines on eco-city concepts, which has led to 'greenwashing.' The Sponge Cities programme offers a more robust planning and governance framework where the concept is defined and made replicable on a national level. It is expected that a more systematic approach to urban water management will enhance the resilience of Chinese cities while providing a roadmap for further scale-up based on the lessons learned during this piloting phase. By 2030, the Sponge Cities programme is expected to be integrated into regional development plans.

Sources: (Qi et al. 2020); (Gill 2021); (Chan et al. 2018); and (Jia et al. 2012)

LAO PDR

Mainstreaming NbS into national planning for urban climate resilience

LOCATION
Lao PDR

IMPLEMENTED BY
CTCN, UNEP-DHI, Ministry of Natural Resources and Environment, Ministry of Finance, UNEP

FINANCING SOURCES
Green Climate Fund

SIZE OF THE FUND
USD 11.5 Million grant

IMPLEMENTATION TIMEFRAME
2020-2025

TYPE OF NBS APPLIED
Water retention and storage through increasing green spaces and permeable surfaces, rehabilitation and protection of urban streams and wetlands

BENEFITS
Flood management, ecosystem rehabilitation, enhancement of urban biodiversity, water quality improvements, livelihood benefits

IMPLEMENTATION CHALLENGES
Lack of data on climate impacts, limited capacity for NbS implementation, limited knowledge about NbS

SCALE-UP
The initial results achieved in the first 6 cities were replicated throughout the country, which led to the GCF grant, as exemplified in this case study. If successful, the project will be scaled up to an additional 13 cities.

Poor urban planning and rapid urbanization leave cities vulnerable to climate change. The urban centers in Lao PDR are growing, but many cities are susceptible to pluvial flooding caused by a combination of factors, including climate change and poor urban planning. As urbanisation continues, the natural systems that are critical to flood management such as urban wetlands, green areas and small streams, are at risk of being cleared to accommodate further settlements, increasing costs and risking further damage. This project has been conceived to strengthen the technical and institutional capacity for planning, designing, and maintaining NbS in these growing cities.

Genesis of the project. The genesis of this case study was Lao PDR's request to the CTCN for technical assistance to identify a set of suitable ecosystem-based adaptation (EbA) options for 6 cities (Luang Prabang, Vientiane, Paksan, Thakek, Savannakhet and Pakse). The CTCN, in collaboration with UNEP-DHI, developed an approach for using natural infrastructure elements as tools to create resilience in urban and peri-urban areas. The organizations assessed climate change impacts for the six cities using meteorological and hydrological data to quantify vulnerabilities to climate change more precisely, and to estimate the adaptive capacities of ecosystems and populations. The team identified, ranked, and prioritized specific options to increase the resilience of both infrastructure and livelihoods, including reforestation, forest conservation, wetland restoration, water harvesting, flood bypasses, green roofs and spaces, and permeable pavements. These results served as inputs to the Government's submission of a GCF funding proposal, funded in 2019 and begun in 2020.

Four cities in Laos were then selected for the GCF project based on climate risk modelling and vulnerability assessments: the capital Vientiane, Paksan, Savannakhet and Pakse. The proposed activities will have a direct impact on 10 per cent of Lao PDR's population. The focus will be on mainstreaming integrated flood management strategies into planning frameworks and implementing urban NbS to decrease climate-induced flooding, including the restoration of 1,500 hectares of urban wetlands. A national knowledge hub is also planned to produce and disseminate lessons learned on urban NbS being used locally, regionally, and internationally. Awareness campaigns targeting communities and the private sector will inform national guidelines and recommendations for policies on urban flood management. The aim is to ensure that NbS are mainstreamed into national planning at all levels.

NbS pilots are changing the national paradigm for urban development and resilience planning. The proposed project (approved by the Green Climate Fund (GCF)) will be led by the Department of Climate Change. The key objective is to achieve a paradigm shift in urban planning and development through the early incorporation of NbS. It is the first ever urban ecosystem-based adaptation project to be approved by the GCF and the largest project of its kind in Lao PDR to date. Upscaling of the interventions from the 4 pilot cities to a further 13 cities is envisioned after the project is completed. The continued use of NbS to mitigate climate risks will be promoted in Lao PDR nationally, and recommendations will be produced to create a regulatory environment that is conducive to these types of measures in the future.

Source: (Sengchandala 2019)

NEPAL

Formulating the National Agroforestry Policy

LOCATION
Nepal

IMPLEMENTED BY
CTCN, World Agroforestry Centre (ICRAF)

FINANCING SOURCES
CTCN, ICRAF, Government of Nepal, Government of India (in kind)

SIZE OF THE FUND
USD 269,725

IMPLEMENTATION TIMEFRAME
2017-2018

TYPE OF NBS APPLIED
Formulation of the National Agroforestry Policy for Nepal

BENEFITS
Climate mitigation (increased carbon sequestration), adaptation (increased resilience to extreme events, increased water retention, food security, livelihoods)

IMPLEMENTATION CHALLENGES
Lengthy election processes for local and federal governments leading to reduced availability and participation of policymakers in consultations.

SCALE-UP
Nepal has pledged to maintain at least 40% of its area under forest; the mainstreaming of agroforestry in national planning through the new policy will support the achievement of this goal.

Growing vulnerability to climate change. Nepal is among the most vulnerable countries to climate change, in particular water-induced disasters and hydrometeorological events such as droughts, storms, floods, landslides, debris flow, soil erosion and avalanches. The IPCC predicts rises in both temperature and fluctuating precipitation patterns, which could have profound impacts on glaciers, wetlands, agriculture, and livelihoods. Climate impacts are already visible, as exemplified by the Glacier Lakes Outburst Floods that are caused by the failure of dams with glacial lakes, which have increased the number of glacial lakes and raised the frequency of extreme events, the adverse effects of which are expected to modify both tree cover and agricultural landscapes and impede carbon sequestration. The variability and uncertainty caused by climate change are slated to make water resource management planning increasingly challenging in Nepal.

Prioritizing forest management strategies and persisting barriers. Nepal has historically prioritized the development of climate-friendly forest management systems in their climate mitigation and adaptation responses, enlisting several community-based forest management groups. The Forestry Sector Strategy (2016-2025) aimed to enhance Nepal's forest carbon stock by at least 5 per cent by 2025 compared to the 2015 level. Agroforestry harbours huge potential and is recognized as one of the most effective overall approaches to provide a buffer against extreme weather events and above/below-ground ecosystem services such as reduced water loss from evapotranspiration, soil moisture retention, decreased wind and water erosion, and subsequent improvements in food, nutrition and energy security. However, harnessing agroforestry's full potential requires an enabling policy and regulatory framework to reverse restrictive regulations on felling, transport, and marketing of tree species, and to create finance and insurance instruments.

Effects on agriculture. Most farming communities have landholdings of less than 0.5 ha, which are being further diminished due to the rising population and divisions of wealth among family members. Thus, farmers need to produce the maximum per unit area to ensure their own food security. This stark reality can be ameliorated using multi-storied agroforestry systems. Agroforestry bestows benefits for both climate mitigation and adaptation. And in Nepal, it builds on practices that have already been in use for quite some time.

Formulation of the National Agroforestry Policy. The articulation of the need to formulate a National Agroforestry Policy in Nepal originated during a 2015 consultation workshop in Kathmandu organized by several ministries and attended by 150 stakeholders resulting in the "Kathmandu Declaration on Agroforestry." The Ministry of Agriculture Development requested support from the CTCN to develop the policy in coordination with the World Agroforestry Centre (ICRAF). To oversee the work on policy development, Government of Nepal constituted an Inter-Ministerial Coordination Committee (IMCC) comprised of several ministries and ICRAF.

Activities leading to the implementation of the national policy included an analysis of existing policies and laws affecting agroforestry, which indicated a clear need to develop a new national agroforestry policy since several existing policies imposed regulations that deterred farmers from adopting agroforestry. Implementers also seized an opportunity to meet with Indian policy makers who developed their own national agroforestry policy. Regional workshops were organized in various mountain areas, and extensive consultation with stakeholders also provided valuable information on barriers to adoption as well as other needs, such as diversification of food production to increase food security. The workshops also created awareness about the role of agroforestry in increasing resilience to climate change.

Mainstreaming gender considerations into policy is also essential. The CTCN Gender Policy and Action Plan 2019-2022 mainstreams gender considerations into all CTCN operations, including the evaluation of technical assistance requests, their design and implementation, and monitoring and evaluation.

The promotion of agroforestry practices through the national policy is expected to benefit approximately 2 million smallholders. Agroforestry practices present important opportunities for women's empowerment and entrepreneurship development, as such practices are generally more accessible to women with limited resources and credit, providing new opportunities for income generation. The creation of this national policy contributes to SDG 1 (no poverty), SDG 2 (Zero hunger), SDG 5 (Gender equality), SDG 6 (Clean water and sanitation), SDG 7 (Affordable and clean energy), SDG 13 (Climate action), and SDG 15 (Life on land).

Source: (CTCN 2017)

Summary of key findings and lessons learned

NbS viability for the Asia-Pacific region

A multitude of NbS application examples in the Asia-Pacific region have confirmed the **growing relevance of NbS in the region's efforts to strengthen water security and climate change resilience**. NbS address key impacts of water management and climate change and provide important opportunities to link adaptation efforts with those of sustainable development, creating benefits for flood and drought mitigation, coastal protection and clean water provision.

The case studies also demonstrate the versatility of NbS applications. From coastal to rural and urban landscapes, and from small-scale localized interventions to large-scale national and regional initiatives, NbS examples demonstrate that **its integration into adaptation and water management efforts can be done at a variety of scales, ecosystems and landscapes, and therefore has relevance for all countries in the region**. A transboundary approach to NbS could also be a viable approach for cooperation amongst countries.

NbS have in many cases shown to be a **cost-efficient supplement or alternative to the conventional water management infrastructure**, delivering benefits such as flood management, water filtration and pollution mitigation. Coastal NbS, targeting mangroves and coastal wetlands, have proven to be equally important for disaster risk reduction, and for protecting and strengthening ecosystem services that coastal communities heavily depend upon. Projects focusing on soil stabilization have also shown that **NbS have an equally important role to play in rural and agricultural cultivation areas, where such ecosystem-based interventions can strengthen resilience, food security, and livelihoods of local populations**.

In addition, a multitude of successful urban greening projects demonstrate **forward-thinking urban planning strategies using NbS to merge elements of climate resilience, ecosystem protection, access to green spaces and leisure opportunities for citizens and growth opportunities for local businesses**. These experiences have produced valuable lessons both from technical design and planning perspectives. In some cases, urban greening projects have highlighted the risks of gentrification. Many Asia-Pacific cities host sizeable poor and often informal settlements, and therefore, planning for urban NbS will need to take into consideration the socioeconomic context of these initiatives and work closely with the communities they seek to support and protect to ensure that NbS benefits are harvested by all.

Local stakeholder involvement as a prerequisite for success of NbS

Direct involvement of communities in the planning and design process of NbS can support inclusive efforts and help avoid unintended consequences. The communities surrounding potential NbS locations can provide invaluable information on the local socioeconomic and ecological conditions under which future NbS will operate. **NbS can be a particularly powerful tool for women's empowerment in climate change adaptation and resource governance, as many women already play an active role as the guardians and 'managers' of the NbS for ecosystem protection and maintenance in their communities.**

NbS initiatives also provide **an important tool for bringing together government and local actors involved in management of water, ecosystems, climate change adaptation and disaster risk management**. These challenges are intrinsically linked in the natural world and therefore cannot be effectively addressed without cross-sectoral coordination. NbS implementation can help establish a collective understanding of these interlinkages and ultimately enhance collective action to overcome administrative boundaries and holistically address challenges.

Taking a pragmatic approach to NbS implementation

Monitoring and evaluation of the impacts of NbS are vital tools for management, but also for communication with all stakeholders, including private sector, governments, and local communities. Through the quantification of NbS benefits, and by monitoring, evaluation and reporting, meaningful communication and negotiation can take place between different actors involved in the use and protection of ecosystems, strengthening the incentive to engage in NbS projects.

Case studies show that many countries have embraced a multitude of NbS types within a single project or initiative, often in combination with conventional built infrastructure. The experiences in the region thus confirm that **keeping options open and making use of the complementary nature of NbS and built infrastructure solutions is key**.

Financing NbS remains a challenge, but as case studies show, **there are many ways to finance NbS**. Because NbS implementation has the potential to deliver benefits to a vast array of ecosystem services users ranging from local farmers to city dwellers and local businesses to large power and industrial producers, this shared dependence on ecosystem services can be a strong motivator to invest in protection and enhancement of ecosystems. Projects have been financed by national and local governments, donor organisations, the private sector, and through community funds. Where government funding falls short, **innovative public-private partnerships can help fill the gap**. Further development of easily accessible economic tools to account for the great variety of costs and benefits will be needed to enable better integration of NbS into infrastructure portfolios, and to support the evaluation and determination of the NbS application modalities that are most cost-efficient in relation to conventional infrastructure.

Finally, **investment in NbS equals investment in the resilience and livelihoods of vulnerable communities of the Asia-Pacific**. There is a great need to continue the work on mainstreaming of NbS into national policies and the upscaling of approaches nationally and regionally.

Opportunities for scaling up NbS in the Asia-Pacific region

Mainstreaming NbS into climate change adaptation and mitigation

Recognizing NbS as a fundamental tool for climate change mitigation, adaptation and resilience building. NbS have a proven track record as an effective and cost-efficient approach to manage and mitigate the impacts of climate change within the water sector and beyond. Recognizing NbS in national climate change adaptation and mitigation plans and strategies can help open access to funding streams for upscaling through climate finance and provides a framework for integrating NbS into national and local climate change adaptation efforts.

Including NbS in countries' National Determined Contributions (NDCs) presents an opportunity to address adaptation and mitigation efforts in an integrated way. Many of the tested NbS (such as wetlands, peatlands, and forests) are important not only for adaptation, but also for mitigation through carbon uptake and reduced CO2 and methane emissions. By highlighting these multifaceted benefits of NbS, countries can increase their NDC ambitions under the UNFCCC convention while addressing important national commitments to achieving the SDGs and Aichi Biodiversity Targets, amongst others.[4]

Integrating NbS into the national and regional disaster risk management discourse can provide opportunities for financing the upscaling of NbS. Given the region's exceptionally high exposure to climate-related disasters, NbS have an important role to play in mitigating these risks, which will be particularly important for coastal communities and areas vulnerable to flooding.

Creating a favourable enabling environment for NbS implementation

Favourable regulatory frameworks on the national scale can also incentivize exploration of NbS for water management and broader sustainable development. National policies that integrate and incentivize NbS applications can help motivate actors to prioritize NbS when considering various infrastructure options.

NbS-focused standards and certification schemes can help mainstream inclusion of NbS into investment portfolios and place NbS on more equal footing with conventional built infrastructure. Such standardization can ease integration of NbS into regulatory environments, build investment confidence and ensure that NbS applications meet necessary quality standards. Global initiatives such as IUCN's Global Standard for NbS (IUCN 2020) and the Climate Bonds Initiative's water infrastructure standard (Climate Bonds Initiative 2021) are good starting points for such quality assurance.

4 Further analysis and guidance are also provided by Seddon et al. 2019.

Mainstreaming NbS into existing participatory planning and sustainable development processes

Building on the existing mechanisms of participatory governance and management of natural resources can help kick-start local and national-level NbS dialogue and initiatives. This includes building on integrated water resources management processes in-country, including basin level planning processes, and utilizing existing cross-sectoral dialogue platforms, organizations, or other participatory processes that bring together stakeholders across sectors and jurisdictions.

Considering rural-urban integration in spatial planning processes. As the regional population grows and city populations surge, sustainable urban development will remain central to ensuring sustainable growth and quality of life for urban communities. Mainstreaming awareness of NbS and the interconnectedness of urbanized areas and surrounding ecosystems into spatial planning processes will be important to shape sustainable and inclusive cities.

Mainstreaming NbS into national SDG coordination and implementation efforts can also help access finance and upscale NbS applications. Through their ability to deliver multiple cross-sectoral benefits, NbS can contribute to the achievement of several SDGs, making NbS a cost-efficient investment in the broader sustainable development agenda.

Building stakeholder capacity and awareness on NbS

Knowledge sharing and innovation platforms that bring together policy and decision-makers with practitioners of water management, conservation, restoration, engineering, spatial planning, disaster risk management and finance can help catalyse knowledge exchange and identify common opportunities to apply NbS.

Upscaling NbS through joining regional level initiatives (e.g. Mangroves for Future (IUCN 2021)) can help not only to improve access to funding opportunities, but also ensure that restoration and protection efforts are coordinated across administrative boundaries, ensuring the vital connectivity of ecosystems.

Finally, **sensitizing governments, businesses, and other stakeholders, including the broader population, to the fundamental value and benefits of our ecosystems** is paramount to changing the existing paradigm in which ecosystems are viewed as 'open' frontier for rampant land development and conversion to one in which ecosystems are valued for their intrinsic value and vital assets.

As the world grapples with the economic and public health effects of the global pandemic, there is an emerging opportunity to re-evaluate how to best invest resources in the post-pandemic recovery. The experiences of the last year have exposed not only the risks to public health but have also highlighted the critical importance and inequality of access to safe water, sanitation, and nature for all citizens.

NbS as an approach offers an opportunity to invest in wise and sustainable recovery from the COVID-19 pandemic, and to address climate resilience and water management through holistic management approaches that maximize the efficiency of future investments in sustainable development for countries of the Asia-Pacific region.

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