WORKING WITH NATURE TO PROTECT PEOPLE

HOW NATURE-BASED SOLUTIONS REDUCE CLIMATE CHANGE AND WEATHER-RELATED DISASTERS

IFRC

Implementing nature-based solutions to protect people and nature

WWF

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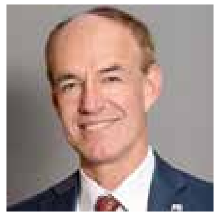
FOREWORD



Marco Lambertini, Director General, WWF

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The world's most vulnerable people are already bearing the brunt of the climate and nature crises. Climate change- and weather-related disasters have increased 40% over the last 20 years, and those disasters are being felt mostly in developing countries. Around the world, sudden-onset climate-related disasters, such as droughts and floods, killed around 410,000 people in the last decade; nine in ten of the victims of those disasters were in the developing world.

With greenhouse gas emissions continuing to rise, the frequency and severity of these disasters will only worsen in the decades to come. This will put enormous pressure on vulnerable communities and on the humanitarian organizations that come to their aid.

The unabated destruction of natural habitats and the decline of biodiversity are the other side of today's global ecological crisis. With 90% of ocean fish stocks over or fully fished, half of coral reefs disappeared, populations of pollinators in steep decline around the world and forests being cleared and burned at an accelerating rate, nature's contribution to humanity is weakening and our chances to eradicate poverty, hunger and malnutrition are deeply undermined.

But we are not helpless in the face of climate and environment related disasters. There is much that we can do to mitigate the impacts, to adapt to a warming world, and to build resilience among communities on the front line of the climate crisis.

We can work together with nature to protect people

In addition to sharply reducing greenhouse gas emissions, transformational Nature-based Solutions are one of the most powerful tools we have at our disposal to help protect communities against disasters and increase their ability to adapt to a changing climate. Such solutions include healthy connected floodplains, which can reduce flood risk; reforestation, which can help prevent landslides; or restoration of mangroves and coral reefs, which can protect against storm surges.

Nature-based Solutions not only promise to save lives; they can also save money. Climate change threatens developing countries with enormous economic impacts, of between U$400-800 billion/year by 2030. Implementing Nature-based Solutions initiatives could reduce this figure by a quarter.

Working with nature brings numerous co-benefits. Such solutions can provide sources of food and fibre critical to local livelihoods, while protecting biodiversity. They can improve communities' water security and contribute to human health and well-being. They also play their part in absorbing carbon from the atmosphere, helping to limit further warming and climate impacts. Critically, they also enhance the health of ecosystems on which livelihoods depend and boost biodiversity, helping to reverse nature loss.

A new partnership

In recognition of the role that nature can play in protecting people and reducing the impact of disasters, our two networks – the International Federation of Red Cross and Red Crescent Societies (IFRC) and the World Wide Fund for Nature (WWF) – have come together to promote awareness of Nature-based Solutions, and to encourage governments, communities, donors, practitioners and the private sector to incorporate nature in their climate adaptation and disaster risk reduction action.

This flagship report frames our partnership. It explains the potential of Nature-based Solutions and sets out the enabling conditions for, and obstacles to, successful Nature-based Solutions initiatives. It provides case studies of the real world Nature-based Solutions that are already in place and the work that the IFRC and WWF are doing in this area, along with key lessons to guide practitioners and policymakers.

In the face of the climate and nature crises, adaptation and mitigation must go hand in hand. Effective disaster risk reduction and adaptation measures help communities cope with the acute challenges facing them. These adaptation measures will be obsolete unless the current level of greenhouse gas emissions are rapidly and drastically reduced. Continued warming will overwhelm the ability of vulnerable communities to adapt, and of Nature-based Solutions to be effective. We have a rapidly closing window in which we must act. And we must act together.

ACKNOWLEDGEMENTS

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Dalberg Advisors
Dalberg Advisors is a strategy consulting firm that works to build a more inclusive and sustainable world where all people, everywhere, can reach their fullest potential. We partner with and serve communities, governments, and companies providing an innovative mix of services – advisory, investment, research, analytics, and design – to create impact at scale.

IFRC
The International Federation of Red Cross and Red Crescent Societies (IFRC) is the world's largest humanitarian network, with 192 National Red Cross and Red Crescent Societies and around 14 million volunteers. Our volunteers are present in communities before, during and after a crisis or disaster. We work in the most hard to reach and complex settings in the world, saving lives and promoting human dignity. We support communities to become stronger and more resilient places where people can live safe and healthy lives, and have opportunities to thrive.

WWF
WWF is one of the world's largest and most experienced independent conservation organizations, with over 5 million supporters and a global network active in more than 100 countries. WWF's mission is to stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature, by conserving the world's biological diversity, ensuring that the use of renewable natural resources is sustainable, and promoting the reduction of pollution and wasteful consumption.

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CONTENTS

CALL TO ACTION

Communities across the world are experiencing the growing devastating impacts of climate change and weather-related disasters. The resulting social, economic and environmental impacts are disproportionately affecting the world's most vulnerable people. Without urgent action to combat climate change, build climate resilience and reduce the risk of climate change and weather-related disasters, these disasters will continue to cause unprecedented damage.

Nature-based Solutions (NbS) have been identified as unique and effective ways to support disaster risk reduction and climate change adaptation while also contributing to multiple societal goals, including improvements in human health and well-being, food and water security, and greenhouse gas emissions reductions. However, NbS are far from reaching their full potential, with initiatives remaining largely small-scale and project based. Faced with the scale of the climate crisis, countries need to start investing in transformational NbS to better manage the ever-increasing risk of disasters.

This report shows that scaling up NbS protects society from some of the most severe consequences of climate change, including the economic cost of losses and damages; reduces some of the intensity of climate and weather-related disasters; and potentially reduces the number of people in need of international humanitarian assistance due to climate change. Each year, implementing NbS could provide developing countries with valuable protection against economic cost of climate change, estimated to save developing countries at least US$ 104 billion damages in 2030. Now is a critical moment to unleash the full potential of NbS for disaster risk reduction and climate change adaptation by supporting their successful implementation and scale-up. IFRC and WWF are joining together to accelerate the implementation of NbS and are calling on governments, the private sector, practitioners and civil society to act.

IFRC AND WWF CALL ON GOVERNMENTS TO:

At the international level:

- Provide technical and adequate financial support to implement NbS at scale, including sharing of the best practices among states and stakeholders, with a particular focus on the most vulnerable communities and ecosystems
- Provide support for increased research into the potential of NbS, in particular for disaster risk reduction, climate change adaptation and in humanitarian contexts, including coordinating research efforts and compiling examples of best practices based on the best available science
- Scale up NbS for disaster risk reduction and climate change adaptation actions while avoiding maladaptation
- Recognize the limitations and trade-offs of NbS for climate change adaptation and disaster risk reduction
- Ensure social and environmental safeguards, and promote NbS implementation in conjunction with rapid, deep and sustained reductions in greenhouse gas emissions.

At the national level:

- Align national policy, planning and legal frameworks with international policy frameworks, including UNFCCC, CBD and the Sendai framework for disaster risk reduction
- Create and adapt national legislation and policies that support multi-sectoral planning and coordination of NbS to incentivize implementation at scale, with a particular focus on synergies between climate change adaptation and disaster risk reduction
- Integrate NbS across local, sub-national, national and regional plans and policies
- Promote NbS alongside more sustainable and resilient 'grey' infrastructure to provide protection against climate change and weather-related disasters while providing multiple co-benefits
- Ensure national budgets include sufficient funding to implement NbS at a scale that can have a meaningful, lasting impact on disaster risk reduction and climate change adaptation
- Ensure Indigenous Peoples and local communities are involved in the decision-making processes; have access to technical and financial resources, and technologies; and are not constrained by discriminatory legal or institutional barriers
- Increase investment in monitoring and evaluation of the performance of NbS, including the quantification and qualitative assessment of potential co-benefits of NbS, including for disaster risk reduction.

PRIVATE SECTOR TO:

- Catalyze collective action on NbS at scale by identifying and/or developing platforms that allow different companies and organizations from across industries and sectors to work together to support NbS implementation and funding
- Scale up investment in existing forms of private sector finance mechanisms for NbS. Invest in exploring innovative new finance mechanisms (such as insurance mechanisms) for NbS for climate adaptation and disaster risk reduction, establishing their scale-up potential and feasibility in different geographies
- Ensure strong environmental and social safeguards are in place when supporting NbS activities/interventions.

PRACTITIONERS TO:

- Follow the IUCN NbS Global Standard when designing, implementing and monitoring NbS projects, and support efforts to understand how it can best be applied in disaster risk reduction, climate change adaptation and within humanitarian contexts
- Work with groups representing Indigenous Peoples and local communities to design and develop high-quality and high-integrity projects, in accordance with local, national and regional circumstances and needs that support disaster risk reduction and climate change adaptation. Use well-reviewed and common tools such as the WWF's systemic enabling framework for NbS (https://lp.panda.org/powering-nature-report) and the IFRC's Roadmap to Community Resilience and EVCA tool (https://www.ifrcr2r.org/).
- Scale up project implementation to develop case studies of NbS in practice and build out the evidence base, in particular filling the evidence gaps that currently exist on the potential of NbS with some climate-related hazards (e.g. droughts and desertification) for disaster risk reduction and in humanitarian contexts.

CIVIL SOCIETY TO:

- Advocate for and provide the necessary support to governments to increase mainstreaming of NbS within national policy, planning and legal frameworks (e.g. Nationally Determined Contributions (NDCs), National Action Plans (NAPs), National Biodiversity Strategies and Action Plans (NBSAPs), national disaster risk reduction plans, etc.) as well as to implement NbS for disaster risk reduction and climate change adaptation
- Disseminate information to close the knowledge gap and enable more successful implementation of NbS interventions
- Advocate for equal public and private investment in climate change mitigation and adaptation, and for a larger portion of funds to go to NbS.

> IFRC and WWF are joining forces to increase awareness and action to build climate and disaster resilience of the most at-risk communities – through working with nature. Their partnership aims to raise awareness of how nature protects people and biodiversity, especially in disaster and humanitarian contexts.

EXECUTIVE SUMMARY

Communities across the world are already experiencing the devastating and increasing impacts of climate change and weather-related disasters and hazards. Climate change and weather-related disasters and hazards have increased over the past decades. This includes sudden-onset climate change and weather-related disasters and hazards such as floods that emerge rapidly and unexpectedly, and slow-onset climate-related disasters and hazards such as sea-level rise that gradually emerge. The number of reported sudden-onset climate change and weather-related disasters has increased by more than 40% over the last 20 years.[1] From 2006 to 2015, the rate of global sea-level rise was 2.5 times faster than it was for almost all of the 20th century.[2] These disasters have caused significant human, economic and environmental impacts. Sudden-onset climate change and weather-related disasters have killed more than 410,000 people from 2010 to 2019[3] and displaced 30 million people in 2020 alone.[4]

The world's most vulnerable people are being hit the hardest, with 91% of sudden-onset related deaths from 1970 to 2019 occurring in developing countries.[5] Climate change and weather-related disasters and hazards can affect anyone, but impacts are not felt equally among affected people. Several factors influence how climate change and weather-related disasters and hazards impact the well-being of people, including wealth, education, race, ethnicity, religion, gender, age, class, disability, and health status.[6] These drive differences in climate change and weather-related disaster and hazard outcomes.

Under the current greenhouse gas emissions trajectory, climate change and weather-related disasters and hazards, and their impacts, will reach unprecedented levels in the coming decades, causing significant damage to people and the environment.[7, 8] Climate change will continue to contribute to increases in the frequency and intensity of climate- and weather-related hazards. The extent of these increases will depend on how greenhouse gas emissions evolve. Under an intermediate emissions pathway, where emissions start decreasing from 2040, heat events that currently happen 2.8 times a decade could increase to 5.6 times a decade within 30 years.[9] Humanitarian response and disaster risk reduction systems will struggle to keep up with the growth in frequency and severity of climate change and weather-related hazards, translating into more severe human, economic and environmental losses. The International Panel on Climate Change (IPCC)[10] estimates that climate change and related extreme events will significantly increase ill health and premature deaths from the near- to long-term (2021-2100).[11]

NbS, which protect, sustainably manage or restore nature, are a key tool to safeguard people from climate change and weather-related disasters and hazards and increase their ability to adapt to climate change. Nature[12] can address all parts of the risk equation, reducing the likelihood of hazards developing, exposure to hazards, and the vulnerability of communities. Nature can reduce the likelihood of and prevent the occurrence of climate change and weather-related hazards. For example, vegetation on slopes can prevent landslides from occurring during heavy rain events by slowing the movement of rainwater and holding the soil together.[13] Nature also often acts as a natural buffer against climate change and weather-related hazards that do happen, reducing exposure and protecting people and their assets from their worst impacts. For example, mangroves and coral reefs act as natural storm and flood defence , providing a protective barrier that buffers shorelines from the hazard impact.[14, 15, 16] Nature also provides multiple services, including the provision of food, which can increase community resilience to climate change and weather-related disaster impacts. NbS include initiatives focused on: i) protecting nature, ii) restoring nature, iii) sustainably managing nature, or iv) creating ecosystems.[17] By allowing nature to continue to provide services that protect communities from climate change and weather-related hazards, and increase community capacity to adapt to them, NbS have a strong potential to reduce disaster risk and support climate change adaptation.

NBS DEFINITION

Actions to protect, sustainably manage and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits.[18]

Scaling up NbS now could protect society from some of the most severe consequences of climate change: the economic cost of losses and damages, and the number of people in need of international humanitarian assistance due to climate- and weather-related disasters..

NbS has the potential to reduce the intensity of climate change and weather-related hazards by at least 26%.[19, 20] A limited number of studies have attempted to quantify the reduction in climate- and weather-related hazard intensity from the presence of nature. This includes a meta-analysis of 69 studies of five habitats worldwide that estimated coastal habitats, including coral reefs, mangroves, salt marshes, seagrass/kelp beds, on average reduce wave heights by between 35% and 71%.[21] An assessment of the evidence suggests that by protecting, restoring or sustainably managing nature, NbS could potentially reduce the intensity of climate change and weather-related hazards by at least 26%.[22]

Implementing NbS could provide developing countries with valuable protection against the economic cost of climate change. By 2030, the annual cost of losses and damages from climate change is projected to reach between US $402 billion and US $805 billion in developing countries.[23] This is expected to rise to between US$1.5 trillion and US $2.4 trillion annually by 2050.[24] Implementing NbS could save developing countries at least US $104 billion in 2030 and US $393 billion in 2050 by reducing the intensity of climate change and weather-related hazards by at least 26%.[25]

Implementing NbS could also reduce the number of people in need of international humanitarian assistance due to climate change and weather-related disasters, but further research is needed to unpack the quantified potential. By 2030, 150 million people a year could need humanitarian assistance due to floods, droughts and storms.[26] By 2050, this is expected to rise to 200 million people annually.[27] Climate change is also increasingly driving displacement, with this expected to increase in the medium-to-long term.[28] By reducing the intensity of climate change and weather-related hazards, implementing NbS now could potentially avoid some of the projected increase in displacement, migration and the number of people in need of humanitarian assistance. However, the drivers of displacement, migration and people in need of international humanitarian assistance are highly complex.[29, 30] Various demographic, historical, political, social and economic factors determine whether people can withstand climate change and weather-related hazard impacts or are forced to leave their homes.[31] Further research is therefore needed to unpack the contribution of hazard intensity reduction in reducing displacement, migration and the number of people in need of humanitarian assistance and quantify the reduction that implementing NbS at scale could achieve.

If well designed, NbS can also achieve multiple co-benefits and contribute to sustainable development. Ensuring nature can provide its many services can contribute to multiple societal goals, alongside supporting disaster risk reduction and climate change adaptation. This contrasts with many traditional approaches, including engineered solutions that often provide only a single benefit of physical protection from hazard impacts.[32] NbS benefits include contributing to food and water security, climate change mitigation, health improvements, protection and enhancement of nature, and job creation. NbS can provide approximately 20-30% of the solutions needed to meet emissions targets under the Paris climate agreement, in a cost-effective way.[33]

However, climate change threatens the future potential of NbS, meaning implementation must be scaled up now as part of a package of disaster risk and climate change initiatives. If global warming increases by more than 1.5°C, some NbS measures will lose their effectiveness at tackling societal challenges. This is because nature will reach hard adaptation limits where it cannot adapt to climate impacts and damage will become unavoidable,[34] resulting in losses of ecosystems and their services. Under such a scenario, the ability of NbS to reduce disaster risk and support climate change adaptation would be limited, as nature would be unable to provide services that protect communities and increase their resilience. For NbS to deliver cost savings and limit the rise in displacement and people in need of humanitarian assistance from climate change and weather-related disasters and hazards, and provide its many co-benefits, implementation must therefore be scaled up now and packaged with climate mitigation and other disaster risk reduction and climate change adaptation initiatives.

The growing base of successful projects highlight several key enablers for NbS: engagement of local stakeholders; a supportive legal and policy environment; multi-stakeholder approaches; utilizing both traditional knowledge and science; and ensuring both long- and short-term benefits are delivered. As NbS often rely on local communities to implement and manage the interventions,[35] the engagement of local stakeholders is crucial for successful implementation.[36] This helps ensure that projects work in the local context, local people experience the benefits, and that the project is sustainable. Establishing legal and policy frameworks that support NbS is also critical for success.[37] Laws, policies and plans provide the often invisible foundation for NbS – performing critical functions such as ensuring adequate funding, and establishing mandates and roles and responsibilities.

However, there are several barriers to mainstreaming NbS for disaster risk reduction and climate change adaptation, including resource gaps and a lack of translating policies into practice. Ambition for NbS does not match reality,[38] and commitments to NbS have yet to translate into sufficient action on the ground.[39] This is because several barriers prevent the mainstreaming and scaling up of NbS for disaster risk reduction and climate change adaptation. NbS are severely underfunded, with adaptation-related NbS receiving only 0.6-1.4% of total climate finance flows in 2018.[40] While policies are increasingly supportive of NbS, there is a lack of sufficient government budgets and investment for policy implementation. There are also implementation challenges, including a lack of implementation knowledge for NbS and difficulties regarding monitoring, evaluating and learning from NbS.

To support the successful implementation, mainstreaming, and scaling-up of NbS for reducing climate change and weather-related disaster risk, several steps need to be taken to overcome these challenges:

- Support development of a stronger evidence base and coordinate research efforts to close the knowledge gap, understand what constitutes successful and sustainable NbS, how NbS can reduce climate change and weather-related disasters, and how climate change affects the potential of NbS
- Examine the limitations of specific NbS measures based on each project context
- Close capacity gaps, at all levels
- Close the NbS funding gap for measures including disaster risk reduction and climate change adaptation through, for example, exploring private-sector innovations beyond carbon markets to support NbS financing
- Align and harmonize international and national policy, planning and legal frameworks on climate change, development, environment and disasters to promote harmonized approaches to resilience and risk reduction across sectors and ministries/ departments
- Promote standardized models of engaging Indigenous Peoples and local communities in planning and implementing NbS
- Recognize that the potential of NbS is limited and therefore implement NbS as part of a broader package of disaster risk reduction, climate change adaptation and climate change mitigation interventions

IFRC and WWF are joining forces to increase awareness and action to build climate and disaster resilience of the most at-risk communities – through working with nature. Their partnership aims to raise awareness of how nature protects people and biodiversity, especially in disaster and humanitarian contexts. It will explore how NbS, and other efforts to protect and enhance nature, can strengthen the resilience of vulnerable landscapes and communities to climate and disaster risk. It will leverage the mandate and expertise of each organization to promote the integration of NbS in national climate and disaster plans, policies and legal frameworks and action on the ground. The combined presence of the organizations in 192 countries, with a long history of work, credibility and relationships with national and local stakeholders, will enable the partnership to support meaningful implementation and scaling up of NbS.

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Aerial view of Cacau Pirêra, a village located on the right shore of the Negro river, in front of the city of Manaus, which is also suffering the impacts of the historic flood.

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CHAPTER 1

Climate change and weather-related disasters are already posing significant threats to human lives, livelihoods and nature

Over the last few decades, climate change and weather-related disasters and hazards have dramatically increased. This includes both sudden-onset disasters and hazards, such as floods and storms, that emerge rapidly and unexpectedly, and slow-onset disasters and hazards, such as sea-level rise and desertification, that emerge gradually. Between 1970 and 2019, a sudden-onset climate change and weather-related disaster occurred every day, on average.[41] The number of reported sudden-onset climate change and weather-related disasters has increased by more than 40% over the past two decades.[42] Slow-onset climate change-related disasters and hazards tend to receive less attention in the literature because their impacts are more gradual.[43] Some data quantifying the rise in slow-onset climate-related hazards are available, but they remain limited. For example, between 2006 and 2015, the rate of global sea-level rise was 2.5 times faster than it was for almost all of the 20th century.[44]

These climate change and weather-related disasters have resulted in three types of losses: social, economic and environmental. Social losses include death, negative health and nutrition impacts, displacement, and livelihood destruction (see spotlight 1 and 2; sometimes also considered within economic losses).[47, 48] Economic losses include economic costs, job losses and reduction of labour productivity. Environmental losses include damage to nature, species losses, and mass mortality events. *See the disaster and hazard impacts panel for a more detailed overview of social, economic and environmental losses.*

CLIMATE CHANGE AND WEATHER-RELATED HAZARDS

Climate change and weather-related hazards are defined as a natural process or phenomenon related to weather or climate that has the potential to cause loss of life, injury or other health impacts, property damage, social and economic disruption or environmental degradation.[45] This includes both sudden and slow-onset hazards:

Sudden-onset climate change and weather-related hazards

Sudden-onset climate change and weather-related hazards emerge quickly and unexpectedly, including wildfires, drought, floods, storms, extreme temperatures and landslides. Sudden-onset climate change and weather-related hazards do not include sudden geophysical hazards such as earthquakes or volcanic eruptions.

Slow-onset climate change and weather-related hazards

Slow-onset climate change-related hazards are defined as natural hazards that emerge gradually and are influenced by climate change, including sea-level rise, drought and desertification, increasing temperatures, ocean acidification, glacial retreat, salinization, land and forest degradation, and loss of biodiversity.

CLIMATE CHANGE AND WEATHER-RELATED DISASTERS

A **disaster** is defined as a serious disruption of the functioning of a community or a society at any scale due to the occurrence of a hazard that causes great damage or loss of life.[46] This report defines climate change and weather-related disasters as disasters caused by the occurrence of climate change and weather-related hazards, including both sudden-onset climate change and weather-related hazards and slow-onset climate change-related hazards interacting with conditions of exposure, vulnerability and capacity, leading to one or more of the following: human, material, economic and environmental losses and impacts.

Sudden-onset climate change and weather-related disaster

A disaster caused by the occurrence of a sudden-onset climate change and weather-related hazard interacting with conditions of exposure and vulnerability and capacity, leading to one or more of the following: human, material, economic and environmental losses and impacts.

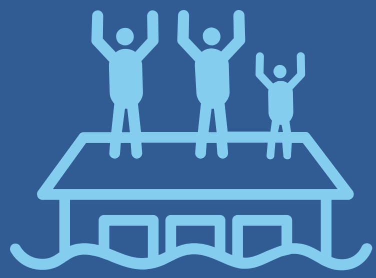
Slow-onset climate change and weather-related disaster

A disaster caused by the occurrence of a slow-onset climate change-related hazard interacting with conditions of exposure, vulnerability and capacity, leading to one or more of the following: human, material, economic and environmental losses and impacts.

***Note:** The literature and reports referenced in this report include a range of terms when talking about climate change and weather-related hazards and disasters including extreme weather events, extremes, catastrophes, sudden-onset events, hazards and disasters. For consistency in this report, the terminology outlined below has been applied throughout this report based on the definitions. In some cases, terminology does not map word for word with the term used in the source material.*

DISASTER AND HAZARD IMPACTS PANEL

Note: The majority of data quantifying climate change and weather-related disaster impacts covers sudden-onset disasters, with a lack of comprehensive data quantifying the impact of slow-onset disasters. This is partly driven by the difficulty associated with quantifying the full extent of slow-onset hazards due to their gradual nature, which means the start of the hazard often occurs long before the impacts are felt.[49]

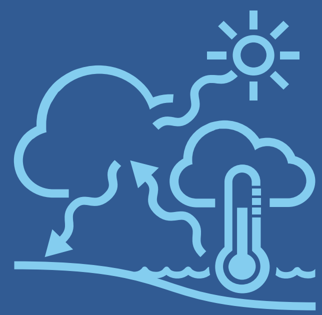


Social losses:

- From 2010 to 2019, 410,000 people were killed by sudden-onset climate change and weather-related disasters.[50] This is despite advances in disaster preparedness and response, which have led to significant reductions in disaster mortality over the past decades.
- Sudden-onset climate change and weather-related disaster deaths are concentrated in developing countries, with 91% of deaths between 1970 and 2019 occurring there.[51, 52]
- Increasing weather and climate extreme events have exposed millions of people to acute food insecurity and reduced water security.[53]
- Climate change has adversely affected both physical and mental health, with mental health challenges associated with increasing temperatures, trauma from extreme weather and climate events, and loss of livelihoods and culture.[54]
- Sudden-onset climate change and weather-related disasters were responsible for 98% of new disaster-related internal displacements in 2020, impacting 30 million people.[55]

Economic losses:

- The reported economic losses from sudden-onset climate change and weather-related disasters from 2010 to 2019 (more than US $1.4 trillion in total, US $413 million per day on average over the decade) were seven times the amount reported from 1970 to 1979.[56, 57]
- The total estimated cost of insured damages from sudden-onset climate change and weather-related disasters in 2021 was US $101.1 billion.[58] However, this is likely to be a significant underestimate of the total cost because a large proportion of damage goes unreported due to the lack of insurance coverage in developing nations.[59]
- The economic cost of land degradation, including desertification, is estimated at US $553 billion per year.[60]
- Globally, between 2000 and 2015, 23 million working-life years were lost annually as a result of hazards caused or intensified by human activity (this includes losses from sudden-onset climate change and weather-related hazards but also biological [e.g. insect infestation] and certain technological [e.g. industrial or miscellaneous accidents] hazards that are not in the scope of this report).[61]



Environmental losses:

- Climate change has caused substantial damage, and sometimes irreversible losses to terrestrial, freshwater, coastal and marine ecosystems.[62]
- Between 2009 and 2018, about 14% of coral in the world's coral reefs was lost. This was mostly due to recurring large-scale coral bleaching events, which are primarily caused by climate change. Other local pressures played a role, including coastal development, land-based and marine pollution, unsustainable fishing and tropical storms.[63]
- Hundreds of local species have been lost because of increases in the magnitude of heat extremes.[64]
- Climate change affects at least 10,967 species on the IUCN[65] Red List of Threatened Species.[66]
- Climate change has caused mass mortality events on land, in rivers and in the ocean.[67]

SPOTLIGHT 1: The increasing frequency of floods is affecting millions of people annually, causing loss of human life, property damage, and threatening livelihoods through crop destruction.

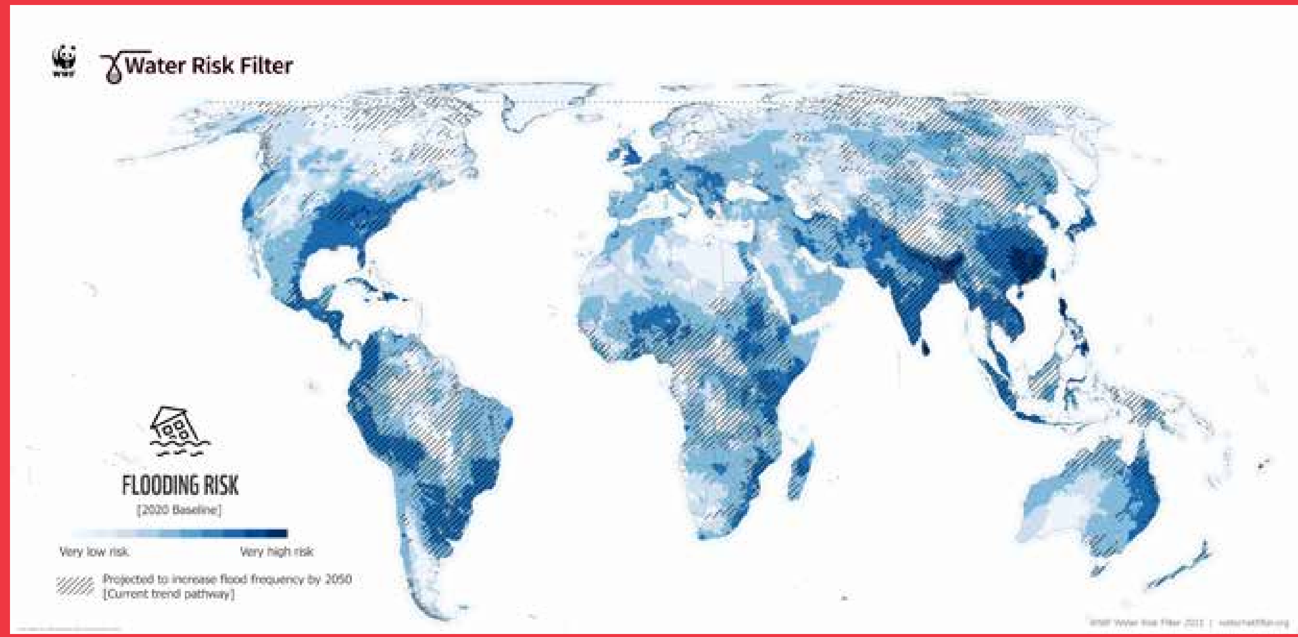
Globally, the frequency of floods and other hydrological events has quadrupled since 1980 and has more than doubled since 2004.[68] Floods affect more people globally each year than any other disaster. In 2019 alone, 127 floods affected 69 countries.[69] Floods have significant social consequences for communities and individuals. Impacts of flooding include loss of human life, damage to property, destruction of crops and loss of livestock.[70] Floods have also led to health problems due to increased occurrence of diarrhoeal diseases, including cholera and other gastrointestinal infections.[71] For example, in August 2018, the Indian state of Kerala witnessed floods in all 44 of its rivers, breaking records going back 100 years. More than 500 people died, 220,00 were made homeless and an estimated 23 million were affected, with 60,000 hectares of cropland destroyed. More floods hit in August 2019 while the state was still recovering. Another 180 people lost their lives, 109,896 people were evacuated, more than 16,000 houses were damaged, and 13 hectares of cropland were washed away.[72]

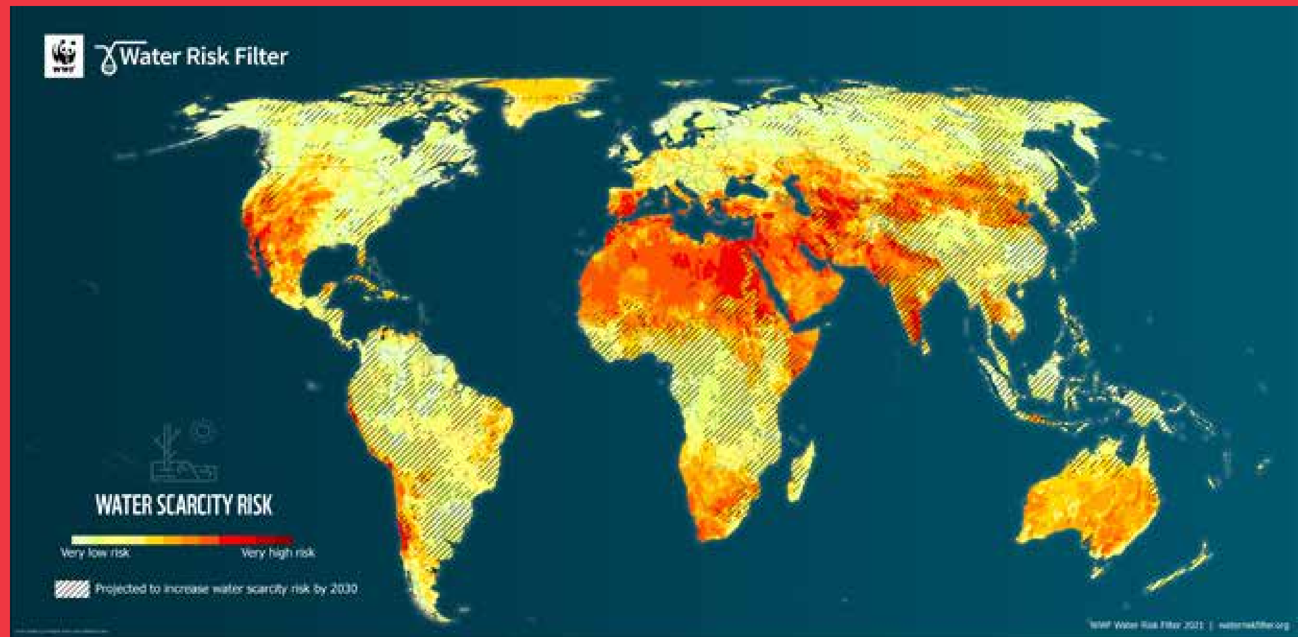
SPOTLIGHT 2: The increase in areas impacted by drought and desertification, together with a rise in the frequency of such events, threatens food security, livelihoods and even lives, and drives displacement and migration.

There is high confidence among climate scientists that the range and intensity of desertification have increased in some dryland areas over the recent decades.[73] There is also evidence of an increase in the frequency and intensity of droughts,[74] as well as an increase in areas impacted by droughts. Regions as diverse as Australia, California, East Africa, the Eastern Mediterranean and South Africa have experienced severe – and, in some cases, unprecedented – droughts in recent years.[75] Desertification and droughts can significantly threaten food and water security, livelihoods and even lives. For example, severe drought affected East Africa from July 2011 to mid-2012,[76] causing a severe food crisis across Djibouti, Ethiopia, Kenya and Somalia. In Somalia, conflict worsened the crisis, leading to an estimated 258,000 deaths.[77] Desertification and drought are also significant drivers of displacement and migration, alongside other social, economic and political drivers. During the East African drought, an estimated 290,000 Somalis fled across the border into neighbouring countries, while an estimated 1.3 million or more were internally displaced.[78] Studies of Africa's Sahel region have also consistently found migration to be a response to long-term drought and desertification.[79]

SPOTLIGHT 3: Sea-level rise and coastal erosion are causing increasing damage to homes, infrastructure, and nature, driving displacement and migration.

Sea-level rise is already impacting livelihoods, infrastructure, food security and nature.[80] It has contributed to coastal erosion, which is widespread in the coastal zone of Asia and other countries in the Indian Ocean.[81] For example, the net erosion along the southern Thailand coastline is approximately 1.3-1.7 metres a year.[82] This sea-level rise and coastal erosion can cause damage to homes, infrastructure and agricultural lands, and threatens the existence of cities and settlements in low-lying areas and some island nations.[83] For example, Bangladesh has suffered some of the fastest recorded sea-level rises globally. A 2013 analysis found that high tides in Bangladesh were rising 10 times faster than the global average.[84] Two-thirds of the country is less than 5 metres above sea level, and floods are increasingly damaging homes, crops and infrastructure.[85, 86] This damage has led to the displacement of coastal populations.[87] Although there are other drivers, the primary driver of the displacement of coastal populations is tidal flooding caused by sea-level rise.





WWF Water Risk Filter maps showing current risk of flooding and water scarcity in river basins across the world. The shading highlights river basins that are projected to be at higher risk of flooding and water scarcity in 2030 based on analysis by WWF Water Risk Filter climate and socio-economic scenarios (waterriskfilter.org/explore/scenarios)

The burden of climate change and weather-related disaster and hazard impacts is disproportionately felt by vulnerable and marginalized groups, worsening existing inequalities and driving further vulnerability. Climate change and weather-related disasters and hazards can affect anyone, but some people have the potential to be more affected than others. Several factors affect how climate change and weather-related disasters and hazards impact the well-being of people or groups, including wealth, education, race, ethnicity, religion, gender, age, class, disability and health status.[88] Vulnerability is higher in locations with poverty, governance challenges, limited access to basic services and resources, violent conflict and high levels of climate-sensitive livelihoods, such as smallholder farmers.[89] These factors can impact people's capacity to respond to climate change and weather-related disasters and hazards, including their ability to anticipate, prevent and mitigate risks. This can lead to differences in climate change and weather-related disaster and hazard outcomes. Between 2010-2020, human mortality from floods, droughts and storms was 15 times higher in highly vulnerable regions, compared to regions with very low vulnerability.[90]

In general, it is the world's poorest and most vulnerable people who suffer most from climate change and weather-related disasters and hazards. From 1970 to 2019, 91% of deaths from sudden-onset climate change and weather-related disasters occurred in developing economies.[91, 92] Economic losses, as a proportion of gross domestic product, are also higher in low-income countries (*see Figure 1*). This higher impact is driven by the higher share of impoverished populations in vulnerable urban zones, weak infrastructure, lack of basic facilities, and limited government capacity. These factors increase both exposure and vulnerability to disaster impacts.[93] Low-income countries also suffer more from slow-onset climate change-related hazards due to higher vulnerability and lower adaptive capacity. According to estimates, 90% of low-income countries[94] face a high or very high risk of loss and damage due to slow-onset hazards, while only 5% of high-income countries face such risks.[95]

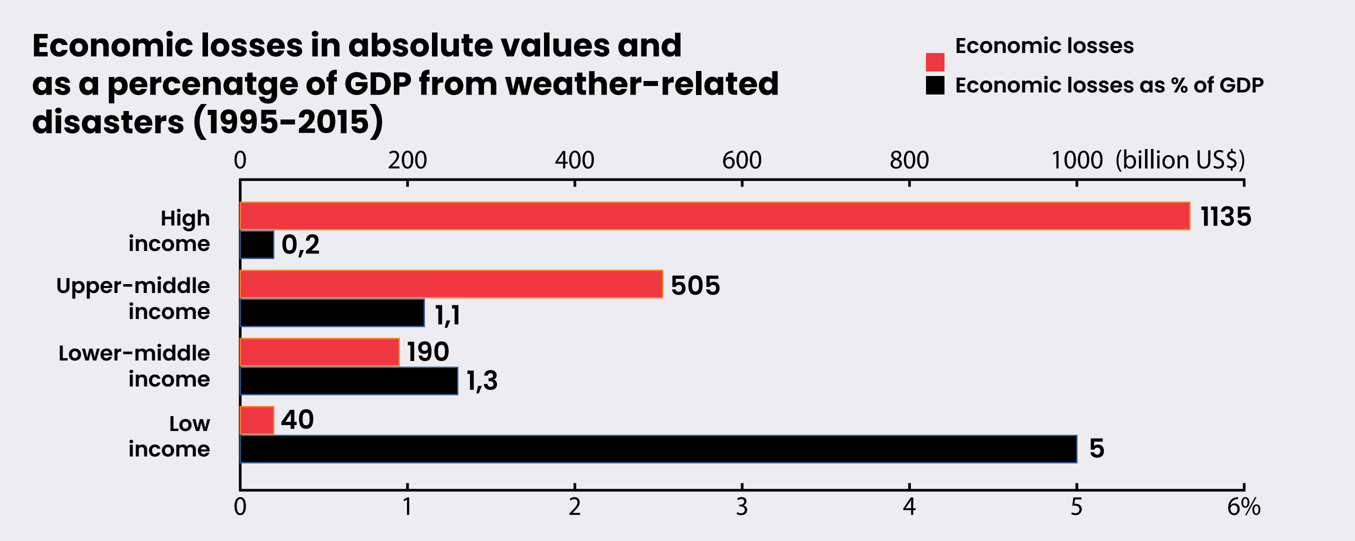


Figure 1: Economic losses from sudden-onset climate change and weather-related disasters as a proportion of GDP [96]

Marginalized groups including women, children, ethnic minorities and those with disabilities also suffer disproportionately from disaster and hazard impacts. Studies show that women, boys and girls are 14 times more likely than men to die during a disaster.[97] This is driven by unequal access to information and preparedness, economic prospects being more dependent on the environment, less aid and response, and less economic mobility. People with existing physical or mental health problems may also suffer larger climate change and weather-related disaster impacts due to a lower ability to respond because of physical constraints or insufficient support provided in emergency preparedness planning.[98, 99] Indigenous People also suffer disproportionately from climate change impacts due to their dependence upon, and close relationship with, nature and its resources.[100]

SPOTLIGHT: Climate change and weather-related disasters are gender-neutral, but their impacts are not.[101]

In general, women are more exposed and vulnerable to climate change and weather-related disasters and their impacts, which drives disproportionate disaster outcomes.

Access to information on disaster preparedness and public shelters, and limits to mobility, contribute to gendered mortality outcomes, disadvantaging women. This gender discrepancy has come to light in a range of major disasters, including Hurricane Mitch, Hurricane Katrina and other storms in the Americas; European heat waves; and cyclones in South Asia.[102] Gendered mortality outcomes are more common in places where women do not have equal economic and social rights to men.[103] In some cases, more men than women have died from climate change and weather-related disasters as they placed themselves at risk while helping their families.[104] Evidence suggests gender-based violence is also likely to increase during climate change and weather-related disasters.[105] For example, after two tropical cyclones hit the Tafe province in Vanuatu in 2011, there was a 300% increase in new domestic violence cases.[106]

Women are also more likely to rely on the environment for their livelihoods. In developing countries, agriculture is the most important economic sector for female employment,[107] with female farmers tending to be more vulnerable to disasters and climate impacts. Existing gender inequalities often leave women with limited control over environmental resources and result in women having a minor role in decision-making.[108] As a result, women are less able to adapt to climate change, increasing the risk of women losing their livelihoods from climate change and weather-related disaster impacts.

The consequences of climate change and weather-related disasters for these groups are more severe on average, leaving them more vulnerable to future disasters. Poor and marginalized groups are less likely to have access to insurance and social protection, meaning they typically use their already limited assets to respond to disaster losses. This can drive them further into poverty and exacerbate vulnerability: poverty is both a cause and consequence of disasters. Estimates for 89 countries show that if all natural hazards were prevented from becoming a disaster over a year, 26 million fewer people would be living in extreme poverty. [109, 110]

Climate change and weather-related hazards rarely happen in isolation and the impacts of multiple compounding hazards and disasters interact in ways governments, civil society and the humanitarian sector have not faced before.[111] Climate change impacts are becoming increasingly complex and more difficult to manage.[112] Climate change and weather-related hazards often happen simultaneously, leading to more severe damage than if they were to occur in isolation (*see spotlight*). Climate change and weather-related hazards can also hit at the same time as non-climate or weather-related hazards, overwhelming response systems. This issue was brought into focus by the COVID-19 pandemic. During the pandemic response phase, governments needed to respond to both the pandemic and climate change and weather-related hazards such as flooding, droughts and heatwaves.[113] For example, in May 2020, community coping mechanisms and disaster management capacities in Ethiopia, Kenya, Rwanda, Somalia, South Sudan, Tanzania and Uganda were stretched by the combined impacts of flooding, locust infestation and the COVID-19 pandemic.[114]

SPOTLIGHT: Sea-level rise caused more than US $9 billion in additional damage during Hurricane Sandy.[115]

Hurricane Sandy hit the US East Coast in 2021, resulting in widespread coastal flooding. The hurricane caused over US $71 billion in reported economic damage.[116] Sea-level rise worsens the effects of coastal storms by intensifying storm surges and increasing floods. Researchers modelled the impact of sea-level rise on Hurricane Sandy outcomes, estimating that without sea-level rise, the economic damages would have been approximately US $9.6 billion lower.[117] Sea-level rise also led to an additional 71,000 people being affected by flooding.

The occurrence of climate change and weather-related hazards does not necessarily lead to climate change and weather-related disasters. Climate change and weather-related hazards are inevitable, but their impacts on society are not. Climate change and weather-related disasters only occur when vulnerable people and their assets are exposed to a hazard. Disaster risk is defined as the potential loss of life, injury, or destroyed or damaged assets that could occur in a specific time.[118] An increase in climate change and weather-related disaster risk is driven by either i) an increase in frequency or severity of climate change and weather-related hazards, ii) an increase in exposure of humans and their assets to those hazards, iii) an increase in vulnerability to the impacts of the hazard, or a combination of all three (*see Figure 2*).

DEFINITIONS

A climate change and weather-related hazard is defined as a natural process or phenomenon related to weather or climate that has the potential to cause loss of life, injury or other health impacts, property damage, social and economic disruption or environmental degradation.[119] This includes both sudden-onset hazards, such as droughts, wildfires, floods, landslides, extreme temperature and storms, and slow-onset hazards, such as sea-level rise, drought and desertification. There is increasing evidence that climate change is contributing to the increase in the total number of reported climate change and weather-related hazards.[120, 121, 122, 123]

Exposure is defined as the situation of people, infrastructure, housing, production capacities and other tangible human assets in hazard-prone areas.[124] Population growth, economic development, urbanization, migration, and environmental degradation are contributing to growing exposure.[125]

Vulnerability is the human dimension, defined as the potential to suffer harm or loss, related to the capacity to anticipate a hazard, cope with it, resist it and recover from its impacts.[126] Vulnerability is the result of a complex set of multi-dimensional drivers including inequality in development patterns, environmental degradation, unplanned urbanization and failed governance.[127]

RISK = Hazard x Exposure x Vulnerability

Figure 2: Disaster risk and event impact risk

A Red Cross volunteer steers his canoe full of mangrove saplings in preparation for planting in Aceh Jaya, Indonesia.

© Jenelle Eli / American Red Cross

CHAPTER 2

Without urgent action to address the climate change and biodiversity loss crises and build climate resilience, damage from climate change and weather-related disasters will become even more devastating

Climate change and weather-related hazards are expected to increase due to climate change. Climate change will continue to contribute to increases in the frequency and intensity of climate change and weather-related hazards. Every additional 0.5°C of global warming increases the intensity and frequency of extreme heat, heavy precipitation and droughts, in some regions.[128] The extent of these increases will depend on how emissions evolve. Under an intermediate emissions pathway, where emissions start decreasing from 2040, heat events that currently occur 2.8 times a decade and heavy precipitation events that occur 1.3 times a decade could increase to 5.6 times and 1.7 times a decade respectively.[129] If the global temperature increase remains under 1.5°C, the Global Mean Sea-Level (GMSL) rise is projected to increase by between 0.26 metres and 0.77 metres by 2100, relative to 1986–2005. If the global temperature increase is under 2°C, the GMSL is projected to be around 0.1 metres higher than what's predicted for an increase of under 1.5°C.[130] By 2050 at least 570 cities and 800 million people are projected to be exposed to rising seas and storm surges.[131]

Without action to reduce exposure and vulnerability, climate change and weather-related disasters will cause unprecedented social, economic and environmental losses. People are better equipped than ever before to save lives during disasters. However, it will be challenging to deploy existing solutions at the pace and scale needed to protect growing and increasingly vulnerable populations in a warming climate. Humanitarian response and disaster risk reduction systems will struggle to keep up with the growth in frequency and severity of climate change and weather-related hazards, translating into more severe social, economic and environmental losses, disproportionately impacting developing countries. *See the projected climate change and weather-related disaster impacts panel for a detailed overview of projected impacts.*

People congregating around the Newlands spring to collect fresh drinking water in Cape Town, South Africa.

© James Suter / WWF

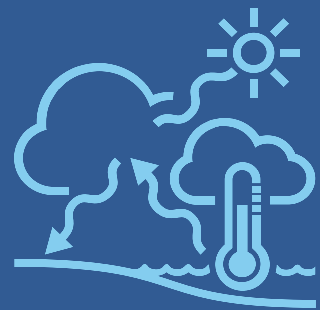
PROJECTED CLIMATE CHANGE AND WEATHER-RELATED DISASTER IMPACTS PANEL

Social:

- In the medium,-to-long-term (2041-2060), displacement will increase with the intensification of heavy precipitation and associated flooding, tropical cyclones, drought and, increasingly, sea-level rise.[132]
- Mental health challenges, including anxiety and stress, are expected to increase under further global warming in all regions assessed by the IPCC, particularly for children, adolescents, elderly and those with underlying health conditions.[133]
- Under global warming levels of 2°C or higher in the medium term (2041-2060), food security risks due to climate change will be more severe, leading to malnutrition and micronutrient deficiencies, concentrated in Central and South America, small islands, South Asia and Sub-Saharan Africa.[134]
- Climate change and related extreme events will significantly increase ill health and premature deaths from the near-to-long term (2021-2100), including heat-related mortality and climate-sensitive food-borne, water-borne and vector-borne disease risks.[135]

Economic:

- Rising seas and greater storm surges are predicted to cost coastal urban areas more than US $1.2 trillion each year by mid-century.[136]
- Climate change could push more than 100 million people below the poverty line by 2030.[137]
- Climate change is predicted to impose an annual cost of loss and damage[138] of US $402-805 billion on developing countries by 2030, and US$1.5-2.4 trillion by 2050.[139, 140]



Environmental:

- In the near term (2021-2040), global warming and the increased frequency, severity and duration of extreme events will place many terrestrial, freshwater, coastal and marine ecosystems at high or very high risks of biodiversity loss.[141]
- Even with the Paris target of under 1.5°C of warming, 3-14% of species assessed by the IPCC in terrestrial ecosystems face a high risk of extinction. But this increases to 3-18% for warming under 2°C.[142]

BOX 1: PERPETUAL CLIMATE CHANGE AND WEATHER-RELATED DISASTER CYCLES

Climate change and weather-related disasters can trigger further increases in hazard, exposure and vulnerability, increasing the frequency and intensity of future climate change and weather-related disasters, and creating a perpetual negative climate change and weather-related disaster cycle:

1. **Climate change and weather-related disasters can damage nature and cause nature loss.** This is through the impacts of the disaster itself and in the aftermath when natural resources are used for disaster response efforts such as the building of shelters.
2. **Climate change and weather-related disasters cause countless negative impacts for people**, including damaging health, destroying livelihoods, and pushing people into poverty (*see page 15*).
3. **Nature loss induced by climate change and weather-related disasters can increase climate change and weather-related hazards.** Both because it can result in the release of greenhouse gas emissions, contributing to climate change that can lead to increases in climate change and weather-related hazards, and through removing the hazard mitigation services provided by ecosystems. This includes vegetation on slopes which can mitigate landslides by slowing the movement of rain and holding soil together.
4. **Nature loss induced by climate change and weather-related disasters and its impacts on people can drive exposure to hazards.** Nature loss removes the protective services that nature can provide against climate change and weather-related hazards. This includes coral reefs that can reduce wave energy and protect coastal communities from storm surges. Human impacts can drive exposure by being one of the driving forces for people to move from their homes to increasingly unsafe areas.
5. **Nature loss induced by climate change and weather-related disasters and its impacts on people can drive vulnerability.** Nature loss removes the life- and livelihood-sustaining services provided by nature, including the provision of food and medicine. This threatens the communities who depend on these services, reducing their ability to respond and recover from disasters, increasing their vulnerability. The impacts of disasters on people can also contribute to vulnerability drivers such as poverty.

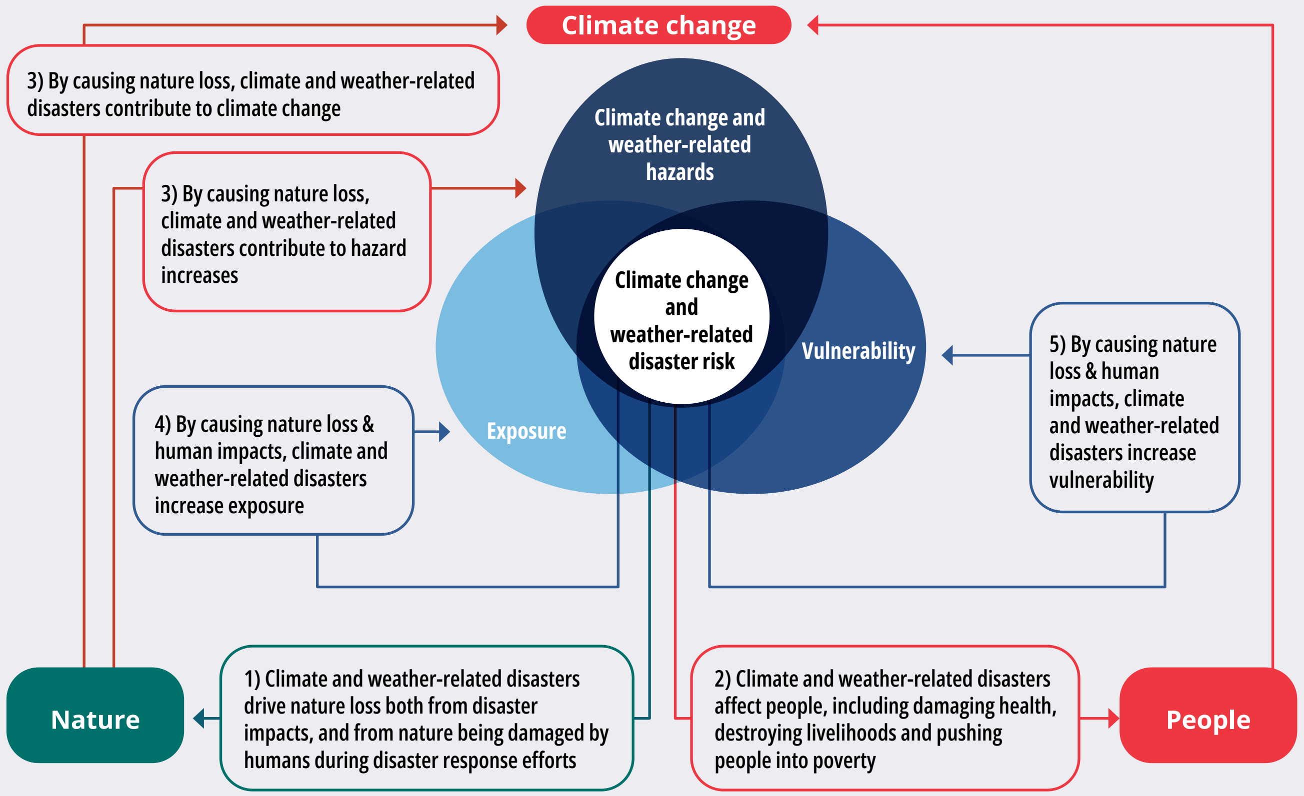


Figure 3: Climate change and weather-related disaster cycle

If these impacts materialize, society will increasingly reach the limits of adaptation, with climate change and weather-related disasters becoming unavoidable, and the international community struggling to support affected communities. Available resources are already insufficient to provide basic support after climate change and weather-related disasters. The international community could struggle to keep up with the funding for post-sudden-onset-disaster assistance. The annual cost is predicted to increase to US $22 billion[143] by 2030 as the population in need of humanitarian assistance as a result of floods, storms and droughts alone increases to 150 million.[144] There is also the risk of society reaching hard adaptation limits, where adaptive actions become infeasible to avoid risks, and impacts and risks become unavoidable. If global warming goes above 1.5°C, limited freshwater resources pose potential hard limits for small Islands and regions dependent on glacier and snow-melt for fresh water.[145]

As climate change and weather-related disasters and their impacts worsen, the risk of communities getting stuck in perpetual negative cycles will increase. When disaster impacts materialize, including significant damage to nature, they can trigger a perpetual negative disaster cycle (*see Box 1*). As climate change and weather-related hazards increase in frequency and severity, damage to nature will increase, and the availability of ecosystem services will significantly reduce, further increasing the risk of negative perpetual cycles. Even for warming of only 1.5°C globally, 70-90% of tropical coral reefs may be severely degraded or extinct by 2050.[146, 147] Communities will also face more extreme and frequent impacts, further threatening their ability to cope with future disasters, increasing the risk of negative cycles. Without efforts to tackle rising hazards, exposure and vulnerability, this cycle of damage will worsen.

DEFINITION:

Ecosystem services: Ecosystem services are defined as the benefits that people derive from nature (ecosystems).[148] This includes provisioning, regulating, cultural and supportive services. Provisioning services include nature providing key life- and livelihood-sustaining resources such as food, firewood and medicine. Regulating services include nature-moderating natural phenomena, such as acting as a protective barrier against climate change and weather-related hazards.

This will be exacerbated as climate change and weather-related hazards cause ecosystems to pass their tipping points, resulting in further losses in ecosystem service availability. Climate change and weather-related hazards are already triggering ecosystem tipping points – when ecosystems are irreversibly altered beyond their natural state - and this will increase as climate change and weather-related hazards become more frequent and severe.[149] An ecosystem's altered state is usually less biodiverse and productive, threatening the ecosystem's ability to provide life-sustaining services, including protection from climate change and weather-related disasters, climate regulation, and provision of life-sustaining resources. For example, climate change and land degradation could convert 30-60% of the Amazon rainforest into a type of dry savanna.[150] This would remove the climate-regulating services of the rainforest, threaten the habitats of thousands of plant and animal species, and remove resources that local communities depend upon for their livelihoods.[151]

A step-change is needed to scale up actions that both limit the increase of hazards, and reduce exposure and vulnerability. Under the current trajectory, climate change and weather-related disasters and their impacts will reach unprecedented levels in the coming decades, causing significant social, economic and environmental damage. At the same time, the global response to COVID-19 showed that nations around the world are capable of mobilizing, taking unprecedented actions, and finding the resources necessary to deal with a threat.[152] This same energy and ambition must be applied to reduce the impacts of climate change and weather-related disasters, including efforts to mitigate greenhouse gas emissions to address climate change and prevent growth in climate change and weather-related hazards. Countries, particularly the largest emitters, must make transformational changes to their energy, agricultural and transport sectors to stop the global temperature from continuing to rise.[153] Investment and action to reduce exposure and vulnerability to the impacts of these hazards are essential. These actions and investments will reduce climate change and weather-related disaster risk and increase the resilience of communities and nature to these disasters.

A group of youth from Kampung Taritipan in the district of Kota Marudu, Malaysia, take the initiative to protect mangrove forest around their village.

CHAPTER 3

NbS can play an important role in reducing disaster risk and increasing climate resilience within communities

Disaster risk reduction addresses both sudden and slow-onset disasters, reducing the threat they pose. Disaster risk reduction efforts have historically concentrated on reacting to sudden-onset disasters such as storms and landslides, including providing post-disaster humanitarian aid relief.[154] But as technology has improved, including early warning systems, alongside an improved understanding of the importance of increasing resilience and reducing vulnerability to disasters, efforts have progressively focused on proactive risk reduction. Additionally, there has been a broadening of focus to include slow-onset disasters in recognition of the damage they cause. For example, the adaptation section of the 2015 Paris Climate Agreement recognized the "*importance of averting, minimizing and addressing loss and damage associated with the adverse effects of climate change, including extreme weather events and slow-onset events*".[155] In 2015, disaster risk reduction also received renewed attention in the international policy agenda through the introduction of the Sendai Framework for Disaster Risk Reduction. The framework aims to achieve a substantial reduction of disaster risk and losses, by better integrating climate change responses within disaster risk reduction efforts and providing specific targets for disaster risk reduction efforts.[156]

Figure 4: Disaster management cycle *(Source: GDRC, 2008)*

Efforts to achieve disaster risk reduction involve activities related to disaster mitigation, preparation, response and recovery.

The disaster management cycle is the ongoing process governments, businesses and civil society undertake to achieve disaster risk reduction *(see Figure 4).* The mitigation phase involves efforts taken to minimize the impacts of a disaster. The preparation phase involves planning how to respond. The response phase involves activities immediately after a disaster to save lives and limit damage, and the recovery phase includes efforts to build back the community and increase their post-disaster resilience.

THE IMPORTANCE OF INCORPORATING NATURE THROUGHOUT THE DISASTER MANAGEMENT CYCLE[157]

- **Prevention:** Assessment of natural resources is key to understanding community dependencies and to informing the concrete steps needed to adequately protect these resources, together with the critical services they provide to communities, from hazards.
- **Mitigation:** Proper management of nature is crucial to ensuring the protection provided by nature is maintained and enhanced. It is also important that disaster risk reduction activities do not jeopardize other ecosystem services (e.g. nature cleared for engineered flood defences).
- **Preparedness:** The role of the environment must be incorporated into preparedness planning and implementation.
- **Response**: Preparedness plans that incorporate ecosystem protection and/or sustainable management must be followed in this stage, and habitats that sustain livelihoods or provide other ecosystem services must be protected. This is because during the response phase, there is a high risk of overexploitation of natural resources and destruction of habitats to get roofs over people's heads at whatever cost.
- **Recovery:** Legislation and rules to protect nature must be followed throughout the recovery and rebuilding process, and nature itself must receive any necessary attention to be restored post-disaster.

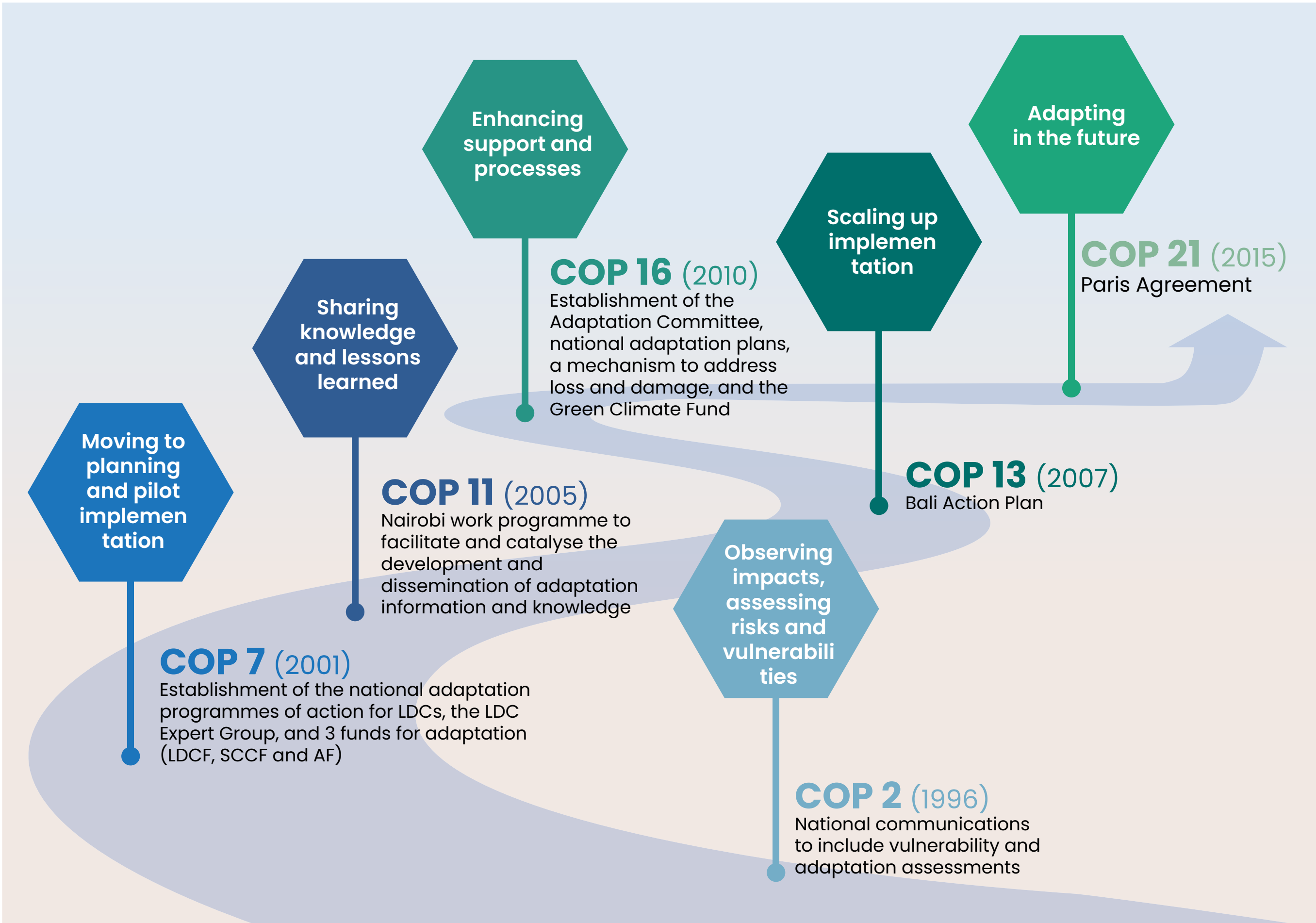


Figure 5: Evolution of climate change adaptation agenda

The climate change adaptation agenda addresses climate change impacts, including climate change and weather-related disasters. Climate change adaptation aims to improve society's capacity to cope with and even thrive in the face of present and future climate change impacts. Adaptation to climate change requires a comprehensive and iterative process that includes i) assessing impacts, vulnerabilities, risks and resilience, ii) planning for adaptation, iii) implementing adaptation measures, and iv) monitoring and evaluating adaptation.[158] Action on climate change adaptation has evolved significantly since 1996 when the international community viewed it as a lower priority than climate change mitigation.[159] Adaptation gained attention after the third IPCC report in 2001 made it clear that climate change mitigation alone would not be sufficient to tackle the climate crisis.[160] Since then, adaptation has risen up the international agenda and become more action-driven. Countries are encouraged to identify short, medium- and long-term adaptation needs and develop and implement strategies and programmes to address those needs.[161] The 2015 Paris Agreement reinforced the critical importance of adaptation in the global effort to respond to the threat of climate change.[162] The 2022 report from the IPCC Working Group 2 also points to the urgent need for action now, as there is a narrowing window of opportunity for society to adapt to climate change.[163]

DEFINITION

Disaster risk reduction: According to the UN Office for Disaster Risk Reduction (UNDRR), disaster risk reduction aims to prevent new and reduce existing disaster risk, and manage residual risk, all of which contribute to strengthening resilience and thereby support sustainable development.

There has been increasing recognition of the synergies between climate change adaptation and disaster risk reduction. Disaster risk reduction and climate change adaptation have evolved as siloed approaches to manage climate change and non-climate-change-related risk.[164] The growth in the proportion of natural hazards that are influenced by climate change has led to increased recognition of the overlap in scope between the two approaches, which both aim to reduce the risk of and increase resilience to climate change and weather-related disaster impacts.[165] There is also growing recognition of the need to integrate these two approaches when responding to climate change and weather-related disasters. A climate- and disaster risk-informed UN Sustainable Development Cooperation Framework promotes integrated risk management practices to respond to crises, including disasters.[166]

Key international agreements recognize the importance of nature for adaptation and disaster risk reduction, including the Paris Agreement adopted under the UN Framework Convention on Climate Change (UNFCCC) and the Sendai Framework (*see Box 2*). The Paris Agreement identifies the sustainable management of natural resources as a climate change adaptation action.[167] Many countries' Nationally Determined Contributions (NDCs) include ecosystem considerations in their visions for adaptation, evidenced in their inclusion in 109 of the 186 NDCs submitted to the UNFCCC Secretariat.[168] Equally, all 19 National Adaptation Plans submitted to the UNFCCC Secretariat from 2014 to March 2020 integrated considerations of ecosystems and identified ecosystem services.[169] For its part, the 2015 Sendai Framework identifies poor land management, unsustainable use of natural resources and declining ecosystems as underlying drivers of disaster risk. It explicitly encourages countries to strengthen the sustainable use and management of ecosystems to achieve the Sendai Framework's targets.[170]

BOX 2: INTERNATIONAL POLICY AGREEMENTS AND CONVENTIONS WHICH RECOGNIZE THE IMPORTANCE OF NATURE FOR ADAPTATION AND DISASTER RISK REDUCTION

(adapted from the UNDRR's Words into Action guide)[171]

- Sendai Framework for Disaster Risk Reduction
- Sustainable Development Goals (SDG)
- United Nations Framework Convention on Climate Change (UNFCCC)
- Convention on Biological Diversity (CBD)
- The Ramsar Conventions on Wetlands (Ramsar)
- United Nations Convention to Combat Desertification (UNCCD)
- New Urban Agenda (UN-Habitat)
- 5th UN Environment Assembly (UNEA 5.2) resolution on NbS for Supporting Sustainable Development

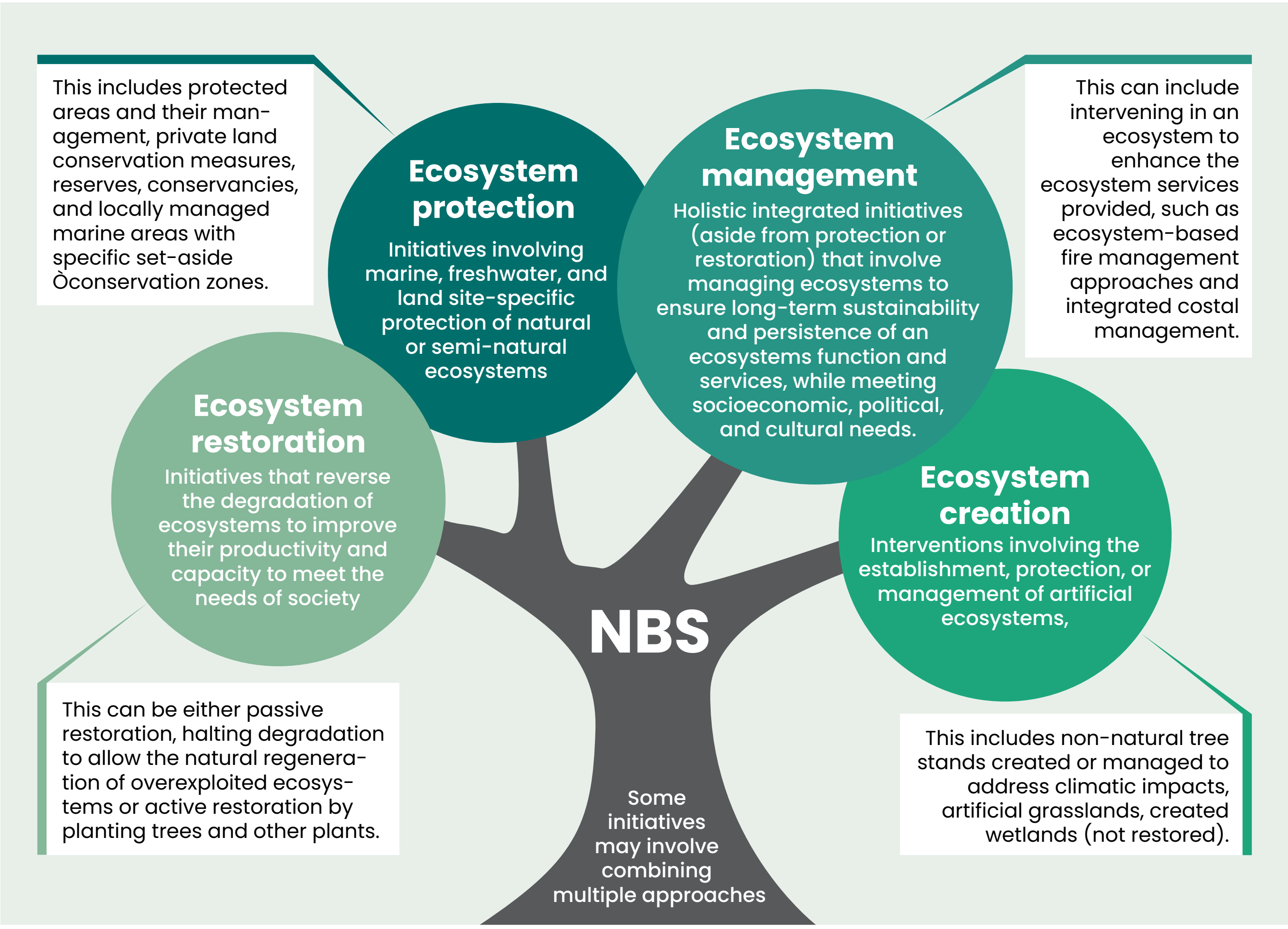


Figure 6: Categories of NbS[181]

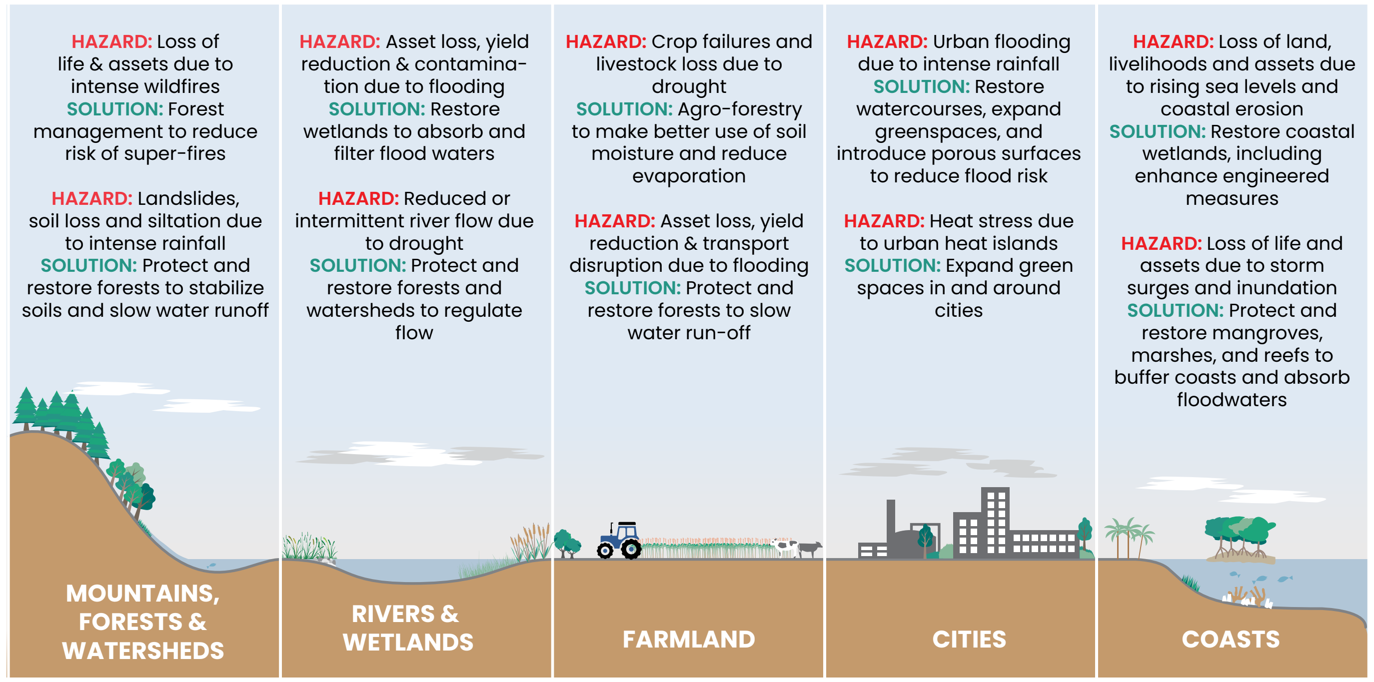
BOX 3: THE PROTECTIVE FUNCTION OF NATURE AGAINST NATURAL HAZARDS

Coral reefs protect Jamaica's shoreline from flooding and coastal erosion.[180] Coral reefs are an important natural defence for Jamaica's coastline, protecting coastal communities and tourist hotels from the destructive force of tropical storms. Coral reefs can reduce wave energy by an estimated 75% under routine and storm conditions. This reduces the risk of coastal erosion and flooding during storms. Fringing, patch and barrier reefs protect an estimated 60% of Jamaica's shoreline.

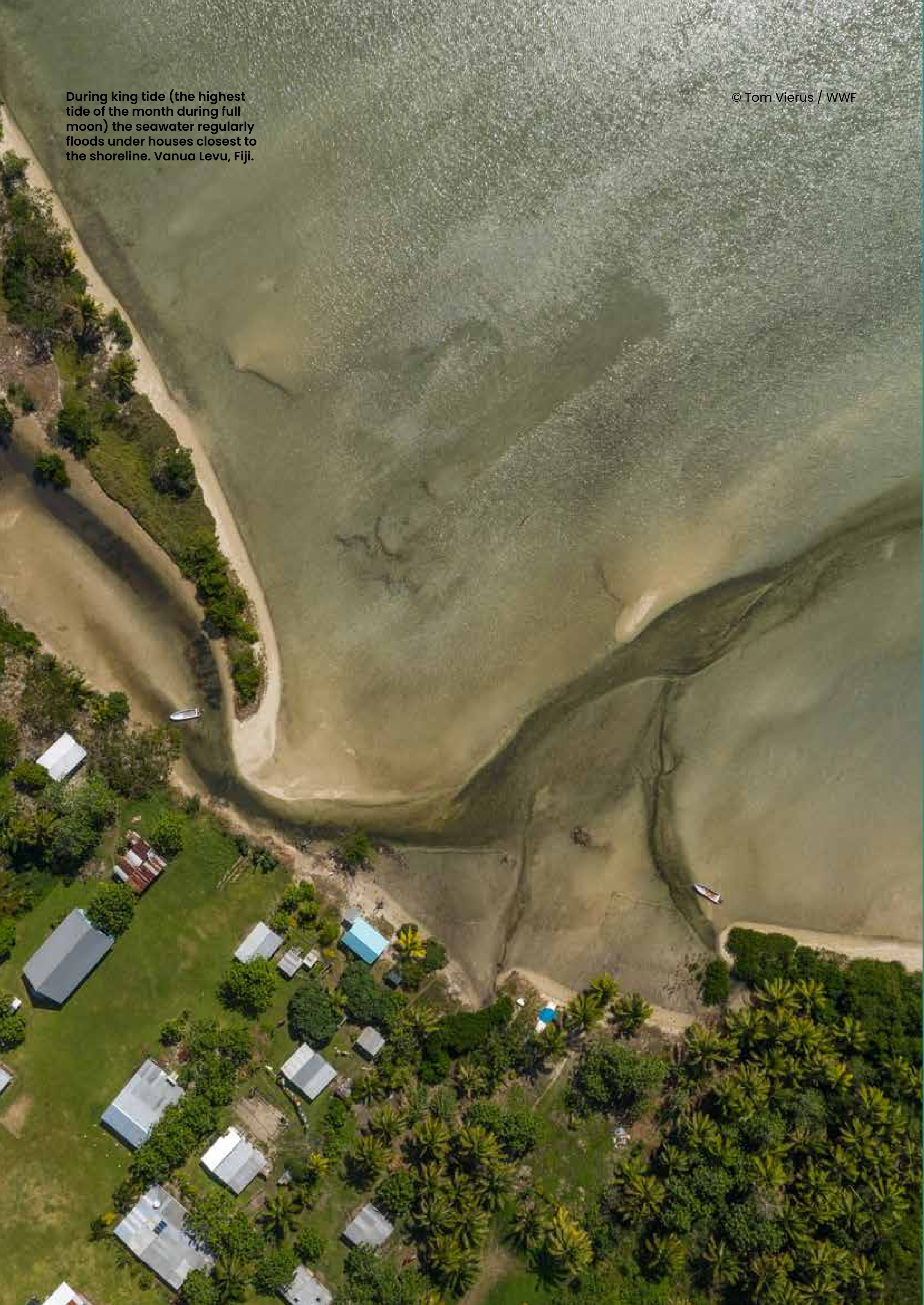
NbS protect, restore or expand nature, leveraging the well-established capacity of nature to reduce disaster risk, supporting climate change adaptation and helping put these international agreements into practice:

Evidence shows that nature can address all parts of the risk equation: regulate and mitigate hazards, control exposure, and reduce vulnerability.[172, 173] Nature can reduce the likelihood and prevent the occurrence of climate change and weather-related hazards. For example, vegetation on slopes can help prevent landslides during heavy rain events by slowing down the movement of rain and holding soil together.[174] Nature often acts as a buffer against climate change and weather-related hazards, reducing exposure and protecting humans and their assets from the worst impacts. There are countless examples of nature protecting people from exposure to climate change and weather-related hazards *(see Box 3)*. This includes mangroves and coral reefs which act as natural storm and flood defences, providing a protective barrier that buffers shorelines from the hazard impact .[175, 176, 177] Alongside mitigating and protecting against hazards, nature provides services essential for human lives and livelihoods and provides resources needed to cope with disasters and climate change impacts, reducing vulnerability. This includes providing food, medicines and water for crop irrigation. 1.2 billion people in tropical countries alone are highly dependent on nature for their basic needs.[178] According to the World Economic Forum, more than half of global GDP depends on natural resources.[179]

By protecting, restoring or expanding nature, NbS can tackle each dimension of climate change and weather-related disaster risk and support climate change adaptation. NbS cover a range of approaches that use nature to help manage social challenges, including climate change and weather-related disasters. They involve initiatives focused on: i) protecting or restoring nature through, for example, reforestation projects), ii) sustainably managing nature in areas such as croplands, or iii) creating new natural systems such as green roofs in cities (*see Figure 6*). By ensuring nature can continue to provide services that mitigate hazards, protect humans and their assets from the impacts of hazards and increase resilience, NbS can contribute to both disaster risk reduction and climate change adaptation. NbS can build resilience to a range of climate change and weather-related hazards, including floods, droughts and sea-level rise *(see Box 4)*.



Box 4: NbS can protect communities and increase their resilience to floods, droughts and sea-level rise
(Source: Global Commission on Adaptation. Adapt Now report, 2019)



During king tide (the highest tide of the month during full moon) the seawater regularly floods under houses closest to the shoreline. Vanua Levu, Fiji.

CHAPTER 4

A growing evidence base of successful interventions demonstrates the full opportunity of NbS

CASE STUDY 1: OLANCHO

Sustainable land management approaches have protected communities in Honduras from landslides[184]

Hazard: Landslides caused by land degradation and extreme events

Solution: Sustainable land management

High-level results: Sustainable reduction of landslide risk and contributions to food security, health improvement and community empowerment

High levels of deforestation have led to soil degradation and erosion, increasing landslide risk in Olancho, Honduras. The majority of Olancho is a protected natural reserve or park, but there are high rates of deforestation, primarily caused by livestock rearing and industrial forest management. Small-scale farmers also contribute to this deforestation. These practices result in forest fires, soil degradation and erosion, increasing landslide risk. Olancho is also regularly affected by tropical storms and hurricanes coming from the Atlantic. This combination of exposure to adverse weather conditions and harmful use of natural resources causes significant material damage and even deaths.

To mitigate landslides and reduce disaster risk, the Swiss and Honduran Red Cross implemented a community-focused sustainable land management project utilizing bioengineering methods. A multi-disciplinary team conducted a comprehensive, participatory risk assessment to identify the areas most vulnerable to landslides. Bioengineering measures, including fascine drains and slope stabilization, were then implemented in these areas. Local communities and land users living in houses threatened by landslide hazards were directly involved in implementing the project. These stakeholders participated in the risk assessment and identification of implementation sites. They implemented the bioengineering measures on their land, as well as on public land to protect public infrastructure, with help from local emergency committees and technical support from the Honduran and Swiss Red Cross. The project also involved community workshops and home visits to raise awareness among beneficiaries about existing hazards and provided training to beneficiaries on bioengineering techniques, soil conservation and climate change.

The project has reduced landslide risk while promoting food security, health improvements and empowerment of local women. The project has mitigated landslides and reduced disaster risk, increasing community safety. For example, fascine drains control surface run-off and enable drainage of excess water, which has helped prevent and reduce the impact of land degradation and landslides, including during tropical storms. The project has also contributed to food security and health improvements. In most cases, the communities transform the stabilized slopes and embankments into sustainable production areas, such as agroecological family orchards or medicinal gardens. As a result, beneficiaries can diversify their diets and generate income by selling the produce from their orchards and gardens. The project has also empowered local women by putting them in management roles and providing training on the necessary skills to manage the medicinal gardens and family orchards. This has enabled women to perform jobs previously done only by men, giving women new roles in their families.

The project design also ensured that the disaster risk reduction practice established is sustainable and can be owned and implemented by the community moving forward. Even though the bioengineering techniques were implemented with technical assistance, the process is not complicated and the materials used are locally available. The methods are therefore easy to replicate. Given they are vegetative, they are also regenerative, making them highly sustainable risk management techniques. The participatory nature of the project has allowed for better community ownership, which will enable longer-term maintenance of the project. Land users actively participated in identifying, developing and building bioengineering techniques and were also provided with sufficient training to prepare and motivate them to maintain the implemented measures in the longer term. This has led to a high level of adoption of the technologies and a strong likelihood that communities would maintain them even after the Red Cross intervention has ended.

The engagement of local institutions and government was a key dimension of the project, ultimately promoting the integration of NbS for disaster risk reduction into local planning and budgeting. The project directly engaged local institutions in the delivery of the project. Local Emergency Committees (CODELs) were involved in implementing bioengineering techniques to protect community infrastructure, including schools and health centres. They also provided some support to household-level bioengineering works. The CODELs also coordinated with community members and other local groups, including health and water management committees, to identify community infrastructure for bioengineering works. This enabled better visibility of CODELs among land users. As part of the project, the Honduran Red Cross also delivered sensitization workshops to authorities and technicians in municipalities.

DEFINITION

Fascine drains: Fascine drains are used to remove excess water from slopes that affect lands or houses in lower areas. Fascine drains are implemented by digging lateral ditches in a fishbone formation connecting to a main central drain. The system is generally built from the bottom of the hill, working upslope. The trenches are filled with 'fascine bundles' which are bunches of grass fixed in place with cuttings of trees that regenerate vegetatively. Soil is then added and grass is sown on top of the fascines to avoid production losses. .

Slope stabilization: Plants are established on the embankments to reinforce the soil with their roots and foliage, facilitating drainage and creating barriers to retain sediment. Vegetation can be combined with local materials such as rocks and wood to create living weirs.

What are CODELs: CODELs are part of the National System for Risk Management of Honduras. CODELs link communities with the national system through its higher level, the Municipal Emergency Committee. Candidates for CODEL must be accepted and approved by the community and included in the process to enhance local capacities for specific functions. CODEL members are trained to carry out all the steps involved in risk management (prevention, preparation, response and rehabilitation).

Academic and scientific literature and project implementation has demonstrated the effectiveness of NbS for reducing disaster risk and supporting climate change adaptation. A growing body of academic and scientific literature showcases the positive contributions of NbS for disaster risk reduction and climate change adaptation. Ecosystem services can play a key role in disaster risk reduction by reducing the impact of hazards, especially mountain hazards, flooding in urban areas and forest fires.[182] NbS can also address climate change impacts, with the potential to protect against a range of climate change and weather-related hazards. The extent of the evidence supporting the effectiveness of NbS varies by hazard. For example, there is more evidence relating to NbS for freshwater flooding than for drought and desertification.[183] Project implementation has also demonstrated the potential for disaster risk reduction and climate change adaptation (*see Case studies 1-6*). This includes a sustainable land management project implemented by the Honduran Red Cross in Olancho, Honduras that led to a significant reduction in landslide risk (*see Case study 1*).

Scaling up NbS now could protect society from some of the most severe consequences of climate change: the economic cost of loss and damage, and the number of people in need of international humanitarian assistance due to climate- and weather-related disasters.

- **NbS has the potential to reduce the intensity of climate change and weather-related hazards by at least 26%.[185, 186]** A limited number of studies have attempted to quantify the reduction in climate and weather-related hazard intensity from the presence of nature. This includes a meta-analysis of 69 studies among five habitats worldwide that estimated coastal habitats, including coral reefs, mangroves, salt marshes, seagrass/kelp beds, on average reduce wave heights by between 35% and 71%.[187] An assessment of the evidence base suggests that by protecting, restoring or sustainably managing nature, NbS could potentially reduce the intensity of climate change and weather-related hazards by at least 26%.[188]

- **Each year, implementing NbS could provide developing countries with valuable protection against the economic cost of climate change, reaching US$ 104 billion in 2030.** By 2030, the annual cost of losses and damages from climate change is projected to reach between US $402 and US $805 billion in developing countries.[189] This is expected to rise to between US$1.5 and US $2.4 trillion annually by 2050.[190] By reducing the intensity of climate change and weather-related hazards by at least 26%, implementing NbS in areas where climate and weather-related hazards occur could save developing countries at least US $104 billion in 2030 and US $393 billion in 2050.[191]

- **Implementing NbS could also reduce the number of people in need of international humanitarian assistance due to climate change and weather-related disasters, but further research is needed to unpack the quantified potential.** By 2030, 150 million people a year could need humanitarian assistance due to floods, droughts and storms.[192] By 2050, this is expected to rise to 200 million people annually.[193] Climate change is also increasingly driving displacement, with this expected to increase in the medium-to-long term.[194] By reducing the intensity of climate change and weather-related hazards, implementing NbS now could potentially avoid some of the projected increase in displacement, migration and the number of people in need of humanitarian assistance. However, the drivers of displacement and people in need of international humanitarian assistance are highly complex.[195, 196] Various demographic, historical, political, social and economic factors determine whether people can withstand climate change and weather-related hazard impacts or are forced to leave their homes.[197] Further research is therefore needed to unpack the contribution of reduction in hazard intensity in reducing displacement, migration and the number of people in need of humanitarian assistance, and quantify the reduction that implementing NbS at scale could achieve.

Alongside the potential of NbS for disaster risk reduction and climate change adaptation, NbS have the advantages of providing multiple co-benefits, avoiding the negative consequences associated with engineered disaster risk reduction approaches and having the potential to increase cost-effectiveness. If well designed, NbS can achieve multiple co-benefits and contribute to sustainable development. Ensuring nature can provide its many services can contribute to multiple societal goals alongside achieving disaster risk reduction and climate change adaptation (*see Figure 7*). This is in contrast to many traditional approaches, including engineered solutions that often provide only a single benefit.[198] NbS can increase the resilience of vulnerable populations by protecting natural resources they depend on for livelihoods, providing health improvements and strengthening food and water security *(see Box 5)*.[199] They can also create a range of other economic and environmental benefits that contribute to sustainable development *(see Box 5 and Case study 2)*.

BOX 5: MULTIPLE CO-BENEFITS FROM NBS FOR DISASTER RISK REDUCTION AND CLIMATE CHANGE ADAPTATION

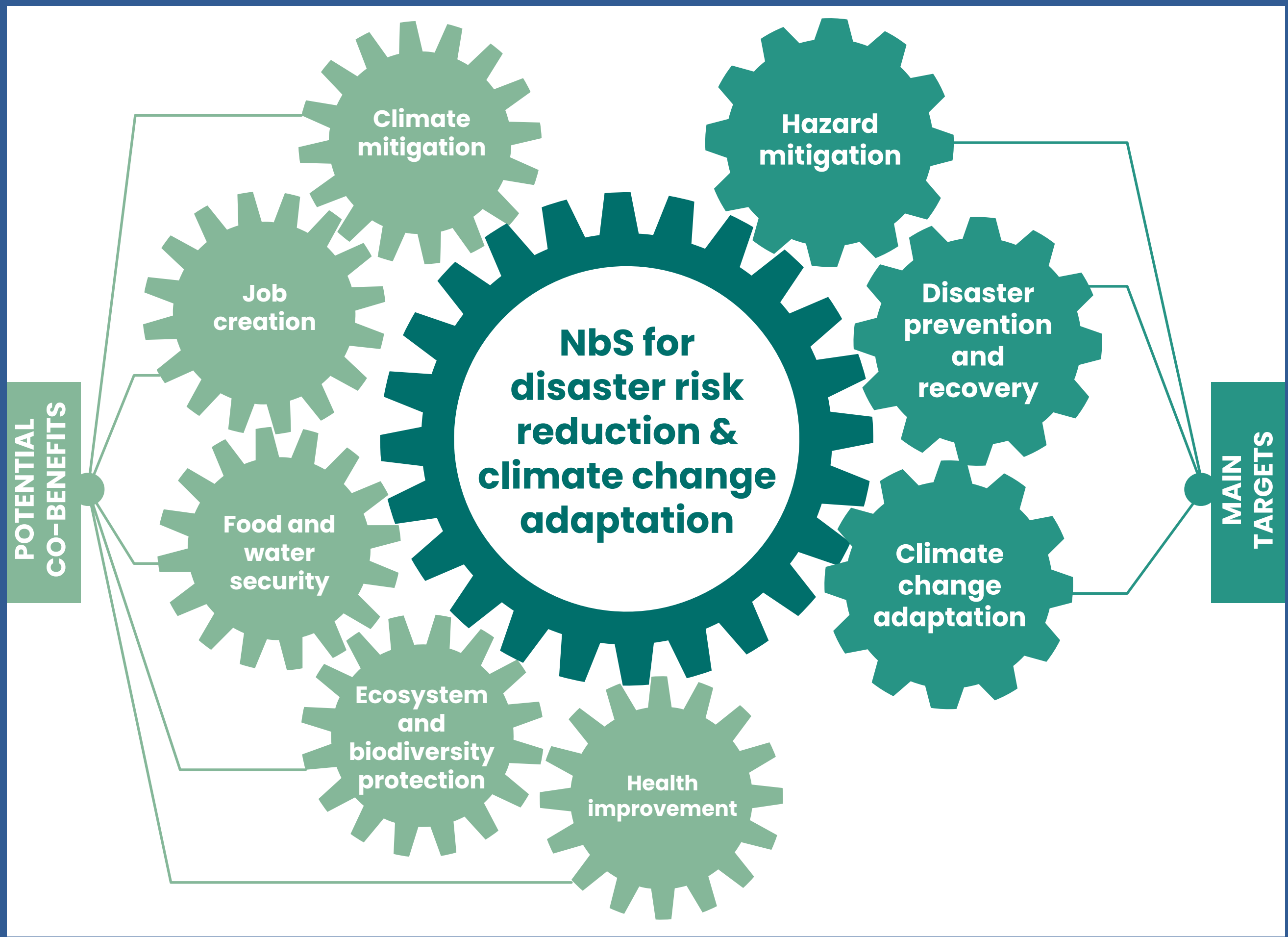
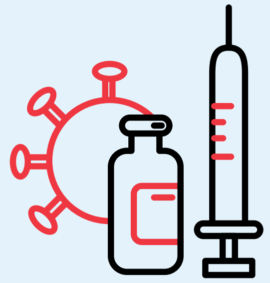


Figure 7: Multiple co-benefits from NbS for disaster risk reduction and climate change adaptation

Health improvement: NbS can support public health by providing an integrated approach to strengthening the social and ecological resilience of communities. Nature provides services that support human health, including air pollution filtering, a reliable supply of clean drinking water and a reduction in the incidence of infectious and respiratory disorders including zoonotic diseases (*see COVID-19 spotlight*).[200] Access to nature also offers many other direct health benefits including areas for physical activity, reduction of developmental disorders and improved mental health. Economic valuations of green spaces in several cities globally have found that nature provides billions of US dollars in cost savings for health services.[201] Therefore, NbS can improve health outcomes by ensuring nature is able to continue to provide services that are critical to human health.

COVID-19 SPOTLIGHT: NbS in the wake of the COVID-19 pandemic



Studies have shown that changes in land use that bring wildlife, livestock and humans into closer contact with each other increase the rate of "spillover" of diseases, including new strains of bacteria and viruses.[208] Approximately 60% of new emerging diseases – including COVID-19 – are zoonotic (jump from one species to another) in origin, and approximately one-third of those are directly attributable to environmental degradation and human land-use changes.[209] Research has linked extensive deforestation and fragmentation in West and Central Africa to several Ebola outbreaks in these regions.

NbS can tackle environmental degradation, one of the main drivers of pandemics. NbS focused on forest protection can reduce pandemic risk by preventing deforestation, which contributes to the emergence of infectious diseases.[210] NbS can also provide natural habitats for wildlife, so they do not encroach on urban areas, potentially reducing the risk of diseases and pandemics in urban areas.[211]

The COVID-19 pandemic and resulting lockdown measures also led to a new recognition of nature's importance for human well-being and physical and mental health. In line with this, NbS can both reduce pandemic risks and also promote physical and mental well-being. The international community recognizes these benefits and are implementing several relevant initiatives. Most notably, the World Health Organization's (WHO) 'One Health' approach has long advocated for a multisectoral approach acknowledging that human health and animal health are interlinked and dependent on the health of nature that surrounds them. In particular, they focus on protecting nature to avoid the spread of infectious diseases.[212] More recently, the OECD Build Back Better pandemic recovery plan highlighted the need to invest in sustainable environmental management practices to prevent future pandemics.[213]

Food security: NbS can restore and strengthen food systems by improving agricultural yields and increasing sustainability. A Honduras Red Cross project which implemented sustainable land management to reduce disaster risk from landslides included agroforestry and agroecology approaches which contributed to the food security of the local communities (*see Case study 1*).

Water security: NbS can secure water supplies by preserving natural streams. In Peru, the protection of 16 watershed areas helps ensure water supplies for 2.7 million people.[202]

Job creation. NbS can provide long-term economic benefits, including creating sustainable new jobs. Since 2007, 21 African countries and international partners have been developing the Great Green Wall initiative. It aims to restore 100 million hectares of land to stop the advance of the Sahara Desert. The initiative is expected to create 350,000 jobs by 2030.[203]

Climate mitigation. NbS can provide 20-30% of global cost-effective solutions to meet the emissions targets under the Paris Climate Agreement.[204] Restoring 350 million hectares of degraded or deforested landscapes can sequester 1-3 billion tonnes of carbon dioxide equivalent[205] per year.[206]

Nature and biodiversity protection. By prioritizing the sustainable management of nature, NbS can also counteract environmental degradation and biodiversity loss.[207] A people-public-private partnership for forest protection in Kenya has already secured the protection of 25,707 hectares of forests through effective management, preventing forest degradation which has increased in recent years (*see Case Study 4*).

CASE STUDY 2: MEKONG DELTA

Piloting alternative cropping systems and working with natural flood pulses in the Mekong delta is expected to enhance livelihoods, improve food security and build resilience.

Hazard: Sinking delta, sea-level rise, storms, salinity intrusion, loss of soil fertility

Solution: Transition from intensive rice cropping to mixed rice and shrimp farming that allows natural sediment deposition to counteract sinking and build greater resilience

High-level results: 110 hectares of rice fields transitioned as a pilot, with plans to scale up to 30,000 hectares

Asia's largest deltas are sinking and shrinking due to human activity, with their vulnerability to climate change and weather-related disasters also increasing, threatening lives, livelihoods, economic assets and critical ecosystems.[214] Asia's great deltas are home to over 400 million people and a wealth of biodiversity. They are critical to the economies, food security and sustainable development of the entire region. Poorly planned hydropower dams, in-channel sand mining, uncoordinated coastal development, intensive agriculture and excessive groundwater extraction are all undermining the natural ability of delta systems to sustain themselves, contributing to their sinking and shrinking. The deltas are also at increased vulnerability to climate change and weather-related disasters, leading to devastating impacts. Since 1988, tropical cyclones have killed over 300,000 people living in Asian deltas. In 2015, flooding and landslides in the Ayeyarwady Delta killed almost 120 people and displaced 1.6 million, severely damaging agricultural land and infrastructure. Climate change will continue to exacerbate this situation. Without major investment in innovative and transformational adaptation initiatives, including NbS, more than 1 million people are projected to relocate from the Mekong Delta because of sea-level rise by 2050.

In response to this threat, WWF launched the Resilient Asian Deltas initiative, a multi-stakeholder partnership to stop six of Asia's largest delta systems from sinking and shrinking.[215] WWF, the Government of the Netherlands and ABInBev, with support from the World Economic Forum, are mobilizing action under the initiative focused on the Ayeyarwady, Chao Phraya, Ganges-Meghna-Brahmaputra, Indus, Mekong and Pearl Deltas. The initiative aims to tackle the systemic challenges facing the deltas by involving a broad coalition of public-private champions and catalyzing unprecedented political support for, and financial investment in, innovative and ambitious NbS to protect and restore the dynamic natural river and coastal processes that replenish deltas and keep them above the rising seas.

One innovative approach uses NbS to counteract the sinking of the Mekong Delta and build a more climate-resilient food production model that can be scaled up and replicated in other Asian river deltas. The Mekong Delta is one of the most vulnerable places in the world to climate change and weather-related disasters, affected by sea-level rise and increasing storm frequency and intensity. Rice and shrimp farmers have been encouraged over the last few decades to increase their rice production, and have moved away from traditional, more sustainable systems based on the natural flow of the river. This new approach involves excessive use of fresh water throughout the year, excluding the natural flood pulses and the nutrient-rich silt they deposit, and an increasing reliance on fertilizers and pesticides. As a result, farming communities are left increasingly vulnerable to soil subsidence and salinization. To help tackle these twin challenges, WWF initiated the Mekong Delta Integrated Rice and Aquaculture Project, which produces rice and freshwater shrimps in the rainy seasons and brackish-water shrimps in the dry season. Critically, the new approach allows the rice paddies to be fertilized naturally by nutrient-rich flood sediment, which will end the farmers' reliance on costly chemical fertilizer, while also building up the paddies over time - counteracting subsidence and building resilience.

Flooded forest in Mekong Delta

© Adam Oswell / WWF

The climate smart model is implemented by WWF and Dutch Fund for Climate and Development (DFCD) in partnership with Minh Phu Seafood Corporation, Viet Nam's largest shrimp producer, and is expected to reduce disaster risk and improve incomes and livelihoods. Estimates are that the land could rise by up to 10 centimetres per year, countering natural subsidence of 2-4 centimetres per year, giving a net elevation gain that will be critical as sea levels rise and salt water threatens to intrude further into the delta. Meanwhile, farmers are expected to double their shrimp production and gain more overall income from their farms, especially once they can start receiving higher premiums for organic rice. The project will initially convert 110 hectares of mixed rice and shrimp farming to the NbS approach. However, the ambition is to scale up this solution to cover 30,000 hectares by 2028 - the level where it can transform the vulnerability of communities across the delta. With additional partners, up to 200,000 hectares could benefit from this approach.

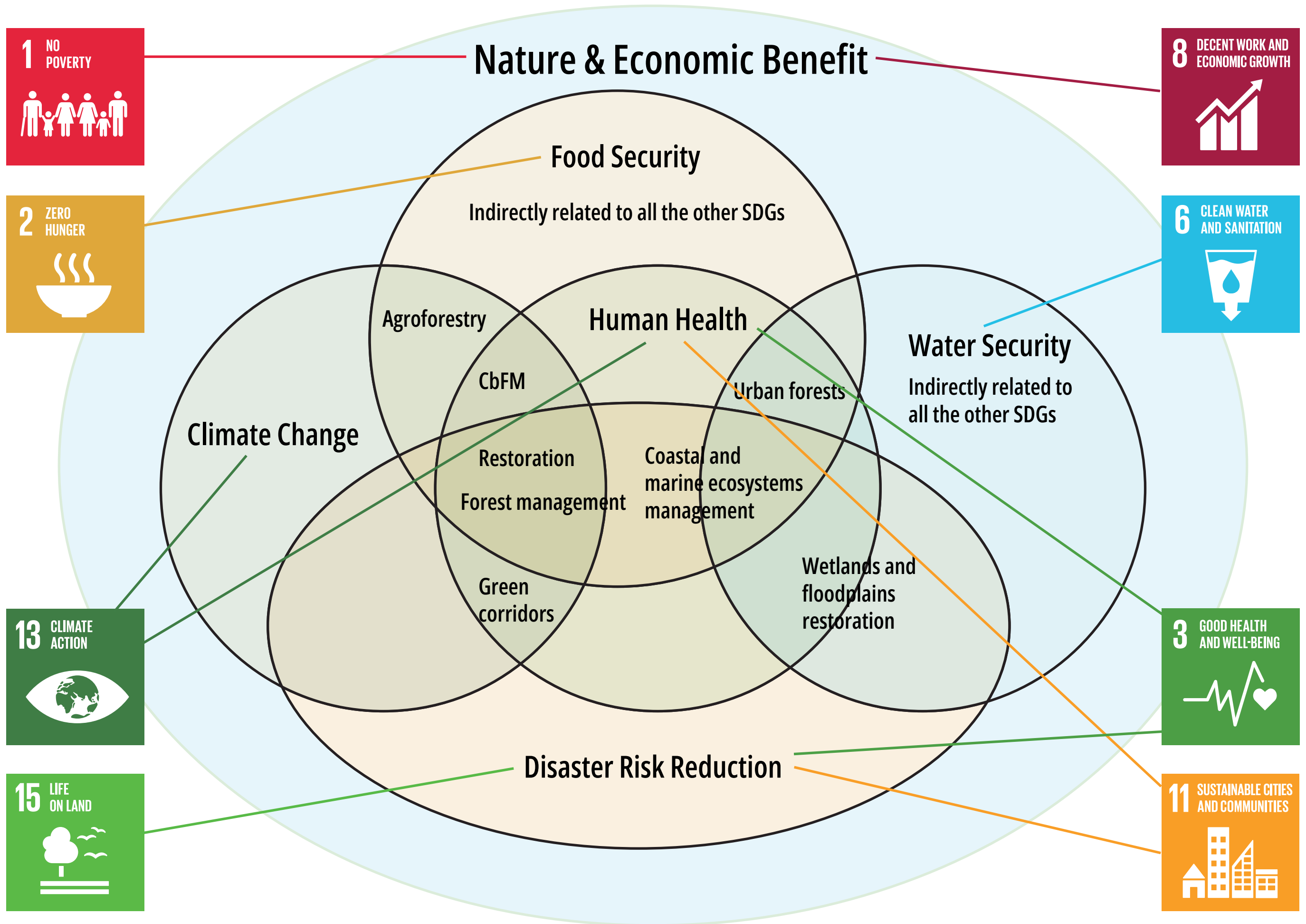


Figure 8: NbS and SDGs

As a result of these co-benefits, NbS can contribute to achieving multiple Sustainable Development Goals (SDGs) *(see Figure 8)*. By contributing to disaster risk reduction and climate change adaptation, NbS can directly input into several SDGs. 10 of the 17 SDGs include targets related to disaster risk reduction.[216] Goal 3 includes target 3d "*Strengthen the capacity of all countries, in particular developing countries, for early warning, risk reduction and management of national and global health risks*", which is directly related to disaster risk reduction.[217] NbS can also directly contribute to Goal 13: "*Take urgent action to combat climate change and its impacts*" by increasing the resilience of vulnerable communities to climate change impacts. By enhancing ecosystem services and providing multiple co-benefits, NbS can contribute to additional SDGs. For example, by sustaining and creating jobs and livelihoods, particularly for the most vulnerable people, NbS can contribute to Goal 8: Decent work and economic growth. The ability of NbS to contribute to multiple SDGs offers an opportunity to integrate with other efforts to achieve each goal. This also means that data and indicators can be shared, reducing the reporting burden.[218]

NbS approaches can avoid the unintended negative consequences associated with engineered approaches. Standard disaster risk reduction approaches include engineered (or grey) solutions that use hard building materials to build structures that protect against hazards. While effective in providing short-term protection, these solutions can themselves contribute to increasing disaster risk by producing greenhouse gas emissions. Constructing these solutions can be carbon-intensive due to the processes and materials involved.[219] These approaches also often involve removing nature to provide space for construction, further releasing greenhouse gas emissions.[220] For example, authorities in Papua New Guinea installed seawalls to protect against flooding, which led to the destruction of biodiverse coral reefs.[221] This environmental degradation also removes ecosystem services. The difficulty associated with valuing ecosystem services means that these consequences are often not accounted for when assessing the cost-benefit ratio of projects to determine whether to go ahead.[222] This can significantly impact local communities who have their natural resources removed, sometimes resulting in involuntary displacement for which they are seldomly adequately compensated.[223] As they involve the protection, restoration or creation of nature, NbS do not have these associated negative consequences.

GREEN VERSUS GREY INFRASTRUCTURE FOR DISASTER RISK REDUCTION

Conventionally, disaster risk management programmes have relied on built structures to protect communities from climate change and weather-related hazards. More recently, disaster management programmes have increasingly used natural systems such as forests, floodplains and soils to provide protection. These green and grey approaches are defined as:

Grey infrastructure: Grey infrastructure approaches are generally defined as traditional methods, which rely on human-built infrastructures to protect humans from hazards. This includes dams, barriers, dikes, seawalls, waterpipes and levees, often made out of concrete.

Green infrastructure: Green infrastructure approaches are defined as a "*strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services, such as water purification, air quality, space for recreation, climate mitigation and adaptation, and management of wet weather impacts that provides many community benefits*".[224] This includes i) wetlands which can reduce flood risk, and ii) forests, wetlands and floodplains that have a natural capacity to help sustain water supplies and protect against droughts.[225]

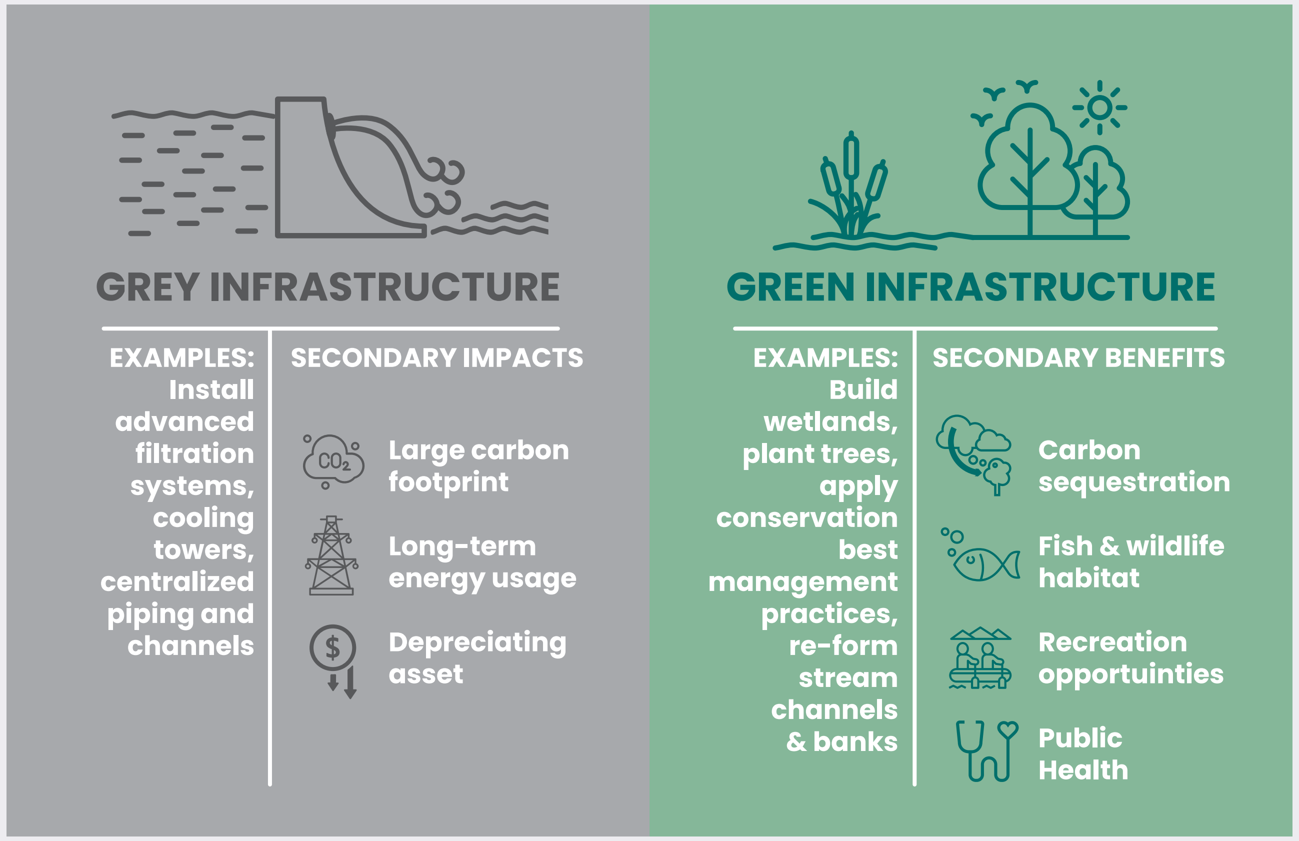


Figure 9: Green vs grey infrastructure

For situations that require engineered solutions, a hybrid approach may be optimal as it can limit negative consequences and provide the benefits of both green and grey approaches. It is possible to combine engineered structures with green approaches, resulting in hybrid solutions.[226] In some cases, these hybrid solutions may be the most optimal approach[227] as they can combine the benefits of both options, allowing for the shorter-term protection of traditional approaches and the long-term protection and co-benefits of NbS approaches. Integrating green and grey approaches can also protect built infrastructure and reduce the impacts of climate change and weather-related hazards on grey infrastructure, increasing its lifespan.[228] Multiple reports and literature outline the effectiveness of hybrid solutions for disaster risk reduction and climate change adaptation.[229, 230, 231, 232] The benefits of a hybrid approach were also demonstrated by the success of a World Bank project, which integrated green and grey infrastructure to reduce flood risk in Colombo, Sri Lanka *(see Case study 3)*.

CASE STUDY 3: COLOMBO

A hybrid approach combining the potential of wetlands with grey infrastructure to protect the residents of Colombo from flooding [233, 234]

Hazard: Floods

Solution: Mixture of green (wetland protection) and grey infrastructure

High-level results: Estimated to benefit, directly and indirectly, 2.5 million people

Climate change and sea-level rise coupled with rising degradation and conversion of wetlands is leaving the Colombo Metropolitan Region at high risk of floods. The Colombo Metropolitan Region (CMR) is the urban belt that encircles Colombo, Sri Lanka's commercial and financial hub. The CMR accounts for almost half of the national GDP and is growing fast, with urbanization increasing significantly in recent decades. This urbanization has caused degradation and conversion of the region's wetlands, which are essential for storing water during heavy rains. This directly increased flood risks by reducing the flood mitigation capacity of the wetlands. The water-holding capacity of the wetlands decreased by 40%. Climate change and sea-level rise further contributed to this rising flood risk, resulting in increasingly severe urban flooding. These floods destroyed livelihoods and infrastructure, bringing the city to a standstill every year.

To tackle rising flood risk, the World Bank approved a hybrid infrastructure project that combined wetland conservation with a package of grey infrastructure development. Since 2012, a World-Bank-funded project, the Metro Colombo Urban Development Project, has supported the local government to implement flood reduction strategies and strengthen their capacity to deliver large-scale hybrid projects. The project utilizes wetlands as green infrastructure to complement a grey infrastructure investment package. The grey infrastructure measures included flood and drainage management and infrastructure rehabilitation, including complex integrated works such as tunnels and pumping stations, and the rehabilitation and management of canals and flood gates. The project's green infrastructure strategy identified about 2,000 hectares of wetlands as key water-storage-capacity areas for Colombo, which help buffer against flood impacts. It also included creating a paradigm shift in how urban wetlands were perceived and incorporated into city development plans by conducting high-level policy discussions drawing on projects that involved the effective use of wetlands.

The project also utilized an innovative decision-making under uncertainty approach to assess the economic desirability of wetland conservation and inform project implementation. Before the project, it was common practice that the local flood management and land reclamation agency would convert wetlands into lakes to preserve water storage capacity in the CMR. The lakes often deliver the same flood protection as the wetland area but most of the co-benefits of wetlands are lost, including biodiversity, wastewater treatment and carbon sequestration. These co-benefits have economic value, but uncertainties regarding climate change factors, the current co-benefits and development patterns inhibit the quantification of this value. A World Bank study applied a cutting-edge decision-making under uncertainty (DMU) approach to better understand the value of wetland conservation. This approach involved developing a sophisticated computer model to compare the value of urban development and wetland protection under hundreds of different scenarios, including under various economic growth and climate change outcomes. The study found that wetland conservation is the most desirable option from a welfare economic perspective, helping to inform project implementation and provide future planners with a degree of confidence to proceed with wetland conservation.

The project established Colombo's first urban wetland park, led to significant improvements in grey infrastructure and is expected to provide increased flood protection for 232,000 people. The project upgraded and revitalized three public spaces and parks. This included establishing Colombo's first urban wetland park in Beddagana, which protects the historic ramparts of the ancient kingdom of Kotte close to the wetland area. Another wetland site, Viharamahadevi Park, was redesigned to enhance water storage capacity. Besides water storage and the associated flood risk reduction, the parks also provide passive recreational space together with education and ecotourism opportunities. The wetlands themselves also provide co-benefits for local people, including carbon sequestration, climate regulation through reduced use of air conditioning near wetland areas, wastewater treatment and recreational opportunities. The project has also led to significant improvements in grey infrastructure, reducing flood risk. For example, the project has improved 10.4 km of primary canals to reduce flooding and implemented three micro-drainage projects, which have reduced the risk of flooding in localized areas. Overall, the flood control and drainage management programme, including the green infrastructure components in the project, is estimated to benefit, directly or indirectly, about 2.5 million people.

Besides water storage and the associated flood risk reduction, wetland parks also provide passive recreational space together with education and ecotourism opportunities.

Footpaths in Beddagana Park, © exploreslk.com, licenced under Creative Commons CC BY-SA 2.0

NbS can be more cost-effective than traditional approaches, particularly in the long term. It is challenging to assess the economic benefits of NbS given their long-term nature, particularly in early implementation stages. Many of the benefits are also non-monetary, which are also challenging to quantify.[235] However, there is a growing evidence base highlighting the cost-effectiveness potential of NbS compared to grey approaches.[236] NbS are often found to be affordable and provide a wide range of ecosystem services. They also offer protection from multiple hazards, which is advantageous as hazards seldom occur in isolation. Projected returns over time increase exponentially because grey infrastructure only provides local benefits, whereas the benefits of NbS can be long term and apply to large geographic areas.[237] As green solutions rely on nature's regenerative processes, they also require less maintenance.[238]

The growing base of successful projects highlights five key success factors for NbS: engagement of local stakeholders, supportive legal and policy environments, multi-stakeholder approaches, utilizing both traditional knowledge and science, and ensuring both long- and short-term benefits are delivered: Local engagement and community ownership. The engagement of local stakeholders has been crucial for successful NbS implementation.[245] This ensures that projects work in the local context and local people experience the benefits.[246] It also creates a sense of ownership and supports project sustainability because NbS often rely on local communities to implement and manage the interventions.[247] Across interventions, local community leadership for NbS has proved make-or-break for success.[248] For example, community ownership and engagement was crucial in the delivery of the Viet Nam Red Cross mangrove plantation, restoration and protection initiative (*see Case Study 7*).

Ensuring short-term benefits are delivered alongside the long-term benefits of the initiative.[249] Some benefits of NbS may take a long time to materialize, especially in areas with severe ecosystem degradation. For example, agroforestry practices may take years to restore degraded soil and deliver more crops for local farmers. This can reduce local community acceptance and engagement in these initiatives, which is crucial for their success. Combining NbS with actions that return short-term benefits can result in broader stakeholder support for NbS. Recognising this challenge, many organizations have adopted strategies that provide both short- and long-term benefits for local communities. This includes a Kenya Red Cross green belt project to support drought recovery that utilized crop production for livelihood and food security needs, increasing community acceptance of the project *(see Case study 5)*.

Multi-stakeholder approaches. Disaster risk reduction and climate change adaptation, together with their integration with development activities, are processes that require the engagement of multiple stakeholders across sectors to be successful. By bringing together diverse stakeholders such as governments, civil society, local authorities, scientists, businesses, local communities and Indigenous Peoples groups, multi-stakeholder approaches can help to address climate change and disaster risk reduction in an integrated manner, comprehensively and inclusively. These partnerships can enable greater uptake of NbS by encouraging collaboration between stakeholders from different sectors in terms of both policy development and implementation. They can also create and catalyze synergies between different parts of society by pooling together resources, knowledge and skills, and institutional and governance capacities. This can improve the effectiveness of NbS design and implementation.[250] For example, WWF is leveraging the power of people-public-private partnerships to support coastal forest protection and restoration in Kwale County, Kenya *(see Case study 4)*.

PANEL: COST-EFFECTIVENESS OF NBS FOR DISASTER RISK REDUCTION AND CLIMATE CHANGE ADAPTATION

- A cost-benefit analysis comparing a concrete dyke (grey option) with a combination of earth dyke and mangrove rehabilitation measures (green option) found that the green option gave a five times higher return than the grey option (GIZ 2013) [239]
- A US $1 million investment in coastal restoration was estimated to create on average 17.1 jobs,[240] compared to 8.9 jobs per US $1 million for offshore oil and gas development.[241] On average, each dollar invested by taxpayers in coastal restoration returns more than US $15 in net economic benefits (Centre for American Progress 2014).[242,243]
- An analysis comparing the cost of restoring earthen dams with building a new dam to help local communities adapt to changes in rainfall patterns and drought, estimated that the cost of desilting and restoring 6,000 natural dams was over six times less than constructing a new dam. (Rizvi et al. 2015).[244]

A dam built in partnership with WWF Dongting Lake, China.

©Justin Jin / WWF

A supportive legal and policy environment. Laws, policies and plans provide the often invisible foundation for NbS. They perform several critical functions that enable NbS including: establishing mandates for government authorities to promote the conservation, sustainable management and restoration of nature; creating coordination mechanisms for the many different government actors involved in implementing NbS; and ensuring funding for NbS through, for example, regular budget allocations. The critical functions that laws, policies and plans play in enabling NbS are listed in Box 6 below. Establishing legal and policy frameworks that enable NbS is critical for success (*see below and case studies 6 and 7).*[251]

NbS need to be integrated into, and supported by, relevant national laws, policies and plans. There is a wide range of laws, policies and plans that may facilitate the implementation of NbS. This includes those relating to environmental conservation, land use, urban planning, natural resource management (agriculture, water, forestry, etc.), disaster risk reduction and climate change. NbS should be integrated into, and supported by, these different types of instruments.

Laws and policies need to establish mechanisms to support multi-sectoral planning and coordination for NbS. Implementation of NbS may be the responsibility of, or may require contributions from, multiple actors across different sectors. Coordination mechanisms are necessary to ensure that different actors work together effectively and their diverse knowledge, capacities and resources are fully harnessed towards the same goals. This can include collaboration between ministries and departments in charge of issues such as the environment, agriculture, water, land use, climate change and disaster management. It is crucial that multi-sectoral planning and coordination mechanisms are not restricted to governmental actors, but also include civil society and communities. The involvement of community members and community-based organizations in planning processes is important as they often have the closest relationship with nature, and rely on it for their livelihoods.

NbS must be integrated across scales from local, sub-national and national to regional-level policies and planning. NbS are often implemented at the local or sub-national level, at a landscape or ecosystem scale. District level and/or sub-national government agencies can therefore be critical to ensuring the alignment of ac-

BOX 6: LAWS, POLICIES AND PLANS FOR NBS

There is a wide range of laws, policies and plans that can facilitate the implementation of NbS. Laws and policies may explicitly and predominantly focus on the conservation, sustainable management and restoration of nature. Alternatively, they may focus on a societal challenges - such as climate change, disaster risk reduction or human health - with conservation, sustainable management or the restoration of nature included as one of the solutions for addressing the challenge.

Laws, policies and plans can perform several key functions to support NbS implementation, including:

- **Establishing a general policy or principles** relating to conservation, sustainable management and restoration of nature including defining key terms, identifying priorities and setting goals;
- **Establishing the mandates of the governmental authorities** that are primarily responsible for conservation, sustainable management and restoration of nature;
- **Allocating a mandate** for conservation, sustainable management and restoration of nature **to other sectoral governmental authorities**, which may be working on issues such as climate change, disaster risk reduction, and social and economic development;
- **Outlining the roles and responsibilities** of the different actors and stakeholders involved in conservation, sustainable management and restoration of nature;
- **Establishing coordination mechanisms** to enhance the implementation of NbS across these various stakeholders;
- **Imposing legal duties or obligations** on relevant actors about how they conserve, sustainably manage and restore nature; and
- **Ensuring funding** for conservation, sustainable management and restoration of nature through, for example, requiring regular budget allocations or establishing a dedicated fund for NbS projects.

tivities across the various actors involved. This is all the more relevant in countries that have a federal or decentralized governance structure. For example, a watershed initiative will require planning and oversight across multiple communities, making district or sub-national policies important. If the ecosystem spans national borders, regional policies are essential to support the coordination of different national actors.

Adequate budgetary allocations and finance for NbS are needed. The effective implementation of NbS depends on the availability of adequate financial resources. This may be achieved by provisions for regular government budget allocations at national, provincial and local levels. Climate finance and official development assistance may also be needed to scale up NbS, particularly where national public budgets may be constrained.[252] Additional financial resources for NbS may also take the form of environmental taxes or payments for environmental services.[253] The private sector also plays an increasingly important role in providing financial resources for NbS.[254]

Utilizing both traditional knowledge and scientific evidence. According to the International Union for Conservation of Nature (IUCN), NbS should be determined by site-specific natural and cultural contexts that include traditional, local and scientific knowledge.[255] Several studies argue that scientific systems of knowledge, in particular western paradigms, are currently unable to grasp the full complexity of environmental challenges. NbS must combine both scientific evidence and local knowledge and innovation to ensure the effectiveness and sustainability of NbS.[256] For example, a WWF initiative to build climate resilience of Fiji's coastal communities has combined local and technical knowledge to support the development of community disaster risk reduction plans involving NbS *(see Case Study 6)*.

Indonesian Red Cross has established mangrove seedling houses in villages across Aceh Jaya district

© Mikko Vähäniitty / Finnish Red Cross

CASE STUDY 4: KWALE COUNTY

Leveraging the power of public-private-people partnerships to support coastal forest protection and restoration, and increase community climate resilience in Kwale County, Kenya

Hazard: Storm surges, sea-level rise, heat waves

Solution: Public-private partnership to support coastal forest protection and restoration

High-level results: Aiming to protect and restore 30,000 hectares of coastal forests, and build climate resilience of coastal communities from heavy storms and sea waves

WWF-Kenya is supporting a coastal forest protection initiative to halt environmental degradation and increase disaster resilience in Kwale County. Since 2019, WWF-Kenya has led an initiative to protect and restore 30,000 hectares of forest in Kwale County. The project focuses on implementing forest restoration through tree planting and supporting control measures against fires and other destructive activities to enable natural forest regeneration. The project also involves developing forest management plans to ensure community participation in the management of forests and allow communities to benefit from the resources that forests provide. To implement the forest management plan, a five-year-cycle management agreement plan has been developed, and the Kenya Forest Service has signed the agreement with the respective community forest association. WWF will be looking after the implementation and monitoring of the management agreement plan.

The project also includes a capacity-building component where community members receive training from relevant experts as per training needs. This training includes securing alternative sources of livelihood and income from the forest areas. Different government (public), private and civil society organizations like Kwale County National Resources Network, National Environment Civil Society Alliance (NECSA) organize training on using forests more sustainably for local livelihoods and income (e.g. ecotourism, bee and/or butterfly farming) as well as other alternative non-forest livelihoods and income (e.g. woodlot farming, briquettes making, climate-smart agriculture). The training in climate-smart agriculture will also equip the community members with climate change adaptation knowledge, which will increase their resilience to climate change impacts, improve livelihood prospects and ensure food security in the face of climate change.

The project is being delivered through a public-private-people partnership. The partnership includes the government, private sector and local communities, with each stakeholder contributing to and benefiting from project implementation. Government actors are responsible for developing and enforcing the relevant policies, plans and regulations for forest protection and restoration, delivering capacity building for the communities and conducting relevant research. The project also supports and encourages the private sector to increase compliance with regulations and implement sustainable practices. The project directly targets and aims to benefit local communities. Communities are the stakeholders leading the implementation of the forest restoration activities and are provided with increased forest management capacity and income opportunities from ecosystem services (*see below for an overview of stakeholders and their activities*).

The multi-stakeholder partnership allowed for easier adoption of the intended interventions, including implementation of International Best Practices (IBPs) and negotiated compliance among the industries. This is because the initial multi-stakeholder consultations held to inform project design established trust, openness and transparency, helping to gain buy-in among all relevant stakeholders. The public-private-people partnership enabled discussions on the conservation agenda, without a feeling of victimization. The open discussion also allowed for information sharing that eliminates rumours and suspicion. Some policies and mandates tend to overlap (e.g. forestry management and environmental management are found in both the national government and the country government) – through this project, any disharmony in the implementation is discussed and the respective agencies agree on implementation plans. The tripartite engagement allows for open-door operations in the private institutions, enables community appreciation of some of the challenges the private companies face, and ensures government regulators have an easier way of determining and supporting compliance.

The project has already secured effective management for thousands of hectares of forest and planted thousands of seedlings, expected to protect communities from heavy sea storms and waves. The project has already secured 25,707 hectares of forests through effective management, with an overall goal of 30,000 hectares. These comprise forests whose management plans are at an advanced stage, finalized, approved or signed. 4,000 hectares of forest have been restored to date, with an overall target of 5,000 hectares. Similarly, the project has managed to restore 1,157 hectares of mangrove trees so far, with an overall target of 2,000 hectares. The protection of forests and restoration of mangroves are expected to protect coastal communities - over 7,000 people in seven villages - and related terrestrial ecosystems from heavy sea storms and waves. This also includes some important areas for the country's tourism sector.

OVERVIEW OF THE PUBLIC-PRIVATE-PEOPLE STAKEHOLDERS INVOLVED IN THE PROJECT AND THEIR ACTIVITIES

Public:

- **Kenya Forest Service** – spearheads forest management, protection and restoration, establishing sustainable wood fuel production and capacity building of community forest associations and communities
- **National Environment Management Authority (NEMA)** – supports at both national and local levels the improvement of Environmental Impact Assessment (EIA) processes and standards, environmental monitoring, operationalization of the environmental bond, and increased compliance of the private sector with the regulations and with cleaner production technologies
- **Kwale County Government** – supports the development and enforcement of county sector plans, international best practices, standards and regulations as well as effective participation in the public-private-people platform and round tables

Private:

- **Dokata Ranch shareholders** – partners in forest restoration and has become a model for best practices for improved rangeland management
- **South Coast Family Forest Cooperative Society** – trained to adopt wood-efficient technologies and sustainable production as well as implement the county charcoal regulations
- **Coast Calcium and Pwani Oil** – sensitized to reduce their ecological footprints through capacity building in energy and water-efficient technology
- **The Kwale International Sugar Company** – will be sensitized on sustainable water management and promoting water stewardship mechanisms in partnership with other players

Local community:

- **Kwale County Natural Resources Network (KCNRN)** – supports the project by providing training for trainers for the wider community; and also by advocating on issues of natural resource management and conservation; and compliance among development agencies
- **Community forest associations: Vanga-Gazi block, Mwache Tsunza area and Mrimadzo (Marenje, Mrima, Dzombo)** – the community groups for those living around the state forests; and upon development of the management agreement plans, they co-manage the state forests together with the Kenya Forest Service
- **Communities living around the Shimba Hills Ecosystem** – the Shimba Hills Community Forest Association (SHICOFA) is one of the community forest associations
- **Members of the Southern Kayas** – the community responsible for the conservation and management of the traditional Kaya forests jointly with the National Museums of Kenya. Specifically involved in this project are Kaya Mtswakara and Kaya Gandini, which are both gazetted as National Monuments under the Kenya National Museums and Heritage Act 2006 and the UNESCO World Heritage Convention.

CASE STUDY 5: DABAAB

The implementation of green belts has supported the drought recovery of the Dadaab refugee camp in Kenya, while also providing significant livelihood and food security benefits.

Hazard:
Drought

Solution:
Land rehabilitation

High-level results: Five green belts have been restored, increasing forest cover by over 70 hectares, protecting the community from drought impacts

The 2011/12 Horn of Africa drought damaged the land surrounding the Dadaab refugee camp and resulted in an influx of refugees, contributing to increased land clearing and removal of the windbreak function provided by trees and shrubs. The Dadaab refugee camp is in Garissa county, a semi-arid area in North-Eastern Kenya, prone to soil erosion and drought. The growth in the camp's population led to an increase in land clearing, including for firewood. This resulted in a loss of the windbreak function provided by trees and shrubs, leading to dust and exposure of the population to respiratory diseases. The situation was exacerbated during the 2011/12 Horn of Africa drought, which led to a sharp influx of refugees from the region, in addition to also impacting the land around Dadaab. As a result, the need for land rehabilitation was identified as a priority for the camp.

Recognising this, Kenya Red Cross supported a land rehabilitation project to provide livelihoods and support drought recovery, with strong community involvement. The project involved the creation of green belts surrounding the camp. The project began with a feasibility study to identify which tree varieties to use on the degraded land. indigenous trees were selected, given their adaptability to the local arid conditions. The trees were planted and actively managed for two years, after which the green belts naturally regenerated without needing management and irrigation. Local communities in the camp were strongly involved in implementing the project. Community members, who were nearest the land allocated for green belts, were made responsible for maintaining the afforested and reforested areas, and received a stipend for their activities. Government agencies and UNHCR, the UN Refugee Agency, also supported the project implementation. For example, government agencies provided technical advice and ensured the initiative supported government plans and programmes. This included providing technical guidance for agricultural officers within the camp and at the sub-county level.

The project has rehabilitated five green belts, supporting drought recovery. This has led to an increase in forest cover of 104 hectares from the green belts and 70 hectares from indigenous trees, reducing disaster-induced material losses to land, crops and livestock from drought. The project has restored the land to such a level that wild animals can return to their habitat. The green belts also provide protective functions from sand and winds.

The project also utilized engineered irrigation methods to support crop production for livelihood and food security needs, with these co-benefits encouraging community acceptance of the project. During project implementation, livelihood and food security needs were rapidly identified as related priorities for the communities. As a result, the project explored agroforestry to combine indigenous trees with fruit trees and vegetable crops in the green belts. This included providing ongoing irrigation to the orchards, such as drip irrigation, solar-powered boreholes and water pans. A total of 3 hectares of orchards have been created. The produce from the agroforestry has been used for local food, leading to an improvement in local diets and associated health benefits. Surplus produce is sold at the market, providing an additional income for families and strengthening their livelihoods. Produce has also been sold to the local hospital. The provision of these short-term co-benefits has incentivized community engagement in the project.

The IFRC Secretary General visits the gardens setup by the Kenya Red Cross in Dadaab.

CASE STUDY 6: FIJI

Multi-pronged approaches helped to build climate resilience of Fiji's coastal communities, supporting the implementation of Fiji's national policies especially the National Adaptation Plans' (NAPs) sectoral priorities, while integrating NbS into the country's Nationally Determined Contributions (NDCs)

Hazard: Droughts, flooding, cyclones, and sea-level rise.

Solution: Sustainable land management practices, application of agricultural best practices and standards for food security, protection and restoration of key coastal habitats (e.g. coral reefs, fisheries, mangroves and coastal land),

High-level results: Expected to build climate resilience of coastal communities, enhance their capacity to sustainably manage their resources, ensure food security and protect key coastal habitats from climate risks and weather-related disasters while integrating NbS into Fiji's updated NDC

Climate change has driven increasing coastal floods, droughts, cyclones and sea-level rise in Fiji. This has led to significant impacts on local communities, including livelihood destruction, infrastructure damage, and public service disruption. For example, in 2016 Fiji was affected by severe tropical cyclone Winston. The cyclone damaged at least 495 schools and 88 health facilities, disrupted public services and destroyed crops and livelihoods. Winston caused total damage and losses estimated to be as high as 31% of gross domestic product.[257]

To increase disaster resilience and respond to climate change impacts, WWF-Fiji launched a project promoting NbS to increase climate resilience in three different districts located on Fiji's Great Sea Reef. The project included deploying NbS to support local communities to better adapt to climate change impacts. This includes helping communities to better adapt to the impacts of climate change through awareness-raising and capacity building for sustainable land use, forest management and soil conservation. The project pursued NbS such as community-led sustainable land management practices; adoption and application of agriculture best practices; mangrove management, protection and restoration; and standards for food security (for example, planting climate-resilient crops as sustainable food security measures). The project also implemented coral replanting in the Nacula district to address sea-level rise while providing food and nutrition security to the communities.

As well as promoting NbS, the project also involved developing community-level plans for disaster risk reduction, natural resource management, food security and fisheries management. For example, the project involved developing community disaster risk reduction plans, where communities used their experience of nature-based adaptation approaches to various disasters to inform the plan content. This included establishing and building the capacity of a committee to coordinate disaster risk reduction plan implementation, and conducting awareness-raising activities on climate change, traditional climate knowledge and Fiji's seasonal calendar. The project also supported the development and implementation of a natural resources management and sustainable fisheries management plan, including setting up committees to oversee the implementation of the plans, monitor compliance and provide feedback during community meetings. The use of nature-based approaches was promoted throughout the development of these plans. During this whole process, local communities especially women, youth and other vulnerable groups were engaged from the planning to the decision-making process and also in all intervention activities.

SUPPORTIVE NATIONAL POLICIES

- **Fiji's National Green Growth Framework 2014** includes responsible stewardship of Fiji's ecosystem as part of the vision for building a better Fiji for all
- **Fiji's National Biodiversity Strategy and Action plan 2017** aims to conserve and sustainably use Fiji's terrestrial, freshwater and marine biodiversity, and maintain the ecological processes and systems which are the foundation of national and local development. One focus of the plan is developing protected areas.
- **Fiji's National Development plan 2017** includes an "*increased focus on proper management of our forests, mangroves and coral reefs because of the complex natural biodiversity that these systems support*"
- **Fiji's National Adaptation Framework 2017** includes the *"Promotion of 'ecosystem-based' and gender and human rights-based approaches to adaptation."* as a key value
- **Fiji's National Adaptation Plan (NAP) 2018** includes different *sectoral adaptation priorities*.
- **Fiji's National Disaster Risk Reduction Plan 2018-2030** is aligned with the Sendai Framework and recognizes that disaster risk reduction is a cross-cutting issue so is formulated to be integrated and consistent.

The national policy environment in Fiji was a key enabler for project implementation. Several national policies supported project implementation (see below). The government undertook nationwide consultations to develop these policies. As a result, they reflected Fiji's national priorities and provided an enabling environment for intervention implementation at the community level. This project has helped to implement several sectoral adaptation priorities of Fiji's NAPs[258] within the three project districts. These adaptation priorities include:

a. **Food and nutrition security:** Agriculture adaptation measures (12.A.2, 12.A.3, 12.A.5, 12.A.6, 12.A.7, 12,A.12); Fisheries adaptation measures (12.F.2, 12.F.3, 12.F.6)
b. **Human settlements:** Adaptation measures (14.1)
c. **Infrastructure:** Adaptation measures (15.A.5, 15.A.8); Hazard Management Adaptation measures (15.D.1, 15.D.5, 15.D.9)
d. **Biodiversity and nature:** Adaptation measures (16.2, 16.3, 16.8, 16.12)

The advocacy activities within the project have further contributed to a supportive policy environment, implementing NAPs and enhancing the NDCs. This project helped to implement national level adaptation priorities at the local level. The lessons learned from the field implementation have also helped to support successful activities at the national level advocating for integrating the importance of the NbS into Fiji's revised NDC, submitted in 2020.

Revised NDC Adaptation Target[259]

- **Target 5:** To adopt Climate Smart Agriculture practice, with emphasis on the promotion of sustainable practices in crop management, livestock and sugarcane farming and fisheries.
- **Target 7:** Develop simplified and standardized early warning systems, and prioritize nature-based solutions to mitigate the impact of flooding and cyclones.
- **Target 10:** To conserve the natural environment and biodiversity wealth enabling the sustainable long-term provision of ecosystem services, including carbon sequestration potential.

Within the project, mangrove restoration and community-led mangrove management plans were also advocated for at the national level. As a result, the Fiji government has moved to reviewing and finalizing Fiji's Draft National Mangrove Management Plan and is in the process of developing new legislation to address legislative gaps in mangrove management. Legislative gaps include a lack of recognition of community-led initiatives to establish mangrove protection areas, guidelines for mangrove restoration that is informed by science, gaps in government and management, and a need for better coordination between the various relevant government agencies.

CASE STUDY 7: VIET NAM

The enabling policy was a key success factor for the long-term sustainability of a Viet Nam mangrove plantation restoration and protection initiative, which has increased protection against coastal hazards and contributed to sustainable livelihoods and climate mitigation.

Hazard: Coastal erosion

Solution: Mangrove restoration - afforestation and reforestation

High-level results: Activities covered 9,000 hectares of mangroves, reached 350,000 beneficiaries directly, and reduced dyke damage by US $96,371 (without expected damage by typhoons) and US $355,368 (with expected damage from typhoons)[260]

Mass conversions of coastal mangroves exacerbated Viet Nam's vulnerability to coastal hazards, resulting in damage to existing coastal protection infrastructure. Viet Nam is particularly vulnerable to coastal hazards, including typhoons, storm surges, sea-level rise and flooding, and is ranked among the most affected countries by extreme weather events, both in terms of fatalities and economic losses.[261] Massive conversion of coastal mangroves into rice fields and aquaculture areas from 1980 to 1990 increased the exposure of coastal infrastructure and livelihoods to typhoons and storm surges. Sea dykes, aquaculture and rice farming along the coastline were damaged and lost as a result. During this period, sea dykes made of soil suffered many broken sections resulting in seawater intrusion into rice fields and aquaculture areas.

The Viet Nam Red Cross (VNRC) launched a mangrove restoration initiative to address the loss of coastal protection, planting thousands of hectares of mangroves. The mangrove restoration project started in 1994 to safeguard sea dykes, reduce flooding risk and protect livelihoods. The project began as a pilot in five communities in Thai Binh province focused on planting mangroves. Following initial successes, the VNRC scaled up the initiative to include over 100 communities in seven additional coastal provinces. They also added a capacity-building component to strengthen community disaster risk reduction, including vulnerability and capacity assessments, planning small infrastructure disaster risk reduction works, training disaster response teams, and awareness-raising with children and teachers at schools in 222 communities.

The project covers thousands of hectares of mangroves, which provide coastal protection and contribute to community livelihoods and climate change mitigation. The VNRC and communities have planted and protected mangroves in nearly 100 coastal communities, covering an estimated 9,000 hectares. From 1999 to 2013, the mangrove area in Vietnam increased by about 6.4%, partly due to the VNRC project.[262] The project successfully protects sea dykes from storm surges and typhoons, resulting in direct benefits to 350,000 people and indirect benefits to another 2 million. For example, a comparison of damages caused by similar typhoons before and after the project found a reduction of US $96,371 (without expected damage by typhoons) to US$ 355,368 (with expected damage from typhoons) per year.[263] The project provided additional socio-economic and ecological benefits. In each commune where mangroves exist, about 150-250 people rely on the forest for their daily livelihoods, collecting aquaculture and non-timber products. The project has increased aquaculture product yields by more than 200%. The project also contributes to climate mitigation, with the value of the minimum estimated CO_2 emissions absorbed by the planted mangroves estimated to stand at US $218 million between 1997 and 2025.[264]

The involvement of the local community, in particular women and children, was a critical dimension of the project design. The project engaged the most vulnerable people in planting, protecting and restoring the mangroves, including the poorest people, community members who depend on mangroves for their livelihoods, and women. Community members who participated in planting mangroves could earn an allowance of US $20 per hectare. The project also engaged school children, conducting awareness-raising sessions on the importance of mangroves through kick-off events for mangrove planting season to enhance their knowledge, awareness and responsibility in forest restoration. The school children then conducted their own awareness-raising activities, with around 300 schools taking part.

Government engagement and supportive policies played a critical role in enabling the success of the project:

- The project has worked closely with the government of Viet Nam from the outset, in particular the Ministry of Agriculture and Rural Development (MARD), including the initial selection of sites and mangrove species as well as an ongoing earning-by-doing process on mangrove restoration involving joint technical advice, implementation and monitoring. Over time, the majority of the mangrove restoration sites have been handed over to local government authorities for continued maintenance. A close relationship has been maintained, including over discussions of land-use change, planning and the role of mangroves.

- In 2016, the government of Viet Nam introduced a policy that supports coastal forest restoration: Decree 119/2016/ND-CP on Sustainable management, protection and development of coastal forests. Existing legislation on forest protection did not include coastal forests. The decree established several measures to support the protection and restoration of mangroves (see below), implemented by local governments under the guidance of MARD. The decree also established a dedicated central and local budget for the management, protection and development of coastal forests. This provides government financial support through MARD, at a rate of VND 4 million per hectare for 5 years, to local government and communities for activities that regenerate coastal forests under a contractual basis. Organizations, individuals or households may receive a land allocation on a contractual basis or may lease coastal forests in order to protect and develop forests. Entities have an obligation to protect and not reduce the area and quality of the forests. They must also pay forest environmental service charges according to the rate prescribed by the People's Committee of the relevant province, should they benefit from forest services.

- The communities involved in the initial VNRC mangrove restoration activities have been able to directly benefit from the new financial support through MARD. For example, it has helped aquaculture farmers shift to more sustainable farming practices. The land allocation stipulation has been critical in facilitating access to land for mangrove restoration by communities, as well as enabling mangrove restoration to be more than a short-term activity. Communities that are maintaining mangrove restoration activities, initially funded by VNRC, are now receiving an allowance from the government. The Ning Binh Chapter of VNRC, which is still maintaining the mangrove restoration and protection activities as an organization (rather than having handed it over to the local government), has benefited from payment of forest services from local companies.

KEY ACTIVITIES UNDER DECREE 119/2016/ND-CP

- Collection of forest statistics, forest inventory and monitoring of changes in forest resources
- Survey and planning for coastal forest protection and development
- Zoning for regeneration and additional planting
- Planting new forests and renovating poor quality coastal forests
- Moving construction works that threaten the protection function of coastal forests
- Constructing works to prevent erosion
- Education, capacity-building and awareness-raising about the role of coastal forests in responding to climate change
- Research and application of scientific and technical advances in the protection, use and development of coastal forests

The activities of Red Cross Viet Nam as part of the project also contributed to more supportive policies being implemented in the country. A multi-stakeholder Climate Change Working Group, of which VNRC was a member, was active in advocating for the new decree. This included communication and advocacy to change the minds of both policymakers and communities to improve forest laws. This has led to increased recognition of the importance of mangrove protection and restoration as a national priority. As a result, the government has introduced policies focused on achieving coastal forest conservation and restoration and penalizing deforestation, including Decree 119/2016/ND-CP mentioned above.

WWF has helped 574 farmers in the region plant 700,000 trees in its 5- year programme to replenish the bare hills in Kasese, Rwenzori Mountains, Uganda

CHAPTER 5

Increased recognition of the opportunity provided by NbS has led to growing momentum, but NbS are yet to reach their full potential

Recognition of the potential of NbS to contribute to disaster risk reduction and climate change adaptation while achieving multiple co-benefits, has resulted in increased support for NbS implementation at the international level. Organizations such as IFRC, IUCN, TNC,[265] WEF,[266] WRI,[267] WWF, UNDP[268] and UNEP[269] are implementing a wide range of NbS initiatives, both to build the knowledge base of NbS and to put NbS into practice. NbS have also gained significant policy attention in recent years and have moved up the policy agenda.[270] There is a growing coherence across global frameworks, with provisions for NbS in many international policy agreements and conventions (*see Box 7*). NbS has also received significant attention at global meetings and conferences, including the resumed 5th session of the UN Environment Assembly (UNEA 5.2) where a resolution was agreed defining and recognizing the potential of NbS and calling on UNEP to support the implementation of such solutions, helping drive their adoption worldwide.[271] The potential of nature was also recognised as part of UNFCCC COP26 with the resulting Glasgow Climate Pact emphasizing the "*importance of protecting, conserving and restoring nature and ecosystems […] to achieve the long-term global goal of the Convention*".[272]

NbS are also gaining traction at the national scale, with governments increasingly taking steps to support and implement NbS for disaster risk reduction and climate change adaptation. The UNFCCC adaptation database, a curated database of adaptation knowledge resources, outlines 65 case studies of projects focused on NbS for adaptation and lists 67 partner organizations working on the topic.[274] An assessment of updated NDCs saw improved integration of NbS in 85 updated NDCs. The number of submissions mentioning NbS for adaptation increased from 85 to 91. This also involved several parties indicating concrete commitments to ecosystem approaches to the climate crisis by linking their commitments to national strategies and plans.[275] Additionally, NbS are being integrated within national disaster risk reduction plans. For example, The Vanuatu Climate Change and Disaster Risk Reduction Policy 2016-2030 explicitly adopts ecosystem-based approaches to implement climate change adaptation and disaster risk reduction, including integrating ecosystem services into adaptation and risk reduction planning and budgeting.[276]

NbS have also attracted increased financing and funding in recent years, including NbS for disaster risk reduction and climate change adaptation. Growth in recognition of the potential for high return on investment and the importance of NbS for a range of societal goals has led to increases in funding pledges and finance mechanisms for NbS.

- **Domestic governments have been the largest contributors of funding for NbS.** Public-sector financing accounts for 87% of the approximately US $139 billion invested annually in NbS, of which US$ 118 billion is invested by domestic governments.[277] Public Overseas Development Assistance (ODA) accounts for only approximately USD$ 2.5 billion annually,[278] including ODA channelled through the Global Environment Facility and the Green Climate Fund. ODA is increasing and plays an important role in terms of raising the profile of NbS and gaining political buy-in. Several funding announcements were made at UNFCCC COP 26, including the Congo Basin Pledge - an initial collective pledge by multiple countries and private capital of at least US $1.5 billion of financing between 2021-2025 to support efforts to protect and maintain the Congo Basin forests, peatlands and other critical global carbon stores.[279] Canada also announced a commitment of CDN $1 billion in international support for NbS, a fifth of its climate finance.[280]
- **The private sector has also started to provide financing, although they make up a much lower proportion (11%).**[281, 282] The majority of this financing comes from investments in sustainable supply chains (US $7 billion), biodiversity offsets (US $5 billion) and private equity impact investments (US $3 billion).[283] By providing this financing, private sector actors can strengthen their business resilience to climate change and biodiversity loss, contribute to their Environmental and Social and Governance (ESG) communication, and respond to increasing public pressure for the private sector to act on the climate and environmental crises.[284]
- **While disaster risk reduction is a minor driver for private sector investments in NbS, this is a growing innovation trend, in particular for the insurance/reinsurance industry.** Insurance companies are in a unique position to recognize the financial potential of NbS for disaster risk reduction. It is in their business model to expand insurance coverage to more people and assets by introducing new insurance products. As rising climate-related losses threaten the viability of insurers' books of businesses and investment portfolios, it is in their best interests to support investment in disaster risk reduction measures, including NbS.[285] In recognition of the benefits of NbS for disaster risk reduction, insurance companies have started exploring innovative insurance solutions that can contribute throughout the disaster risk management cycle *(see Box 7)*. These initiatives have taken the form of smaller-scale pilots to establish feasibility. More work is needed to establish scale-up potential and feasibility across different geographies.
- **The private sector can also scale up financing for NbS for disaster risk reduction and climate change adaptation.** Private-sector companies can fund public-private sector partnerships that catalyze investment in disaster risk reduction and climate change adaptation, including NbS. Some private-sector actors are already exploring this. This includes the Zurich Flood Resilience Alliance, a partnership between Zurich Insurance, IFRC and a combination of non-governmental and research organizations working together to increase public and private investment in evidence-informed community-based flood resilience.[289] However, there are currently a limited number of these partnerships with room for further collaboration. The private sector can also utilize innovative financing mechanisms to channel funding for NbS focused on disaster risk reduction and climate change adaptation. This can include investing in bankable nature solutions, which both address environmental challenges and generate a financial return. For example, MunichRe has issued a green bond, the proceeds of which are used to finance projects including environmentally sustainable land use management.[290] Although in this case none of the projects are explicitly NbS for disaster risk reduction, the private sector could explore utilizing this mechanism with a specific disaster risk reduction lens.

BOX 7: INTERNATIONAL POLICY AGREEMENTS AND CONVENTIONS WHICH HAVE PROVISIONS FOR NBS

(adapted from the UNDRR's Words into Action guide)[273]

- The resumed 5th session of the UN Environment Assembly (UNEA 5.2) resolution on Nature-based Solutions for Supporting Sustainable Development
- Sendai Framework for Disaster Risk Reduction
- Sustainable Development Goals (SDG)
- United Nations Framework Convention on Climate Change (UNFCCC)
- Convention on Biological Diversity (CBD)
- The Ramsar Conventions on Wetlands (Ramsar)
- United Nations Convention to Combat Desertification (UNCCD)
- New Urban Agenda (UN Habitat)

[Black = specifically mentions ecosystem-based approaches / Red = implied]

BOX 8: INNOVATIVE INSURANCE SOLUTIONS THAT EXPAND NBS FOR DISASTER RISK REDUCTION

Insurance companies can apply parametric insurance schemes to nature, expanding product coverage and contributing to better disaster response and post-disaster rebuilding. Such insurance schemes offer coverage for extreme weather events, with insurance payments triggered by a set of parameters or disasters of a specific type and severity predetermined in the contract.[286] In the case of storms, the insurance gets triggered if winds reach above a predetermined speed, allowing for rapid disbursement of funds after severe storms. Insurance companies have started to explore applying parametric insurance to protect nature. In 2017, Swiss Re launched the world's first nature-based insurance solution to protect Mexico's Quintana Roo coral reef.[287] They collaborated with The Nature Conservancy and Mexican regional governments to provide rapid disbursement of funds and training to community members to support coral reef restoration actions quickly and minimize coral damage following a severe storm.

Insurance companies can also help fund green infrastructure through innovative insurance-based financing to reduce disaster risk and enable investment in NbS for disaster risk reduction, contributing to response, recovery and mitigation. Insurers are exploring combining natural infrastructure with Community-Based Catastrophe Insurance (CBCI), an innovative insurance product. With CBCI, a local government or community-based organzsations can procure a collective policy for the community. With a more diverse mix of underlying subscribers, policies can be written more affordably, reducing premiums. By protecting communities against climate change and weather-related hazards, implementing NbS can reduce the risk of impact following such hazards. Insurance companies can quantify this risk reduction and guarantee future reductions in insurance premiums following the NbS implementation. These reductions can be used to offset or replace the cost of funding the NbS project, enabling local governments or community-based organizations to provide the initial investment. TNC and Munich Re studied the potential of combining NbS for flood reduction (e.g. reconnected floodplain restorations, wetlands and levee setbacks) with CBCI, which would reduce insurance premiums by 55%.[288] These solutions not only mitigate risk but also support recovery and rebuilding by allowing low-income households better access to hazard insurance. For insurers, the benefits of a joint CBCI and NbS approach is that it enables them to continue to underwrite policies for a specific area and expand that ability as risk decreases, increasing their business.

The full potential of NbS has not yet been unleashed, and initiatives need to be brought to scale. Despite increasing recognition of their potential, investments in NbS are underexplored in policies to reduce disaster risk and support climate change adaptation.[291] In most cases, ambition for NbS does not match practice[292] and intention or commitments to NbS have yet to translate into action on the ground.[293] An assessment of the inclusion of NbS in the first round of NDCs found that although the majority outline intentions of working with nature to address climate change in one form or another, these intentions rarely translate into measurable evidence-based actions and targets.[294] As a result, many NbS initiatives for disaster risk reduction and climate change adaptation either fail to materialize or only occur at the project or pilot level, at a limited scale. One-off projects fail to build the evidence base for NbS. They also do not offer the potential of large, ecosystem-scale projects that are mainstreamed into disaster risk programmes and maintained over time, with full potential to increase the resilience of vulnerable people and nature. [295]

THE FULL POTENTIAL OF NBS HAS NOT BEEN REACHED BECAUSE OF FUNDING GAPS, LACK OF TRANSLATING POLICIES INTO PRACTICE, AND IMPLEMENTATION CHALLENGES.

Funding gaps:

NbS in general are severely underfunded and require significant investment to bridge the gap. Currently, US $139 billion are invested in NbS annually.[296] This figure must triple in real terms by 2030 and increase fourfold by 2050 if the world is to meet its climate change, biodiversity and land degradation targets.

NbS for climate change adaptation and disaster risk reduction are particularly underfunded. This is in part driven by the general imbalance between funding for mitigation and adaptation projects. In 2017 and 2018 adaptation received on average only 7% of total climate finance flows, with the majority of finance going towards mitigation efforts including renewable energy (59% of finance) and low-carbon transport (24%).[297] Within funding for adaptation, NbS are deprioritized compared to other adaptation investments, receiving only 9-21%[298] of adaptation flows in 2018. As a result, NbS for adaptation represented only 0.6-1.4% of total climate finance flows in 2018.[299] Disaster risk reduction also receives less funding compared to other international development issues, representing only 11% of total aid. Of the US $133 billion of financing for disaster risk reduction made available between 2010-2019, just US$5.5 billion was aimed at risk reduction measures before a disaster.[300] This limits the amount of funding available for NbS-related disaster risk reduction projects.

Several factors must be overcome to attract further investment in NbS, including lack of revenue in many existing NbS projects, lack of coherent regulation and lack of appropriate funding mechanisms.[301] In addition, scaling up private sector investment -currently representing 11% of NbS flows - will be crucial to bridge the finance gap.[302]

Lack of translating policies into practice:

The policy environment is not always conducive to translating NbS policies into practice, due to short-term planning and decision-making, siloed approaches and policy incoherence, a top-down policy approach, and limited budget allocation:

Short-term planning and decision-making. NbS typically need a relatively long time to produce demonstrable societal benefits such as improvements in public health. In the case of restoration projects, it can take time for the protective function of nature against climate change and weather-related hazards to be provided. In contrast, political decision-making tends to be more interested in projects that generate short-term outcomes.[303] The adoption, implementation and maintenance of NbS also often require long-term planning which conflicts with the short-term planning cycles of many municipal administrations, limiting sustainable NbS uptake.[304] In some cases, the responsibility for NbS maintenance and monitoring can remain unspecified, posing risks to the long-term realization of multiple benefits.[305]

Siloed approaches and policy incoherence. Government departments often work in silos in line with their vision, legal frameworks and procedures, and use their own sectoral language.[306] This siloed way of working can lead to a lack of exchange, cooperation and collaboration between actors, hindering the development of integrated policies for NbS and causing policy incoherence.[307] For example, a land-use plan for a new development in a vulnerable beach area would be incoherent with a mangrove restoration project to protect the local community from storm surges. This incoherence can lead to activities in one sector causing damage to existing NbS, or implementation of poor quality interventions aimed at just one goal that fail to deliver multiple benefits.[308] This can include existing sectoral regulatory frameworks and policies hindering NbS uptake, with, for example, limited land space and planning permits restricting the areas available for Nbs implementation.[309, 310] The issue is particularly acute in urban settings where space is limited and land often belongs to private owners who are likely to prioritize short-term financial benefits over sustainability goals.[311] Policy incoherence can also lead to inaction when the roles and responsibilities of different actors are unclear, with, for example, one actor seeing 'adaptation' as the responsibility of another actor.[312]

Insufficient national budget. NbS are typically the mandate of the ministry of environment. Ministries of environment are not core ministries like planning and finance and may have limited influence over the underlying reforms necessary to implement activities, including securing sufficient provisions for NbS within national budgets and cross-sectoral planning and implementation.[313] This can result in insufficient national budgets to deliver on climate change adaptation and disaster risk reduction goals in general, as well as on NbS specifically.

A top-down policy approach that does not involve local actors. Climate change adaptation, including NbS, is not systematically considered in local planning or budgeting across countries, even when there are national adaptation plans or policies.[314] This can result in the imposition of top-down policies on local communities that are not involved in the national planning process. Capacity and funding gaps can also limit the integration of NbS into local policies. For example, Ghana's process of adaptation decentralization has highlighted the need to strengthen the institutional arrangements that should link the local to national levels, including providing capacity building activities and increasing funding to support local activities.[315]

Implementation challenges:

Lack of implementation knowledge surrounding NbS. Successful implementation of NbS is dependent on having sufficient scientific, technological and local knowledge of their functions, performance and benefits in specific ecosystems and contexts. Even though there is a growing body of knowledge and experience of NbS, existing evidence is often presented in a way that can be difficult for communities, governments and practitioners to understand. It is frequently not in a 'ready-to-apply' format or tailored to the specific local challenge.[316] This can limit local communities', governments' and practitioners' abilities to learn from best practices and ensure new projects build on the lessons learned from previous implementation. It can also hinder decision-making when it comes to planning NbS initiatives in practice.[317]

Difficulty in Monitoring, Evaluation and Learning (MEL). MEL activities apply lessons from evidence and analysis of initiatives and projects to improve outcomes. These activities are needed to assess the effectiveness of NbS initiatives, increase the comparability of different interventions, improve NbS design and provide the evidence base to support scale-up.[318] They also support a process of "learning by doing" whereby those implementing the project can course correct and adapt as success factors and barriers emerge. Monitoring and measuring the effectiveness of NbS can prove challenging. Measuring the non-material benefits from NbS, such as the mental and physical health benefits provided by ecosystem services, is difficult.[319] Given that NbS can reap benefits for a wider-reaching geographic area and over a long period, it can also be challenging to identify the full scale of project benefits.[320] Decision-makers may also lack baseline data that would allow for an accurate assessment of the impacts of NbS projects.[321]

The potential of NbS is also threatened by climate change as nature may be unable to provide its services if global temperatures continue to rise. If global warming goes above 1.5°C, some NbS measures will lose their effectiveness at tackling societal challenges. This is because nature will reach hard adaptation limits where it cannot adapt to climate impacts, and damage will become unavoidable,[322] resulting in severe and irreversible damage to and losses of ecosystems and their services. Under such a scenario, the ability of NbS to reduce disaster risk and support climate change adaptation would be limited, as nature would be unable to provide services that protect communities and increase their resilience to climate change and weather-related disasters. NbS implementation must therefore be scaled up now and be part of a package of disaster risk reduction, climate change adaptation and climate change mitigation initiatives, that protect communities and increase their resilience to climate change and weather-related disasters.

Margaret Wanjiru Mundia, a participant in the PES (Payment for Environmental Services) programme, farms 5.8 hectares using conservation practises to retain soil and water.

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CHAPTER 6

Action and investment are needed to support mainstreaming and scale-up of NbS, and IFRC and WWF are joining forces to support this

Given the urgency of the crisis, now is the time for NbS-related action and investment. The impacts of the climate crisis are already materializing, with increased incidence and severity of climate change and weather-related disasters. Without scaled-up mitigation and adaptation actions, climate change will continue to exacerbate the situation with devastating social, environmental and economic consequences. Initial implementation shows NbS are effective at protecting against climate change and weather-related hazards. They also have the added advantages of providing multiple co-benefits and increasing overall resilience to multiple hazards, avoiding the negative consequences associated with engineered disaster risk reduction approaches, and having the potential to be more cost-effective than engineered solutions. Momentum has been growing for NbS implementation in recent years. However, implementation challenges, funding gaps and a lack of translating policies into practice have prevented them from reaching their full potential. The potential of NbS is also threatened by climate change as global warming will damage nature and result in the loss of ecosystem services. As such, urgent investment and action are needed to scale up and mainstream NbS to ensure they can reach their full potential for disaster risk reduction and climate change adaptation.

To support the successful implementation, mainstreaming and scale-up of NbS for reducing climate change and weather-related disaster risk, several steps need to be taken:

- Support development of a stronger evidence base and coordinate research efforts to close the knowledge gap, understanding what constitutes successful and sustainable NbS, how Nbs can reduce climate change and weather-related disasters and how climate change affects the potential of NbS
- Examine limitations of specific NbS measures based on each project context
- Close capacity gaps, at all levels
- Close the funding gap, including exploring private-sector innovations beyond carbon markets to support NbS financing for disaster risk reduction and climate change adaptation
- Align and harmonize international and national policy, planning and legal frameworks on climate change, development, environment and disasters to promote harmonized approaches to resilience and risk reduction across sectors and ministries/departments
- Promote models of engaging local communities and Indigenous Peoples in planning and implementing NbS as a standard
- Recognize that the potential of NbS has limitations and therefore implement NbS as part of a package of disaster risk reduction, climate change adaptation and climate change mitigation interventions

IFRC and WWF are joining forces to increase awareness and action to build climate and disaster resilience of the most at-risk communities - through working with nature. The partnership aims to raise awareness of how nature protects people and biodiversity, especially in disaster and humanitarian contexts. It will explore how NbS, and other efforts to protect and enhance nature, can strengthen the resilience of vulnerable landscapes and communities to climate and disaster risk. It will leverage the mandate and expertise of each organization to promote the integration of NbS in national climate change adaptation and disaster laws, policies, frameworks and practices. The combined presence of the organizations in 192 countries, with a long history of work, credibility and relationships with national and local stakeholders, will enable the partnership to scale up meaningful NbS implementation.

The partnership will focus on awareness-raising, promoting the integration of NbS into national policy frameworks, supporting the scaling up of community-led programming, building coalitions and mobilizing resources. IFRC and WWF will collaborate to develop awareness-raising materials that underscore how protecting and restoring nature reduces people's exposure and vulnerability to climate change and weather-related disasters. The partnership will also leverage the mandate and expertise of each partner to promote the integration of NbS for climate change adaptation and disaster risk reduction in relevant laws, policies and plans. This will support the development of coherent policies and practices that work for both people and the planet. IFRC and WWF will also use the partnership to identify opportunities to work together to develop and scale up pilot NbS projects and programmes for disaster risk reduction and climate change adaptation, including gathering and sharing evidence on the value of nature in supporting the interventions. The partnership will focus on utilizing NbS for different disasters and in humanitarian contexts. IFRC and WWF will also work together to harness partnerships and mobilize resources to support implementation and scale-up of actions to support NbS for disaster risk reduction and climate change adaptation.

Recognizing that NbS interventions must be well-designed to reach their full potential, the partnership will support the implementation of the IUCN Global Standard for NbS. NbS needs to be developed and implemented based on the best criteria and practices available. Recognizing this, IUCN developed a Global Standard for NbS that provides eight criteria and associated indicators *(see Box 8).* The standard aims to equip practitioners with a robust framework for designing, verifying and strengthening NbS that yield the desired outcomes and are sustainable and adaptable.[323] The standard was developed in collaboration with NbS users, "*as a facilitative Standard, purposefully avoiding a rigid normative framing with fixed, definitive thresholds of what NbS ought to achieve*". The standard needs to be further unpacked to fully understand how it can be applied in disaster risk reduction and humanitarian contexts.

BOX 9: THE IUCN GLOBAL STANDARD CRITERIA[324]

NbS effectively address social challenges: The purpose of this criterion is to ensure that the NbS is designed as a response to a societal challenge that has been identified as a priority by those who are or will be directly affected by the challenge.

Design of NbS is informed by scale: The purpose of this criterion is to encourage NbS design that recognize the complexity and uncertainty that occur in living dynamic land/seascapes. Scale applies not only to the biophysical or geographic perspective but also to the influence of economic systems, policy frameworks and the importance of cultural perspectives.

NbS result in a net gain to biodiversity and ecosystem integrity: NbS design and implementation must avoid undermining the integrity of ecosystems and, instead, proactively seek to enhance the functionality and connectivity of the ecosystem. Doing so can also ensure the long-term resilience and durability of the NbS.

NbS are economically viable: This criterion requires that sufficient consideration is given to the economic viability of the intervention, both at the design stage and through monitoring the implementation.

NbS are based on inclusive, transparent and empowering governance processes: This criterion requires that NbS acknowledge, involve and respond to the concerns of a variety of stakeholders, especially rights holders.

NbS equitably balance trade-offs between the achievement of their primary goal(s) and the continued provision of multiple benefits: This criterion requires that advocates of NbS acknowledge these trade-offs and follow a fair, transparent and inclusive process to balance and manage them over both time and geographic space.

NbS are managed adaptively, based on evidence: This criterion requires that NbS implementation plans include provisions to enable adaptive management as a response to uncertainty and as an option to effectively harness ecosystem resilience.

NbS are sustainable and mainstreamed within an appropriate jurisdictional context: This criterion requires that NbS interventions are designed and managed with a view to long-term sustainability and that they take account of, work with and align with sectoral, national and other policy frameworks.

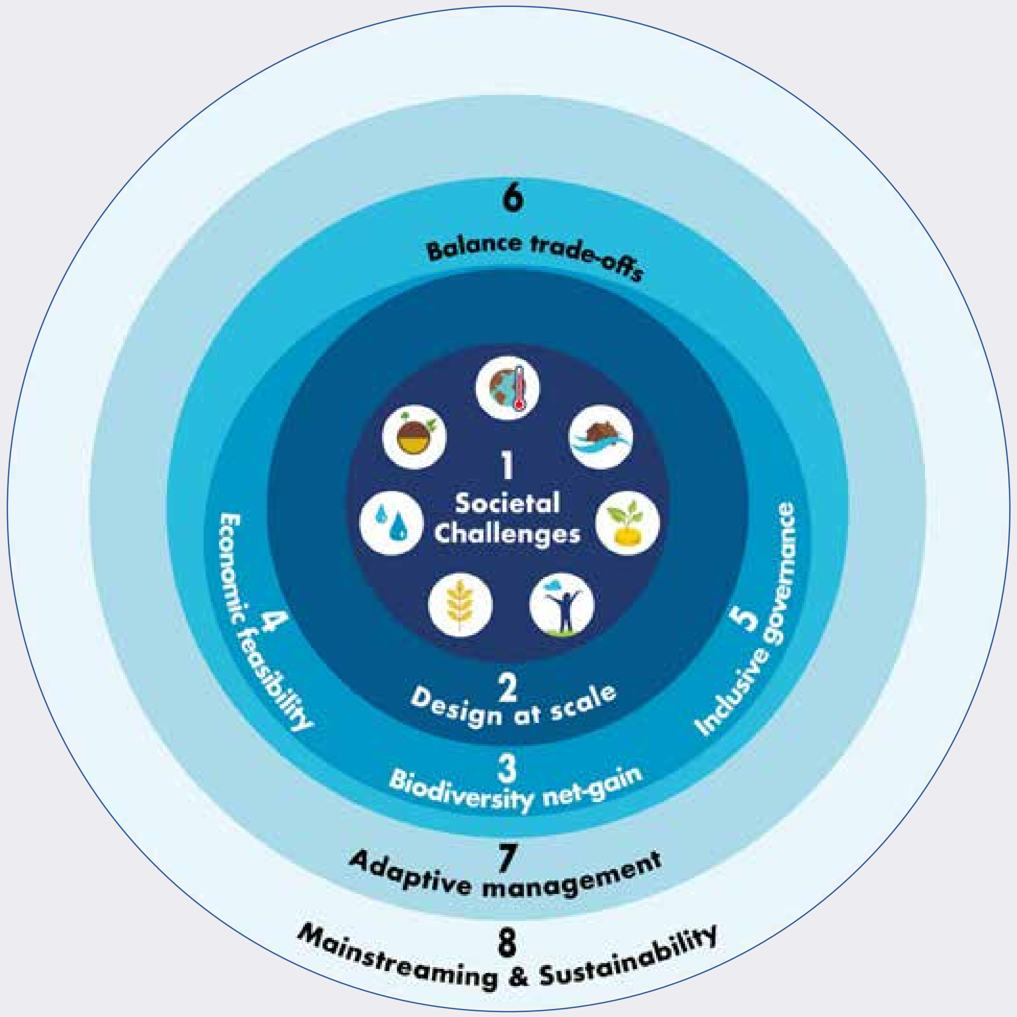

Figure 10: IUCN Global Standard Criterion *(© IUCN)*

Planting pine trees, Rwenzori Mountains, Uganda

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ANNEX 1: METHODOLOGY

INTRODUCTION

This annex describes the approach taken to estimate the economic cost of loss and damage that could potentially be avoided by implementing NbS. The estimates in the statements *"NbS has the potential to reduce the intensity of climate change and weather-related hazards by at least 26%*" and *"Each year, implementing NbS could provide developing countries with valuable protection against the economic cost of climate change, reaching US$ 104 billion annually by 2030"* were developed to provide an initial assessment of the magnitude of potential impact avoided by implementing NbS initiatives, using the best available evidence. It is important to note that these figures are not the result of developing primary data or original modelling.

Approach limitations: The lack of a robust evidence base was a limitation in this assessment. There is a lack of data availability that comprehensively assesses the potential of nature for reducing the intensity of each type of climate change and weather-related hazard. For example, studies that look at the reduction in hazard intensity from nature are often not quantified or are quantified only for regional or local projects or small-scale studies. Additionally, studies projecting future climate change and weather-related disaster impacts are inherently uncertain, with outcomes highly dependent on climate scenarios and several interconnected factors, including disaster response efforts and the multi-dimensional factors that impact vulnerability.

An overview of the approach taken to develop the estimate is presented in the following pages:

Successful tree replanting in Ankazomborona, Ambaro Bay, Ambilobe, Madagascar.

© Nick Riley / WWF

HIGH-LEVEL APPROACH

The following equation was used to estimate the economic cost of loss and damage that could potentially be avoided by implementing NbS:

Input 1		Input 2		Output2
Projected economic cost of loss and damage for developing countries	X	Potential % reduction in climate change and weather-related hazard intensity provided by NbS	=	Economic cost of loss and damage that could potentially be avoided bu implementing NbS

Figure 1: Equation to calculate the methodology output

Input 1: The projected economic cost of loss and damage for developing countries. Existing data and evidence on economic and social climate change and weather-related disaster impacts were assessed to determine which impacts could be projected for the period 2030-2050. Comprehensive estimates or literature were found for economic loss and damage, climate-change-related displacement, mental and physical health impacts, food insecurity and people in need of humanitarian assistance as a result of floods, storms and droughts [Table 1]. Due to the lack of quantification of projections for displacement, mental and physical health, and food insecurity, together with the complexities regarding the drivers of humanitarian assistance and displacement,[325, 326] only the economic loss and damage projection was included in the estimate.

Input 2: Potential % reduction in climate change and weather-related hazard intensity provided by NbS. An estimate of the reduction in climate change and weather-related hazard intensity that can be achieved annually by implementing well-designed NbS was developed using the best available quantitative data [Table 3].

Simplifying assumptions: When calculating the equation [Figure 1], it is assumed that NbS would be implemented where climate change and weather-related hazards occur and that the hard adaptation limits of nature would not be reached, meaning nature could continue to provide its protective ecosystem services.
The below sections provide a more detailed description of how each input and output was estimated:

DETAILED APPROACH

Approach to calculate input 1: Future total climate change and weather-related disaster impacts

Step 1: **Assessment of literature on the future impacts of climate change and weather-related disasters.** There are a wide range of future climate change and weather-related disaster impacts, including social, economic and environmental impacts [Chapter 2]. The uncertainty related to future climate scenarios and the complex interconnected factors that can influence climate change and weather-related disaster impacts hinders estimation of these impacts. This means there are a limited number of robust studies projecting future climate change and weather-related disaster impacts. For the purposes of this methodology, the IPCC AR6 WG2 report[327] and other reputable literature and reports[328, 329, 330] projecting future social and economic climate change and weather-related disaster impacts were assessed to identify sufficiently robust data and evidence. Evidence was selected according to the following criteria: **i)** global or multi-regional scope, **ii)** covers multiple climate change and weather-related disasters, **iii)** peer-reviewed or utilizes the most up-to-date and comprehensive data. The selected evidence is captured in Table 1.

Step 2: Decision on which impacts to include as input 1. Evidence that did not provide a quantitative estimate was excluded from the scope of input 1 [Evidence points 3-6 in Table 1]. Evidence points 2 and 3 were also both excluded due to the complexity surrounding the drivers of displacement, migration and people in need of humanitarian assistance, which would prevent a confident assessment of reduction in projected impact from implementing NbS:[331, 332] As a result, the projected economic cost of loss and damage in developing countries was selected as the sole focus for input 1, because economic damages are more influenced by hazard and exposure, with a clearer link between reduction in hazard intensity and reduction in economic damages.[333]

Impact	Projection	Rationale	Source
Included in Input 1			
1. Economic cost of loss and damage for developing countries	Residual damage is[334] estimated between US$ 290-580 billion in 2030 and US$ 1.1-1.7 trillion 2050 for MENA, SSA, SASIA, China, EASIA and LACA regions[335]	Peer-reviewed source which has been widely cited in the climate literature. Within the study, the authors outline how their estimate is consistent with other projections made for loss and damage. There is a lot of uncertainty regarding loss and damage due in particular to the variability of the emissions outcomes, but this source provides the current best estimate for the future cost of loss and damage.	Markandya A., González-Eguino M. (2019) [336]
Excluded from Input 1 due to lack of quantified data and/or complexity with linking to reduction in hazard intensity (see Step 2 above)			
2. People in need of humanitarian assistance from climate change and weather-related disasters	150 million people by 2030 and 200 million by 2050 could need help from the international humanitarian system because of floods, storms and droughts, under a pessimistic scenario.[337, 338]	Based on the most comprehensive available database on disasters (EM-DAT) and robust projections of future populations affected by a disaster as a result of climate change, from the World Bank	EM-DAT database, World Bank (2015), IFRC(2019) [339]
3. Climate change-related displacement	In the medium-to-long term, displacement will increase with the intensification of heavy precipitation and associated flooding, tropical cyclones, drought and, increasingly, sea-level rise	Most up-to-date and comprehensive assessment of the impacts of climate change, looking at ecosystems, biodiversity and human communities at global and regional levels. Developed with contributions from 270 experts from 67 countries	IPCC (2022) [340]
4. Climate change-related mental health challenges	Mental health challenges, including anxiety and stress, are expected to increase under further global warming in all regions assessed by the IPCC, particularly for children, adolescents, elderly and those with underlying health conditions [341]	Most up-to-date and comprehensive assessment of the impacts of climate change, looking at ecosystems, biodiversity and human communities at global and regional levels. Developed with contributions from 270 experts from 67 countries	IPCC (2022) [342]
5. Climate-change-related food security risks	Under global warming levels of 2°C or higher in the medium term (2041-2060), food security risks due to climate change will be more severe, leading to malnutrition and micronutrient deficiencies, concentrated in Sub-Saharan Africa, South Asia, Central and South America and small islands [343]	Most up-to-date and comprehensive assessment of the impacts of climate change, looking at ecosystems, biodiversity and human communities at global and regional levels. Developed with contributions from 270 experts from 67 countries	IPCC (2022) [344]
6. Climate-change-related health issues and mortality	Climate change and related extreme events will significantly increase ill health and premature deaths from the near- to long-term (2021-2100), including heat-related mortality and climate-sensitive food-borne, water-borne and vector-borne disease risks [345]	Most up to date and comprehensive assessment of the impacts of climate change, looking at ecosystems, biodiversity and human communities at global and regional levels. Developed with contributions from 270 experts from 67 countries	IPCC (2022) [346]

Table 1: Overview of climate change and weather-related disaster impacts

Step 3: Selection of data to be included as Input 1. The projections of economic loss and damage [Table 1] to be used as input 1 were selected and updated from 2005 US$ to 2021 US$ values for consistency with the dollar value estimates throughout this report. The resulting figures are outlined in Table 2 which are used as input 1.

	Lower bound		Upper bound	
Impact	**2030**	**2050**	**2030**	**2050**
Loss and Damage (US$ billion)	402	1526	805	2359

Table 2: Overview of data included as input 1

Approach to estimate Input 2: The protective potential of nature

Step 1: Assessment of the academic literature. A high-level review of the available academic literature was conducted to assess the reduction in climate change and weather-related hazard intensity that can be achieved by nature. The list of studies considered was constrained by selecting those which were global in coverage or provided a meta-analysis of multiple studies. One study which did not fulfil these criteria was included given it was peer-reviewed and covered a particularly relevant hazard [storm surge] and geographic area [Southern Asia] [Study 1 in Table 3]. The final subset of studies [Table 3] provided the basis for the percentage estimate of the reduction in hazard intensity from nature.

Hazard	Data points	Source
Storm surges/ coastal erosion	A hydrodynamic model for the Bay of Bengal, based on the MIKE21FM system, was run multiple times to simulate the surge of cyclone Sidr (2007) at the Barisal coast. A simulation for mangroves in Bengal Bay showed a **significant reduction in water flow velocity (29-92%)** Meta-analyses of 69 studies, among five habitats worldwide (coral reefs, mangroves, salt marshes, seagrass/kelp beds), show that these habitats reduce wave heights significantly. The paper analyses data from 69 field measurements in coastal habitats globally and examines measures of the effectiveness of mangroves, salt marshes, coral reefs and seagrass/kelp beds for wave height reduction: On average, coastal habitats **reduce wave heights between 35% and 71%**. Coral reefs reduce wave heights by 70% (*95% CI: 54–81%*), salt marshes by 72% (*95%CI: 62–79%*), mangroves by 31% (*95% CI: 25–37%*) and seagrass/kelp beds by 36% (*95% CI: 25–45%*)	1. Dasgupta *et al.* (2019) [347] 2. Narayan *et al.* (2016) [348]
Landslides	A study aiming to help improve decision-making on forestation in the Andes synthesised 155 studies concerning the impacts of forestation on water supply, hydrological regulation and mitigation of erosion and landslides. Forestation, in this case, is defined as the establishment of forest by plantation or natural regeneration on areas that either had forest in the past or not. The meta-regression found that the **mean annual relative interception in tree plantations, native forests and agroforestry was 25% of bulk rainfall (CI at 95%: 19–33%)**. Plantation forests had a relative interception that was similar to native forest or agroforests.	3. Bonnesoeur *et al.* (2019) [349]
Floods	A study drawing together 25 natural flood management schemes, providing a meta-analysis of hydrological performance, reported that **woodland coverage of 80% in a 400-hectare grassland and forest area in Wales was reported to reduce peak flow by 30%** for larger events (50-200-year flood events) [350]	4. Iacob *et al.* (2014)

Table 3: Overview of the evidence base of the protection potential of nature

Step 2: Selection of data points for the potential of nature estimate. Given the lack of data surrounding the potential of nature, the authors took a conservative approach and selected the lower bound estimate of each study to be the inputs in the calculation estimating the protection potential of nature against climate change and weather-related hazards [figure 1]. The selected data points are in Table 4:

Hazard	Data points
Storm surges/ coastal erosion	**29%** which is the lower bound of the estimated reduction in water flow velocity from mangroves (29-92%) in Study 1 in Table 3 **25%** which is the lower bound of all of the 95% confidence intervals of the estimated reduction in wave heights provided by coastal habitats in Study 2 in Table 3
Landslides	**19%** which is the lower bound of the 95% confidence interval for the estimated interception (25% of bulk rainfall) in tree plantations, native forests and agroforestry (CI at 95%: 19–33%) in Study 3 in Table 3
Floods	**30%** which is the estimated reduction in peak flow values from woodlands in Study 4 in Table 3

Table 4: Data points selected for the potential of nature estimate

Step 4: Calculation of average reduction in hazard intensity. The average of the selected data points [Table 4] was used to estimate the reduction in climate change and weather-related hazard intensity from nature. Well-designed NbS conserve, restore and/or sustainably manage nature, ensuring it can continue to provide its ecosystem services. Therefore, the reduction in hazard intensity from nature can be used as a proxy for the reduction in hazard intensity achieved by well-designed NbS initiatives. The reduction in climate change and weather-related hazard intensity provided by NbS is **estimated as ~26%** [351] which was used as input 2.

Input 2 approach limitations and simplifying assumptions: This is a simplified estimate because different NbS solutions may have higher or lower hazard intensity reduction potential, NbS performance will vary based on geography, and NbS will have differing levels of intensity reduction potential for each type of climate change and weather-related hazard. However, given the growing evidence base of successful projects, empirical studies and modelling studies,[352] this estimate can provide an initial assessment of the average reduction in hazard intensity that can be achieved by NbS. The approach taken to derive this estimate is also conservative as it only includes the sub-set of studies that fulfil the selection criteria discussed above, takes the lower bound of the included studies, and also excludes estimates that fit the criteria but are inconsistent with the other estimates. For example, Ferrario et al. 2014,[353] a meta-analysis study that estimated that coral reefs provide substantial protection against natural hazards by reducing wave energy by an average of 97% (95% CI 94–98%), was excluded from the estimate given this was much higher than other data points.

Approach to calculate the output: The economic cost of climate change loss and damage that could potentially be avoided in developing countries by implementing NbS.

Step 1: Output calculation. To calculate the output, the authors applied the reduction in hazard intensity estimate to the projected cost of loss and damage in Table 2. This gave the estimated savings in the below table:

	Lower bound		Upper bound	
Impact	**2030**	**2050**	**2030**	**2050**
Loss and Damage (US$ billion) [354]	104	393	207	607

Table 5: Overview of output estimates

Output approach limitations and simplifying assumptions: These estimates include the simplifying assumption that NbS would be implemented at the same place that climate change and weather-related hazards occur. It also includes the assumption that the hard adaptation limits of nature would not be reached and nature can continue to provide its ecosystem services.

ENDNOTES

1 Based on WMO (2021) which estimates that the number of climate, weather and water extremes have increased by more than 40%. The extremes covered in the WMO report (storm, extreme temperature, drought, wildfire, flood, landslide) are equivalent to the disasters included in this report's definition of sudden-onset climate change and-weather related disasters. WMO. (2021) WMO Atlas of Mortality and Economic Losses from Weather, Climate and Water Extremes (1970-2019). Available at: https://library.wmo.int/doc_num.php?explnum_id=10989

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