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Becoming #GenerationRestoration

ECOSYSTEM RESTORATION FOR PEOPLE, NATURE AND CLIMATE

UNITED NATIONS DECADE ON ECOSYSTEM RESTORATION 2021-2030

UN environment programme 50 1972-2022

Food and Agriculture Organization of the United Nations

ISBN: 978-92-807-3864-3

Job number: DEP/2362/NA

Suggested citation

United Nations Environment Programme (2021). Becoming #GenerationRestoration: Ecosystem restoration for people, nature and climate. Nairobi.

Production

United Nations Environment Programme (UNEP) and UN Environment Programme World Conservation Monitoring Centre (UNEP-WCMC).
https://www.unep.org/resources/ecosystem-restoration-people-nature-climate

Supported by:

The United Nations Environment Programme (UNEP) would like to thank the Governments of Finland and Germany for their financial contributions towards this report, and the Food and Agriculture Organization of the United Nations (FAO) for technical review and data provision.

supported by

Ministry for Foreign Affairs of Finland

Supported by:

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

based on a decision of the German Bundestag

INTERNATIONAL CLIMATE INITIATIVE (IKI)

UN environment programme WCMC

Acknowledgements

The United Nations Environment Programme (UNEP) would like to thank the members of the Steering Committee, the lead and contributing authors, the peer reviewers, the UN Decade on Ecosystem Restoration Science Task Force, led by IUCN, and the partner organizations of the UN Decade for their contributions to the preparation of this report.

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FOREWORD

The world is facing severe challenges. Billions of people around the world are suffering the consequences of the climate emergency, food and water insecurity, and the COVID-19 pandemic. Ecosystems are an indispensable ally as we meet these challenges. Protecting them and managing their resources in a sustainable manner is essential. But just increasing the protection and sustainable management of our remaining natural landscapes and oceans will not be enough: the planet's degraded ecosystems and the huge benefits that they provide must also be restored.

By declaring the UN Decade on Ecosystem Restoration, governments have recognized the need to prevent, halt and reverse the degradation of ecosystems worldwide for the benefit of both people and nature. The 2021–2030 timeline underlines the urgency of the task. Without a powerful 10-year drive for restoration, we can neither achieve the climate targets of the Paris Agreement, nor the Sustainable Development Goals.

This report presents the case for why we all must throw our weight behind a global restoration effort. Drawing on the latest scientific evidence, it explains the crucial role played by ecosystems from forests and farmland to rivers and oceans, and charts the losses that result from our poor stewardship of the planet.

The UN Decade on Ecosystem Restoration provides a unique opportunity to transform food, fibre and feed production systems to meet the needs of the 21st century, and to eradicate poverty, hunger and malnutrition. This we seek to achieve through effective and innovative landscapes and seascapes management that prevents and halts degradation, and restores degraded ecosystems. The restoration of forest landscapes, farming, livestock and fish-producing ecosystems should primarily contribute to restoring them to a healthy and stable state, so that they are able to provide ecosystems services and support human needs for sustainable production and livelihoods.

For example, around one third of the world's farmland is degraded, about 87 per cent of inland wetlands worldwide have disappeared since 1700, and one third of commercial fish species are overexploited. Degradation is already affecting the well-being of an estimated 3.2 billion people – that is 40 per cent of the world's population. Every single year, we lose ecosystem services worth more than 10 per cent of our global economic output.

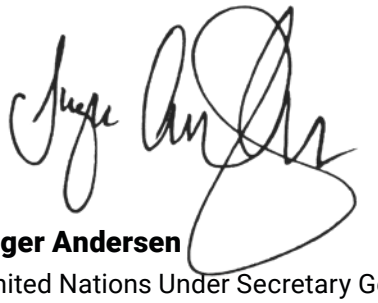
If we can manage to reverse this trend, massive gains await us. Reviving ecosystems and other natural solutions could contribute over one third of the total climate mitigation needed by 2030. Restoration can also curb the risk of mass species extinctions and future pandemics. Agroforestry alone could increase food security for 1.3 billion people.

Restoration on a global scale requires sustained investments. But there is growing evidence that it more than pays for itself. For example, restoring coral reefs to good health by 2030 could yield an extra USD 2.5 billion a year for both Mesoamerica and Indonesia; having doubled its forest cover since the 1980s, Costa Rica has seen ecotourism grow to account for 6 per cent of GDP.

While restoration science is a youthful discipline, we already have the knowledge and tools we need to halt degradation and restore ecosystems. Farmers, for instance, can draw on proven restorative practices such as sustainable farming and agroforestry. Landscape approaches that give all stakeholders – including women and minorities – a say in decision-making are simultaneously supporting social and economic development and ecosystem health. And policy makers and financial institutions are realizing the huge need and potential for green investment.

The United Nations stands behind this crucial initiative. As well as contributing research to this report, the United Nations Environment Programme (UNEP) and Food and Agriculture Organization (FAO) along with their partners will provide leadership, coordination and technical support throughout the UN Decade.

International cooperation can help countries to implement their existing restoration pledges, which cover more than 1 billion hectares, an area bigger than China. Global meetings on climate and biodiversity slated for later this year are an opportunity for governments to increase their ambition further, and to force the pace of implementation. But long-term success will depend on the UN Decade realizing its overarching goal of catalysing a global movement that outgrows and outlives the 10-year timeframe. By engaging in restoration, everyone – from governments and businesses to civil society groups and individuals – can contribute towards resetting our relationship with nature.



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CONTENTS

KEY MESSAGES

Photo: Neil Palmer/CIAT

KEY MESSAGE 1

Countries need to deliver on their existing commitments to restore 1 billion hectares of degraded land and make similar commitments for marine and coastal areas.

The fulfilment of these commitments is not simply something that is 'nice to have'. Restoration is essential for keeping global temperature rise below 2°C, ensuring food security for a growing population and slowing the rate of species extinctions. Humanity is not outside of nature; it is part of it. We need to recreate a balanced relationship with the ecosystems that sustain us.

KEY MESSAGE 2

Unfortunately, we are still going in the wrong direction.

The world's ecosystems – from oceans to forests to farmlands – are being degraded, in many cases at an accelerating rate. People living in poverty, women, indigenous peoples and other marginalized groups bear the brunt of this damage, and the COVID-19 pandemic has only worsened existing inequalities. While the causes of degradation are various and complex, one thing is clear: the massive economic growth of recent decades has come at the cost of ecological health.

KEY MESSAGE 3

Ecosystem restoration is needed on a large scale in order to achieve the sustainable development agenda.

The conservation of healthy ecosystems – while vitally important – is now not enough. We are using the equivalent of 1.6 Earths to maintain our current way of life, and ecosystems cannot keep up with our demands. Simply put, we need more nature. The good news is that nature has an extraordinary capacity for renewal. While some ecosystems are approaching a tipping point from which they cannot recover, many others can flourish again if we stop the damage and restore their health, biodiversity and productivity.

KEY MESSAGE 4

Ecosystem restoration delivers multiple benefits.

It is one of the most important ways of delivering nature-based solutions for societal challenges.

- Half of the world's GDP is dependent on nature, and every dollar invested in restoration creates up to USD 30 dollars in economic benefits.
- Restoring productive ecosystems is essential to supporting food security. Restoration through agroforestry alone has the potential to increase food security for 1.3 billion people. Restoring the populations of marine fish to deliver a maximum sustainable yield could increase fisheries production by 16.5 million tonnes, an annual value of USD 32 billion.
- Actions that prevent, halt and reverse degradation are needed if we are to keep global temperatures below 2°C. Such actions can deliver one-third of the mitigation that is needed by 2030. This could involve action to better manage some 2.5 billion hectares of forest, crop and grazing land (through restoration and avoiding degradation) and restoration of natural cover over 230 million hectares.
- Large-scale investments in dryland agriculture, mangrove protection and water management will make a vital contribution to building resilience to climate change, generating benefits around four times the original investment.
- With careful planning, restoring 15 per cent of converted lands while stopping further conversion of natural ecosystems could avoid 60 per cent of expected species extinctions.

KEY MESSAGE 5

Achieving successful ecosystem restoration at scale will require deep changes, including:

- Adopting inclusive wealth as a more accurate measure of economic progress. This will rest on the widespread introduction of natural capital accounting.
- Creating an enabling environment for private sector investment, including through public-private partnerships.
- Increasing the amount of finance for restoration, including through the elimination of perverse subsidies that incentivize further degradation and fuel climate change, and through initiatives to raise awareness of the risks posed by ecosystem degradation.
- Taking action on food waste, making more efficient use of agricultural land, and encouraging a shift to a more plant-based diet.
- Expanding awareness of the importance of healthy ecosystems throughout our educational systems.

KEY MESSAGE 6

Everyone has a role to play in ecosystem restoration.

The restoration of ecosystems at scale is no small task, and it will take a concerted effort to truly restore the planet. The UN Decade on Ecosystem Restoration aims to catalyse a global movement among local communities, activists, women, youth, indigenous groups, private companies, financial investors, researchers and governments at all levels.

The beauty of restoration is that it conveys a message of action and hope, and it can happen at any scale – whether a backyard plot, a city park, a river valley, a national forest or a globally threatened ecosystem. This means that everyone can get involved.

KEY MESSAGE 7

Achieving the aims of the UN Decade will require action by many. We call on:

- Governments to ensure that their COVID-19 recovery plans incorporate significant allocations for ecosystem restoration as a central component to delivering a green, sustainable and fair recovery. Currently, only about 18 per cent of recovery stimulus plans can be characterized as ‘green’.
- Parties to deliver on existing commitments under the Rio Conventions and the Bonn Challenge to restore 1 billion hectares of land.
- Donors and institutions working on coastal and marine restoration to develop and deliver on ambitious restoration goals equivalent at least to the Bonn Challenge.
- Public and private financial institutions and regulatory bodies to develop and strengthen instruments and mechanisms to ensure that finance flows support – and do not compromise – restoration efforts.
- Indigenous peoples and local communities across the world to build on their knowledge, experience and capacity for action to help achieve restoration goals.
- Youth organizations to play an active leadership role in ecosystem restoration locally, nationally and globally and to actively participate in the governance and implementation of the UN Decade.

CHAPTER 1

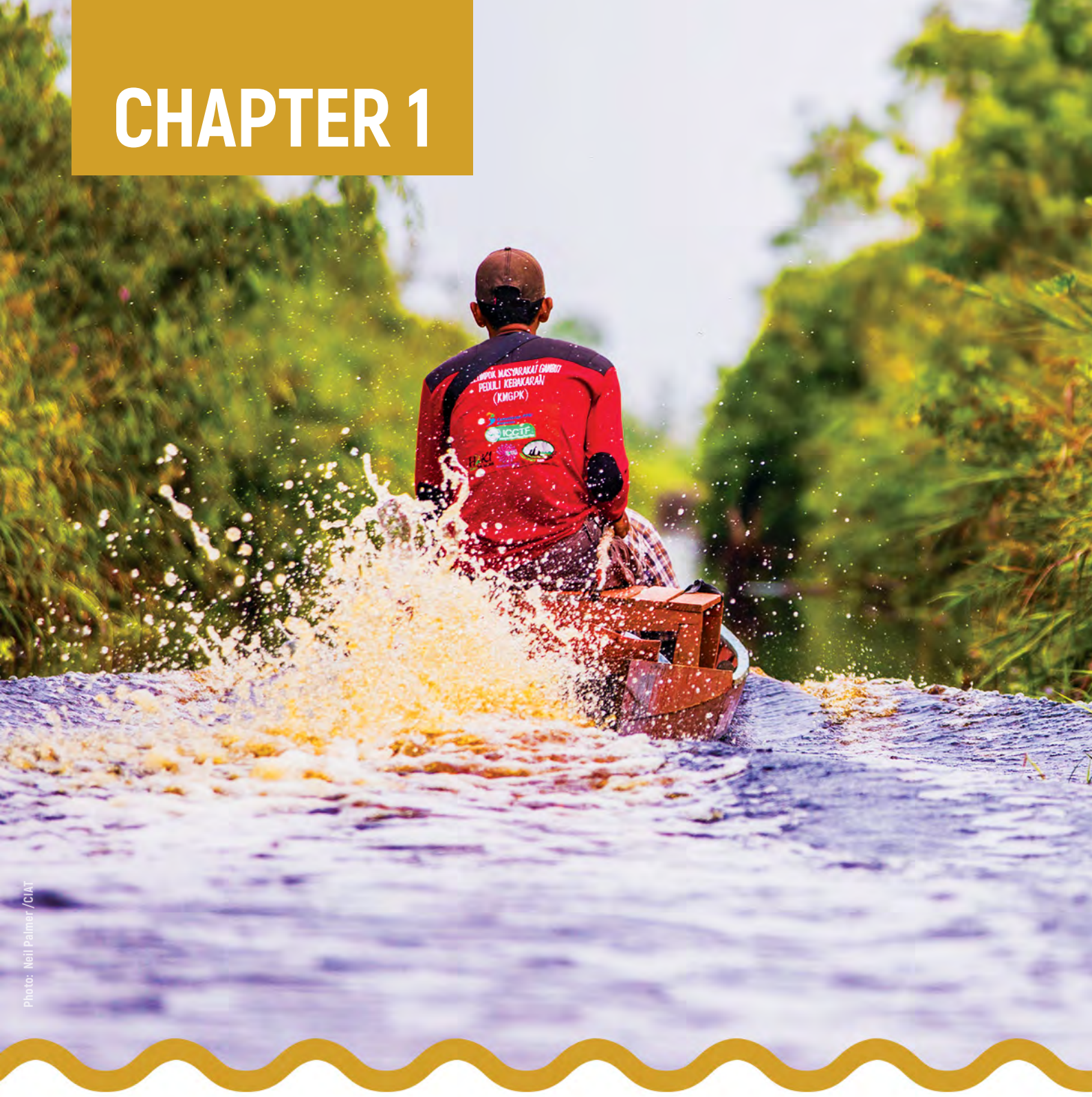

Photo: Neil Palmer /CIAT

INTRODUCTION

Humanity now faces a choice: we can continue down a path where our demands on Nature far exceed its capacity to meet them on a sustainable basis; or we can take a different path, one where our engagements with Nature are not only sustainable but also enhance our collective well-being and that of our descendants.

– The Economics of Biodiversity: The Dasgupta Review

We can no longer deny that we are a part of our environment, which we are degrading at an alarming rate. In order to embark on a more sustainable pathway, we need both to conserve and restore ecosystems. This report makes the case for why restoration, in particular, is so important and outlines how the UN Decade can catalyse a movement to restore the world's ecosystems.

Healthy, stable and biodiverse ecosystems are the foundation of our health and well-being, as well as that of our fellow species. They help to regulate our climate and control extreme events, pests and diseases, as well as to provide us with water, food, raw materials and spaces for recreation. They absorb our wastes, sustain economic sectors and the livelihoods of millions of people, and they nurture our health, culture and spiritual fulfilment (IPBES 2019).

However, we have been overexploiting and degrading the world's ecosystems and wild species, causing the erosion of the very services we depend on (UNEP 2021). Driving this degradation are the ways we produce food (Benton et al. 2021) and alter our landscapes and oceans, along with climate change, pollution and invasive species (IPBES 2019). The global economy has seen incredible growth over recent decades – growth that has been fuelled by the erosion of the world's natural assets. Thus, our massive gains in income and poverty reduction come at the expense of a significant deterioration of the health of the biosphere. We are using the equivalent of 1.6 Earths to maintain our current lifestyle (Global Footprint Network 2021) and are putting the future of our economies at extreme risk (Dasgupta 2021).

This report represents a synthesis of recent research. All selected ecosystems – farmlands; forests; freshwater; grasslands, shrublands and savannahs; mountains; oceans and coasts; peatlands; and urban areas – are being degraded, often at an accelerating rate. We are fast approaching a tipping point for the climate (IPCC 2018) and are close to overshooting some of our other 'planetary boundaries'. The demands humanity places on the biosphere – our ecological footprint – are simply too much (Dasgupta 2021). Because ecosystem degradation does not affect everyone equally, its worst impacts mainly affect people living in poverty, women and girls, members of indigenous and traditional communities, older persons, persons with disabilities, ethnic, racial or other minorities and displaced persons (Stoeckl et al. 2013; OHCHR 2018; UN HLCP 2021). These are the same groups of people who are suffering the worst effects of the COVID-19 pandemic, as it is exacerbating pre-existing inequalities (UNEP and FAO 2020). Chapter 2 provides a snapshot of the current state of the world's ecosystems.

The need to restore damaged ecosystems has never been greater. Degradation is undermining hard-won development gains and threatening the well-being of today's youth and future generations, while making national commitments increasingly more difficult and costly to reach. None of the agreed global goals for the protection of life on Earth and for halting the degradation of land and oceans have been fully met (UNEP 2021), and only 6 of the 20 Aichi Biodiversity Targets have been partially achieved (CBD 2020a). We need to re-create a balanced relationship with nature, not only by conserving ecosystems that are still healthy, but also by urgently and sustainably restoring degraded ones. Ecosystem restoration alone cannot solve the crises we face, but it is key to averting the worst of them. Chapter 3 details the myriad ways that nature-based solutions like restoration can benefit the climate, food systems, health and the economy.

Much has been done already, and we can build on the lessons learned from existing restoration approaches and initiatives. Commitments by 115 governments to restore a total of nearly 1 billion hectares of land as a contribution to achieving the objectives of the CBD, UNCCD, UNFCCC and the Bonn Challenge (Sewell et al. 2020) are a good start. However, achieving restoration goals will require a fundamental shift in the way we value ecosystems, their biodiversity and the vital services we depend on (Dasgupta 2021). Chapter 4 provides an overview of different approaches to restoration, guiding principles and helpful technical and scientific innovations, as well as the broader conditions needed to address the drivers of degradation and enable the transition to a more sustainable way of life.

The UN Decade on Ecosystem Restoration aims to prevent, halt and reverse the degradation of all kinds of ecosystems, contributing to reductions in global poverty and ensuring that no one is left behind. Running from 2021

until 2030, the UN Decade launches a global movement to restore ecosystems worldwide. This will help to achieve multiple global goals, including the Post-2020 Global Biodiversity Framework under the CBD, the Paris Agreement under the UNFCCC, the Sustainable Development Goals (SDGs) under 2030 Agenda and the Land Degradation Neutrality targets under the UNCCD. There are also clear complementarities with the efforts being developed in both the UN Decade of Ocean Science for Sustainable Development (2021–2030) and the UN Decade of Family Farming (2019–2028). The UN Food Systems Summit 2021 provides an opportunity to promote scaled up action on restoring farmlands and other food-producing systems. Chapter 5 presents the overall strategy for the UN Decade and the way forward.

The impacts of the COVID-19 pandemic will be felt for generations. Yet this crisis has also demonstrated the power of international cooperation and provided us with an opportunity to steer away from our current destructive trajectory (UNEP 2021). To put countries on a path that is green, sustainable and fair, national governments must include ecosystem restoration in their pandemic recovery plans. This Decade can serve as a launchpad to accelerate the transformative changes we need to combat the climate crisis, prevent mass extinctions and build social and economic resilience.

[1] Convention on Biological Diversity (CBD), United Nations Convention to Combat Desertification (UNCCD), United Nations Framework Convention on Climate Change (UNFCCC)

Photo: Georgina Smith/CIAT

WHAT IS ECOSYSTEM RESTORATION?

Ecosystem restoration is the process of halting and reversing degradation, resulting in improved ecosystem services and recovered biodiversity. Ecosystem restoration encompasses a wide continuum of practices, depending on local conditions and societal choice.

Depending on objectives, restored ecosystems can follow different trajectories:

- **from degraded natural to more intact natural ecosystems (often by assisting natural regeneration)**
- **from degraded, modified ecosystems to more functional modified ecosystems (e.g. restoration of urban areas and farmlands)**
- **from modified ecosystems towards more natural ecosystems, providing that the rights and needs of people who depend on that ecosystem are not compromised.**

PAKISTAN HOSTS WORLD ENVIRONMENT DAY 2021: CELEBRATING ECOSYSTEM RESTORATION

As the leader of one of the world's most ambitious forest landscape restoration efforts, Pakistan is hosting World Environment Day 2021, celebrating the year's theme of ecosystem restoration and the launch of the UN Decade on Ecosystem Restoration.

Over the next five years, the 10 Billion Tree Tsunami programme will aim to expand and restore Pakistan's mangroves and forests, while also generating jobs amid the COVID-19 pandemic, boosting conservation and curbing the impacts of climate change. In alignment with international and national commitments, the campaign focuses on forest restoration in both rural and urban areas, including growing trees in schoolyards, colleges, public parks and green belts.

This flagship programme will contribute to the country's goals to conserve and restore its fragile ecosystems and safeguard the livelihoods of communities. There are also efforts to restore wetlands, such as the Miani Hor Lagoon, home to the largest mangrove forests along the Balochistan coast. In 2020, government-led efforts brought together non-governmental organizations and local fishermen and women to restore land using over 250,000 nursery plants and 461,000 cuttings. The programme is beginning with a goal of 404 hectares, expanding to 1,214 hectares over the coming years. The government is also developing a novel debt-for-nature scheme to ease its debt burden and accelerate the **10 Billion Tree Tsunami.**

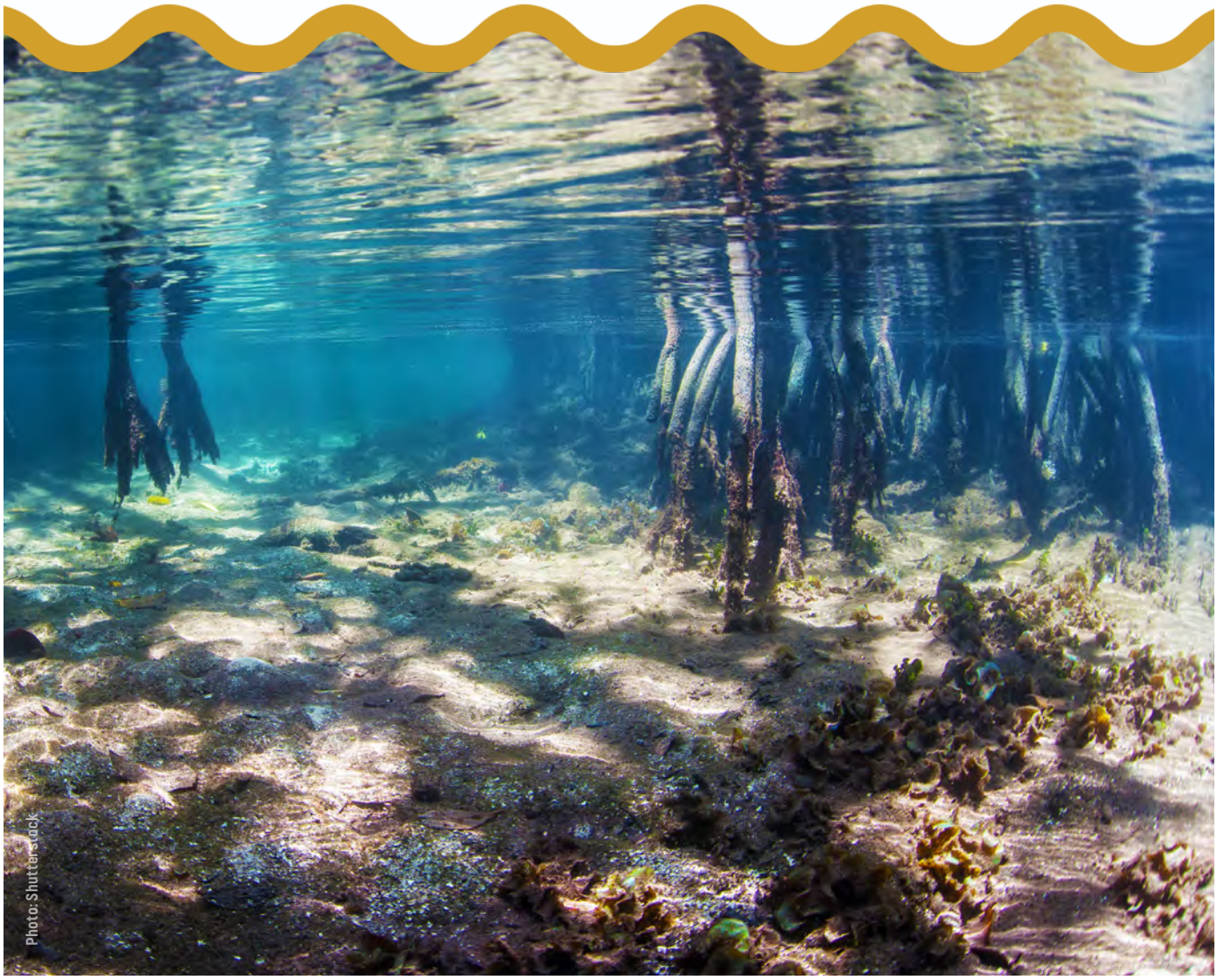

Photo: Shutterstock

CHAPTER 2

Photo: www.grida.no/resources/1005

WHAT IS HAPPENING TO THE WORLD'S ECOSYSTEMS

We are degrading our ecosystems in serious ways. From farmlands to forests, from mountains to oceans, our diverse ecosystems – both natural and modified – are being damaged faster than they can recover. This means they are losing their integrity, their biodiversity and their ability to provide essential services.

In all ecosystems, biodiversity loss and degradation are caused by direct drivers (land- or sea-use change, direct exploitation, climate change, pollution, and invasive species), which are underpinned by demographic and economic indirect drivers that interact in complex ways. While the specific causes of degradation vary across ecosystems, in general overfishing is having the greatest impact on oceans, and terrestrial and freshwater ecosystems are most affected by land-use change, which is driven mainly by agriculture, forestry and urbanization (IPBES 2019).

The UN Decade focuses on eight broad categories of ecosystems, based upon the International Union for Conservation of Nature (IUCN) Global Ecosystem Typology 2.0 (IUCN 2020). These ecosystems overlap somewhat; for example, some grasslands or forests are also peatlands, and all three of these ecosystems can occur in mountains. This chapter provides a snapshot of each ecosystem, including the benefits that humans and other species gain from it and how it is being degraded. The following figure describes the coverage and state of degradation of each of the selected ecosystems.

2.1 Farmlands

Farmlands sustain human life. They provide us with food, fibre and other essential products and also supply biodiversity habitat, economic opportunities and spiritual and cultural benefits (UNCCD 2017). At least two billion people depend on the agricultural sector for their livelihoods, particularly poor and rural populations (Searchinger et al. 2019; Abraham and Pingali 2020), and over 90 per cent of our calories and protein originate on land (FAOSTAT 2021)

Farmland degradation is reducing crop and livestock yields. While farmland degradation typically involves harm to soils (FAO and ITPS 2015), it can also result from the loss of wild species that provide pest control and crop pollination (Dainese et al. 2019). Roughly 80 per cent of global arable land is impacted by at least one form of degradation, such as aridity, vegetation decline, soil salinization and loss of soil carbon. Soil erosion alone affects roughly one-fifth of farmlands worldwide and is estimated to have increased by 2.5 per cent between 2001 and 2012, primarily due to deforestation and cropland expansion (Prăvălie et al. 2021). Estimates project that land degradation could reduce global food productivity by 12 per cent, causing food prices to soar by up to 30 per cent by 2040 (Noel et al. 2015; Kopittke et al. 2019). Approximately 12 million hectares of severely eroded croplands in the European Union contribute to an annual loss in agricultural productivity of EUR 1.25 billion (Panagos et al. 2018). In the USA it is estimated that the decline in soil fertility in maize fields costs farmers over half a billion dollars per year in extra fertilizer (Jang et al. 2020). In China, where only 14 per cent of the land area is suitable for crop production, over 50 per cent of cultivated land has experienced degradation (Deng 2016).

Examples from around the world

In Kenya, land degradation is having a significant impact on crop productivity, and hence on local livelihoods and the overall economy. Soil nutrient mining – when crop producers remove more nutrients from the soils than they apply – is leading to lower yields for wheat, maize and rice crops, costing the country an estimated USD 270 million each year. This, in combination with wind and water erosion, rangeland degradation, deforestation and desertification, is threatening not only rural livelihoods but also water supplies and wildlife habitat (Mulinge et al. 2015).


Photo: Reuters

Ecosystems worldwide are under pressure

FARMLANDS

Croplands and pastures (modified grasslands on which domestic animals are grazed)

4.8 billion ha[a]
Croplands and pastures cover ~12% and 26% of the world's ice-free land[b]

20%
of croplands show stressed or declining productivity[c]

FORESTS

Tropical, subtropical, temperate, boreal and polar forests, plantations, low-density woodlands and agroforests

4.06 billion ha
~31% of global land area[d]

~420 million ha
of forest have been converted to other land uses since 1990[e]

FRESHWATER

Rivers, lakes, wetlands and other inland waters

<0.01%
of the earth's surface[f]

35%
average decline in area of natural inland wetlands since 1970[g], with 87% total loss since 1700[h]

GRASSLANDS, SHRUBLANDS & SAVANNAHS

Shrublands, shrubby woodlands, heathlands, savannahs, steppes and grasslands

Grasslands and savannahs cover
26-40%
of the earth's land surface[i]

~19%
of grasslands and 27% per cent of rangelands show stressed or declining productivity[j]

MOUNTAINS

Found on all of the world's continents, in biomes from hot deserts to tropical forests to polar ice caps

27%
of global land area[k]

5 days
per decade = average decline in duration of mountain snow cover, especially at lower elevation[l]

OCEANS & COASTS

Tropical, temperate and polar marine ecosystems from shallow coastal to deep sea

Oceans occupy
36 billion ha[m]

~66%
of ocean ecosystems are damaged, degraded or modified[n]. ~1/3 of commercial marine fish populations are fished unsustainably[o]

PEATLANDS

Wetland habitats with organic peaty soils (e.g. marshes, swamps, fens and bogs)

~400 million ha
across 169 countries[p]

Degradation has affected nearly
65 million ha
of peatlands[q], especially in Europe, Central and Southeast Asia, East Africa, southernmost America and the Amazon[r]

URBAN AREAS

Cities, towns and villages. Habitats in green spaces and waterways

2%
of global land area[s]

>50%
Since 2000, the number of city inhabitants without access to safely managed drinking water has increased by more than 50 per cent[t]

[a] FAO 2016a, [b] Foley et al. 2011, [c] UNCCD 2017, [d] FAO and UNEP 2020, [e] FAO and UNEP 2020, [f] Lehner and Döll 2004, [g] Darrah et al. 2019, [h] Reid et al. 2020, [i] Dudley et al. 2020, [j] UNCCD 2017, [k] Romeo et al. 2020, [l] IPCC 2019, [m] NOAA 2020a, [n] IPBES 2019, [o] FAO 2016b, [p] Joosten 2009; Kirpotin et al. 2021, [q] Bonn et al. 2016, [r] FAO 2020a, [s] UN Habitat 2020, [t] UN-Water, 2021

2.2 Forests

Forests regulate the climate (FAO and UNEP 2020), absorb carbon from the atmosphere (−15.6 ± 49 gigatonnes of CO_2 equivalent [$GtCO_2e$] gross annually, between 2001 and 2019) (Harris et al. 2021), and provide habitat for 80 per cent, 75 per cent and 68 per cent of all amphibian, bird and mammal species, respectively (Vié, Hilton-Taylor and Stuart 2009). They contribute to precipitation, regulate streamflow and foster groundwater recharge (FAO 2019), providing drinking water to one-third of the world's largest cities (HLPE 2017). Food, shelter, energy, medicines and around 86 million associated jobs come from forest products (FAO 2018; FAO 2014).

Although deforestation has slowed in recent years, the world lost around 10 million hectares of forests per year between 2015 and 2020 (FAO and UNEP 2020). If these rates continue unabated, the global canopy could shrink by 223 million hectares by 2050 (Bastin et al. 2019). Each year, an average of 122 million hectares of forests are affected by fires, pests, diseases, invasive species, drought and adverse weather events (IUFRO 2018). Degradation could affect up to 1.75 billion people who live in or near forests, including indigenous and local communities, smallholders and people who work in formal or informal forest-based enterprises. Degradation increases the risk of flooding (HLPE 2017) and, along with fragmentation of ecosystems, increases human-wildlife conflicts (Gibb et al. 2020). It has been linked to outbreaks of vector-borne diseases like malaria (Morand and Lajaunie 2021) and animal-borne diseases, such as COVID-19 (UNEP and ILRI 2020) and Ebola (Olivero 2017). Finally, the consequences for the climate are staggering: between 2001 and 2019, deforestation, logging and other disturbances resulted in emissions of 8.1 ±2.5 $GtCO_2e$ annually (Harris et al. 2021).

2.3 Freshwater

Freshwater bodies are home to around one-third of vertebrate species and 10 per cent of all described species on Earth (CBD 2020b), with many more in the world's wetlands. Freshwater ecosystems provide food through inland fisheries (Funge-Smith and Bennet 2019), water for drinking, agriculture and industry, and transportation of goods. They regulate water quality and regional climate and provide flood protection. Forests and water are interlinked, with an estimated 75 per cent of the world's accessible freshwater coming from forested watersheds (FAO 2019). Approximately 1.4 billion livelihoods worldwide are directly reliant on water, including jobs related to the food and beverage, energy and water industries (UN 2018).

The integrity of freshwater ecosystems – and their capacity to provide ecosystem services – is increasingly under threat. Worldwide water use has increased by nearly 600 per cent over the past 100 years (Wada et al. 2016), and by 2050 the global demand for water is expected to increase by 20–33 per cent from 2010 levels (Burek et al. 2016). Use of freshwater for power generation and irrigation provides economic benefits, but it can also cause environmental and socioeconomic impacts downstream (Snoussi et al. 2007). Agriculture accounts for 92 per cent of the global freshwater footprint, and 29 per cent of the water in agriculture is directly or indirectly used for animal production (Hoekstra and Mekonnen 2012). Since 1900, 64–71 per cent of wetlands have been lost. While the rate of wetland loss in Europe has slowed, and in North America has remained low since the 1980s, in Asia it has remained high due to large-scale and rapid conversion of coastal and inland natural wetlands (Davidson 2014). Freshwater ecosystem degradation and over-abstraction are contributing to water scarcity; half a billion people worldwide face severe water scarcity year round (Mekonnen and Hoekstra 2016).

Examples from around the world

Agriculture consumes a large amount of freshwater. The most dramatic example of this is the Aral Sea in Central Asia. Once the fourth-largest freshwater lake in the world, with a surface area of 68,000 km^2, it is now only one-tenth of its original size (Loodin 2020). Construction of large-scale irrigation infrastructure in the 1960s diverted its source rivers towards cotton and other crops, leaving the remaining water and dried-out land polluted and salty (Earth Observatory, n.d.). Local populations continue to suffer from food insecurity, job losses and health problems (Wæhler and Dietrichs 2017; Dasgupta 2021; Loodin 2020).

2.4 Grasslands, shrublands and savannahs

Most grasslands, shrublands and savannahs are found in drylands, although some are cool and wet. Occurring in every continent but most extensively in Africa and Asia (Prăvălie 2016), drylands also include hyper-arid deserts (UNCCD 2017). Drylands generally have a low productivity, yet they support the livelihoods of over 1.75 billion people (Safriel et al. 2005), including many poor populations (Mortimore 2009). In East Africa alone, over 250 million people depend on drylands for their livelihoods (De Leeuw et al. 2014). Collectively they store substantial soil organic carbon, helping to mitigate climate change (Mbaabu et al. 2020). They also provide water storage and regulation, woodfuel, timber and charcoal, as well as forage for livestock. Drylands host unique wildlife and are home to many global biodiversity hotspots (FAO and UNEP 2020).

Yet these ecosystems are sensitive to over-exploitation. Agriculture has cleared or transformed an estimated 70 per cent of grasslands and 50 per cent of savannahs worldwide (Foley 2011). In Europe almost half of grasslands had a 'bad' conservation status, with managed grasslands (68 per cent) in particular in a bad state (European Environment Agency 2020). Degradation of grasslands and savannahs threatens the culture and livelihoods of indigenous and ethnic minority communities (Dudley et al. 2020).

Examples from around the world

During the 20th century, conversion of an estimated 29 million hectares of former grasslands in western Canada to agricultural production, including the practice of leaving the tilled earth exposed to wind every other year, led to an estimated 25 per cent loss of soil organic carbon. Severe wind erosion events led to significant areas of the region being abandoned in the 1930s (IPBES 2018).

Examples from around the world

The Hindu Kush Himalaya (HKH) is the source of ten of Asia's largest river systems and the main source of freshwater in South Asia (Alfthan et al. 2018). Ecosystem services from the HKH sustain an estimated 240 million people in the region and benefit some 1.7 billion people in downstream river basins (Xu et al. 2019). Global warming is a key driver of change in HKH. Glacier volumes are projected to decline by up to 90 per cent throughout the 21st century. Degradation of permafrost is expected to destabilize mountain slopes, alter hydrology and threaten infrastructure. HKH is also facing environmental degradation from overexploitation of natural resources, land use and land cover change (Bolch et al. 2019).

2.5 Mountains

Mountain ecosystems host roughly half of the world's biodiversity hotspots (UN 2020b). They directly support the livelihoods of people living in mountain regions and provide critical ecosystem services to inhabitants of lower lands, including freshwater, timber and recreation opportunities (CBD 2007). Known as the 'water towers of the world', mountain ecosystems fulfil the freshwater needs of half the global population (CBD 2007; UNEP, Grid-Arendal, GMBA 2020). Mount Kenya, for example, provides water to over 7 million people, while the Andes provide water to over 95 million. Mountains are also a source of food: of the 20 plant species that supply 80 per cent of the world's food, six – maize, potatoes, barley, sorghum, tomatoes and apples – originated from and have been diversified in mountains (UN 2020b).

Degradation of mountain ecosystems is endangering crop production, animal husbandry (Romeo et al. 2020) and overall food security. Globally, 311 million people, approximately half of the mountain population in developing countries, live in areas exposed to progressive land degradation. Of these, 178 million are considered vulnerable to food insecurity (FAO and UNCCD 2019). Over the past 200 years, floods due to glacial lake outbursts alone have caused at least at least 400 deaths in Europe, 5,700 in South America and 6,300 in Asia, and the number of new glacial lakes is increasing with climate change. Changes in snow and glaciers affect run-off in some river basins, in turn impacting local water resources and agriculture (Hock et al. 2019).

2.6 Oceans and coasts

The ocean sustains all life on Earth. It provides 90 per cent of the world's life-supporting space (UNESCO 2017) and 50–80 per cent of the oxygen in the atmosphere (NOAA 2020b). It regulates our weather and climate, provides food and medicine and holds sacred and intrinsic value for many indigenous and local communities. International shipping is essential to the global economy, accounting for 80 per cent of global trade (UNCTAD 2018). Salt marshes, coral reefs, seagrass beds and mangroves protect coastlines by slowing floodwater release and reducing wave heights (UNEP 2016; Ferrario et al. 2014; Shepard et al. 2011; Das and Vincent 2009). Mangrove ecosystem services are estimated to be worth USD 33–57 thousand per hectare per year (UNEP 2014).

Yet a third of our oceans' commercial fish stocks are now overfished (FAO 2016b; FAO 2020b). This threatens the livelihoods of fishers, of which there are 60 million globally (FAO 2020b). With 1.15–2.41 million tonnes of plastic entering the ocean each year (IPBES 2019), plastic pollution is estimated to reduce marine ecosystem services by 1–5 per cent, equating to annual losses of USD 500–2,500 billion (Beaumont et al. 2019). Microplastics, and their toxic chemicals, are present in seafood and drinking water (UNEP 2019a). Over the last 50 years, the open ocean has lost 77 billion metric tonnes of oxygen (Schmidtko et al. 2017), expanding 'dead zones' by 4.5 million km^2 – similar in size to the European Union (Stramma et al. 2010).

Rising water temperatures and acidification (caused by rising CO_2 levels) are affecting the productivity and the distribution of marine fish stocks (FAO 2020b). If ocean acidification continues unabated, it will cause a global loss of USD 1 trillion per year by 2100 (CBD 2014). Unless we make drastic cuts to greenhouse gas (GHG) emissions, all coral reefs worldwide are expected to disappear due to bleaching and acidification by the end of this century (UNEP 2017). Sea level rise is predicted to cause a 46–59 per cent loss of global coastal wetlands by 2100 (Spencer et al. 2016). Yet ocean temperatures continue to increase (Cheng et al. 2019).

Forty percent of us live within 100 km (60 miles) of the coast (UN 2017), making coastlines some of the most densely populated areas on Earth. Coastal development and conversion to aquaculture have led to the loss of 20 per cent of the world's mangroves, along with their protective services (Friess et al. 2019; UNEP 2014). Almost 30 per cent of all seagrass has been lost since the late 19th century (UNEP 2020a). Dredging for port construction covers reefs with sediment, causing the death of corals (Cunning et al. 2019).

Photo: Shutterstock

Examples from around the world

In Australia, the Great Barrier Reef has lost half of its corals since 1995 due to bleaching events (Dietzel et al. 2020). This poses a threat to the 64,000 jobs and the AUD 6.4 billion the reef brings to the Australian economy – mostly from tourism but also from fishing, recreational and scientific activities (O'Mahoney et al. 2017).

Photo: Shutterstock

Examples from around the world

Around 10 per cent of European lands are peatlands, but in many countries, more than half are degraded by drainage. This drainage has allowed the lands to be used, mainly for agriculture, but also for forestry or even peat extraction. Across the European Union, these degraded peatlands emit greenhouse gases of around 0.2GtCO_2e per year, or around 5 per cent of EU emissions from all sectors. They also release 1–5 Mt per year of nitrate, which pollutes freshwaters, with impacts on drinking water and biodiversity (Tanneberger et al. 2020).

2.7 Peatlands

Peatlands store nearly 30 per cent of global soil carbon (Scharlemann et al. 2014) despite covering only 3 per cent of the world's land area (Joosten 2009). They purify and supply water, offer a natural haven for culture and recreation, and provide biomass, food and other livelihoods to millions of people (Crump 2017). In Peru, for example, peatland swamp forests provide habitat for fish, wild animals and more than 50 plants, including palm fruit (*Mauritia flexuosa*), which holds sacred cultural value for the indigenous Achuar people (López Gonzales et al. 2020), and which accounts for 80 per cent of the income of many rural households during winter (Olsson et al. 2019).

Although more than 80 per cent of the global peatland area is still largely untouched, with vast and relatively intact peatlands remaining in Russia, the central Congo basin and Canada, Latin America and the Caribbean, peat volumes are decreasing globally by approximately 0.2 per cent per year (Joosten 2009). Many European countries have drained the majority of their peatlands, including Germany (98 per cent), The Netherlands (95 per cent), Denmark (93 per cent), and Ireland (82 per cent) (Tanneberger et al. 2017). Drainage, which affects nearly 15 per cent of all peatlands (Crump 2017), leads to subsidence (sinking), land loss, vulnerability to toxic haze-producing fires and, in coastal peatlands, salinization (Crump 2017; FAO 2020a). It also contributes to peatland degradation, which accounts for 3–4 per cent of all global GHG emissions each year (Leifeld and Menichetti 2018; Olivier and Peters 2019; IPCC 2014). In the tropics, drainage is mainly associated with commodity plantations, such as oil palm cultivation (IPBES 2018), as well as acacia (Evans et al. 2019). Restoring peatlands could avoid GHG emissions equivalent to 12–41 per cent of the remaining GHG budget for keeping global warming below 2°C (Leifeld et al. 2019).

2.8 Urban areas

Urbanization is a key driving force in the global economy and a strong indicator of economic development (Zhang 2016). Urban areas generate roughly 80 per cent of the world's gross domestic product (UN Habitat 2020), facilitate trade and commerce, and are incubators of innovation (Zhang 2016; UN Habitat 2020). Cities can play a key role in increasing standards of living and decreasing poverty and, if well-managed, provide good homes, opportunities for social interaction, clean air and water, food and climate regulation. 'Green infrastructure' within and around cities, from green roofs to green belts, can help ensure that these services are sustainable. Street trees, for example, are estimated to reduce summer maximum air temperatures by 0.5–2.0°C, benefiting at least 68.3 million people (MacDonald et al. 2016). In addition to climate regulation, green and blue infrastructure contributes to water regulation and pollution reduction, as well as enhancing human well-being (Elmqvist et al. 2015). Cities can also harbour significant biodiversity in urban parks, gardens and restored landscapes such as industrial parks, railway tracks and residential areas (CBD 2021).

However, ineffective urban planning and management have contributed to socioeconomic inequality and deteriorating environmental quality. Currently, 1.6 billion people live in inadequate, crowded and unsafe housing (UN Habitat 2020). Although access to water and sanitation is usually better in urban areas than rural ones, the number of city inhabitants without access to safely managed drinking water has increased by more than 50 per cent since 2000 (UN Water 2021). Urban areas also cause high levels of waste and emissions. According to estimates, cities generate 70 per cent of global carbon emissions and consume two-thirds of the world's energy (UN Habitat 2020). Air pollution is a major health risk: more than 80 per cent of people living in urban areas that monitor air pollution are exposed to air quality levels exceeding World Health Organization guidelines (UN 2016).

Summary

Since the 1950s humanity has made enormous advances in health, poverty reduction and economic development. However, those gains have come at a massive ecological cost (Dasgupta 2021). Between 1992 and 2014, we doubled the per capita value of produced capital (roads, machines, buildings, factories and ports) and slightly increased the value of human capital (health and education), while the value of stock of natural capital (specifically, minerals and fossil fuels, agricultural land, forests as sources of timber and fisheries) fell by a staggering 40 per cent (Managi and Kumar 2018). These facts are connected. The increase in produced capital was achieved, in significant part, through the degradation of nature. This is not sustainable.

Humans are a part of nature. Yet all ecosystems discussed in this report are suffering from degradation – in many cases at an accelerating rate. The complex interactions between ecosystems mean that degradation of one ecosystem type can lead to the degradation of another. There is no guarantee that ecosystems will continue to be able to provide many of the services we rely on, from food, water and raw materials, to protection from disease and natural disasters, to clean air and a stable climate. These losses are usually felt locally, but as ecosystems lose their ability to regulate the climate, the consequences will reverberate around the globe.

Chapter 3 outlines how restoration can help ecosystems regain their capacity to provide these services.

CHAPTER 3

Photo: Neil Palmer/CIAT

WHY RESTORATION IS NECESSARY

We need to recreate a balanced relationship with the ecosystems that sustain us. Far from being something that is 'nice to have', restoration is essential to mitigating climate change, ensuring food security for a growing population and halting biodiversity loss. Cutting emissions through decarbonization of our energy systems will simply not be enough to keep the average global temperature rise below 2°C. We also need nature-based solutions like restoration (Griscom et al. 2019).

Poverty is partly a consequence of land degradation and, in certain circumstances, can exacerbate damage to ecosystems. Gender inequality plays a significant role in land-degradation related poverty (UNCCD 2011). In developing countries, agriculture is the most important source of income for women (ILO 2016), who bear the brunt of degraded soils, unpredictable rainfall and displacement. Although women are often stewards of the environment, lack of secure land rights can increase the likelihood of degradation (Mor 2018), which can in turn expose women and girls to a greater risk of gender-based violence (e.g., when they are forced to travel longer distances to collect fuelwood; Castañeda Camey 2020). Degradation also disproportionately affects indigenous and local communities that depend directly on natural resources for their livelihoods (UNEP 2019b) and threatens the health of young people and elders, women, poor people, indigenous peoples, people with chronic health conditions, and those targeted by racism (Solomon et al. 2016; Landrigan et al. 2017).

Restoring degraded ecosystems has tremendous potential to advance the achievement of all Sustainable Development Goals (IRP 2019a; Ramsar 2018), often contributing to several goals at once. This chapter demonstrates the value of ecosystem restoration for the global economy, food and water, health, climate mitigation and adaptation, security and the diversity of species on our planet; it also discusses how to balance synergies and trade-offs.

Healthy, restored ecosystems provide many benefits

HEALTH & WELFARE

The restoration of ecosystems can provide benefits and services which are essential to physical and mental health such as clean air, climate regulation and disease prevention

Example

Investing just

US$4

per resident in growing trees could improve health of millions of people by filtering and cooling air[a]

FOOD SECURITY

Restoration of farmlands and the food-producing services of natural ecosystems can help the world to achieve the Sustainable Development Goal of zero hunger by 2030

Example

Restoring mangroves could add

60 trillion

young, edible and commercially valuable fish and invertebrates to coastal waters every year[b]

BIODIVERSITY

Restoration can reverse biodiversity losses and increase provision of ecosystem services

Example

Restoring 15% of converted land in the right places could avoid

60%

of expected species extinctions[c]

ECONOMY

The longer that ecosystems are left to degrade, and the more degraded they become, the larger the costs to society due to decreasing ecosystem services and the higher cost of the restoration itself

Example

≈10 trillion

in global GDP could be lost by 2050 if ecosystem services continue to decline[d]

ECOSYSTEM RESTORATION

CLIMATE ADAPTATION

Ecosystem restoration can play an important role in people's adaptation to climate change

Example

Restoration of oyster reefs in Mobile Bay, Alabama USA reduced average wave heights and energy at the shoreline by

53-91%

with co-benefits of increased seafood production, improved fish stocks and better opportunities for tourism and recreation[e]

CLIMATE CHANGE MITIGATION

To avoid catastrophic climate change, the world must limit global warming to well below 2°C

Example

Protecting intact ecosystems, halting and reversing degradation has the potential to contribute over

1/3

of the total climate change mitigation required by 2030[f]

WATER

Natural ecosystems offer critical services to people including the provisioning of clean water, sanitation, and irrigation. Fresh water is essential to food security, energy production and health

Example

Globally

81%

of cities could reduce sediment or nutrient pollution in the water used by their populations by coupling forest protection and restoration with improvements in agricultural practice[g]

SECURITY

Restoring degraded ecosystems reduces the pressure on resources, helping to prevent conflicts and migration in the long term

Example

Africa's Great Green Wall aims to integrate the promotion of peace and security into larger objective of restoring

100 million hectares

of degraded land across the Sahel[h]

[a] Dasgupta 2021, [b] Worthington and Spalding 2018, [c] Strassburg et al. 2020, [d] Johnson et al. 2020, [e] Fodrie et al. 2017, [f] Griscom et al. 2019, [g] Abell et al. 2017, [h] Great Green Wall 2021

3.1 The economy

Our economies and societies are embedded in nature. Beyond contributing to the production of many of the goods and services that are produced and consumed in our economies, ecosystems also supply a wide range of essential services.

Despite the fact that we rely on these services, we continue to undercut the ability of ecosystems to provide them. The 2021 **Dasgupta Review** highlights this as a widespread failure of markets and institutions to integrate the value of ecosystems into decision-making. Because we have obtained many of their services 'free of charge', we have used ecosystems unsustainably and failed to invest in them. The outcome is that the current economic and societal demand for ecosystem services far exceeds ecosystems' ability to supply them. In short, we 'need' more nature than we have.

Recent economic development has substantially increased the material standard of living of many people in the world. However, this economic development trajectory at the expense of lost biodiversity and ecosystem services is unsustainable. This is particularly true for low-income countries, whose citizens rely more directly on ecosystems and their contributions to the economy, livelihoods and human well-being.

Ecosystem restoration is essential for sustainable economic development. The Dasgupta Report identifies investment in ecosystems to boost the supply of their services as essential for a transition to a sustainable economic development pathway. This requires building the enabling environment for channelling financial investment into economic activities that enhance the stock of ecosystem assets (Dasgupta 2021). Examples that highlight the potential positive economic returns of such investments include:

- Restoring coral reefs in Mesoamerica and Indonesia could deliver an additional USD 2.5–2.6 billion in ecosystem service benefits per year (UNEP, ISU, ICRI and Trucost 2018).
- Restoring mangroves to 40–100 per cent of their pre-1980s extent may increase commercial fisheries output by USD 1.9–3.0 billion per year (Konar and Ding 2020).
- Restoring populations of marine fish to deliver a maximum sustainable yield could increase fisheries production by 16.5 million tonnes, an annual value of USD 32 billion (Ye et al. 2013).
- Large-scale investments in dryland agriculture, mangrove protection and water management will make a vital contribution to building resilience to climate change, generating benefits around four times the original investment (Kapos et al. 2019).

The cost of inaction is greater than the cost of restoration. Half of the world's GDP is dependent on nature (WEF 2020), and around USD 10 trillion in global GDP could be lost by 2050 if ecosystem services continue to decline (Johnson et al. 2020). Every dollar invested in restoration creates up to 30 dollars in economic benefits (Ding et al. 2018). Therefore, we need to act quickly to restore ecosystems if we hope to avoid major economic consequences.

Ecosystem restoration creates livelihood opportunities. So far, only 18 per cent of COVID-19 recovery spending is expected to enhance sustainability (O'Callaghan and Murdock 2021). Shifting towards investment in ecosystem restoration can be a powerful means of job creation, supporting economic recovery at the same time as rebuilding natural capital (OECD 2020). For instance:

- In the United States, investment in landscape-scale restoration creates at least twice as many jobs as similar investment in the oil and gas sector (Calderón 2017).
- New Zealand has dedicated NZD 1.1 billion in recovery funds towards 11,000 restoration jobs (Robertson 2020).
- Ethiopia is aiming to double its forest cover by 2030 by planting 5 billion seedlings, thereby creating green jobs (Federal Democratic Republic of Ethiopia 2020).

Examples from around the world

Costa Rica has doubled its forest cover since the 1980s through restoration, while simultaneously tripling its national income. It has reversed deforestation by paying landowners for ecosystem services such as carbon sequestration and watershed protection, providing economic incentives for landowners to restore and protect their natural resources. Costa Rica is now a leader in ecotourism; its tourism sector, which accounts for 6 per cent of GDP, is growing by 6 per cent per year (Pharo et al. 2019), and provides 7 per cent of all jobs (OECD 2021).

Photo: Shutterstock

3.2 Food security

Achieving SDG 2 (Zero hunger) by 2030 requires healthy and biodiverse production landscapes and healthy populations of fish and other wild species that humans depend on for food.

On agricultural land, a variety of practices can contribute to ecosystem restoration, including agroecology, climate-smart and conservation farming practices, organic farming, sustainable land management and intensification, integrated production systems, regenerative agriculture and bio-innovations (CPF 2021; FAO 2020c; HLPE 2019; Mbow et al. 2019). Agroforestry alone has the potential to increase food security for 1.3 billion people (Smith et al. 2019), and can reduce soil erosion by 50 per cent and increase soil carbon by 21 per cent, inorganic nitrogen by 46 per cent and phosphorus by 11 per cent (Muchane et al. 2020). Innovative solutions, such as the enhancement of natural bioremediation processes to counter soil pollution, capitalize on the functions of soil and plant microorganisms. These natural processes can be enhanced by biostimulation (inputs to boost the action of existing microbiomes) and bioaugmentation (addition of new microorganisms to degrade specific pollutants) (Goswami et al. 2018).

Restoration of mangroves, coastal and marine ecosystems and freshwater ecosystems can all help to achieve food security targets. Aquatic system restoration measures include transforming management and production processes that cause ecosystem damage (e.g. overfishing, habitat destruction from fishing gear, clearing mangroves for aquaculture), as well as similar transformations in other industries (e.g. reducing the impact of agricultural run-off on water quality and flow, or of coastal development on seagrasses and coral reefs) (FAO 2020c). According to the Mangrove Restoration Potential Map, restoring mangroves in 105 countries and territories could add over 60 trillion young fish and invertebrates of commercially valuable species to coastal waters every year (Worthington and Spalding 2018). The UN Food Systems Summit 2021 provides an opportunity to promote action in this area.

Examples from around the world

Despite improving food production, India's 'Green Revolution' had unintended consequences, including an increase in soil degradation, run-off and water consumption. To address the issue of unsustainable agriculture, Andhra Pradesh state is promoting the use of Zero-Budget Natural Farming. The approach is an alternative to high-cost chemical inputs-based agriculture, based on the latest scientific research in ecology and rooted in Indian tradition.

The programme aims to reach all farmers in the state and achieve 100 per cent chemical-free agriculture by 2024, using low or no-cost locally sourced inputs, including cow dung and cow urine. A recent study found that the approach: boosted farmers' incomes; increased carbon sequestration, biodiversity and soil fertility; reduced pesticide use, water used for irrigation and electricity consumption; and improved crop resilience by over 40 per cent (Galab et al. 2019; ZBNF, n.d.). The practice involves *waaphasa* (soil aeration), which was found to reduce water use in paddy farming, saving 1,400 to 3,500 cubic metres of water per acre per paddy cropping period and reducing farmers' reliance on groundwater reserves for irrigation and its associated electricity consumption (CSTEP 2020).

3.3 Clean water

Restoring wetlands and riverine areas can improve water quality by capturing pollutants and sediment from land degradation. The Itaipu hydroelectric dam in Brazil now benefits from sediment control by restored areas upstream, thanks to a programme that encourages farmers to create terraced fields and reforest river banks (Fraser 2018; Rycerz et al. 2020). Sediment or nutrient pollution in water could be reduced by at least one-tenth across 81 per cent of the world's 4,000 largest cities by combining improved agriculture with forest protection and restoration (Abell et al. 2017).

In catchment areas, restoration can improve the flows and availability of water. Restoration of forests and other ecosystems has the potential to save an estimated USD 890 million each year in water treatment costs in the world's largest cities (McDonald and Shemie 2014). Improved management within irrigation-fed croplands could, as a single measure, reduce water use by an amount equivalent to the annual needs of 1.4 billion people (Brauman et al. 2013). In Madagascar, allowing tropical forests to regenerate by increasing fallow periods in shifting cultivation could improve water availability for irrigation, reducing overland flow and increasing water recharge (van Meerveld et al. 2021). In cities, restoring freshwater ecosystems can offer several co-benefits. For instance, in Shanghai, one wetland reduced the amount of suspended sediments by 70 per cent, while also providing cultural value (Li et al. 2009).

Examples from around the world

South Africa has invested USD 1.15 billion in restoration, including as part of the 'Working for Water' initiative. Since 1995, three million hectares have been cleared of invasive species (CHM 2018), which affect water quality through an increased fire risk and subsequent soil erosion (Chamier et al. 2012).

In Brazil the Green-Blue Water Coalition is implementing nature-based solutions to promote water security in at-risk cities. The initiative works to conserve and restore forests across 21 watersheds that supply almost 42 million people.

3.4 Health and well-being

Ecosystem health is interconnected with both physical and mental human health. We rely on ecosystems to regulate the climate, prevent disease and provide natural spaces in which to exercise and lower stress levels. They are also a source of ingredients for both traditional medicine and biomedical and pharmaceutical development (WHO and CBD 2015). Nature is also central to the identity and spirituality of people worldwide, as promoted by partners of the UN Decade such as the **Faith for Earth Initiative** and the **Interfaith Rainforest Initiative**.

The effects of heatwaves are responsible for more deaths worldwide than any other weather-related event, with urban populations being particularly vulnerable. Yet research on the effects of trees on air quality in 245 of the world's largest cities shows that spending an additional USD 100 million on growing trees in urban areas could help lower temperatures and reduce air pollution (TNC 2016). This, when combined with reductions in the sources of air pollution, could improve the health of millions of people.

Air pollution is a major health risk, leading to an estimated 9 million premature deaths every year (UNEP 2019b). Fires used to clear peatlands for farming and those fires starting in peatlands can smoulder for weeks. Over the next few decades, air pollution from fires could cause 36,000 excess deaths each year on average in Indonesia, Malaysia and Singapore. Comprehensive land management strategies, including peatland restoration, could cut this mortality by about 66 per cent (Marlier et al. 2019).

Although the relationship between biodiversity and infectious disease is complex, the risk of infection rises as land-use change and greater use of wildlife bring people and animals into closer contact (CBD 2020b; Everard et al. 2020). This creates opportunities for viruses to 'jump species' from other animals to people. Of all new and emerging human infectious diseases, roughly 75 per cent are zoonotic (Taylor et al. 2001; UNEP and ILRI 2020). Deforestation has been linked to outbreaks of insect-borne diseases such as malaria (Morand and Lajaunie 2021) and animal-borne diseases such as Ebola (Olivero 2017).

Psychological health can improve with exposure to nature. There is a growing body of evidence linking better sleep, less stress and greater psychological well-being with contact with nature (Bratman et al. 2019). Exposure to natural settings, both indoors and out, has been linked to enhanced mood (Browning et al., 2020).

Restoring green and blue spaces can therefore make a significant contribution to human well-being. The COVID-19 pandemic has illustrated the need for a holistic approach to the human and ecosystem health crisis, one that unites experts from epidemiology and public health to ecology and social science. The World Health Organization's 'One Health' approach seeks to foster collaboration and communication between multiple sectors to achieve public health outcomes based on the recognition that human and environmental health are interconnected (WHO 2017).

3.5 Climate change mitigation

To avoid catastrophic climate change, 2030 should mark two milestones: the end of the UN Decade on Ecosystem Restoration and the achievement of emissions reduction targets in line with the Paris Agreement goal to limit global warming to below 2°C. Delaying this will push us past a tipping point, beyond which solutions will be less effective – and some damage, irreversible (IPCC 2018). Improved land stewardship, including restoration, is one effective strategy to limit global warming (Griscom et al. 2017; Bastin et al. 2019; Strassburg et al. 2020). However, restoration is only part of the solution. Successfully achieving net zero emissions will also rely on rapid emission reductions across all sectors worldwide. Without this multi-pronged effort, the benefits gained through restoration efforts may be only temporary.

Nature-based solutions can potentially contribute over one-third (11.3 $GtCO_2e$ per year) of the total climate change mitigation needed by 2030 to keep global warming to just below 2°C. Within nature-based solutions, restoration is a key element. This could involve action to better manage some 2.5 billion hectares of forest, crop and grazing land (restoration and avoided degradation), and restoring over 230 million hectares of natural cover (Griscom et al. 2019).

Soils represent around 25 per cent of the nature-based solutions required for climate change mitigation by 2030; with half of this considered low cost at USD 10 per tonne of CO_2 (Griscom et al. 2017; Bossio et al. 2020).

In agricultural ecosystems, restoration has the potential to significantly reduce the annual increase of CO_2 in the atmosphere and could offer one-fifth of the contribution to the climate change mitigation required by 2030 (Griscom et al. 2017; "4 per 1000" Initiative 2018). Coastal and inland wetlands are rich carbon sinks. Restoration and avoiding the conversion of wetland ecosystems, including mangroves, saltmarshes, seagrasses and peatlands, could offer 14 per cent of the nature-based solution to climate change mitigation (Griscom et al. 2017). Restoring eligible mangroves could sequester 0.69 GtC in aboveground biomass and replace or avoid further losses of approximately 0.296 GtC in the top metre of soil (Worthington and Spalding 2018).

Done in the right place and in the right way, nature-based climate mitigation solutions are cost-effective, low-tech and scalable (Cook-Patton et al. 2020; Griscom et al. 2017; IRP 2019b; Strassburg et al. 2019; Strassburg et al. 2020) – and it is possible to safeguard global food production and biodiversity at the same time.

Photo: Shutterstock

Examples from around the world

Countries are increasingly including nature-based solutions in their Nationally Determined Contributions (NDCs) to meet their targets for the Paris Climate Agreement. For example, Chile's NDC includes targets to sustainably manage and recover degraded functions of 200,000 hectares of native forests, capturing 0.9–2.1MtCO_2e annually by 2030. The country has also committed to afforest/reforest 200,000 hectares of land, of which 100,000 hectares will be permanent forest cover, capturing 3–3.4 MtCO_2e annually by 2030. It aims to promote this in priority conservation areas, using native species where possible. It also aims to reduce emissions from deforestation and land degradation by 25 per cent by 2030, compared to its emissions average of 2001–2013. In addition, Chile has committed to evaluate peatland mitigation capacity, develop a National Plan for the Restoration of Landscapes, incorporate 1,000,000 hectares into the restoration process, and protect at least 30 coastal wetlands and at least 10 per cent of underrepresented marine ecoregions by 2030 (UNFCCC 2020).

3.6 Climate change adaptation

That we are altering the climate by continually emitting GHGs into the atmosphere is an inescapable reality (IPCC 2014). But ecosystem restoration can play an important role in people's adaptation to climate change by increasing resilience and reducing vulnerability to extreme events. Restoration, conservation and sustainable management of biodiversity and ecosystem services can be included alongside more conventional approaches as part of an overall adaptation strategy (Kapos et al. 2019).

Restoration of coastal ecosystems can often help communities adapt to climate hazards such as sea level rise, storm surges and associated flooding. Growing evidence shows that healthy mangroves can be an effective defence against the destructive impacts of tsunamis, and can reduce wave heights by 5–30 per cent (Spalding et al. 2014). Restoration of mangroves in the Philippines could protect more than 267,000 people from flooding, saving USD 450 million/year in damage (Mountford et al. 2018; Losada et al. 2018). Restoring coastal wetlands in high-risk areas of the gulf coast of United States by 2030 could avoid an estimated USD 18.2 billion in storm damage (Gilman and Ellison 2007). Restoration of oyster reefs in Mobile Bay, Alabama, USA reduced average wave heights at the shoreline by 53–91 per cent (Kroeger 2012). It also increased seafood production, improved fish stocks and led to better opportunities for tourism and recreation (Fodrie et al. 2017). Restoration of wetlands and oyster reefs on the coast of Florida could prevent an estimated USD 50 billion in losses from flooding, with a projected benefit-to-cost ratio of 3.5 (Reguero et al. 2018).

Ecosystem restoration inland can also reduce climate-related hazards, such as flooding, soil erosion and landslides linked to extreme rainfall events. Forest restoration on slopes reduces erosion that results from intense rainfall. For instance, in Singapore, restoring rivers, streams and lakes so that they blended more naturally with urban environments reduced flood-prone areas in the city from 3,200 hectares to 32 hectares (Lim and Lu 2016).

Upland forest restoration helps to regulate water flow, stabilizing supplies in the face of both intense rainfall and drought (Kapos et al. 2019). In the Philippines, Manila is experiencing changing rainfall patterns as a result of climate change and El Niño events. To stabilise water supplies, the public and private sector are working together to reforest the watersheds that supply the city (McDonald and Shemie 2014). Ecosystem restoration in watershed reserves in Mexico have similarly improved the natural flow regime and ecosystem function needed to sustain water availability. As a result, 45 million people are projected to have increased water availability by 2050 (Barrios-Ordoñez et al. 2015), reducing their vulnerability to climate change induced droughts. In Ecuador, restoration of páramo peatland by removing livestock, rewetting and restoring vegetation is contributing to better water supply for the city of Quito (De Bievre et al. 2015)

Finally, as mentioned in Chapter 3.4, ecosystem restoration can help humans adapt to rising temperatures. Restoration of forest canopy cover increases shading and evaporative cooling, which have adaptation benefits in both rural and urban environments. Restoration of urban green spaces, including parks, can maintain air temperatures 4°C below those of less vegetated areas (Gago et al. 2013).

3.7 Security

There is an urgent need to invest in ecosystem restoration as a key element of conflict resolution, peacebuilding, improving access to resources and managing climate-related security risks (UNCCD 2018; UN 2020a; IRP 2019b; IPBES 2018). Investing in ecosystem restoration builds trust in communities affected by conflict and can be a tool for resolution and peacebuilding (Monga 2018; UN 2020a; IRP 2019b), reducing recruitment by terrorist groups and alleviating pressure on people to migrate (UN 2020a; Barbut and Alexander 2016). Improving resource access and creating jobs through restoration helps to alleviate poverty and provides opportunities for youth and returning migrants, who may be vulnerable to exploitation by extremist organizations (Monga 2018; Wetlands International 2018). UN research found that 50 per cent of former combatants participating in reintegration programmes choose agriculture as a livelihood, but access to land and resources could be a limiting factor (Unruh and Williams 2013; UNEP and UNDP 2012).

Ensuring that indigenous and local communities have stewardship of their land, and providing them with support, is key to the success of restoration activities and to safeguarding the rights of community members. In Ecuador, the Socio Bosque programme paid indigenous and Afro-Ecuadorian communities to care for their forests. Benefits of the programme include reduced deforestation rates and fewer invasions into their territories, as communities were able to hire forest guards and clear trails for land demarcation (Perefán and Pabón 2019). Ecosystem restoration is often driven most effectively by local leaders and communities (GEF 2020). Giving people rights to their land provides incentives to reverse degradation and manage land and resources sustainably. Doing so improves yields, lifts people out of poverty and creates conditions that reduce conflict around resource control (Suazo 2015; Barbut and Alexander 2015; UNCCD, n.d.).

Between 50 and 700 million people are predicted to migrate because of land degradation and climate change by 2050 (IPBES 2018). By reducing resource scarcity, increasing income generation and aiding mitigation and adaptation to climate change, restoration can address some of the main drivers of environmentally triggered human migration (IPBES 2018; UNCCD 2018).

Examples from around the world

The 8,000 kilometre-long Great Green Wall (GGW) is an African-led initiative to combat land degradation, desertification and drought across 11 countries in West Africa's semi-arid Sahel region, where conflict is displacing communities. The initiative aims to promote peace and security as part of its larger objective to restore 100 million hectares of degraded land, while creating 10 million jobs (UNEP 2020b; Great Green Wall 2021). The UN Decade, recognizing the importance of the GGW, adopted it as its first Flagship Initiative, and UNEP, through the Global Environment Facility and other donors, operates many restoration projects along the wall.

Before the initiative was launched in 2007, the region had already begun to realize the transformational value of ecosystem restoration. Between 1987 and 2015, more than 200 million trees were planted, helping restore over 5 million hectares of land. The re-establishment of nitrogen-fixing native Acacia species through agroforestry helped increase grain production by half a million tonnes per year, boosting food security for more than 2.5 million people (IPBES 2018). And in areas of barren lands where native tree stumps remained, bio-reclamation techniques such as half-moon planting pits, which collect rainwater and increase soil fertility, encouraged these remnants to sprout naturally. This offers a cheaper and more successful restoration alternative to manual tree planting (Bohissou 2019; Carey 2020). In one study of areas in central Burkina Faso that had undergone restoration, more than 66 per cent of surveyed households felt that the restored forest was a highly important source of food – specifically, wild meat, fruits, nuts and leafy vegetables. Many of these foods fill important dietary gaps during months when grain is in short supply and in times of intense drought. Women often sell products from trees and forests to buy food during times of scarcity (Djenontin and Djoudi 2015).

With the launch of the Great Green Wall initiative, these efforts have received more global attention and can benefit from regional collaboration and coordination (Great Green Wall 2021), thereby helping to foster greater stability in the region.

3.8 Biodiversity

To bend the curve on biodiversity loss, we need to halt the loss of natural habitat, conserve what remains and restore degraded ecosystems (IPBES 2018; Leclère et al. 2020). Loss and degradation of habitat are the main identified threat to 85 per cent of all species described on the IUCN Red List (IUCN 2015). Scenarios show that, in principle, the worldwide trend of decline in terrestrial biodiversity caused by habitat conversion could be reversed

by the middle of this century, halting further biodiversity loss (Leclère et al. 2020). With careful spatial planning, restoring just 15 per cent of converted lands while halting further conversion of natural ecosystems could avoid 60 per cent of expected species extinctions (Strassburg et al. 2020). This 15 per cent figure is informed by Aichi Biodiversity Target 15 (CBD 2020a) and reinforced in SDG 15 (Life on land). Restoration focused on biodiversity will often, but not always, also result in increased ecosystem services (Bullock et al. 2011).

Ecosystem restoration can enlarge the extent of habitats, increase species diversity and restore ecosystem complexity and function over time, as well as support the recovery of individual species populations. Increasing ecosystem extent can increase the resilience of species populations that have suffered severe habitat loss. The Atlantic Forest Restoration Pact is is a Brazilian initiative that aims to restore 1 million hectares of Atlantic Forest by 2020 and 15 million hectares by 2050. This could double the native cover to at least 30 per cent of the original biome area and significantly reverse biodiversity loss (IPBES 2018).

The restoration of biodiversity often involves restoring ecosystems as a whole, but can also focus on restoring (reintroducing) species to ecosystems from which they have been lost. Of course, these approaches can be combined. Species may be chosen as ecosystem building blocks (e.g. tree species), engineers for re-wilding (e.g. beavers), to restore missing predators (e.g. wolves) or to improve species survival chances (e.g. scarce fritillary butterfly) (Soorae 2021).

Photo: Shutterstock

Examples from around the world

The restoration of Chilika Lake, a large brackish water coastal lagoon on the east coast of India, resulted in an increase in the population of endangered Irrawaddy dolphins from 89 to 158 between 2003 and 2015. There was an increase in habitat use, improved breeding, dispersal and a decline in mortality rate of the dolphins (Pattnaik and Kumar 2018). An expansion of the seagrass meadows from 20 km² in 2000 to 80 km² was also recorded, helping the species' recovery.

In China, restoration of aquatic vegetation in the polluted Hong Lake increased species diversity and led to the return of the endangered oriental white stork after 11 years of absence. Water bird populations soared to 20,000 breeding and 45,000 wintering birds. Meanwhile in Zhangdu Lake, opening a sluice gate in 2005 to reconnect it with the Yangtze River restored seasonal migration of fish, and introduced about 5.26 million wild fish fry (Yu et al. 2009).

In the United States, the Glacial Ridge project aims to restore a largely wet, temperate grassland landscape that had been drained and used for agriculture by reconnecting small fragments of tallgrass prairie. Hydrology has been restored across 9,000 hectares, native plant seeds can be sourced from the prairie remnants, and birds and butterflies have started to recolonize the area (Gerla et al. 2012).

3.9 Synergies and trade-offs

In the last half century, we have been making a trade-off between two types of ecosystem services. By over-exploiting the provisioning services – extracting food, water, fibre and raw materials – we are losing ecosystems' capacity to regulate our climate, purify our water, pollinate our crops and protect us from floods, with potentially disastrous consequences (Dasgupta 2021).

Bringing ecosystems back to health through restoration can deliver multiple benefits for people and nature. Restoration of terrestrial and aquatic ecosystems is linked to the delivery of all 17 SDGs, with many occurring simultaneously (IRP 2019a; Ramsar 2018). Certain benefits rely on different systems working together. Often these interact in complex ways and therefore need close monitoring and adaptive management. Some benefits are enjoyed directly by the people living and working in and around the restored ecosystems, while other benefits can reach people who are geographically distant, as well as future generations.

Successful restoration requires an integrated, holistic approach, and it will involve some trade-offs. While some, but not all, trade-offs are negative, many are needed. Decisions on where to restore, and what approaches to use, will influence the type of benefits that result, as well as their quantity and speed of delivery. It is possible to have more of one service at the expense of one or more others. For example, cropland could be restored to produce more food, converted for timber production, or restored for biodiversity conservation or water management. Integrated spatial planning can help to improve trade-offs between economic, social and ecological objectives, ensuring the sustainability and efficiency of these systems and reducing their overall footprint.

The precise balance of the benefits delivered by restoration (be that at the individual site or at a number of locations) and the communities that benefit from these services will be determined by the decisions and actions taken. We need to carefully consider who will benefit, who may be affected and how. Therefore, we need to think holistically about our actions when restoring individual degraded ecosystems or developing a strategy across a broader jurisdiction, understanding the benefits that healthy ecosystems can deliver and the trade-offs implied by different choices.

Chapter 4 explores the principles of good restoration and the enabling conditions for effective ecosystem restoration throughout the UN Decade and beyond.

CHAPTER 4

Photo: Widen Collective

RESTORING ECOSYSTEMS

One hundred and fifteen governments have committed to restoring a total of around 1 billion hectares on land, as a contribution to achieving the objectives of the CBD, UNCCD, UNFCCC or the Bonn Challenge on forest landscape restoration (Sewell et al. 2020). Chapter 3 delivered evidence to back up the social, environmental and economic case for restoration, including its critical role in meeting these international agreements. But because the roots of degradation lie within our economic and political systems, the solution will be neither quick nor easy. It will take a concerted, coordinated effort to change course from our current trend of accelerating degradation towards a global economy that sustains, rather than depletes, our ecosystems.

This chapter sets out the foundations for successful ecosystem restoration. While the challenge of wide-scale restoration is daunting, there is substantial experience to learn from. Chapter 4.1 outlines insights from a growing body of research that is establishing the principles of successful restoration, as well as technical and scientific innovations to facilitate the work. However, achieving restoration at scale will require fundamental changes to economic and political systems. Chapter 4.2 lays out the broader conditions needed to enable this transition, including financing mechanisms and policy frameworks.

4.1 Approaches, principles and tools for restoration

Ecosystem restoration encompasses a wide variety of approaches that contribute to conserving and repairing damaged ecosystems (UNEP and FAO 2020). This may involve active restoration or the removal of drivers of degradation to 'passively' promote natural regeneration. Whatever the approach, restoration requires time, resources, knowledge, enabling policies and governance if it is to contribute to human well-being, economic development, climate stability and biodiversity conservation.

Many restoration projects and programmes have underperformed in the past. Adhering to standardized principles and guidelines, as well as continued monitoring and an adaptive approach, can ensure better performance and impact.

Restoration approaches

ECOLOGICAL RESTORATION

Process

Assisting the recovery of a terrestrial, freshwater or marine ecosystem that has been degraded, damaged, or destroyed.

Intended end point

Transition from degraded ecosystem to a reference ecosystem, which may be a natural or a cultural one.

Source: Gann et al. 2019

FOREST AND LANDSCAPE RESTORATION

Process

Reversing the degradation of soils, agricultural areas, forests and watersheds thereby regaining their ecological functionality

Intended end point

Restoring multiple ecological, social and economic functions across a landscape and generating a range of ecosystem goods and services that benefit multiple stakeholder groups.

Source: Besseau et al. 2018

RESTORATION OF AQUATIC PRODUCTION ECOSYSTEMS

Process

Maintaining ecosystem structure and function to support food provisioning, while minimizing impacts, rather than restoring ecosystems to an initial state before production activity started.

Intended end point

Large/oceanic marine ecosystems supporting or affected by direct and indirect impacts of fishing gears and fisheries production; recovery through changes in fishing methods and gear modification to rebuild fish stocks and reduce adverse impacts on the environment. Specificities shown for both freshwater ecosystems and coastal ones with linkages to fisheries and aquaculture.

Source: FAO 2020c

REGENERATIVE AGRICULTURE

Process

Farming that uses soil conservation as the entry point to regenerate and contribute to multiple provisioning, regulating and supporting services.

Intended end point

Enhancing environmental, social and economic dimensions of sustainable food production. Soil carbon, soil health and on-farm biodiversity are restored.

Sources: Schreefel et al. 2020; Giller et al. 2021

REWILDING

Process

Rebuilding, following major human disturbance, a natural ecosystem by restoring natural processes and the complete or near complete food-web at all trophic levels as a self-sustaining and resilient ecosystem using biota that would have been present had the disturbance not occurred.

Intended end point

No pre-defined end point. Functioning native ecosystems complete with fully occupied trophic levels that are nature-led across a range of landscape scales.

Source: IUCN CEM, n.d.

Photo: Axel Fassio/CIFOR

Principles for successful restoration

Governments do not have to choose between economic priorities and environmental concerns (Mansuy 2020), as the restoration agenda can help to deliver on goals for livelihoods, food and water security, international trade, poverty alleviation and human rights (Perring et al. 2018; CPF 2021). However, sustainable restoration requires supportive and lasting social, economic and governance structures, engaged and empowered stakeholders, and a strong scientific evidence base to guide restorative practices. Restoration as a response to ecosystem degradation needs to address its underlying causes. Achieving national restoration commitments will take not only the right policies and regulations, but also coherence across sectoral, environmental and economic policies to ensure the alignment of public incentives and consistent implementation across national and sub-subnational levels (CPF 2021). Successful restoration can involve all actors in the land or seascape, from the private sector to local and rural communities to youth. Recent research highlights 14 'meta-lessons' from seven forest landscape restoration initiatives, providing a good example of various approaches to restoration (Mansourian et al. forthcoming).

Due to social and cultural norms, women and men often hold different environmental knowledge, and thus have different priorities for restoration (Sijapati Basnett et al. 2017). Failure to incorporate a gender-responsive approach – one that ensures women and men can fully participate in and equally benefit from interventions – could worsen existing inequalities and limit the sustainability of restoration outcomes (IUCN 2017). Therefore, the Strategy of the UN Decade on Restoration calls for the development and implementation of gender-responsive methods for empowering women and girls in dialogue, planning, decision-making and implementation of ecosystem restoration (UNEP and FAO 2020).

Indigenous peoples are responsible for managing approximately 28 per cent of the world's land surface and 37 per cent of all remaining natural lands (Garnett et al. 2018). Through their traditional knowledge, customary sustainable use and collective actions in the various ecosystems that they inhabit, indigenous peoples and local communities play a vital role in both the conservation and restoration agendas (FPP 2018). Restoration plans developed in collaboration with indigenous and local communities must be equitable, ensuring that the human rights, tenure rights and resources of all stakeholders – in particular the poorest and most vulnerable – are respected. Land tenure must be clearly defined (Ding et al. 2018) and restoration efforts must ensure that the benefits generated are equitably distributed (UNEP and FAO 2020).

Such principles can help to address challenges in restoration, including effective design and implementation, accounting for complex ecosystem dynamics in the context of climate change and navigating trade-offs associated with land management priorities and decisions (Gann et al. 2019).

Box 4.1 Guiding principles for the UN Decade on Ecosystem Restoration

Common principles are critical for a shared vision of ecosystem restoration. Towards this end, the FAO-led Task Force on Best Practices, the Society for Ecological Restoration, and IUCN's Commission on Ecosystem Management led an expert consultation process. Based on a synthesis of published principles for restorative activities, the process resulted in nine proposed principles that underpin ecosystem restoration throughout the UN Decade and across sectors, biomes and regions. The final wording and full descriptions of these principles will be developed collaboratively during 2021 to support effective restoration efforts around the world.

Ecosystem restoration:

PRINCIPLE 1	PRINCIPLE 2	PRINCIPLE 3
Promotes inclusive and participatory governance, social fairness and equity, from the start and throughout the process and outcomes.	Includes a continuum of restorative activities.	Aims to achieve the highest level of recovery possible for ecosystem health and human wellbeing.
PRINCIPLE 4	**PRINCIPLE 5**	**PRINCIPLE 6**
Addresses drivers of ecosystem degradation.	Incorporates all types of knowledge and promotes their exchange throughout the process.	Is tailored to the local context, while considering the larger landscape or seascape, and social-ecological and cultural settings.
PRINCIPLE 7	**PRINCIPLE 8**	**PRINCIPLE 9**
Is based on well-defined short- and long-term ecological and socioeconomic objectives and goals.	Plans and undertakes monitoring, evaluation, and adaptive management throughout the lifetime of the project or program.	Integrates policies and measures to ensure longevity, maintain funding and, where appropriate, enhance and scale up interventions.

Technical and scientific developments

Recent developments have improved the ways we monitor ecosystems, identify degraded areas, work collaboratively and restore ecosystems, making restoration easier. These new methods can be employed across different levels of knowledge, resources, finances, and spatial and temporal scales. Here are three examples:

1. Remote monitoring

Harnessing the power of Earth observation has been instrumental in identifying degraded areas with potential for restoration, in monitoring ongoing initiatives and in developing indicators to improve restoration outcomes (Worthington et al. 2020). Earth observation data collected by satellites, aeroplanes and drones have been rapidly improving, producing datasets at high spatial and temporal resolution that enable us to monitor restoration with increased precision. Access to data is being democratized through new platforms and tools that increase both transparency and access, allowing restoration stakeholders to monitor terrestrial and marine ecosystem health in near real-time from almost anywhere in the world (Grantham et al. 2020).

However 'eyes in the sky' cannot detect all changes on the ground. Social media and other innovative technologies can offer unexpected methods for monitoring by citizens. Smartphone apps put monitoring tools into the hands of practitioners, local communities and visitors. For example, the **Regreening Africa App** allows users in eight African countries to collect data on restoration projects, including the number of hectares regreened, the progress of individual trees, and management practices used, as well as to document trainings.

Box 4.2 Monitoring the UN Decade on Ecosystem Restoration

With the aim of supporting existing targets, goals and indicators, it is key for the UN Decade to have a centralized platform for monitoring restoration and measuring progress at all scales. The FAO-led Task Force on Monitoring is working alongside UNEP, with support from the Rio Convention secretariats and experts from all eight selected ecosystems, to develop the Framework for Ecosystem Restoration (FERM). Launching in 2021 on a geospatial platform, the FERM will enable the identification of global, regional and national indicators for restoration, for all stakeholders of the UN Decade. **The FERM platform** will enable knowledge and technology transfer, as well as capacity development for people, communities and countries.

2. Better knowledge sharing

Effective restoration is essential to the UN Decade's success. However, what works in one place may have negative consequences elsewhere. Scientific understanding of restoring ecosystems and the complex interactions between habitats, people and climate has been developing rapidly. These advances must be able to reach those on the ground, and platforms such as the **Forest and Landscape Restoration Mechanism**, **Restoration Resource Center** and **Global Tree Knowledge Platform** bring together the latest resources, knowledge and databases on planting techniques, best practices and capacity building guidelines, maps and analysis packages, among others. Similar platforms exist for marine and freshwater ecosystems, such as **NFI Fisheries Resources and Information System**, **Global Mangrove Alliance** and **Allen Coral Atlas**. These platforms help practitioners make informed decisions and enhance the success of their restoration projects.

3. Improved on-the-ground practices

Low-tech, cost-effective practices to enhance the success of restoration are becoming widespread, easily accessible and scalable. For example, farmer-assisted natural regeneration and bio-reclamation techniques have been successful in restoring drylands (see Great Green Wall example in Chapter 3.7).

Restoring millions of hectares to meet forest and landscape restoration targets will require many millions of plants, seedlings and seeds where natural regeneration will not meet restoration needs. Nurseries and seed banks, which allow for experimentation, could play a critical role in creating healthy and resilient ecosystems, particularly when planting in harsh climates and landscapes (Haase and Davis 2017; Chapman et al. 2019).

Incorporating agroforestry practices into the production of crops such as cocoa and coffee increases tree diversity and cover on plantations. It also helps improve and restore habitats for wildlife and provide carbon storage. When the correct balance between trees and crops is achieved, agroforestry has the potential to increase yields while offering alternative income streams for farmers through fruit or timber production from shade trees (Jose 2009).

Finally, new platforms such as **Collect Earth** bring together Earth observation datasets and facilitate new ways of working together to process and analyse data, such as 'mapathons' to identify areas with potential for restoration. The El Salvador government used this approach to identify restoration opportunities in the Cerron Grande watershed (Reytar et al. 2021). These collaborative approaches help to include the voices of local communities and strengthen their capacity to take an active role in restoration.

4.2 Broader conditions needed for successful ecosystem restoration

Investing in ecosystem restoration will be fundamental to transitioning to sustainable economic development that works in balance with nature. Directing financial flows towards such investment requires better integration of information on ecosystems into economic planning tools. It also requires financial systems that channel investments towards economic activities that enhance, rather than degrade, ecosystems (Dasgupta 2021).

Highlighting the interlinkages between restoring ecosystem health and economic sustainability will be key to moving restoration forward in the context of the build-back better recovery plans, as well as to ensuring the equitable delivery of benefits (Aronson et al. 2020). Initiatives to raise awareness of the risks posed by ecosystem degradation will also be crucial for raising restoration finance (Dasgupta 2021).

Despite the economic imperatives, over-exploitation of natural resources is embedded in our economies and governance systems. Breaking this habit requires recognizing the environmental externalities – the unaccounted-for consequences for nature and future generations – of our current approaches to planning economic development. Fundamental to this will be addressing perverse subsidies and other economic incentives that drive ecosystem degradation. Currently, worldwide activities that degrade ecosystems are subsidized at an estimated USD 4–6 trillion per year (Dasgupta 2021).

However, we can't expect markets alone to solve the problem. The path to a more sustainable use of ecosystems must begin with the development of inclusive wealth measures – which capture natural, social, human and manufactured capital and are thus more accurate ways to measure economic progress – and natural capital accounting. The recent adoption of the System of Environmental Economic Accounting Ecosystem Accounting (**SEEA EA**) framework by the international statistical community is a major step towards the integration of ecosystems into national accounts and macroeconomic planning. The SEEA EA is part of the System of National Accounts, organizing information on ecosystems in a way that is consistent with national statistics on economic activity. It is a key part of the tool kit for reflecting the value of ecosystems in public policies, plans and economic systems. For example, a recent study on Pakistan shows that while inclusive wealth has increased over the past three decades, natural capital has declined for most of that period. A very recent upturn in natural capital may reflect Pakistan's efforts on restoration. This type of country-level analysis provides policymakers with a framework for decision-making to ensure increases in inclusive wealth are sustainable (UNEP forthcoming).

Effective implementation and uptake of integrated environmental-economic planning can transform public expenditure patterns and deliver improved outcomes for ecosystems, for instance, by helping to inform:

- Investment in ecosystem-based livelihoods and adaptation that directs public expenditure towards activities based on the sustainable use of ecosystems and on building the resilience of landscapes (e.g., with respect to climate change).
- Integrated economic planning across sectors and landscapes to direct funds that capture the multiple benefits that investment in ecosystems may deliver and to inform cost sharing.
- Subsidy reform to incentivize ecosystem restoration, for example via payments for ecosystem services. Substantial revenues could be made available by removing subsidies that currently damage ecosystems (Dasgupta 2021).
- Taxing activities that degrade ecosystems and creating revenue for ecosystem restoration.
- Charging appropriate fees to use ecosystems and ecosystem services to help address unsustainable open access use and create revenues for restoration.

The enabling environment for private sector investment needs to be supported via regulatory frameworks, finance mechanisms, safeguards for investment, and through public-private partnerships. Public funding can facilitate private investment to transform conventional production systems into more sustainable models using de-risking tools such as guarantees, layered funds and support for innovative microfinance initiatives (CPF 2021).

Innovative finance mechanisms including blended finance have been developed in recent years to encourage private investment in bankable nature solutions (Mirova 2019; WWF 2020). Developing the capacity of entrepreneurs and promoters to develop business models for restoration is also essential to expand innovative models at scale (e.g., via the Restoration Factory developed by UNEP, FAO and IUCN; Restoration Factory 2021). The agriculture sector is a key global driver of ecosystem degradation (Benton et al. 2021). However, subsidy reform, sustainable intensification, action on food waste and encouraging people to adopt a diet containing fewer animal products would allow land to be released from conventional agriculture (Strassburg et al. 2020).

Estimating the global costs of ecosystem restoration from the existing literature is not straightforward, since most cost assessments typically neither focus on restoration alone, nor include all forms of restoration. According to one source, the annual funding gap for both restoration and terrestrial conservation is estimated at USD 300 billion (Ding et al. 2018). A more recent study looks at the cost of the nature-based solutions on land needed to meet climate, biodiversity and land degradation targets; it states that by 2030 investments will need to be over USD 350 billion per annum (UNEP, WEF, ELD forthcoming). This does not include the cost of restoring marine ecosystems.

Communities and civil society need to be engaged and supported to secure ecosystem restoration across scales. Public and private funds can help communities secure land tenure and support local investment in ecosystem restoration. These may be encouraged based on payments for ecosystem services or in response to voluntary environmental performance and certification commitments. Education is also vital to ensuring that future generations benefit from a greater understanding of nature and an appreciation of its value (Dasgupta 2021).


Photo: Neil Palmer/CIAT

Examples from around the world

The Colombian government has established the Certificates for Forest Incentives (CIF 'Certificado de Incentivo Forestal'; Law No. 139 of 1994). The programme pays landowners to plant trees, with a higher payment for native species. So far, it has enabled the restoration of 258,075 hectares of forest over two decades. In 2015 an environmental trust fund (BanCO_2) funded by private firms, citizens' donations and public funds, was established to promote forest and landscape restoration in the country (Mansourian 2020).

In the United States, the Forest Resilience Bond uses private capital to fund restoration activities that deliver long-term cost savings for water utilities, electric companies and the U.S. Forest Service. In this public-private partnership developed by the American Forest Foundation, Blue Forest Conservation and the World Resources Institute, beneficiaries pass along savings to investors through payments to the Forest Resilience Bond (Blue Forest n.d.; Ding et al. 2018).

CHAPTER 5

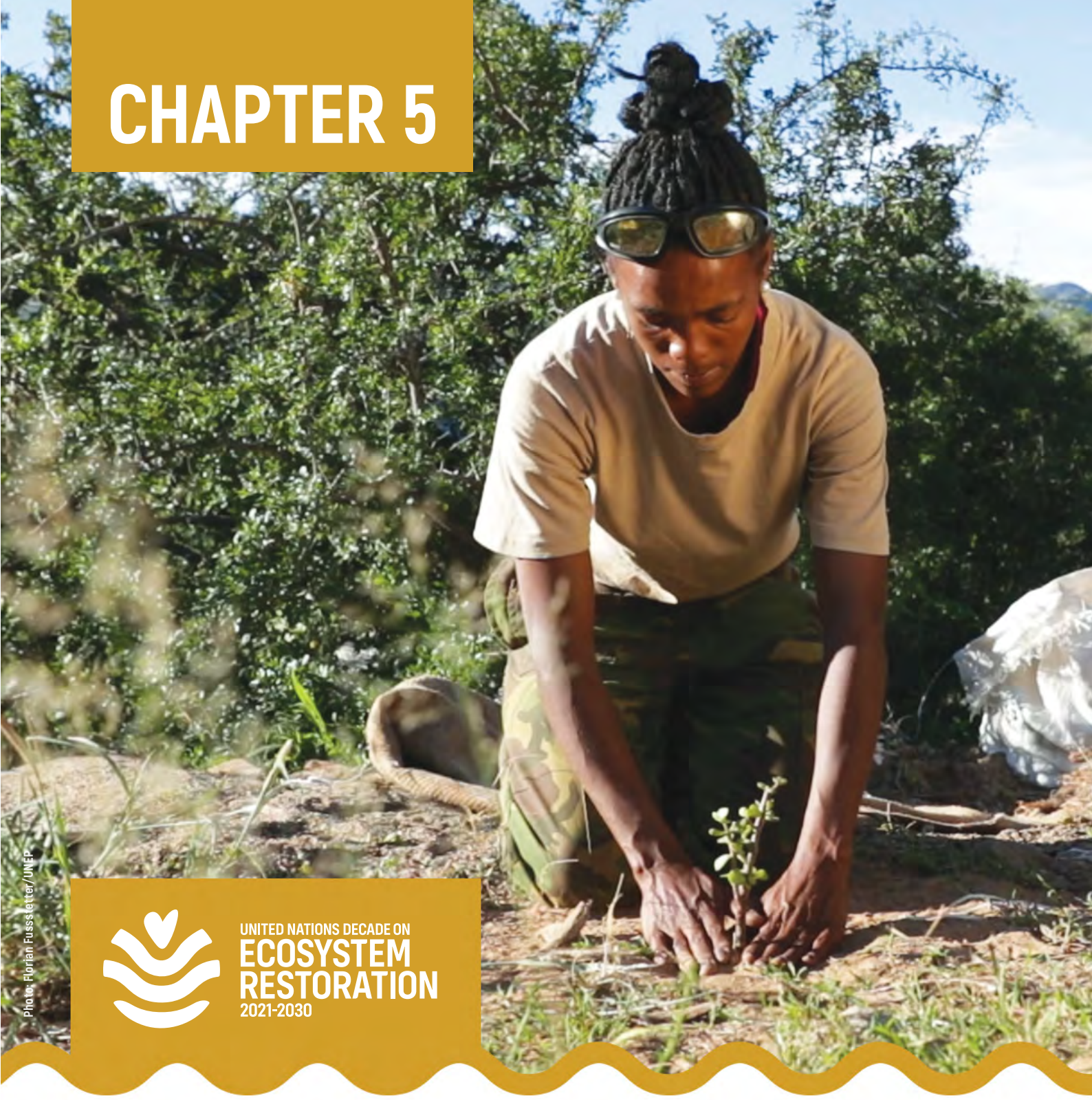

Photo: Florian Fussstetter/UNEP

UNITED NATIONS DECADE ON
ECOSYSTEM
RESTORATION
2021-2030

HOW THE UN DECADE WORKS

5.1 Objectives for the UN Decade

The UN Decade has the overarching goal to prevent, halt and reverse the degradation of ecosystems around the world. The vision for the UN Decade is a world where – for the health and well-being of all life on Earth and that of future generations – the relationship between humans and nature has been restored, where the area of healthy ecosystems is increasing and where ecosystem loss, fragmentation and degradation has been ended.

This is an endeavour that no single entity can undertake alone. It requires political will, innovation and collaboration. The UN Decade aims to catalyse the delivery of existing restoration goals, targets and initiatives, as well as the development of new ambitions for impact.

Underpinning this vision are three main goals of the **UN Decade's Strategy**:

- **Goal 1**. Enhancing global, regional, national and local commitments and actions to prevent, halt and reverse the degradation of ecosystems.
- **Goal 2**. Increasing our understanding of the multiple benefits of successful ecosystem restoration.
- **Goal 3**. Applying knowledge of ecosystem restoration in our education systems and within all public and private sector decision-making.

Supporting these goals are three action pathways:

- **Pathway I** "Global movement" will generate the peer-driven, participatory global movement that focuses on upscaling restoration.
- **Pathway II** "Political will" will empower leaders in the public and private sectors to champion restoration.
- **Pathway III** "Delivery at scale" will generate the technical capacity that is needed to restore ecosystems at scale.

5.2 Mandate, structure and strategy

Mandate

Founded in a resolution by the UN General Assembly in March 2019 (UNGA 2019), the UN Decade stems from a strong political commitment from UN Member States to build global momentum for ecosystem restoration, as a requirement for achieving the Sustainable Development Goals. UNEP and FAO have been asked to co-lead the implementation of the UN Decade in collaboration with the secretariats of the Rio Conventions, other relevant multilateral environmental agreements and entities of the United Nations System. Joint evaluations of the UN Decade's progress will be undertaken by UNEP and FAO Evaluation Offices, and the Secretary-General will report to the UN General Assembly at its eighty-first session on the status of implementation, including its contribution to the implementation of the 2030 Agenda for Sustainable Development.

Structure

The UN Decade itself will have two layers of implementation.

The first layer, led by FAO and UNEP with a growing number of partner organizations, comprises the activities undertaken by the UN Decade's core team to catalyse and support a movement that starts and scales up restoration initiatives globally. It also includes the goals of the UNFCCC, UNCCD and CBD (Box 5.1), the Sustainable Development Goals and the Bonn Challenge's target of restoring 350 million hectares of degraded landscapes.

The second layer is made up of the self-orchestrated activities by the actors and stakeholders that engage in restoration activities around the world. The UN Decade has a diverse range of partners, including researchers, practitioners, businesses, non-governmental organizations (NGOs) and faith-based organizations such as Faith for Earth. Restoration is a monumental task and every country, company, organization and individual has a role to play. Join the **#GenerationRestoration** movement.

Box 5.1 The Rio Conventions and the UN Decade on Ecosystem Restoration

The UN General Assembly requested that UNEP and FAO, as the lead agencies of the UN Decade on Ecosystem Restoration, collaborate closely with the Rio Conventions on Biodiversity, Climate Change and Desertification. All three Convention Secretariats are official partners of the UN Decade. The UN Decade aims to facilitate synergies between the Conventions and to support each Convention in achieving their specific decisions and objectives related to ecosystem restoration. These include:

- The Convention on Biodiversity (CBD) is preparing a post-2020 global biodiversity framework with 2050 goals and 2030 targets that are directly relevant to ecosystem restoration. In several previous decisions, CBD has highlighted the need and guidance for ecosystem restoration to achieve its objectives. In decision **14/30**, Parties to the CBD called for the establishment of the UN Decade on Ecosystem Restoration.
- The UN Convention to Combat Desertification (UNCCD) aims to achieve **Land Degradation Neutrality** (LDN), including restoration of degraded lands in the context of integrated landscape management. The UNCCD secretariat supports countries to develop LDN transformative projects and programmes that enhance national capacities and leverage innovative financing.
- Under the UN Framework Convention on Climate Change (UNFCCC), restoration activities can contribute to achieving the objectives of the Convention and Paris Agreement in several ways: countries can include restoration actions in their Nationally Determined Contributions; restoration actions can be part of reducing emissions from deforestation and forest degradation 'plus' the conservation, sustainable management and enhancement of forest carbon stocks (REDD+); and the central role of vulnerability and adaptation assessment of ecosystems in National Adaptation Plans is instrumental to ecosystem restoration.

Strategy

Focused on triggering a coordinated global effort, the Strategy for the UN Decade on Ecosystem Restoration was developed throughout 2019 and 2020 in an open and collaborative manner, built from input from over 1,000 organizations, institutions, governments, businesses and individuals. The Strategy is designed to connect and empower at all scales, with everyone able to see the ways they can contribute (**www.decadeonrestoration.org/strategy**). The UN Decade Action Plan is currently under public consultation. It will articulate how the Strategy will be implemented effectively and collaboratively.

When done efficiently and sustainably, and when complemented by conservation, ecosystem restoration can significantly contribute to all 17 Sustainable Development Goals, in particular life below water (SDG 14) and life on land (SDG 15). Initiatives that incorporate principles of gender equality and restorative justice in restoration efforts can also provide work opportunities and improve income streams (SDGs 1, 5, 8, 10, 16), as well as support cross-sectoral collaboration, learning and innovation on the use of ecosystem goods and services (SDGs 4, 7, 9, 17). This can help countries resolve conflicts over natural resources and limit associated migration. Finally, central to all activities of the UN Decade is the need to recognize the human rights of all people, including local communities and indigenous peoples (UNEP and FAO 2020).

5.3 Supporting the development of a global movement

Achieving the vision and goals of the UN Decade will require a concerted global effort. To guide and accelerate the global restoration movement, as of 2020, the UN Decade has established five Task Forces:

- **Best Practices:** UN Decade's core team and partners will provide technical support to ecosystem restoration initiatives globally. A FAO-led Task Force, working across more than 35 organizations, has been established to prepare guiding principles and collate good practices on ecosystem restoration and indigenous knowledge around the world (see Box 4.1). It will focus on the dissemination of restoration knowledge over the next ten years.
- **Finance:** The World Bank is chairing the Finance Task Force, which will: 1) provide guidance to reorient subsidies towards ecosystem restoration in an appropriate manner; 2) counter economic forces and vested interests that result in ecosystem degradation; and, 3) incentivize public and corporate investors to co-invest in ecosystem restoration, including in areas where the benefits from restoration are predominantly public goods.
- **Monitoring:** To avoid extra reporting burdens, the UN Decade will not establish formal country monitoring and reporting. Instead, it will employ and build on existing data reporting systems within relevant international commitments, conventions and plans. An FAO-led Monitoring Task Force, with support from over 270 experts across 100 organizations, is identifying the best options for monitoring global progress of the UN Decade and how to fill current information gaps. See Box 4.2 for more information on the Framework for Ecosystem Restoration Monitoring.
- **Science:** This IUCN-led Task Force will provide an authoritative scientific reference for the UN Decade. It will collate and convey concise information and concepts of terrestrial, freshwater and marine ecosystem restoration based on rigorous evidence. The Task Force will aim to address pertinent scientific questions that might arise during the implementation of the UN Decade and provide guidance to UNEP, FAO and all partners.
- **Youth:** The involvement of youth in the UN Decade and #GenerationRestoration movement is critically important, not only for the sustainability of restoration initiatives beyond 2030 but also for promoting intergenerational equity. During the UN Decade, the United Nations Major Group for Children and Youth, through its UNEP Major Group for Children and Youth and SDG 2 Working Group, will facilitate the engagement of youth advocates, youth-led restoration initiatives and a wide range of formal and informal youth groups.

Advisory Board

As the main external body of the UN Decade's governance structure, the Board's main objective is to offer relevant perspectives and schools of thought in response to the challenges and barriers for implementing the UN Decade. The Board will provide guidance to the UN Decade's lead agencies, including to the UNEP/FAO Strategy Group, the UN Decade Task Forces and to all UN Decade partners. It is comprised of leading thinkers and restoration practitioners from all regions and across stakeholder groups.

UN Decade Digital Hub

In addition to technical support, the UN Decade will also communicate and raise awareness about restoration efforts around the world. The Hub will showcase activities as well as platforms that have regional or global application to increase the scale, scope and pace of restoration. Digital content developed for the hub will include modules in video games that feature ecosystem restoration and the development of lesson plans on ecosystem restoration for teachers. The **Digital Hub** will also facilitate dialogues between stakeholders in different sectors to reach consensus on how to develop land-use plans that maximize ecosystem restoration benefits, as well as connecting investors with restoration implementers.

Everyone

Finally, since reviving ecosystems is a rewarding task that anyone can get involved in, the UN Decade Partners have co-developed the **Ecosystem Restoration Playbook** to inform the actions and choices of individuals and organizations across stakeholder groups. This practical guide shows how anyone, anywhere can contribute meaningfully to healing our ailing planet.

Restoration initiatives around the world

4 PER 1000 INITIATIVE

Region / Ecosystem

Global

Description / Target

A network to demonstrate the role of agricultural soils in climate mitigation and food security

BONN CHALLENGE

Region / Ecosystem

Global / Forests and landscapes

Description / Target

350 Mha

Target of 350 Mha forest and landscapes restored by 2030

RESTORE/EUROPEAN CENTRE FOR RIVER RESTORATION

Region / Ecosystem

Greater Europe / Rivers

Description / Target

A network to promote and build capacity for ecological river restoration across Europe

GREAT GREEN WALL INITIATIVE

Region / Ecosystem

Africa / Landscapes

Description / Target

100 Mha

To restore 100 million ha of currently degraded land by 2030

GLOBAL MANGROVE ALLIANCE

Region / Ecosystem

Global / Mangroves

Description / Target

20%

Aims to increase global mangrove cover by 20% by 2030

GLOBAL PEATLANDS INITIATIVE

Region / Ecosystem

Global / Peatlands

Description / Target

Focused on the conservation restoration and sustainable management of peatlands

INTERNATIONAL CORAL REEF INITIATIVE

Region / Ecosystem

Global

Description / Target

An informal partnership between nations and organizations that strive to preserve coral reefs and related ecosystems around the world

REGREENING AFRICA

Region / Ecosystem

8 countries in sub-Saharan Africa

Description / Target

500K

Restoring ecosystems in 8 countries and improving the resilience of 500,000 households

Find out more about **restoration initiatives** around the world.

Photo: iStockphotos

THE WAY FORWARD

"Making peace with nature is the defining task of the 21st century. It must be the top, top priority for everyone, everywhere."

– António Guterres, UN Secretary-General, 2021

The UN Decade on Ecosystem Restoration is a global rallying call from the United Nations General Assembly to make peace with nature and build back better. However, meeting the scale, scope and pace needed to achieve effective restoration is no small task. We need to catalyse a global movement. This movement will be diverse, including local communities and activists, the private sector, finance institutions, researchers, NGOs and national governments.

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Achieving the aims of the UN Decade requires all actors to engage in effective restoration of all degraded ecosystems. Specifically, we call on:

All stakeholders

- To recognize the importance of human rights, tenure rights, and traditional ecological knowledge for ecosystem restoration.

The UN System

- To collaborate with UNEP, FAO, the Rio Conventions and other partners to implement the UN Decade strategy.

National governments

- To incorporate significant allocations for ecosystem restoration as a central component of their COVID-19 recovery plans, to ensure that they deliver a green, sustainable and fair recovery, and to include ecosystem restoration in their Nationally Determined Contributions, National Adaptation Plans and other relevant development and environmental plans and strategies.
- Parties to existing restoration initiatives, including under the Rio Conventions, other multilateral agreements and the Bonn Challenge, to deliver on existing commitments for restoration.
- Countries involved in coastal and marine restoration to develop and deliver on similar ambitious restoration goals – a 'Bonn Challenge equivalent' for the ocean.
- Parties to the Rio Conventions to embed strong commitments on restoration within their existing and emerging agreements, frameworks and instruments.
- Heads of State and Government, and Ministers of Finance, to become champions for ecosystem restoration; to adopt an inclusive wealth approach for national accounting, and to repurpose fiscal policies that are degrading the natural world towards restoration.
- Governments (that are in a position to do so) to provide financial support to developing countries and civil society organizations for their restoration efforts.
- Public financial institutions and regulatory bodies, working with private financial institutions, to develop and strengthen instruments, including co-financing to de-risk private investments, to ensure that financial flows fully support restoration efforts.

Local governments and cities

- To include restoration goals in jurisdictional and urban development plans, and raise awareness across the population about the importance of healthy ecosystems and urban green spaces.
- To invest in the health and productivity of ecosystems that sustain critical urban infrastructure and services.

Private sector

- Private sector companies that rely on ecosystems for their supply chains to source only from sustainable sources; to eliminate deforestation from supply chains, and to re-invest significantly into supply chain security through ecosystem conservation and restoration.
- Private financial institutions, working with public bodies as needed, to invest in ecosystem restoration as an emerging asset class.

Research and education institutions

- To further increase our understanding of best practices, monitoring and the multiple benefits of successful ecosystem restoration.
- To educate the next generation of citizens to be aware of the value of nature, and to train a generation of entrepreneurs who can scale up restoration efforts.

Civil society

- Indigenous peoples and local communities across the world to build on their knowledge, experience and capacity for action to deliver restoration.
- Civil society organizations to include and prioritize restoration and related awareness-raising efforts in their programmes.
- Youth organizations to play an active leadership role in ecosystem restoration locally, nationally and globally, and to be involved in the governance of the UN Decade for a #GenerationRestoration movement.
- Citizens across the world to actively participate in the UN Decade and to consider their consumption choices, with a view to restoring healthy ecosystems for the benefit of present and future generations.


Photo: Stephanie Foote/UNEP

Photo: Grup Arendal / Peter Prokosch

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