



Making Peace with Nature

A scientific blueprint to tackle the climate, biodiversity and pollution emergencies

Key Messages and Executive Summary



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UN Secretary-General's Foreword

Humanity is waging war on nature. This is senseless and suicidal. The consequences of our recklessness are already apparent in human suffering, towering economic losses and the accelerating erosion of life on Earth.

Ending our war does not mean surrendering hard-won development gains. Nor does it cancel the rightful aspiration of poorer nations and people to enjoy better living standards. On the contrary, making peace with nature, securing its health and building on the critical and undervalued benefits that it provides are key to a prosperous and sustainable future for all.

The urgent need to transform our relationship with nature risks being overlooked amid the huge suffering inflicted by the COVID-19 pandemic. Saving precious lives and livelihoods is our top priority. But by exposing humanity's vulnerability, the pandemic can also help make 2021 a turning point towards a more sustainable and inclusive world.

This report provides the bedrock for hope. By bringing together the latest scientific evidence showing the impacts and threats of the climate emergency, the biodiversity crisis and the pollution that kills millions of people every year, it makes clear that our war on nature has left the planet broken. But it also guides us to a safer place by providing a peace plan and a post-war rebuilding programme. By transforming how we view nature, we can recognize its true value. By reflecting this value in policies, plans and economic systems, we can channel investments into activities that restore nature and are rewarded for it. By recognizing nature as an indispensable ally, we can unleash human ingenuity in the service of sustainability and secure our own health and well-being alongside that of the planet.

Making peace with nature is the defining task of the coming decades. We must seize the opportunity presented by the COVID-19 crisis to accelerate change. This year, several major international conferences, including on climate change, biodiversity and desertification, provide an opportunity to increase ambition and action on recovering better and addressing climate disruption. Our central objective is to build a global coalition for carbon neutrality. If adopted by every country, city, financial institution and company around the world, the drive to reach net-zero emissions by 2050 can still avert the worst impacts of climate change.

Similar urgency and ambition are needed to transform other systems, including how we produce our food and manage



our water, land and oceans. Developing countries need more assistance to redress environmental decline. Only then can we get back on track to achieve the Sustainable Development Goals by 2030.

This report shows that we have the ability to transform our impact on the world. A sustainable economy driven by renewable energy and nature-based solutions will create new jobs, cleaner infrastructure and a resilient future. An inclusive world at peace with nature can ensure that people enjoy better health and the full respect of their human rights so they can live with dignity on a healthy planet.

A handwritten signature in black ink, which appears to read 'António Guterres'. The signature is fluid and cursive, with a long horizontal line extending to the right.

António Guterres

Secretary General, United Nations,
February 2021

UNEP Executive Director's Foreword

Before the COVID-19 pandemic, 2020 was emerging as a moment of truth for our commitment to steer Earth and its people toward sustainability. Momentum was building and global meetings were set to discuss bold action on the three interconnected planetary crises facing humanity, namely the climate crisis, the nature crisis and the pollution crisis. These crises, driven by decades of relentless and unsustainable consumption and production, are amplifying deep inequalities and threatening our collective future.

This report makes the strongest scientific case yet for why and how that collective determination must be urgently applied to protecting and restoring our planet. Drawing on a unique and comprehensive synthesis of global environmental assessments, it details the self-defeating and dangerous consequences of our overconsumption of resources and overproduction of waste.

The science is clear that we are putting extreme pressures on the planet. According to the 2020 UNEP Emissions Gap Report, while the pandemic resulted in a temporary decline in greenhouse gas emissions, we are heading for at least a 3°C temperature rise this century. Our colleagues at the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) have sounded the alarm on the rapid decline of nature and what this means for Agenda 2030 and the Sustainable Development Goals.

Loss of biodiversity and ecosystem integrity, together with climate change and pollution will undermine our efforts on 80 per cent of assessed SDG Targets, making it even more difficult to report progress on poverty reduction, hunger, health, water, cities and climate. We need to look no further than the global pandemic caused by COVID-19, a zoonotic disease, i.e. transmitted from animal to human, to know that the finely-tuned system of the natural world has been disrupted. And finally, the “toxic trail” of economic growth – pollution and waste which results every year, in the premature deaths of millions of people across the world.

While the response to the medical emergency of COVID-19 rightly preoccupies government budgets and political action, the response to this pandemic must ultimately accelerate the economic and social transformations needed to address the planetary emergency. As the UN Secretary-General noted in his State of Planet speech, “COVID recovery and our planet’s repair must be two sides of the same coin.”



The report outlines what the “repair” of our planet entails, the transformative actions that can unleash human ingenuity and cooperation to secure livelihoods and well-being for all. Repair means solutions that recognize how our environmental, social and development challenges are interconnected. Repair means shifting our values and worldviews as well as our financial and economic systems. Repair means taking a whole-of-society approach. And repair means being fair and just.

With science as our guiding light, UNEP’s Medium-Term Strategy (2022-2025) seeks to ensure the link between science, policy and decision-making remains stronger than ever, sustained by strong environmental governance and supported by economic policies that can be the foundation of a catalytic response to the challenges of climate change, biodiversity loss and pollution. In doing so, we support member states, working with partners, scientists, civil society and business to tackle the three interconnected crises so that we stabilize climate; live in harmony with nature and secure a pollution free planet.

2021 must be remembered as the year we took it upon ourselves to ensure that the pandemic is remembered not only as a human tragedy, but as the moment when people reconsidered their priorities as individuals and societies and took to heart that safeguarding the health and well-being of current and future generations means safeguarding the health of our planet.

A handwritten signature in black ink, which appears to read 'Inger Andersen'. The signature is stylized and cursive.

Inger Andersen
Executive Director, United Nations Environment Programme,
February 2021



Preface

This report presents a scientific blueprint for how climate change, biodiversity loss and pollution can be tackled jointly within the framework of the Sustainable Development Goals. The report is a synthesis based on evidence from global environmental assessments. It has been a privilege to oversee the production and peer review of the report by the eminent group of experts and advisors appointed by Inger Andersen, the Executive Director of UNEP, for their leading contributions to and intimate understanding of the interface between science and policy in addressing the environmental challenges of today.

The expert analysis rests on the synthesis of key findings from a range of recent intergovernmental global environmental assessments and assessments prepared under the auspices of Multilateral Environmental Agreements, UN bodies and others (see annex 1). The report makes reference to the assessments, not the original literature referred therein. The presentation of the findings from the assessments is the responsibility of the authors of the current report. In a limited number of cases, additional high-impact peer-reviewed literature and grey literature have been assessed and referenced in order to present a complete and updated picture of the knowledge base.

The results of this synthesis are presented for decision makers in the form of clear, digestible and facts-based core and key messages and an executive summary substantiated and referenced in the main report. Part I of the report shows how the findings of the assessments are interlinked and add up to an unparalleled planetary emergency. While most of the underlying assessments are relevant for policy formulation, Part II goes a step further in recommending how the accumulated scientific evidence can be turned into concrete and far-reaching actions by a broad range of actors across society in order to transform humankind's relationship with nature.

This report was prepared amid the challenges of the COVID-19 pandemic, which meant that the authors, scientific advisory group and secretariat had to work without ever meeting face to face. All work was carried out through dozens of virtual conference calls.

This synthesis would not have been possible without the work undertaken for the international assessments used as the evidence base in this report and the contribution by experts from these assessments. We also highly appreciate



Ivar A. Baste



Robert T. Watson

the outstanding contributions by the group of experts who have joined us in authoring this report and the valuable guidance by the members of the scientific advisory group who peer-reviewed the report multiple times. We would particularly like to acknowledge the sustained enthusiasm for this endeavour by authors and advisors given their many other commitments. We are also indebted to the strong support received from the UNEP secretariat, research fellows, designers and the science communications editor, in particular the visionary guidance and inspiration provided by Inger Andersen and the unwavering commitment of the core team of the secretariat.

A handwritten signature in black ink that reads "I. A. Baste".

A handwritten signature in black ink that reads "R. T. Watson".

Ivar A. Baste and Robert T. Watson
Report Leads



Key Messages

Humanity's environmental challenges have grown in number and severity ever since the Stockholm Conference in 1972 and now represent a planetary emergency. While tackling the emergency is demanding, this report, Making Peace with Nature, lights a path to a sustainable future with new possibilities and opportunities (figure KM.1).

The top five

- Environmental changes are undermining hard-won development gains by causing economic costs and millions of premature deaths annually. It is impeding progress towards ending poverty and hunger, reducing inequalities and promoting sustainable economic growth, work for all and peaceful and inclusive societies.
- The well-being of today's youth and future generations depends on an urgent and clear break with current trends of environmental decline. The coming decade is crucial. Society needs to reduce carbon dioxide emissions by 45 per cent by 2030 compared to 2010 levels and reach net-zero emissions by 2050 to achieve the 1.5°C Paris Agreement target, while at the same time conserving and restoring biodiversity and minimizing pollution and waste.
- Earth's environmental emergencies and human well-being need to be addressed together to achieve sustainability. The development of the goals, targets, commitments, and mechanisms under the key environmental conventions and their implementation need to be aligned to become more synergistic and effective.
- The economic, financial and productive systems can and should be transformed to lead and power the shift to sustainability. Society needs to include natural capital in decision-making, eliminate environmentally harmful subsidies and invest in the transition to a sustainable future.
- Everyone has a role to play in ensuring that human knowledge, ingenuity, technology and cooperation are redeployed from transforming nature to transforming humankind's relationship with nature. Polycentric governance is key to empowering people to express themselves and act environmentally responsibly without undue difficulty or self-sacrifice.

Transforming nature puts human well-being at risk

The current mode of development degrades the Earth's finite capacity to sustain human well-being

- Human well-being critically depends on the Earth's natural systems. Yet the economic, technological and social advances have also led to a reduction of the Earth's capacity to sustain current and future human well-being. Human prosperity relies on the wise use of the planet's finite space and remaining resources, as well as on the protection and restoration of its life-supporting processes and capacity to absorb waste.
- Over the last 50 years, the global economy has grown nearly fivefold, due largely to a tripling in extraction of natural resources and energy that has fuelled growth in production and consumption. The world population has increased by a factor of two, to 7.8 billion people, and though on average prosperity has also doubled, about 1.3 billion people remain poor and some 700 million are hungry.
- The increasingly unequal and resource-intensive model of development drives environmental decline through climate change, biodiversity loss and other forms of pollution and resource degradation.
- Social, economic and financial systems fail to account for the essential benefits society gets from nature and to provide incentives to manage it wisely and maintain its value. The majority of the essential benefits of nature currently have no financial market value despite being the underpinning of current and future prosperity.

Society is failing to meet most of its commitments to limit environmental damage

- Society is not on course to fulfil the Paris Agreement to limit global warming to well below 2°C above pre-industrial levels and to pursue efforts to further limit the temperature increase to 1.5°C. At the current rate, warming will reach 1.5°C by around 2040 and possibly earlier. Taken together, current national policies to reduce greenhouse gas emissions put the world on a pathway to warming of at least 3°C by 2100. Human-induced current warming of more than 1°C has already led to shifts in climate zones, changes in precipitation patterns, melting of ice sheets and glaciers, accelerating sea level rise and more frequent and more intense extreme events, threatening people and nature.

- 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. Three quarters of the land and two thirds of the oceans are now impacted by humans. One million of the world's estimated 8 million species of plants and animals are threatened with extinction, and many of the ecosystem services essential for human well-being are eroding.
- Society is on course to restore the Earth's protective stratospheric ozone layer. However, there is a lot more to be done to reduce air and water pollution, safely manage chemicals, and reduce and safely manage waste.

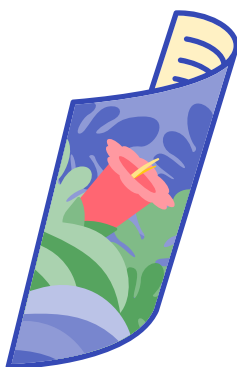
The achievement of the Sustainable Development Goals is threatened by an array of escalating and mutually reinforcing environmental risks

- Current and projected changes in climate, biodiversity loss and pollution makes achieving the SDGs even more challenging. For example, even small increases in temperature, along with associated changes such as in weather, precipitation, heavier rainfall events, extreme heat, drought and fire, increase risks to health, food security, water supply and human security, and these risks increase along with warming. In 2018 alone, damages from climate-related natural disasters cost about US\$155 billion.
- The burden of environmental decline is felt by everyone, but disproportionately by the poor and vulnerable and looms even larger over today's youth and future generations. Producers and consumers in wealthy countries often export their environmental footprint to poorer countries through trade and the disposal of waste.
- Environmental changes are already undermining hard-won development gains and impeding progress towards ending poverty and hunger, reducing inequalities and promoting sustainable economic growth, work for all and peaceful and inclusive societies. Land degradation, for instance, adversely affects more than 3 billion people.
- Earth's capacity to sustain growing needs for nutritious food, water and sanitation will continue to weaken in the face of ongoing environmental declines, as vulnerable and marginalized people are currently experiencing. For example, food security is threatened by the loss of pollinators and fertile soil. Loss of pollinators, threatens annual global crop output worth between US\$235 billion and US\$577 billion.

- The deteriorating state of the planet undermines efforts to achieve healthy lives and well-being for all. Around one quarter of the global burden of disease stems from environment-related risks, including those from animal-borne diseases (such as COVID-19), climate change, and exposure to pollution and toxic chemicals. Pollution cause some 9 million premature deaths annually and millions more die every year from other environment-related health risks.
- Environmental risks in cities and urban areas, including those from heatwaves, flash floods, drought, wildfires and pollution, hamper efforts to make human settlements (including informal settlements) inclusive, safe, resilient and sustainable.

There is an urgent need for a clear break with current trends of environmental decline and the coming decade is crucial

- The risks to human well-being and the achievement of the Sustainable Development Goals will continue to escalate unless environmental degradation is halted. Global warming of more than 2°C combined with continued loss of biodiversity and increasing pollution will likely have dire consequences for humanity.
- The costs of inaction on limiting environmental change far outweigh the costs of action. Global aggregate impacts from climate change are estimated to be very high by the end of the century unless cost-effective mitigations strategies are undertaken.



Transforming humankind's relationship with nature is the key to a sustainable future

Human knowledge, ingenuity, technology and cooperation can transform societies and economies and secure a sustainable future

- Decades of incremental efforts have not stemmed the environmental decline resulting from an expansive development model because vested and short-term interests often prevail.
- Only a system-wide transformation will achieve well-being for all within the Earth's capacity to support life, provide resources and absorb waste. This transformation will involve a fundamental change in the technological, economic and social organization of society, including world views, norms, values and governance.
- Major shifts in investment and regulation are key to just and informed transformations that overcome inertia and opposition from vested interests. Regulatory processes should embody transparent decision-making and good governance involving all relevant stakeholders. Opposition to change can be defused by redirecting subsidies toward alternative livelihoods and new business models.
- The COVID-19 crisis provides an impetus to accelerate transformative change. The pandemic and the ensuing economic upheaval have shown the dangers of ecosystem degradation, as well as the need for international cooperation and greater social and economic resilience. The crisis has had major economic costs and is triggering significant investments. Ensuring that these investments support transformative change is key to attaining sustainability.

Earth's environmental emergencies should be addressed together to achieve sustainability

- Given the interconnected nature of climate change, loss of biodiversity, land degradation, and air and water pollution, it is essential that these problems are tackled together. Response options that address multiple issues can mitigate multidimensional vulnerability, minimize trade-offs and maximize synergies.
- Limiting global warming to well below 2°C above pre-industrial levels and pursuing efforts to further limit the temperature increase to 1.5°C requires rapid implementation and a significant strengthening of pledges under the Paris Agreement. Globally, net carbon dioxide emissions need to decline by 45 per cent by 2030 compared with 2010 levels

and reach net zero by 2050 to put the world on a pathway to 1.5°C with a probability of about 50 per cent, whereas more ambitious targets would be necessary for higher certainty. A pathway to 2°C would require global emissions to be reduced by 25 per cent by 2030 compared with 2010 levels and reach net zero by around 2070. Both pathways entail rapid transformations in areas including energy systems, land use, agriculture, forest protection, urban development, infrastructure and lifestyles. Mitigating climate change is vital, urgent and cost saving: the lower the degree of warming, the easier and cheaper it will be to adapt.

- The loss of biodiversity can only be halted and reversed by providing space dedicated for nature while also addressing drivers such as changing land and sea use, over exploitation, climate change, pollution and invasive alien species. To prevent extinctions and maintain nature's life-supporting contributions, biodiversity conservation and restoration must be integral to the many uses of terrestrial, freshwater and marine ecosystems, and coupled with an expanded and better-managed global network of interconnected protected areas designed to be resilient to climate change.
- The adverse effects of chemicals and waste on the environment and human health can be substantially reduced by implementing existing international chemicals conventions. Further progress will require strengthening the science-policy interface as the basis for evidence-based policymaking and improved management systems, along with legal and regulatory reform.

The economic and financial systems can and should be transformed to lead and power the shift to sustainability

- Governments should incorporate full natural capital accounting into their decision-making and use policies and regulatory frameworks to provide incentives for businesses to do the same. Yardsticks such as inclusive wealth (the sum of produced, natural, human and social capital) provide a better basis for investment decisions than gross domestic product, as they reflect the capacity of current and future generations to achieve and sustain higher living standards.
- Governments should shift away from environmentally harmful subsidies, invest in low-carbon and nature-friendly solutions and technologies, and systematically internalize environmental and social costs.
- Achieving the Sustainable Development Goals will require massive shifts and increases in public and private financial flows and investment patterns, including in the water, food

and energy sectors. Incentives must be shifted so that investments in sustainable development are financially attractive.

- The Global South needs increased access to low-interest finance in order to build its capacity and overhaul accounting systems and policy frameworks in pursuit of the Sustainable Development Goals. The Global North has exacerbated the finance gap by failing to meet its commitments on international environmental and development assistance.
- Shifting taxation from production and labour to resource use and waste promotes a circular economy. Potential inequalities resulting from this shift can be offset through social safety nets.
- Reducing inequalities and the risk of social conflict requires the minimization and reversal of environmental degradation and declines in natural resources. It also requires structural changes to the economy, including steps to promote equity and address individual and community rights to property, resources and education.

The food, water and energy systems can and should be transformed to meet growing human needs in an equitable, resilient and environmentally-friendly manner

- Feeding humanity, ensuring water and energy security, and enhancing the conservation, restoration and sustainable use of nature are complementary and closely interdependent goals. Achieving these goals requires food systems that work with nature, reduce waste, and are adaptive to change and resilient to shocks. Small-scale farmers, especially women farmers, are central to the challenge of food and nutrition security and must be empowered.
- Changes in global patterns of consumption are critical to transforming food, water and energy systems, and to challenging social norms and business practices. Improving access to safe, nutritious and affordable food for all, while reducing food waste and changing dietary choices and consumer behaviour in high-income countries and groups, is central for the achievement of hunger, biodiversity, waste and climate goals.
- Ensuring sustainable food production from the oceans while protecting marine biodiversity requires policy action to apply sustainable harvesting approaches to fisheries management, improve spatial planning and address threats such as climate change, ocean acidification and pollution.

- Sustaining freshwater in the context of climate change, rising demand, and increased pollution involves cross-sectoral and sector-specific interventions at the watershed or river basin scale. This can be achieved by simultaneously increasing water-use efficiency, wisely expanding storage, reducing pollution, improving water quality, minimizing disruption, and fostering the restoration of natural habitats and flow regimes.
- Universal access to clean and affordable energy requires a transformation of both the production and use of energy. Increasing the supply of clean energy coupled with innovation and efficiency gains is vital to achieving equitable and sustainable economic growth while limiting global warming. Clean energy will also reduce poverty and indoor and outdoor air pollution and provide critical services such as communications, lighting and water pumping.

Keeping the planet healthy is key to providing health and well-being for all

- Policies, good practices and appropriate technologies to limit climate change, ecosystem degradation and pollution can significantly reduce associated human health risks, including from respiratory diseases, water-borne, vector-borne and animal-borne diseases, malnutrition, extreme weather events and chemical exposure. Technological change and diffusion are important mechanisms to drive transformation.
- A One Health approach integrates action across sectors and disciplines to protect the health of people, animals and the environment. Such an approach is key to minimize future human health risks from climate change, ecosystem degradation and deteriorating food, air and water quality. It is also essential in preventing and limiting the impact of future health emergencies, including pandemic outbreaks of animal-borne diseases such as COVID-19.
- Cities and other settlements, especially rapidly expanding urban areas and informal settlements, must be made more sustainable. Improvements in urban planning, governance, infrastructure and the use of nature-based solutions can be cost-effective ways to reduce pollution and make settlements more environment friendly and resilient to climate change impacts such as increased urban heat island effects and flooding. Blue and green infrastructure in urban areas has significant benefits for mental health.

Everyone has a part to play in transforming social and economic systems for a sustainable future

- All actors have individual, complementary and nested roles to play in bringing about cross-sectoral and economy-wide transformative change with immediate and long-term impact. This can be enhanced through capacity-building and education. Governments initiate and lead in intergovernmental cooperation, policies and legislation that transform society and the economy. Such transformations enable the private sector, financial institutions, labour organizations, scientific and educational bodies and media as well as households and civil society groups to initiate and lead transformations in their domains.
- Individuals can facilitate transformation by, for instance, exercising their voting and civic rights, changing their diets and travel habits, avoiding waste of food and resources, and reducing their consumption of water and energy. They can also promote behavioural change by raising awareness in their communities. Human cooperation, innovation and knowledge-sharing will create new social and economic possibilities and opportunities in the transformation to a sustainable future.



MAKING PEACE WITH NATURE

Transforming nature puts human well-being at risk

HUMAN DEVELOPMENT (1970–2020):

- ▶ The economy has grown nearly fivefold and trade tenfold
- ▶ Human population has doubled to 7.8 billion
- ▶ Still, 1.3 billion people are poor and 700 million hungry

DISPOSALS OF WASTE MATTER:

- ▶ Greenhouse gas emissions have doubled
- ▶ Chemical production, waste and pollution have increased

USE OF SPACE AND RESOURCES:

- ▶ Resource use has tripled
- ▶ Humans impact 3/4 of ice-free land and 2/3 of oceans

Transforming humankind's relationship with nature is the key to a sustainable future

HUMAN DEVELOPMENT (from 2020):

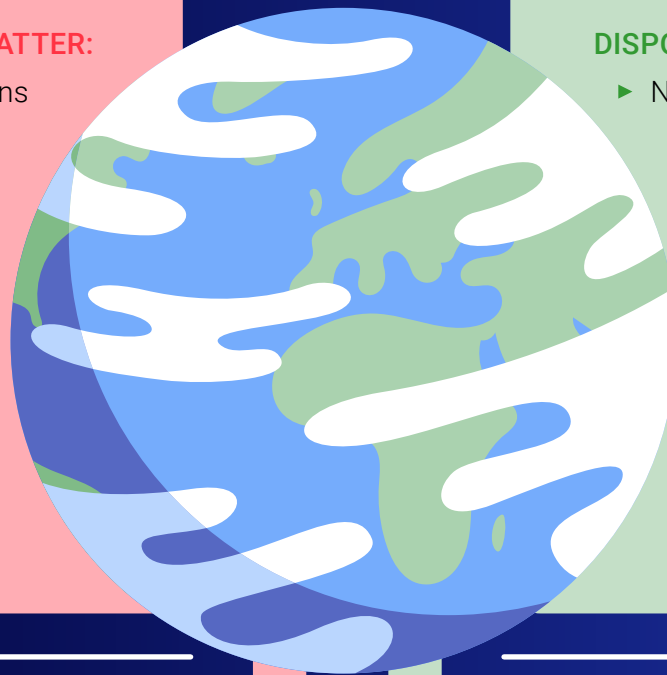
- ▶ Sustainable economic and financial systems
- ▶ Healthy, nutritious food and clean water and energy
- ▶ Healthy lives and well-being for all in safe cities and settlements

DISPOSALS OF WASTE MATTER:

- ▶ Net-zero carbon dioxide emissions by 2050
- ▶ Management of chemicals, waste and pollution

USE OF SPACE AND RESOURCES:

- ▶ Recycling of resources
- ▶ Protection and sustainable use of land and oceans



Earth's capacities to

- ▶ support life
- ▶ provide resources
- ▶ absorb waste matter

ARE DEGRADED AND SURPASSED

RISK to:

Livelihoods, equity, health, economic development, peace, food, water, sanitation, safe cities and settlements

Earth's capacities to

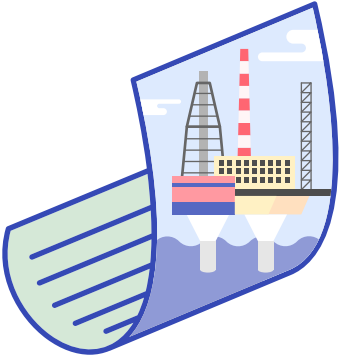
- ▶ support life
- ▶ provide resources
- ▶ absorb waste matter

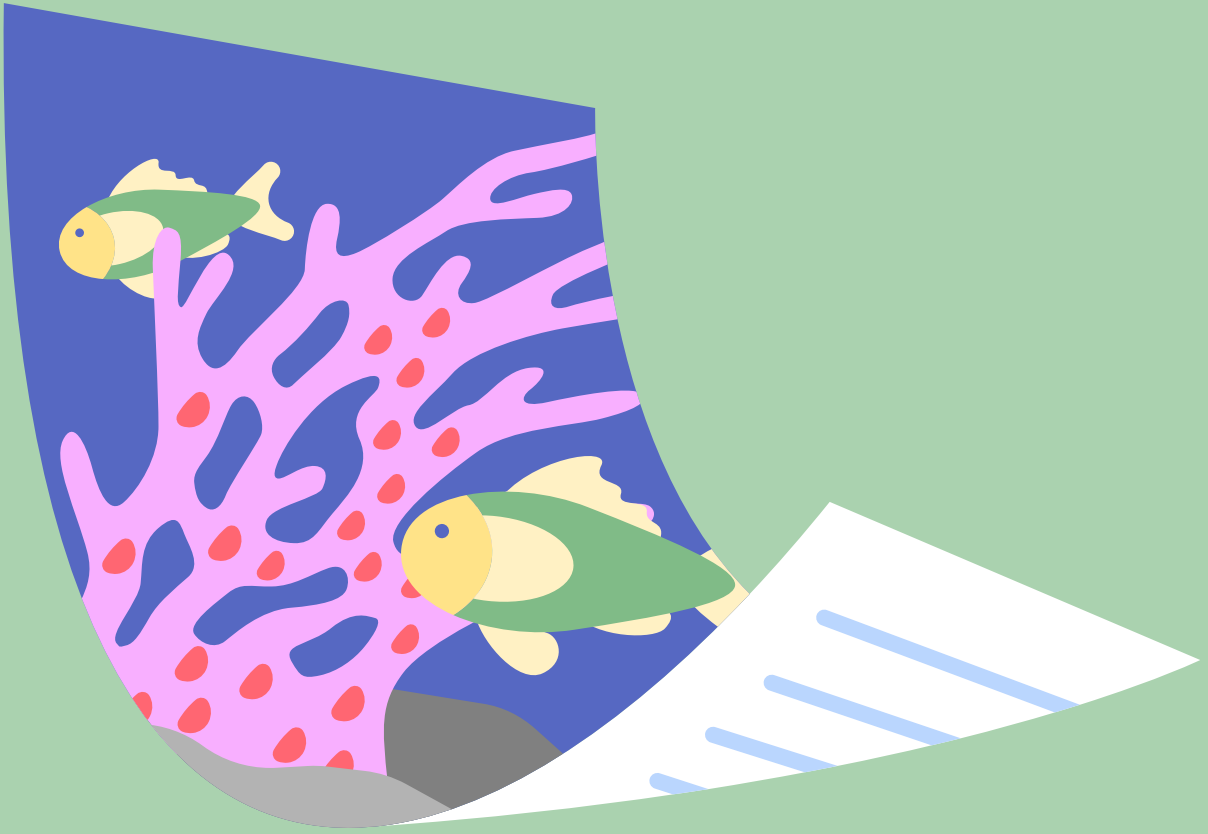
ARE RESTORED AND ADAPTED

SUPPORT for:

Poverty elimination, equity, health, economic development, peace, food, water, sanitation, safe cities and settlements

Figure KM.1: The well-being of today's youth and future generations depends on an urgent and clear break with the current trends of environmental decline. Human knowledge, ingenuity, technology and cooperation need to be redeployed from transforming nature to transforming humankind's relationship with nature. Time is of the essence. Society needs to reduce carbon dioxide emissions by 45 per cent by 2030 compared to 2010 levels and reach net-zero emissions by 2050 to achieve the 1.5°C Paris Agreement target, while at the same time conserving and restoring biodiversity and minimizing pollution and waste.





Executive Summary

Humanity has been grappling with environmental challenges that have grown in number and severity ever since the Stockholm Conference in 1972. The scientific assessments synthesized in this report show that those challenges now represent a planetary emergency. While tackling the emergency is demanding, the report lights a path to a sustainable future marked with new possibilities and opportunities.

I. Transforming nature puts human well-being at risk

Part I of the report addresses how the current expansive mode of development degrades and exceeds the Earth's finite capacity to sustain human well-being. The world is failing to meet most of its commitments to limit environmental damage and this increasingly threatens the achievement of the Sustainable Development Goals (SDGs).

A. The current mode of development degrades the Earth's finite capacity to sustain human well-being

Human well-being is critically dependent on Earth's natural systems. Economic, social and technological advances have come at the expense of the Earth's capacity to sustain current and future human well-being. Human prosperity rests on the wise use of the finite space and resources available to all life on Earth, as well as on the restoration of its life-supporting processes and capacity to absorb human waste. Every person benefits from clean air and water, a protective stratospheric ozone layer, a hospitable climate and the many additional benefits that land and oceans provide, including food, medicines, energy, materials, inspiration and a sense of place. The rich web of life, of which humanity is a part, modulates and maintains Earth's systems in ways critical to people, for example by reducing the severity of natural disasters and by providing soil, pollination and pest control that help people harness the planet's fertility. Over the past 50 years, human

societies have dramatically increased the production and extraction of food, energy and materials, resulting in economic, technological and social advances and increased prosperity for many. However, the exploitation of nature has reached unsustainable levels and is undermining the Earth's capacity to sustain human well-being, now and in the future.

Human prosperity is strained by widening inequalities, whereby the burden of environmental decline weighs heaviest on the poor and vulnerable and looms even larger over today's youth and future generations. Across the world, people are living longer, are more educated and have greater opportunities on average than previous generations, but the wealth gap is growing between rich and poor, both among and within countries. Economic growth and poverty reduction occurred across the developing world prior to the COVID-19 pandemic. However, little of the economic progress seen in high- and middle-income countries has benefitted the least developed countries. About 1.3 billion people remain poor, and some 700 million are going hungry, and both numbers are expected to increase significantly because of the economic impact of the pandemic. Environmental decline affects and concerns everyone, rich and poor. However, the burden weighs most heavily on the poor and vulnerable, where women are often overrepresented. Future generations in many localities risk a situation where more people must struggle to make a living from diminished natural resources in a changing environment.

Economic and financial systems fail to account for the essential benefits that humanity gets from nature and to provide incentives to manage nature wisely and maintain its value. Nature provides the foundation for human existence and prosperity. From an economic perspective, nature is a vital capital asset that provides many essential goods and services. Conventional metrics like gross domestic product (GDP) overstate progress because they fail to adequately capture the costs of environmental degradation or reflect declines in natural capital. Conventional economic measu-

res also fail to reflect indicators of health, education and other dimensions of human well-being. Most of the essential benefits of nature currently have no financial or market value despite providing the underpinnings of current and future prosperity. Inclusive wealth, which sums the value of natural, human, manufactured and social capital, is a better measure of sustainable progress. The current practice of excluding the value of nature and the costs of its degradation from economic accounting and market prices, along with the impact of environmentally harmful subsidies such as those for agricultural output and fossil fuel energy, poses an increasing risk to economies and societies. Excluding the value of nature skews investment away from economic solutions that conserve and restore nature, reduce pollution, expand renewable energy and make more sustainable use of resources while also increasing prosperity and well-being.

The resource-intensive and increasingly unequal model of human development indirectly drives global environmental change. Over the last 50 years, the human population has more than doubled, while the extraction of materials and the production of primary energy and food have all more than tripled. The global economy has grown nearly fivefold, and trade has grown tenfold. Resource use is driven by growing supply resulting from innovation and efficiency gains in production of goods and services as well as from marketing, governance and increasing consumer demands from a wealthier and expanding population. People in high-income countries generally each consume far more than people in low- and middle-income countries. The world population, the economy and resource use are expected to continue growing, though at a slower rate. By 2050, the global population is projected to have increased from 7.8 billion people today to nearly 9 billion and become wealthier and more urban. The production of energy is projected to increase by about 50 per cent and food by 70 per cent. Projections depend on the implementation of policies in areas ranging from reproductive health and tenure rights to the economy.

Increases in resource use and waste generation drive global environmental change in ways that transcend borders and continents. To satisfy growing demands, humans use an ever-increasing fraction of the Earth's land, freshwater and oceans for the production and extraction of food, fibre, energy and minerals as well as for industrial facilities, infrastructure and settlements. In doing so, society also releases greenhouse gases and pollutants, including nutrients and toxic chemicals as well as household, industrial and human waste. Humans modify life and move organisms around the world in pursuit of increased production or through accidental introductions. They also narrow down the range of genetic

material in domesticated species. Many of the impacts of human activities are felt over large distances, such as through transboundary pollution or when wealthy countries export their environmental footprint by meeting their demands through trade.

B. Society is failing to meet most of its commitments to limit environmental damage

The Earth's climate is changing and its web of life is unravelling as land and oceans degrade and chemicals and waste accumulate beyond agreed limits. The international community has set targets, informed by science, in multilateral agreements for protecting natural assets and limiting harmful environmental change. Despite some progress, efforts to date have failed to meet any of the agreed targets.

The world is not on course to fulfil the Paris Agreement to limit global warming to well below 2°C above pre-industrial levels, let alone meet the 1.5°C target. The Earth's mean near-surface temperature has already risen by more than 1°C compared to the period from 1850 to 1900. At the current rate, warming will reach 1.5°C by around 2040 and possibly earlier. Taken together, current national policies to reduce greenhouse gas emissions put the world on a pathway to warming of at least 3°C by 2100, though this may change as countries update their pledges.¹ Current warming, which is greater over land than over the ocean and is highest in the polar regions, has already led to melting of ice sheets and glaciers, accelerating increases in sea level, more frequent and more intense extreme events, changes in precipitation patterns, as well as shifts in climate zones, including expansion of arid zones and contraction of polar zones. Emissions of heat-trapping greenhouse gases are still increasing with current atmospheric concentrations much higher than at any time in the past 800,000 years. The accumulation of heat in the oceans will persist for centuries and affect many future generations. About two thirds of the warming caused by anthropogenic greenhouse gases is due to carbon dioxide, mostly originating from the use of fossil fuels and some industrial processes. About one quarter of the warming results from activities related to the land – agriculture, pastoralism, forestry and especially changing natural land covers to human-dominated ones. Natural sinks today are only able to absorb around half of anthropogenic carbon dioxide emissions, split between terrestrial ecosystems and the ocean. The increased uptake of carbon dioxide by the oceans is causing harmful ocean acidification. To fulfil the Paris Agreement to limit warming to well below 2°C or meet the agreement's goal of restricting the increase to 1.5°C, net global emissions from human activities need to reach zero or even become negative

¹ At the Climate Ambition Summit on 12 December 2020, 45 countries pledged significant emissions reductions by 2030, and 24 countries committed to reach net-zero by the middle of the century.

by the middle of the century. While meeting the Paris Agreement targets is technically feasible, political commitment to do so is currently lacking.

None of the global goals for the protection of life on Earth have been fully met, including those in the strategic plan for biodiversity 2011-2020 and its Aichi biodiversity targets.

At the global level, only six of the 20 Aichi targets have been partially achieved, including increases in the proportion of land and oceans designated as protected areas and improved international financial flows to developing countries. Little or no progress has been made on others, such as eliminating harmful subsidies. Species are currently going extinct tens to hundreds of times faster than the natural background rate. One million of the world's estimated 8 million species of plants and animals are threatened with extinction. The population sizes of wild vertebrates have dropped by an average of 68 per cent in the last 50 years, and the abundance of many wild insect species has fallen by more than half. The number of local varieties of domesticated plants and animal breeds and their wild relatives has been reduced sharply. For example, over 9 per cent of animal breeds have become extinct and at least another 17 per cent are threatened with extinction. Ecosystems are degrading at an unprecedented rate, driven by land-use change, exploitation, climate change, pollution and invasive alien species. Climate change exacerbates other threats to biodiversity, and many plant and animal species have already experienced changes in their range, abundance, and seasonal activity. Degradation of ecosystems is impacting their functions and harming their ability to support human well-being. Loss of biodiversity is anticipated to accelerate in coming decades, unless actions to halt and reverse human transformation and degradation of ecosystems and to limit climate change are urgently implemented.

Society is not on course to achieve land degradation neutrality, where degradation is minimized and offset by restoration. Land degradation objectives are embedded in the SDGs and land degradation neutrality is a focus of the UN Convention to Combat Desertification (UNCCD). International targets on aspects such as combatting desertification, soil degradation, or wetland loss as well as national targets on preventing or reversing land degradation have in aggregate not been sufficient to achieve land degradation neutrality. Natural ecosystems have been transformed by humans at an accelerating rate since the middle of the twentieth century. Only a quarter of the original habitat on ice-free land is still functioning in a nearly natural way. Much of this quarter is located in dry, cold, or mountainous areas with low human population densities and also includes the protected areas that currently cover 15 per cent of the total land area. A quarter of land has

been radically transformed to cropland, plantations and other human uses. Half of the land area functions in an increasingly human-dominated and semi-natural way. It includes the rangelands grazed by livestock, the semi-natural forests harvested for wood, and the freshwater systems altered by water use. The world's forests constitute nearly a third of the land area, and about 10 per cent of their area has been lost through conversions to other land uses since 1990, though the deforestation rate is decreasing. Of the combined area of semi-natural and highly transformed landscapes, around one sixth is degraded to the degree that ecological capacities to support human well-being are reduced. Of particular concern is degradation where ecological processes have been impaired to the point that the ecosystem is no longer able to recover. Wetlands are the most transformed and degraded ecosystem type. Only 15 per cent of wetlands remain. Land degradation and transformation contributed around a quarter of greenhouse gas emissions in the decade 2010-2019. Over half of these emissions derive from land transformation (particularly deforestation) and most of the remainder from the loss of soil carbon in cultivated land. Notwithstanding the agreed goal of halting land degradation, all development scenarios explored in the relevant assessments project that land degradation will continue to increase in the twenty-first century. The fraction of remaining near-natural land is projected to be only 10 per cent by mid-century, while degraded land will reach over 20 per cent.

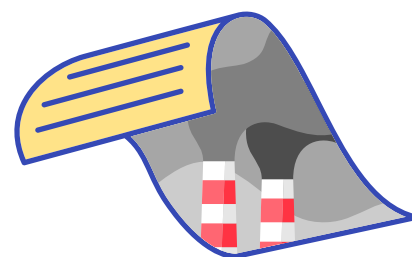
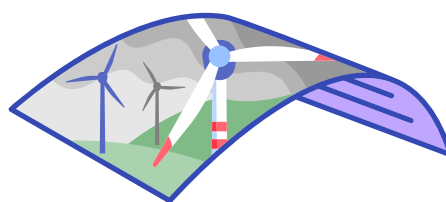
Many of the targets for conservation, restoration and sustainable use of oceans, coasts and marine resources will likely not be fully met as marine and coastal ecosystems are declining. Targets for oceans and coasts have been agreed as part of the SDGs. Detrimental human activities including overfishing, coastal and offshore infrastructure and shipping, climate change, ocean acidification and waste and nutrient runoff combine to affect two thirds of ocean area. One third of marine fish stocks were overharvested in 2015, a portion that has increased from 10 per cent in 1974. Sixty per cent of stocks are fished at maximum sustainable yield and only 7 per cent are underexploited. Fertilizers entering coastal ecosystems have produced more than 400 "dead zones" totalling more than 245,000 km² – an area bigger than the United Kingdom or Ecuador. Marine plastics pollution has increased tenfold since 1980, constituting 60-80 per cent of marine debris, and is found in all oceans at all depths and concentrates in the ocean currents. Marine plastic litter causes ecological impacts including entanglement and ingestion and can act as a vector for invasive species and other pollutants. The risk of irreversible loss of marine and coastal ecosystems including seagrass meadows and kelp forests increases with global warming. Warming of 2°C is projected to result in a decrea-

se in the biomass of marine animal communities and their productivity. Coral reefs are particularly vulnerable to climate change and are projected to decline to 10-30 per cent of their former cover at 1.5°C of warming and to less than 1 per cent at 2°C of warming, compromising food provision, tourism and coastal protection. Depending on the amount of sea level rise, 20-90 per cent of current coastal wetlands may be lost by the end of the century. Climate change is increasing the chances of the Arctic Ocean being ice-free in summer, further disrupting ocean circulation and Arctic ecosystems.

The world is on course to restore Earth's protective stratospheric ozone layer, but there is much more to be done to reduce air and water pollution and to safely manage chemicals and waste. Large quantities of hazardous chemicals and pollutants continue to leak or be dumped into the environment. Up to 400 million tons of heavy metals, solvents, toxic sludge and other industrial wastes enter the world's waters annually. The global chemical industry's production capacity almost doubled between 2000 and 2017. Chemicals of particular concern include those that are carcinogens, mutagens, bioaccumulative and toxic, as well as those with endocrine-disrupting or neurodevelopmental effects. The synergies between multilateral agreements related to chemicals and waste have been instrumental in addressing the life cycle of chemicals, but many developing countries still lack the capacity to manage chemicals safely. In recent decades, outdoor air pollution – for example, sulphur dioxide and particulate matter in the troposphere (i.e. lower atmosphere) – has improved in high-income countries but continues to worsen in most low-income countries. Urban areas typically have high levels of pollution. Of 45 megacities with measurements, only four satisfied World Health Organization (WHO) guidelines for air quality. Currently, more than 90 per cent of the world's population live in places breaching WHO guidelines for particulate matter. The stratospheric ozone layer that protects life from ultraviolet radiation has started to recover and should return to its pre-1980 levels by mid-century as long as countries continue to eliminate the production and consumption of ozone-depleting chemicals as agreed under the Montreal Protocol. Some of these gases are also potent greenhouse gases. The success in phasing out these gases demonstrates the role that multilateral treaties can play in achieving joint action based on the scientific findings in international assessments.

Climate change, loss of biodiversity, land degradation, and accumulating chemicals and waste reinforce each other and are caused by the same indirect drivers. Environmental changes are projected to increase and accelerate in the coming decades due to further expansion in human activities

and time lags in the Earth's systems. Climate change drives changes in wildfires and water stress and combines with biodiversity loss to degrade land and enhance drought in some regions. Globally, risks from dryland water scarcity and wildfire damage are projected to be high with global warming of 1.5°C, and very high for warming of 3°C. The combination of climate, land-use and land-cover changes has over the last few decades already resulted in more frequent and intense dust storms in many dryland areas. Climate change and land degradation combine to drive loss of biodiversity and increase extinction risks. Geographic range losses of over 50 per cent are expected for between a quarter and a half of terrestrial species at 3°C warming. Climate change, land degradation and pollution of land, water and oceans can degrade ecosystems in ways which exacerbate air and water pollution, reduce water availability and diminish nature's uptake of carbon dioxide, which in turn can further increase climate change. Efforts to reduce carbon dioxide emissions from the use of fossil fuels also reduces local air pollution (as fossil fuels are also responsible for a very large share of pollutant emissions). Efforts to reduce local air pollution, such as from black carbon (soot), and ground-level ozone and its precursors, can also contribute to mitigating climate change.



C. An array of escalating and mutually reinforcing environmental risks threatens human well-being and the achievement of the Sustainable Development Goals

Current and projected future environmental degradation will seriously undermine society's chances of achieving the Sustainable Development Goals (figure ES.1). Recent data and projected trends show that society prior to the COVID-19 pandemic was reducing hunger, increasing access to safe drinking water and adequate sanitation and increasing access to clean modern energy services, but not enough to meet the targets in the 2030 Agenda for Sustainable Development. Current and projected changes in climate, biodiversity loss and pollution make achieving the SDGs even more challenging. For example, even small increases in temperature, along with associated changes such as in weather, precipitation, heavier rainfall events, extreme heat, drought and fire, increase risks to health, food security, water supply and human security, and these risks increase along with warming. Combined environmental changes increase the risks of crossing thresholds beyond which ecological and climatic shifts accelerate and become very hard to reverse. Socioeconomic development patterns strongly determine the vulnerability and exposure of people, and thus related impacts, as well as the groups in society that would bear the brunt of these impacts. The COVID-19 pandemic has disrupted already uneven progress towards achieving many of the SDGs and caused the first increase in global poverty in decades by pushing an estimated 70 million more people into extreme poverty in 2020.

Damaging and long-lasting environmental change impedes progress towards ending poverty, reducing inequalities and promoting sustainable economic growth, decent work for all and peaceful and inclusive societies. Progress towards ending poverty in all its forms (SDG 1) is countered by the impacts of climate change, which are expected to exacerbate poverty in most developing countries and, in combination with increasing inequalities, create new pockets of poverty everywhere. Worldwide, 3.2 billion people (around 40 per cent of global population) are adversely affected by land degradation, and the number is growing. Environmental change impedes the achievement of gender equality (SDG 5) especially in rural, agricultural and resource-based economies and livelihood systems, where women's adaptive capacities are hampered by poorer access than men to financial resources, land, education, health, and other basic rights. Inequalities in environmental opportunities and burdens along ethnicity, gender, race and income levels hamper efforts to reduce inequalities within and among countries (SDG 10). Countries with high average temperatures, low levels of development,

and high dependence on climate-sensitive sectors such as agriculture, are expected to bear the largest burdens of climate change. Efforts to promote sustained, inclusive and sustainable economic growth and decent work for all (SDG 8) are hampered by loss of natural capital and climate change. In 2018 alone, damages from climate-related natural disasters cost about US\$155 billion. Poorer workers in industry, agriculture or the informal sector are more likely than higher-wage workers to be employed in dangerous, unregulated settings with high exposures to heat stress and hazardous chemicals. Environmental change also hampers the promotion of peaceful and inclusive societies (SDG 16). Climate change can amplify migration and environmental degradation and intensify competition for natural resources, which in turn can spark conflicts, including between actors with power asymmetries where indigenous peoples or local communities are often vulnerable. Since the mid-twentieth century, at least 40 per cent of all intrastate conflicts have been linked to the exploitation of natural resources. More than 2,500 conflicts over such resources are currently occurring across the planet, and at least 1,000 environmental activists and journalists were killed between 2002 and 2013.

Earth's capacity to meet growing human needs for nutritious food, water and sanitation for all will weaken in the face of continued environmental decline. Environmental degradation makes ending hunger, achieving food security and improved nutrition and promoting sustainable agriculture (SDG 2) more demanding. Agricultural yields are projected to be negatively impacted by climate change due to warming, changing precipitation patterns, greater frequency of extreme events such as heatwaves, heavy precipitation in several regions, and droughts in some regions, and changes in the incidence of pests and diseases. While sustainability choices influence food security at the local scale, climate change risks to food security could become very high at 2°C, whilst 4°C of warming is considered catastrophic. Air pollution such as ground-level ozone also negatively impacts agricultural yields and will be impacted by climate change. Species and genetic diversity in agriculture, which are critical to resilient food systems, is lower than ever. Future agricultural expansion is projected to take place on more marginal lands with lower yields. Biodiversity loss poses risks to food production. The loss of animal pollinators, critical to more than 75 per cent of food crops, including many fruit and vegetables and cash crops such as coffee, cocoa and almonds, threatens annual global crop output worth between US\$235 billion and US\$577 billion. Soil erosion from agricultural fields is estimated to be 10 to more than 100 times higher than the soil formation rate, affecting agricultural yields through reduced water-holding

capacity and loss of nutrients. An estimated 176 gigatonnes of soil organic carbon has been lost historically, mostly from land-use change, and another 27 gigatonnes is projected to be lost between 2010 and 2050. Wild fish catch, which has already declined due to overfishing, is under additional threat due to changing climatic conditions, ocean acidification and pollution. Efforts to ensure the availability and sustainable management of water and sanitation for all (SDG 6) are also impeded by environmental change. Climate change will exacerbate water stress risks, especially in areas of decreased precipitation and where groundwater is already being depleted, affecting both agriculture and more than 2 billion people who already experience water stress. Water pollution has continued to worsen over the last two decades, increasing the threats to freshwater ecosystems and human health.

The deteriorating health of the planet undermines efforts to secure healthy lives and well-being for all (SDG 3).

Pollution is estimated to cause some 9 million premature deaths annually and millions more die every year from other environment related health risks. Around one quarter of the global burden of disease stems from environment-related risks, including climate change, air and water pollution, and exposure to toxic chemicals. Climate-related health risks, which become greater with rising temperatures, include undernutrition, vector-borne diseases (including dengue, chikungunya, yellow fever and zika virus), animal-borne (zoonotic) diseases (see box below), heat-related morbidity and mortality, and food- and water-borne diseases. Indoor air pollution from cooking with biomass on traditional stoves, and outdoor air pollution, much from the combustion of fossil fuels, currently cause around 6.5 million premature deaths per year related to respiratory diseases and are projected to continue to represent a serious human health risk. Other major environmental health risks include lack of access to clean drinking water and sanitation services, causing 1.7 million deaths per year from diarrheal diseases, many of which are deaths of children under the age of five. Pollution-related health risks also stem from exposure to heavy metals and chemicals. The stratospheric ozone layer – which is slowly recovering – reduces the risk of excessive solar ultraviolet radiation exposure that leads to skin cancer, cataracts, and other health problems in humans. As a result of the loss of biodiversity and ecosystem services, nature’s ability to support human health through regulation of air and water quality is in decline in many places, as well as its ability to provide opportunities for recreation and relaxation, which support physical and mental health and well-being. Biodiversity loss is also negatively affecting nature’s ability to supply medicines. An estimated 4 billion people – more than half the global population – rely primarily on natural medicines

for their health care, and some 70 per cent of drugs used for treating cancer are natural or are synthetic products inspired by nature. Antimicrobial resistance, industrial chemicals, multi-exposures, and newly emerging diseases are increasingly threatening human health and well-being.

Diseases that originate in wild and domestic animals (zoonotic diseases) pose threats to human health and the economy, as the COVID-19 pandemic demonstrates. Addressing the pandemic has upended people’s lives, brought sectors such as travel and tourism to a standstill, and caused major health, economic and social impacts around the world. The crisis, which was still unfolding as this report was completed, shows that modern society is susceptible to the risks that zoonotic diseases have presented throughout human history. It has been estimated that, of the 1.6 million potential viruses in mammals and birds, 700,000 could pose a future risk to human health. Risks depend partly on how human interaction with nature is managed. Ecological degradation increases the risk of zoonotic diseases through increased human contact with pathogens and changes in pathogen ecology. Human impacts that may increase the risk include climate change, land-use change and fragmentation, agricultural intensification, deforestation, and the legal and illegal wildlife trade. The creation of new habitat edges provides more opportunities for spillover events from wildlife hosts into humans and livestock. A One Health approach recognizing how human health is interconnected with the health of animals, plants and the shared environment and applied at all levels of decision-making – from the global to the local – can reduce the risk of zoonotic pandemics and epidemics into the future.

Environmental degradation hampers efforts to make cities and human settlements inclusive, safe, resilient and sustainable (SDG 11).

Climate change and loss of biodiversity and ecosystem services can negatively impact the provision of basic services and accentuate natural disasters, while air pollution and waste management remain challenging in many cities. Coastal communities are exposed to multiple climate-related hazards, including tropical cyclones, sea level rise and flooding, marine heatwaves, sea-ice loss, and permafrost thaw. Global warming exacerbates the urban heat island effect in cities and their surroundings, especially during heatwaves, increasing people’s exposure to heat stress. At 1.5°C of warming, twice as many megacities than at present are likely to become heat-stressed, possibly exposing more than 350 million more people to potentially deadly heat stress by 2050. Urbanization can amplify the effects of extreme rainfall

Environmental degradation threatens the achievement of the SDGs

Impeding poverty elimination, inequity reduction, economic development and peace

- ▶ Exacerbated multi-dimensional poverty
- ▶ Accentuated inequality, including gender inequality
- ▶ Lost income opportunities
- ▶ Increased risk of conflict over resources
- ▶ Increased risk of displacement and outmigration

Threatening human health

- ▶ Increased undernutrition, heat stress and air pollution-related diseases
- ▶ Exacerbated food- and water-borne infections and zoonotic diseases
- ▶ Reduced ability of nature to provide medicines and support physical and mental well-being

Hampering efforts to make cities and communities sustainable

- ▶ Increased vulnerability to natural disasters
- ▶ Stresses on urban infrastructure
- ▶ Rising air and water pollution
- ▶ Rising waste disposal problems

Weakening food and water security

- ▶ Increased food-system vulnerability
- ▶ Reduced agricultural productivity
- ▶ Reduced nutritional value of crops
- ▶ Lower catch in fisheries
- ▶ Increased water scarcity

Changing climate

- ▶ Higher temperatures
- ▶ More extreme weather events, e.g. flooding, droughts, storm surges and heatwaves
- ▶ Rising sea level
- ▶ Changing precipitation patterns
- ▶ Ocean acidification

Biodiversity loss and ecosystem degradation

- ▶ Loss of species richness and accelerated species extinction
- ▶ Loss of genetic resources in domestic and wild species
- ▶ Loss of ecosystem functions, such as pollination, seed dispersal, soil formation and biological productivity

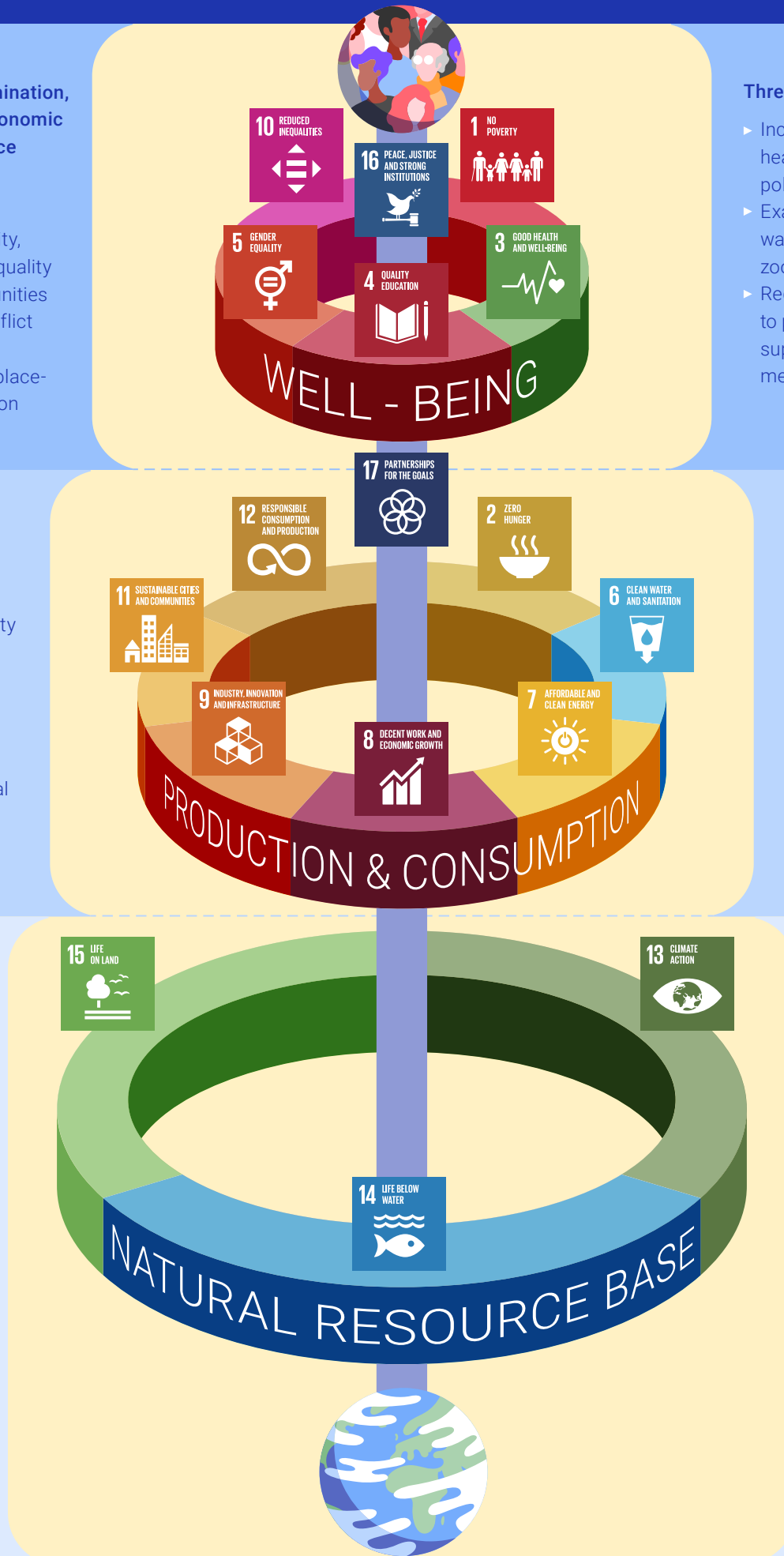


Figure ES.1: Selected environmental changes and related impacts on the SDGs. The clustering of SDGs provides an integrated perspective with the environment as the foundation for the economy, human development and, ultimately, human well-being. Human-induced environmental degradation adversely impacts human well-being.

and wind. Large-scale urbanization is also impacting on biodiversity hotspots and agricultural land, which in turn will have consequences for human settlements in terms of declining ecosystem services and food security. Urban populations are particularly exposed to air pollution. Solid waste per capita has doubled in the last decade to 1.3 billion tons a year, most of which is generated and disposed of in cities. At least 2 billion people lack access to collection services for solid waste and 3 billion people lack access to adequate waste disposal facilities. Many low-income cities still have waste collection coverage in the range of 30 to 60 per cent.

The risks to human well-being and to the achievement of the Sustainable Development Goals will continue to escalate unless current rates of environmental degradation are halted. Global warming of more than 2°C combined with continued loss of biodiversity and increasing pollution will likely have dire consequences for humanity. If warming exceeds 2°C, both marine and terrestrial animals and plants are projected to decline, including the decline of warm-water coral reefs by 99 per cent, the decline of Arctic summer sea ice, large declines in marine fishery catches, and the placing of 20-30 per cent of terrestrial species at increased risk of extinction. Substantial increases in heatwaves, heavy precipitation in several regions and drought in some regions are associated with global warming, and in turn increase risks to food security. Crop yields are already declining in some regions due to global warming. The fraction of remaining near-natural land is projected to be only 10 per cent by mid-century, while degraded land will reach over 20 per cent.

The costs of inaction on limiting environmental changes far outweighs the costs of action. By 2100, negative impacts from climate change exceeding 2.5°C of warming are likely to be substantial, far in excess of impacts with limiting warming to 1.5°C or well below 2°C. Furthermore, limiting greenhouse gas emissions would also generate considerable benefits, including for human health. Cost estimates for reducing emissions, though substantial, are far less than the avoided economic damage. There is an urgent need for a clear break with current trends of environmental decline, and the coming decade is crucial.

II. Transforming humankind's relationship with nature is the key to a sustainable future

Part II of the report addresses the transformational changes required to achieve a sustainable world. It also assesses the roles and responsibilities of different actors and presents options for action in the interconnected sectors of environment, economics, finance, energy, food, water, health and cities.

D. Human knowledge, ingenuity, technology and cooperation can transform societies and economies and secure a sustainable future

Decades of growing efforts have not stemmed the environmental decline resulting from the current development model because vested and short-term interests often prevail. While progress has been made in addressing climate change, biodiversity loss, land degradation, and air and water pollution, the types of transformational change needed have often been thwarted by vested interests that benefit from preserving the status quo.

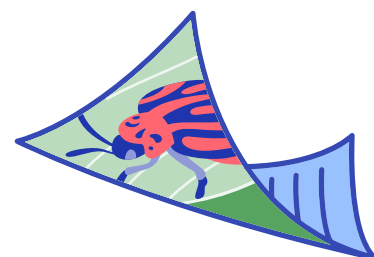
Only system-wide transformation will enable humanity to achieve well-being for all within the Earth's finite capacity to provide resources and absorb human waste. Society continues to exceed and degrade the Earth's capacities despite clear evidence of the risk that this development path poses to humanity and growing efforts to reduce its environmental impacts. Continuing along this path constitutes an ongoing and increasing risk to current and future prosperity and well-being. Human skills need to be redeployed from transforming nature to transforming the social and economic fabric of society. This effort needs to put human well-being centre stage, and speed progress towards achieving the opportunities set out in the indivisible and interdependent SDGs, whose target date is fast approaching. Transformation involves a fundamental, system-wide shift in world views and values and in the technological, economic and social organization of society. Transformations requires amongst other things innovation, learning, collaboration, multilateralism and adaptation of governance structures, policies, business models, technologies, education and knowledge systems. In particular, cross-sectoral planning and integrated policy mixes are essential to find synergies, address trade-offs, and manage the interactions between areas including water, food, energy, climate change and human health. Beyond policy, initiatives from actors in society that challenge current social norms or the status quo can spark organizational and societal deliberation, which may substantially speed up transformations.

Transformation towards sustainability involves significant and mutually reinforcing changes in behaviour, culture, material flows and systems of management and knowledge transmission. With successful transformative change, the consumption of resources would decrease in wealthy contexts and increase sustainably elsewhere. People would be empowered to express and act in accordance with values of environmental responsibility without undue difficulty or self-sacrifice. Human opportunities and outcomes would be more equitable across dimensions of social difference including gender, ethnicity, race, and region. Trade and other economic activities including resource extraction and production of goods and services would yield net-positive effects, resulting in a substantial reduction in negative consequences. Systems of innovation and investment would yield technologies that enable net-positive environmental effects. Education and knowledge transmission would enable everyone to participate in well-functioning societies and new practices of stewardship and sustainability. Human ambitions for a good life would no longer be centred around high levels of material consumption, but around rich relationships involving people and nature, in keeping with diverse traditions throughout the world. Behaviour change can be achieved by enabling the strong underlying values of responsibility that are already present via subtle or structural changes in institutions and infrastructure, but paradigms, goals and values would further change as systems and human action transform. The above components of transformative change have been called the “leverage points” to reflect the potentially synergistic nature of change.

Achieving sustainability will entail interventions across scales and sectors and changes to incentive structures, management systems, decision-making processes, rules and regulations. Transformed incentive structures would encourage conservation and discourage actions that result in environmental degradation. Systems for policymaking, planning and managing natural resources and the use of lands and waters would be coordinated across sectors and jurisdictions; pre-emptive in addressing emerging threats via effective environmental monitoring and evaluation; include meaningful participation, especially of stakeholders and rightsholders such as indigenous peoples and local communities; and be designed for resilience and adapted to uncertainties. Strong environmental laws would protect ecosystems and the human enjoyment of a healthy environment, bolstered by consistent enforcement of laws and independent judiciaries. These three sets of governance interventions have been called the “levers” of transformation to reflect their power to effect change at the specified leverage points and also more broadly.

Opposition from vested interests to transformations aiming to secure a sustainable and prosperous future is to be expected but can be addressed. Existing infrastructure and built capital provide system inertia that can make change difficult and incurs short-term costs, especially if change involves the premature retirement of capital stock. Also, individuals and organizations have habits, procedures, and ways of doing business that can yield a reluctance and resistance to change. Individuals and organizations can also oppose change that disrupts their livelihoods, market share and revenues, or that otherwise appear unfair. Transparent regulatory action and consistent enforcement, coupled with political leadership, media vigilance, and civil society engagement, can shift the status quo and help level the playing field so that firms cannot gain competitive advantages by externalizing costs that are then borne by society. Some opposition can be addressed proactively by redirecting subsidies to steer workers and firms toward opportunities associated with transformative change. Programmes fostering a just transition can include, for instance, retraining workers from unsustainable industries and helping them relocate in order to take up new jobs.

The COVID-19 crisis provides the impetus to rethink how society can accelerate the transformation to a sustainable future. Governments and other actors are rolling out significant policy measures and investments to help societies and economies recover from the COVID-19 crisis. These initiatives are an opportunity to move away from unsustainable practices and accelerate transformation towards implementation of the SDGs. Economic support can be channelled into, for example, sustainable infrastructure and programmes that reduce the risks and impacts of future pandemics. A post-COVID world needs to address the issues of habitat destruction, wildlife trade, and other human-nature interactions that increase exposure to zoonotic diseases. It also needs stronger international governance structures that can help take coordinated actions quickly and transparently.



E. Earth's environmental emergencies must be addressed together to achieve sustainability

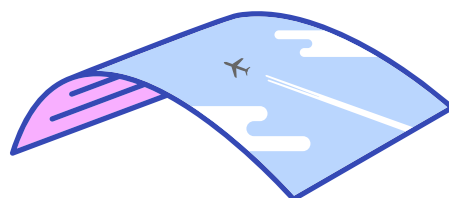
Given the interconnected nature of climate change, loss of biodiversity, land degradation, and air and water pollution, it is essential that these problems are tackled together now. Immediate action is required to mitigate climate change, conserve and restore biodiversity, improve air and water quality, make more efficient use of resources, and reduce the adverse effects of chemicals. Actions also need to be taken now even where the benefits may not be realized for years due to the long-lasting nature of environmental effects or to inertia in the socio-economic system. Essential actions with delayed effects include reforestation and restoration of degraded lands. Response options that can address multiple environmental issues, mitigate multi-dimensional vulnerability and help minimize trade-offs and maximize synergies, need to be implemented. Numerous response options that can preserve and restore the environment and contribute to achieving some of the other SDGs have already been identified. For example, large-scale reforestation with native vegetation can simultaneously help address climate change, biodiversity loss, land degradation and water security. A key challenge is to avoid unintended consequences. For instance, large scale afforestation schemes and replacing native vegetation with monoculture crops to supply bioenergy can be detrimental to biodiversity and water resources.

The further development and implementation of the goals, targets, commitments, and mechanisms under the key multilateral agreements on climate change, biodiversity, land-degradation, oceans and pollution need to be aligned and become more synergistic and mutually supportive. There needs to be enhanced harmonization in the implementation, monitoring and financing of the multilateral agreements. Sustainable policies, technologies and management practices need to be implemented within the interconnected agriculture-fisheries-forestry-water-energy systems given their impact on climate, biodiversity and land degradation.

Governments must scale up and accelerate action to meet the Paris Agreement goals and limit dangerous climate change. Evidence shows that the risks associated with climate change, including the risks of extreme weather events, impacts on unique and threatened systems, and large-scale discontinuities such as the disintegration of the Greenland and Antarctic ice sheets (Figure 1.1), are generally higher than previously understood. Limiting the global mean temperature increase to well below 2°C and pursuing efforts

to hold it to 1.5°C, in line with the Paris Agreement, require immediate significant strengthening and rapid implementation of existing national pledges to reduce greenhouse gas emissions. To limit global warming to 1.5°C, with a probability of about 50 per cent, net emissions of carbon dioxide will need to be reduced by 45 per cent by 2030 compared to 2010 levels and reach zero by 2050. To limit global warming to 2°C, emissions need to decline by about 25 per cent by 2030 compared to 2010 levels and reach net zero by around 2070. The emissions of other greenhouse gases must also be reduced. More ambitious reductions would be necessary for higher certainty in limiting dangerous climate change. The emission gaps presented in figure ES.2 show pathways with about 66 per cent chance of limiting global warming to 1.5°C and 2°C. Delaying action exacerbates difficulties and incurs greater costs. Scenarios in which warming temporarily exceeds the Paris Agreement targets around mid-century before falling rapidly depend heavily on the development of carbon dioxide removal technologies, whose ability to capture and store carbon dioxide at scale is so far unproven and could lead to unintended negative impacts on biodiversity and food production.

Emissions reductions entail rapid and far-reaching transformations in the energy, land, industrial production, urban and infrastructure sectors. Such transformations are unprecedented in scale, implying deep emissions reductions in all sectors and in all countries, as well as new lifestyles, norms and values. Developing countries will need financial and technical assistance. Nature-based solutions, such as reforestation with native trees, restoration of degraded lands, improved soil management and agroforestry can contribute significantly to reducing the atmospheric abundance of carbon dioxide. Such solutions have been estimated to be able to provide between 35 per cent and 40



ES-2. The Emissions Gap

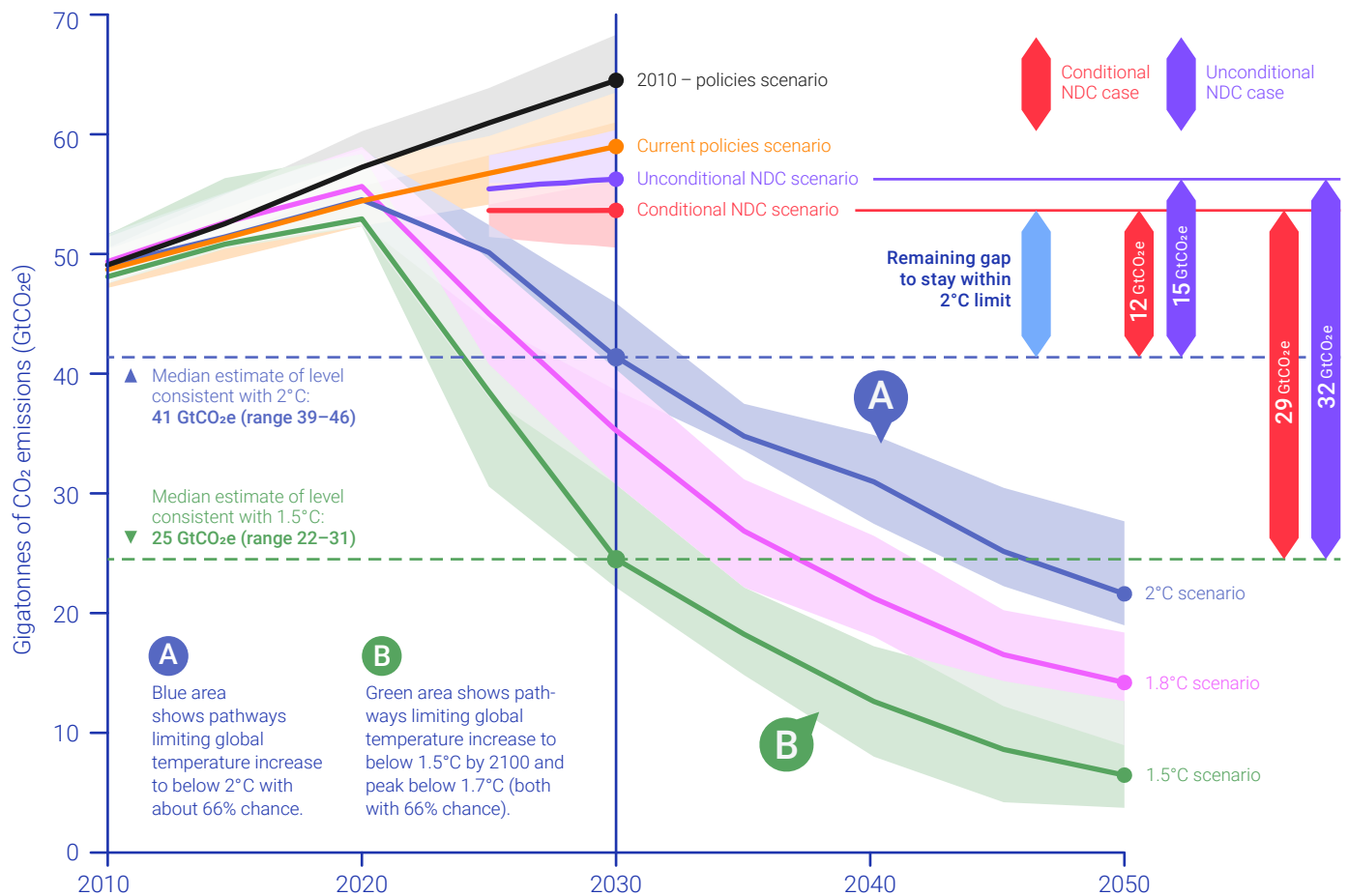


Figure ES.2: Global greenhouse gas emissions under different scenarios and the emission gap in 2030 for unconditional and conditional nationally determined contributions (NDCs) scenarios (median and 10th to 90th percentile range; based on the pre-COVID-19 current policies scenario).

per cent of the mitigation effort needed until 2030 to limit warming to 2°C. Bioenergy (often in combination with carbon capture and storage) and afforestation can contribute to mitigation but must be designed to avoid or minimize adverse effects on biodiversity, food and water security, and air quality.

Reducing short-lived climate forcers is a key part of the global climate response and must be pursued with high priority. Reducing short-lived climate forcers such as black carbon, ground-level ozone and methane is one of the most effective options for slowing the rate of global warming in the near term. It also delivers ancillary benefits by improving public health from lowering air pollution, improving food security from increasing crop yields, and reducing poverty and inequality.

Adaptation to the impacts of climate change is critical and involves both preparations for and responses to, the impacts, with nature-based solutions playing a vital role.

Mitigating climate change is vital, urgent and cost saving: the lower the degree of warming the easier and cheaper it will be to adapt. Societies, economies and ecosystems must adapt to changing temperature and precipitation patterns, including more heatwaves, heavy precipitation in several regions and droughts in some regions and higher sea levels. There has been significant progress in planning for climate change preparedness over the last two decades. Adaptation options, if well designed and managed in a participatory manner, can reduce the vulnerability of human and natural systems, and have many synergies with most of the SDGs, such as food and water security, though potential trade-offs must be recognized. Adaptation is

place- and context-specific and can be enhanced through complementary actions across all levels from individuals to governments. Increasing investment in social and physical infrastructure is vital to enhance the resilience and adaptive capacity of societies. Specific interventions can include climate-resilient agriculture, nature-based solutions such as conserving and restoring ecosystems, land-use planning, coastal defence systems and social safety nets. Nature-based solutions have gained prominence, given the close interlinkages between climate change and biodiversity loss, and the potential to deliver co-benefits for livelihoods and human well-being. Adaptation actions include restoration or protection of coral reefs, seagrass meadows, coastal wetlands, mangroves, and beaches to reduce coastal flooding and erosion; green and blue spaces to reduce urban flooding and heat-related risks; protecting and restoring floodplains, peatlands and riparian vegetation to reduce river flooding.

The unravelling of the web of life on Earth can only be halted and ultimately reversed by addressing the indirect and direct human drivers of its decline. The causes of biodiversity decline are many and deeply embedded in society, so the future of life on land, in freshwater and in the oceans fundamentally depends on society embracing transformative pathways. Halting and reversing biodiversity loss means addressing the direct drivers such as land and sea use, overexploitation, climate change, air and water pollution and invasive species. That in turn is contingent on incentive structures, improved management systems and the rule of law that promotes conservation, restoration and sustainable use of biodiversity. Such efforts need to be embedded in system-wide reforms addressing poverty, sustainable livelihoods, food, energy and resource-use systems. They also need to encompass combatting the illegal wildlife trade and avoiding human development in biodiversity hotspots. Systemic shifts will mean changing lifestyles and economic systems, including measures of progress. Alleviating these existing and growing pressures will permit populations of many wild organisms to remain viable as they shift their ranges under the influence of climate change. Measures to protect biodiversity from the impacts of trade and corporate supply chains are important to slow and reverse biodiversity loss. This includes the removal of implicit or explicit harmful subsidies for farming, fishing, mining, and industries that export commodities. Production standards, moratorium agreements, consumer pressure and education, product traceability to source and certification are all important complementary interventions. Well-designed, legitimate offsets could facilitate market transformation.



Biodiversity conservation and restoration must be integral to the many uses of terrestrial, freshwater and marine ecosystems. Reduction of pressure on biodiversity and ecosystem services in populated, productive and human-transformed landscapes and freshwater systems is a key conservation strategy, especially in large-scale intense and highly transformed agricultural lands. The use of transparent participatory approaches to landscape planning and resource management is key to success. Recognition of the custodial traditions and knowledge of indigenous peoples and local communities is also important. Pastoral, cropping and forestry practices can sustain biodiversity while supporting local livelihoods, avoiding land degradation and embracing restoration of degraded lands. Community gardens and parks can be designed and implemented to enhance biodiversity in cities. Equally, there needs to be reduced pressures on coastal ecosystems and the open ocean.

A more extensive, better managed and more representative global network of interconnected terrestrial, freshwater and marine protected areas, designed to adapt to climate change, can contribute to the conservation of biodiversity.

A more extensive network of protected areas is needed in order to include key biodiversity currently not protected. Many protected areas are currently too small or isolated to be effective in the long term, given that climate change is shifting the geographic ranges of animal and plant species. Increasing connectivity between protected areas makes them more resilient to climate change and more able to sustain viable populations of threatened species. Some ostensibly protected areas have weak management and governance and need increased investment for surveillance, law enforcement and restoration. A number of governments and NGOs are committing to or promoting the protection of 30 per cent of the land and oceans by 2030.

Fisheries reform, integrated spatial planning, conservation, climate mitigation and reduced pollution are all key to restoring marine life. Sustainable fish quotas are essential to reform fisheries, end overfishing and restore marine biodiversity. Trade negotiations are ongoing to craft new rules on the elimination of harmful fisheries subsidies. Expanded protected areas in both territorial waters and the open ocean can conserve and rebuild stocks of commercial and non-commercial species. Achieving the Paris Agreement goal of holding global warming to 1.5°C would limit harmful ocean acidification. Protecting marine life also means countering ocean contamination from chemicals, plastics, sewage and excess sediment resulting from land degradation. Integrated spatial planning covering multiple uses of marine resources can help advance sustainable development in oceans and coastal areas.

The impact of chemicals and waste on human health and the environment can be substantially reduced by implementing existing international chemicals conventions, strengthening the science-policy interface, and further legal and regulatory reform. A strengthened scientific assessment process is needed to provide a stronger basis for evidence-based policymaking aimed at improving the management of chemicals and waste and minimizing their adverse impacts. Successful implementation of the 2030 Agenda for Sustainable Development can accelerate progress in achieving sound whole cycle management and minimizing adverse impacts. This will require more ambitious, urgent and worldwide collaborative action by all stakeholders in all countries. Policies and procedures need to be enacted to reduce the pollution loads of these chemicals and human exposure by reducing their release to the air, water, and soils. A well-defined set of indicators for chemicals management needs to be developed for global and national accounting.

F. Economic and financial systems can and must be transformed to lead and power the shift toward sustainability

Economic and financial systems need to be significantly transformed to attain a vibrant and sustainable world. These systems need to help align production, consumption, infrastructure and human settlement with the SDGs. Governments should incorporate full natural capital accounting into their decision-making and use policies and regulatory frameworks to provide incentives for businesses to do the same. Incentives can favour sustainability and penalize environmental degradation, for instance by taxing unsustainable resource use and pollution rather than production and labour, measures that also promote a circular economy. Governments phasing

out harmful subsidies can redirect that support to low-carbon and nature-friendly solutions and technologies. Governments and businesses need to systematically internalize environmental costs and benefits throughout their management systems and supply chains. Using full natural capital accounting and providing economic incentives will also shift finance away from investing in environmentally harmful activities and towards sustainable investments. Some nations may need development assistance to help finance shifts towards a more sustainable economy. Transforming the interacting nexus of energy, human settlements, agriculture, forestry and water systems is among the highest priorities.

Measures of economic performance must include the value of nature's contributions to human well-being. Conventional measures of economic activity such as GDP are commonly used as indicators of national prosperity and to guide economic planning. But GDP fails to properly account for gains or losses in the natural capital that underpin many vital economic activities or for environmental quality and other non-monetary factors that contribute to human well-being. More inclusive economic yardsticks such as changes in inclusive wealth – the sum of produced, human, social, and natural capital – provide a better measure of the capacity of current and future generations to achieve and sustain higher living standards and quality of life without eroding natural capital and causing environmental harm, as well as a better basis for investment decisions. Some natural capital cannot be fully substituted by other forms of capital and may require special protection. Another approach is to use a Genuine Progress Indicator to correct GDP for social and environmental factors such as inequality, costs of underemployment and costs of pollution. Quality-added GDP is a further alternative to conventional GDP.

Progress towards achieving the Sustainable Development Goals requires increased financing and massive shifts in public and private financial flows and investment patterns. To meet the SDGs, large increases and shifts in investments will be needed in the water, food, energy and other sectors. The investments required exceed the capacity of public financing, therefore substantial private sector financing is essential. Socially and environmentally oriented investment funds that provide low-cost financing to sustainable initiatives can partly close the gap but achieving large-scale financial flows will require shifting incentives such that only investments in sustainable development are financially attractive. New tools and approaches that can leverage and incentivize private sector funding include the use of capital markets to unlock private sector investment in sustainable infrastructure. The Global South needs increased access to low-interest finance in order to achieve the

SDGs. The Global North has exacerbated the shortfall by failing to meet its commitments under environmental conventions and on international development assistance.

Reducing inequalities and the risk of social conflict requires the minimization and reversal of environmental degradation and declines in natural resources, as well as structural changes to the economy. Removing inequality requires steps to address individual and community property rights, persistent poverty, hunger, education, equity, and inclusion in resource management. Actions include reforming trade agreements, eliminating perverse subsidies and taxes that promote wasteful and harmful use of natural resources, and investing in urban areas, public services, education and health care facilities. Investments should be targeted at indigenous peoples and local communities, as well as underrepresented and marginalized social groups.

G. Food, water and energy systems can and must be transformed to meet growing human needs in an equitable, resilient and environmentally friendly manner

Feeding humanity, ensuring water security, and enhancing the conservation, restoration and sustainable use of nature are complementary and closely interdependent goals. Irrigated agriculture is the largest human use of water, currently accounting for about 70 per cent of freshwater withdrawals worldwide and projected to increase. The impacts of land and water use on nature, and therefore on long-term food and water security, must be addressed together. Practices and policies that affect the demand for food, as well as its production, will have strong feedbacks on water and nature. Sustainable solutions will be context-specific. Reducing food and water waste is critical, requiring changes in areas ranging from production and extraction systems to storage and distribution infrastructure to individual consumption patterns.

Agricultural systems that work with nature, are adaptive to change, resilient to shocks, and minimize environmental impacts, are critical to eliminate hunger and malnutrition and contribute to human health. Sustainable agricultural systems and practices include integrated pest and nutrient management, organic agriculture, agroecological practices, soil and water conservation, conservation aquaculture and livestock systems, agroforestry, silvopastoralism, integrated farming systems, improved water management, and practices to improve animal welfare. Sustainable agriculture conserves and restores soils and ecosystems, rather than degrading them. Sustainable agricultural systems must be resilient to climate change, addressing issues of temperature,

drought, pests and salinity through the development of new traits, and the conservation of genetic and species diversity will help facilitate this. Multifunctional landscapes and waterscapes can be the basis for a shift towards ecological intensification or biodiversity-based agriculture, which aims to enhance ecosystem services generated by agro-diversity, some of which boost production.

Changes in patterns of consumption are critical to transforming food, water and energy systems and can be achieved through altered norms in business and cultural practices.

Strategic use of economic instruments, new forms of poly-centric governance involving all key stakeholders, and changes in purchasing patterns will all be necessary to transform food, water and energy systems. Sustainable agricultural practices are often disincentivized by current systems of industrial-scale agricultural production, inappropriate subsidies, crop insurance and capital investments. Changing the dietary habits of consumers, particularly in developed countries, where consumption of energy- and water-intensive meat and dairy products is high, would reduce pressure on biodiversity and the climate system. These habits are a function of individual choices but are also influenced by advertising, food and agricultural subsidies, and excess availability of cheap food that provides poor nutrition.

Small-scale farmers, particularly women farmers, are central to the challenge of achieving sustainable food security and need to be empowered. Women farmers need access to education and training, information and technology, gender-sensitive extension services, financial and legal services, markets, crop insurance and social safety nets. They also need access to and control over land and production inputs such as high-yielding, water efficient, and pest- and disease-resistant crops, fertilizers and other inputs, as well as groundwater and irrigation services.

Maintaining aquatic food production requires sustainable fisheries management, the implementation and expansion of marine protected areas, including no-take zones, and action on climate change and pollution. Pathways to sustainable fisheries entail conserving, restoring and sustainably using marine and freshwater ecosystems, rebuilding overfished stocks (including through targeted limits on catches or moratoria), reducing pollution from chemicals and plastics, managing destructive extractive activities, eliminating harmful subsidies and illegal, unreported and unregulated fishing, adapting fisheries management to climate change impacts and reducing the environmental impact of aquaculture. Marine protected areas, including no-take zones and locally managed marine areas, have demonstrated success

in biodiversity conservation and rebuilding fish stocks when managed effectively; they can be further expanded through larger or more interconnected protected areas or new protected areas in currently underrepresented regions and key biodiversity areas.

Sustaining adequate and high-quality freshwater in the context of climate change, rising demand and increased pollution requires improving efficiency, wisely increasing storage, and fostering the restoration of natural habitats and flow regimes. Cross-sectoral and sector-specific interventions may require actions to reduce pollution, improve water quality, sustainably manage groundwater extraction, and minimize disruption. Achieving sustainability will require increased water use productivity in agriculture, improved management of urban water and other water users, redirected investments in water distribution infrastructure and in wastewater treatments that recover resources, and climate- and biodiversity-sensitive increases in water storage. Policy instruments include water reallocation at the basin scale, shifting incentives to increase water-use efficiency, drought resilience, and appropriate pricing. Transboundary agreements and regional frameworks provide a strong foundation for regional coordination and cooperation for the equitable sharing of water.

Universal access to clean energy requires a rapid transition to low-carbon systems in both the production and use of energy. Improving access to affordable and modern energy (SDG 7) coupled with innovation and efficiency gains are vital to achieving equitable and sustainable economic growth while limiting global warming. Clean energy will also reduce poverty and indoor and outdoor air pollution and provide critical services such as communications, lighting, and water pumping. Achieving this goal while combating climate change involves a rapid transition to low-carbon energy systems encompassing both production and consumption. Investments in the energy transition need to grow five- or sixfold between now and 2050 to achieve the Paris Agreement goal of limiting warming to 1.5°C. Renewable energy technologies such as wind and solar, along with improved energy efficiency in buildings and elsewhere, will be key. Governments must develop laws and policies that enable greater public and private investments in generation and distribution, while also encouraging more responsible energy consumption. Government policy and incentives can speed the phase-out of fossil fuels in power generation and transportation, including by supporting the development of renewable energy storage and electric vehicles. Large-scale renewable energy installations on land, watercourses and in the ocean require careful planning to avoid or minimize adverse effects on nature and on food and water security.

H. Keeping the planet healthy is key to providing health and well-being for all

Reversing environmental decline reduces threats to human health and well-being. Human health and the health of the planet are closely interlinked, underlining how policies aimed at protecting human and planetary health should also be integrated. For example, mitigating greenhouse gas emissions will limit the health risks and impacts from climate change. These include vector- and water-borne diseases such as malaria and cholera, heat stress, extreme weather events, loss of nutrients in foods, air pollution leading to cardiovascular and respiratory diseases. Halting and reversing ecosystem degradation will help safeguard food and water security, secure medicinal plants and genetic resources valuable to medical research and reduce the risk of zoonotic disease pandemics. The reduction of air and water pollution and safe management of chemicals are key to safeguarding human health.

Future human health risks from environmental decline can be minimized with a One Health approach. One Health is an approach that seeks to simultaneously secure optimal outcomes for human health, animal health and the health of the environment. A healthy society relies on a multifactorial foundation of physical, mental and social well-being, which can only be maintained and fostered if cross-sectoral and interdisciplinary approaches are pursued. Collaborative efforts under a One Health approach can prevent human health disasters such as zoonotic pandemics. The need for such an approach is widely recognized as a critical component in creating a healthier world. The COVID-19 pandemic has underlined the need for bold and creative actions and agendas that facilitate cooperation across institutional, geographical, and socio-economic boundaries and help remove current constraints. Health is increasingly influenced by geopolitical developments that are affected by environmental factors, such as climate change-induced mass migration. It is key to target the social determinants of the many aspects of human health.

Cities and communities, including informal settlements, can and must be made much more sustainable, including with nature-based solutions. Urban populations face immense risks from environmental degradation, including extreme heat and flooding, air and water pollution, infectious diseases and growing inequality. The opportunities for promoting sustainability are also huge, including the transition to a low-carbon economy, reduced pollution and energy demand, sustainable consumption and production, and the restoration of biodiversity. Improved urban plan-

ning and nature-based solutions offer cost-effective ways to address the SDGs in cities and make urban areas more resilient to climate change. Options include protecting or expanding green spaces that can reduce the heat island effect and absorb rainwater, retrofitting infrastructure, and promoting urban and peri-urban agriculture. Cities are expected to expand significantly in the next two decades, making the application of sustainable urban planning and development to existing and new residential and commercial areas extremely urgent. Cities must also address the issue of informal settlements, which contribute to environmental degradation and bear the brunt of its consequences. City planners must deliver or facilitate high-density, mixed-use and resource-efficient settlements, connected by multimodal and low-carbon transport and other infrastructural systems, with access to safe and abundant green space. Coastal cities need to be designed or retrofitted to face the threat of flooding due to sea level rise and salt water intrusion into freshwater systems, including, in some cases, planned retreat.

I. All actors have a part to play in transforming social and economic systems for a sustainable future

Transformations can be just, informed and effective if the full range of actors in the public, private and civil society sectors collaborate. At the heart of the various transformational changes needed for a sustainable future are informed, fair and participatory governance systems, where all relevant stakeholders have a voice. Polycentric systems of governance allow for improved information flow as well as collaborative planning, participation and coordination. Because governance systems are not merely the product of governments but rather of all societal actors, realizing governance systems suited for sustainability will require coordination amongst many different actors, including those who may not cooperate at present. This will mean transcending formal boundaries between individuals, and between and within organizations, agencies, and sectors to achieve vibrant, sustainable futures.

All actors have individual, complementary and nested roles to play in bringing about cross-sectoral and economy-wide transformative change with immediate and long-term impact (Table ES.1). Governments initiate and lead in intergovernmental cooperation, policies and legislation that transform society and the economy. Such transformations enable the private sector, financial institutions, non-governmental organizations, scientific and educational institutions and media, as well as households and civil society groups,

to initiate and lead transformations in their domains. Multiple actors will need to cooperate within each transformation, for example in developing frameworks to use inclusive wealth in decision-making, or policies and strategies to integrate biodiversity conservation and restoration into the many uses of terrestrial, freshwater, and marine ecosystems. Human innovation and knowledge-sharing will create new social and economic possibilities and opportunities in the transformation to a sustainable future.

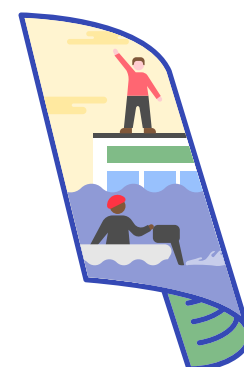


Table ES.1 Actors and actions to transform humankind’s relationship with nature

Actors	Examples of key actions to be taken
<p>Governments – legislature, judicial and executive branches at national, subnational and local level</p>	<ol style="list-style-type: none"> 1. Address Earth’s environmental emergencies and human well-being together <ol style="list-style-type: none"> a) Synergies Establish mechanisms and approaches for cross-sectoral coordination of assessments, policies, legislation, enforcement and financing, including through integrated approaches such as a One Health policy for human and animal health and the environment. b) Climate change Adopt plans and goals consistent with the Paris Agreement for transitioning to net-zero carbon dioxide emissions by 2050, cutting emissions by 45 per cent by 2030 compared with 2010. Put a price on carbon, phase out fossil fuel finance and end fossil fuel subsidies, stop building new coal power plants and advance adaptation and resilience to climate change. c) Biodiversity loss and ecosystem degradation Develop policies and strategies to integrate biodiversity conservation and restoration into the many uses of terrestrial, freshwater, and marine ecosystems, as well as expanding and improving protected areas. Drastically reduce deforestation and systematically restore forests and other ecosystems as the single largest nature-based opportunity for climate mitigation. d) Health and well-being Recognize a healthy environment as a basic human right and provide health and well-being for all. Comply with obligations under the chemicals conventions. Implement and enforce chemicals and waste policies, adopt reuse and recycling standards and develop strategies to meet WHO guidelines for air pollutants. Invest in community-based family planning and assist women to access financing and education. e) Cities and settlements Design and develop socially and environmentally sustainable cities and settlements by embracing nature-based solutions, promoting enhanced access to services such as clean water and energy and public transport, and making infrastructure and buildings sustainable. 2. Transform economic and financial systems so they lead and power the shift toward sustainability <ol style="list-style-type: none"> f) Accounting for nature Reform national economic, financial, planning and tax systems to include natural capital (using inclusive wealth as a measure of sustainable economic performance) and environmental costs (by internalizing externalities) in decision-making. Integrate the goals of carbon neutrality, land degradation neutrality and conservation of biodiversity into all economic and fiscal policies and decisions. g) Subsidies and markets Reform subsidies to eliminate harmful environmental and social effects including by ending fossil fuel subsidies. Establish carbon taxes, carbon pricing, markets for carbon trading, and schemes for offsetting of nature and payments for ecosystem services. Regulate to establish a level playing field in national and international markets.

<p>Governments – legislature, judicial and executive branches at national, subnational and local level (continued)</p>	<p>h) Investments Invest in economic activities, research and development – nationally and through international development assistance and transfer of technology – that enhance the stock of natural assets and advance the shift towards sustainability and a low-carbon economy. Provide funding for developing countries to meet their obligations under the multilateral environmental agreements and SDGs.</p> <p>3. Transform food, water and energy systems to meet growing human needs in an equitable, resilient and environmentally friendly manner</p> <p>a) Access Develop and implement policies to provide sustainable access to affordable and nutritious food, clean energy and safe water for all.</p> <p>b) Food and water Integrate sustainable production and management of food and water within terrestrial, freshwater and marine ecosystems. Make agriculture, forestry, fisheries, aquaculture and resource extraction biodiversity-positive. Promote sustainable agricultural intensification, agroecological practices and conservation of genetic resources. Stop overfishing. Promote healthy diets and reductions in food and water waste. Restrict groundwater extraction and advance appropriate water pricing and the use of agricultural, forestry, and fisheries certification standards.</p> <p>c) Energy Develop energy efficiency regulations, renewable energy targets, sustainable bioenergy strategies and infrastructure for electric vehicles.</p>
<p>Intergovernmental organizations</p>	<p>1. Address Earth’s environmental emergencies and human well-being together</p> <p>a) Synergies Facilitate international cooperation in science-policy interfaces and advance UN system-wide efforts including by promoting synergies among scientific assessments and multilateral environmental agreements through norms, implementation, financing, capacity-building and technological cooperation.</p> <p>b) Climate change Build a global coalition for carbon neutrality consistent with the Paris Agreement for transitioning to net-zero carbon dioxide emissions by 2050 and cutting emissions by 45 per cent by 2030 compared with 2010. Advance adaptation, especially in least developed countries.</p> <p>c) Biodiversity loss and ecosystem degradation Advance international cooperation on addressing the biodiversity emergency, including through relevant multilateral environmental agreements. Promote ambitious post-2020 targets and actions for biodiversity and land neutrality. Support the UN Decade on Ecosystem Restoration focused on preventing, halting and reversing the degradation of forests, land and other ecosystems worldwide. Make own international activities and operations sustainable.</p> <p>d) Health and well-being Facilitate international cooperation on protecting the health of the planet in order to provide health and well-being for all. Advance a One Health approach and strategies to meet WHO guidelines for air pollutants. Continue to promote the coordination and implementation of existing chemicals conventions and strengthen the science-policy interface for chemicals and waste. Implement monitoring and surveillance and early warning systems.</p>

<p>Intergovernmental organizations (continued)</p>	<ul style="list-style-type: none"> e) Cities and settlements Promote sustainable urban planning, nature-based solutions for climate and biodiversity in urban areas, retrofitting of blue and green infrastructure, and access to urban services including clean energy and water. <p>2. Transform economic and financial systems so they lead and power the shift toward sustainability</p> <ul style="list-style-type: none"> a) Accounting for nature Facilitate international cooperation on frameworks for natural capital accounting, reform of measures and models of economic growth including through the use of natural capital and inclusive wealth in decision-making, and reform of trade systems to make them more fair and environmentally sustainable. b) Subsidies and markets Promote a circular economy, elimination of environmentally damaging fossil fuel and agricultural subsidies, harmonization of environmental taxes such as carbon taxes, cooperation on carbon trading, schemes for offsetting nature, and payments for ecosystem services. Support private sector initiatives to create sustainable global supply chains. c) Investments Facilitate cooperation on international development assistance, capacity-building and transfer of technology that help enhance the stock of natural assets in recipient countries and advance their shift towards sustainability and a low-carbon economy. <p>3. Transform food, water and energy systems to meet growing human needs in an equitable, resilient and environmentally friendly manner</p> <ul style="list-style-type: none"> a) Access Facilitate international research and cooperation on improving access to affordable and nutritious food, clean energy and safe water for all. b) Food and water Promote and facilitate sustainable policies, technologies and management within agriculture-fisheries-forestry-water-energy systems, including through sustainable fisheries, agricultural intensification, agroecological practices and multifunctional landscapes. Advance the use of agricultural, forestry, aquaculture and fisheries certification standards and labelling. Encourage healthy diets, and reductions in food and water waste. Support cooperation on water management including through freshwater treaties and assist the development of agreements for the protection of genetic resources for agriculture and the fair and equitable sharing of benefits arising from their use. c) Energy Support the transition to a low-carbon economy, both in the production and use of energy.
<p>Financial organizations</p>	<p>1. Address Earth's environmental emergencies and human well-being together</p> <ul style="list-style-type: none"> a) Synergies Finance international and cross-sectoral cooperation, capacity-building and technological cooperation that address environmental challenges and human well-being. Disclose climate-related financial risk, and the use of natural resources and the impact of these activities on the environment. Align operations with the net-zero carbon emissions objective and sustainability principles.

Financial organizations
(continued)

- b) **Climate change** Multilateral, regional and national development institutions as well as private banks should commit to align their lending to the global net-zero carbon emissions objective. Asset owners and managers should decarbonize their portfolios and join initiatives including the Global Investors for Sustainable Development Alliance and the Net-Zero Asset Owners Alliance. Multilateral and national development banks should commit to increase the share of adaptation and resilience finance to at least 50 per cent of their climate finance to support activities such as early warning systems, and climate-resilient infrastructure and agriculture.
 - c) **Biodiversity loss and ecosystem degradation** Develop and promote innovative financing mechanisms for the conservation and restoration of biodiversity, including through payments for ecosystem services. Support the expansion and better management of protected areas and other effective area-based conservation measures and activities aligned with the UN Decade on Ecosystem Restoration.
 - d) **Health and well-being** Support One Health and disease prevention initiatives and strategies to meet WHO guidelines for air pollutants. Support health research, especially in developing countries. Provide financing for improved waste management.
 - e) **Cities and settlements** Develop and promote innovative financing for sustainable infrastructure. Support sustainable urban planning and investments in low-carbon infrastructure, including mass transportation, congestion charges, nature-based solutions and green and blue spaces.
- 2. Transform economic and financial systems so they lead and power the shift toward sustainability**
- a) **Accounting for nature** Promote and use natural capital accounting and inclusive wealth in decision-making, including lending and grant-making policies. Promote the internalization of externalities in prices and a circular economy.
 - b) **Subsidies and markets** Promote the elimination of environmentally harmful subsidies. Facilitate carbon trading, schemes for offsetting nature, and payments for ecosystem services. Develop environmental and social risk registers for all financial transactions.
 - c) **Investments** Facilitate a major shift away from investments in environmentally unsustainable activities and toward economic activities that enhance the stock of natural assets. Fund the transition to a circular, green and low-carbon economy. Funding should flow to resilience, adaptation and just transition programmes. Fund research and development nationally and through international development assistance.
- 3. Transform food, water and energy systems to meet growing human needs in an equitable, resilient and environmentally friendly manner**
- a) **Access** Fund programmes that improve access to affordable and nutritious food, clean energy and safe water for all.

<p>Financial organizations (continued)</p>	<ul style="list-style-type: none"> b) Food and water Finance sustainable intensification and ecological intensification of agriculture, and sustainable fisheries, and stop supporting unsustainable activities such as deforestation. Advance the use of agricultural, forestry, aquaculture and fisheries certification standards and labelling and encourage healthy diets, and reductions in food, water and energy waste. Support the development and use of certification standards for agriculture, fishing, aquaculture, forestry and water use. c) Energy Finance low-carbon energy production and use, and stop supporting unsustainable activities, such as fossil fuel energy.
<p>Private sector</p>	<ol style="list-style-type: none"> 1. Address Earth’s environmental emergencies and human well-being together <ul style="list-style-type: none"> a) Synergies Help develop and comply with strong environmental legislation that levels the playing field so that firms cannot gain competitive advantage by externalizing costs that are then borne by society. Implement certified and traceable sustainable practices along the complete supply chain. Disclose climate-related financial risk, use of natural resources and the impact of activities on the environment. Practise corporate social responsibility. b) Climate change Adjust business models and align them with the global net-zero carbon emissions objective and sustainability practices in all sectors, including in shipping and aviation. Investors should demand information from companies on the resilience of those models. c) Biodiversity loss and ecosystem degradation Develop and promote innovative public-private partnerships for financing and engaging in the conservation and restoration of biodiversity, including through the use of payments for ecosystem services. Implement sustainable land management practices for agriculture and forestry. Engage in transformative landscape governance networks. Develop sustainable global supply chains for deforestation-free agricultural commodities. d) Health and well-being Comply with environmental standards to protect human health. Move industries to a sustainable and circular business model by reducing waste and resource use and encouraging sharing, reuse and recycling. Promote and support plastic free/environmentally friendly packaging. Conduct transparent risk assessments of the impact of chemicals on the environment and human health. Increase the use of green chemistry, invest in waste recycling, and set high standards for waste disposal. e) Cities and settlements Engage with and support government in sustainable urban planning, public transport, energy-efficient buildings, and partnerships to enhance access to urban services. 2. Transform economic and financial systems so they lead and power the shift toward sustainability <ul style="list-style-type: none"> a) Accounting for nature Use natural capital in decision-making and develop environmental and social risk registers for all projects and investments.

<p>Private sector (continued)</p>	<ul style="list-style-type: none"> b) Subsidies and markets Engage in carbon trading, schemes for offsetting nature, and payments for ecosystem services. Promote behaviour change in customers. Further develop and implement social and environmental standards for corporate operations. c) Investments Shift investments and operations away from unsustainable industries, such as fossil fuels. Invest in innovation and environmentally sound technologies, and move towards a circular economy. <p>3. Transform food, water and energy systems to meet growing human needs in an equitable, resilient and environmentally friendly manner</p> <ul style="list-style-type: none"> a) Access Develop and invest in systems to produce, store and distribute affordable and clean power and water and healthy food to all. b) Food and water Provide modern food storage and distribution services that minimize waste. Promote the development and use of food certification standards and product labelling. Invest in sustainable intensification in agriculture, fisheries and aquaculture. Develop climate-resilient crops and livestock breeds and alternatives to harmful agricultural inputs, including fertilizers and pesticides. c) Energy Develop, invest in and use low-carbon energy technologies and distribution networks.
<p>Non-governmental organizations</p>	<p>1. Address Earth's environmental emergencies and human well-being together</p> <ul style="list-style-type: none"> a) Synergies Support education, promote youth movements and engage communities in citizen science. Participate in community-led initiatives to promote sustainable consumption and production. Help hold societal actors accountable for their environmental promises, commitments and responsibilities. Support the training of the next generation of leaders. b) Climate change Promote and align activities and operations with the net-zero carbon emissions objective. Implement mitigation, adaptation and resilience programmes and projects, including through nature-based solutions. c) Biodiversity loss and ecosystem degradation Support and implement efforts for the conservation, restoration and sustainable use of biodiversity. Develop local-regional-national conservation programmes. Participate in community-led initiatives to conserve nature. Engage in transformative landscape governance networks. Support the development and management of protected areas and other effective area-based conservation measures. d) Health and well-being Raise awareness on chemical safety and take a greater role in the SAICM chemicals management processes. Work with communities and local municipalities for the safe disposal of waste. e) Cities and settlements Campaign for and support sustainable urban planning and improved access to urban services and community initiatives, especially for the urban poor.

<p>Non-governmental organizations (continued)</p>	<p>2. Transform economic and financial systems so they lead and power the shift toward sustainability</p> <p>a) Accounting for nature Promote the use of natural capital accounting, and initiatives for the transformation to a sustainable and circular economy.</p> <p>b) Subsidies and markets Engage in carbon trading, schemes for offsetting of nature and payment for ecosystem services Promote behavioural change in consumption and production, including among their own members and wider society.</p> <p>c) Investments Advocate for policies and regulations that promote investment in sustainable development.</p> <p>3. Transform food, water and energy systems to meet growing human needs in an equitable, resilient and environmentally friendly manner</p> <p>a) Access Advocate for and implement programmes and projects for improved access to affordable and nutritious food, clean energy and safe water for all.</p> <p>b) Food and water Develop and implement initiatives for the ecological intensification and sustainable use of multifunctional landscapes. Promote dietary transitions and reductions in food, water and energy waste. Assist in improving certification standards.</p> <p>c) Energy Participate in community-led initiatives to shift toward cleaner fuels, increase energy-efficiency, conserve energy and develop sustainable bioenergy strategies.</p>
<p>Individuals, households, civil society and youth groups, and indigenous peoples and local communities</p>	<p>1. Address Earth’s environmental emergencies and human well-being together</p> <p>a) Synergies Foster social norms and behaviours that embody sustainability principles by exercising voting and civic rights and holding governments and the private sector accountable for their actions. Review and comment on local and national policies. Engage in initiatives that promote sustainable consumption. Engage in education and citizen-science initiatives.</p> <p>b) Climate change Make climate-friendly everyday choices on travel and consumption that contribute to the net-zero carbon emissions objective. Engage in local adaptation and resilience initiatives, including through nature-based solutions.</p> <p>c) Biodiversity loss and ecosystem degradation Engage in local and national conservation and restoration efforts, transformative landscape governance networks, and awareness campaigns to influence consumer behaviour.</p> <p>d) Health and well-being Understand and promote the links between environment and human health. Participate in community-led clean-ups of waste in public spaces. Ensure materials are recycled and waste is properly disposed of.</p>

<p>Individuals, households, civil society and youth groups, and indigenous peoples and local communities (continued)</p>	<ul style="list-style-type: none"> e) Cities and settlements Engage in participatory processes to advance sustainable urban planning and initiatives to increase access to urban services, and promote nature-based solutions and green and blue infrastructure. <p>2. Transform economic and financial systems so they lead and power the shift toward sustainability</p> <ul style="list-style-type: none"> a) Accounting for nature Foster economic and financial transformations by supporting initiatives to include environmental costs in the prices of goods and services. b) Subsidies and markets Engage in carbon trading, schemes for offsetting nature, and payments for ecosystem services. Support fair trade and companies with sustainable production models that provide services and products that foster societal well-being. c) Investments Support shifts in investment towards those needed to achieve the SDGs, and away from unsustainable industries, such as fossil fuels. <p>3. Transform food, water and energy systems to meet growing human needs in an equitable, resilient and environmentally friendly manner</p> <ul style="list-style-type: none"> a) Access Support and engage in local production and distribution systems for healthy food, safe water and clean energy. b) Food and water Consider what constitutes a healthy diet and also reduces environmental damage. Adopt sustainable practices in community-based and small-scale food production. Purchase sustainably produced food and reduce waste. Reduce wasting water, and collect rainwater and use grey water. c) Energy Support community-based energy production. Reduce energy consumption and chose clean energy when possible.
<p>Scientific and educational organizations</p>	<p>1. Address Earth’s environmental emergencies and human well-being together</p> <ul style="list-style-type: none"> a) Synergies Develop analytical tools, including plausible futures models, using exploratory, target-seeking and policy-screening scenarios that account for the complex interlinkages between environment and development. Further develop observational programs. Engage in national and international scientific assessments. Develop environmental education programs for all age groups. Raise public awareness through public engagements, editorials, social media. b) Climate change Assess the impact of climate change on socio-economic sectors, nature and human health at all scales. Assess the efficacy and cost-effectiveness of different mitigation and adaptation policies and technologies. c) Biodiversity loss and ecosystem degradation Assess the impact of multiple drivers on biodiversity and ecosystem degradation, and the efficacy and cost-effectiveness of conservation and restoration activities, including nature-based solutions.

Scientific and educational organizations
(continued)

- d) **Health and well-being** Promote education, information and awareness of One Health approaches. Assess interactions among environmental issues and their impacts on socio-economic sectors and human health. Assess the implications of chemicals for human health and the environment, and develop health surveillance and monitoring systems, and approaches to prevent disease outbreaks, including pandemics. Assess the mental health implications of green and blue infrastructure in urban environments.
 - e) **Cities and settlements** Support sustainable urban planning and development, including the use of nature-based solutions. Promote education, information and awareness on sustainable cities and settlements and their importance for human health.
- 2. Transform economic and financial systems so they lead and power the shift toward sustainability**
- a) **Accounting for nature** Further develop the framework for natural capital accounting and the relevant databases. Assess the costs and benefits of mitigating and adapting to climate change, loss of biodiversity and ecosystem degradation, land degradation, and air and water pollution at a range of spatial scales. Assess the implications of reforming measures and models of economic growth. Promote education, information and awareness on sustainable economic and financial systems.
 - b) **Subsidies and markets** Assess the environmental and distributional social impacts of reductions in harmful subsidies, and the reallocation of these resources to support sustainable consumption and production.
 - c) **Investments** Assess the environmental and social impacts of switching investments from unsustainable activities such as fossil fuels to sustainable activities.
- 3. Transform food, water and energy systems to meet growing human needs in an equitable, resilient and environmentally friendly manner**
- a) **Access** Help develop and monitor systems and networks to produce and distribute clean water and energy and nutritional food. Support the development of certification processes.
 - b) **Food and water** Promote education, information and awareness on sustainability within agriculture-fisheries-forestry-water-energy systems. Assess the implications of environmental degradation on agriculture and water resources. Develop temperature, drought, pest and salinity resistant crops. Assess how to reduce the environmental footprint of agriculture. Facilitate the conservation and use of genetic resources. Develop water purification and desalination technologies.
 - c) **Energy** Develop low-carbon production and use technologies, and assess how to overcome the barriers to market penetration of these technologies.

Media and social networks

1. **Address Earth's environmental emergencies and human well-being together**
 - a) **Synergies** Inform all actors about the relationships between environment and development issues. Help hold societal actors accountable for their environmental promises, commitments, and responsibilities. Support campaigns for meaningful actions to address environmental degradation. Counter disinformation and promote environmentally responsible social norms.
 - b) **Climate change** Highlight the implications of climate change for people and nature, and the opportunities for adaptation and mitigation.
 - c) **Biodiversity loss and ecosystem degradation** Highlight the importance of biodiversity for human prosperity and well-being and the options for its conservation and restoration.
 - d) **Health and well-being** Spread understanding and awareness of One Health approaches. Support campaigns for meaningful transformations in the health sector.
 - e) **Cities and settlements** Document the impact on people and nature of unsustainable systems in urban areas and support campaigns for transformations in how cities and settlements are planned and designed, including the supply of essential services.
2. **Transform economic and financial systems so they lead and power the shift toward sustainability**
 - a) **Accounting for nature** Raise awareness of how current economic models and performance measures as well as the price of some goods and services fail to fully account for natural capital and environmental costs, and how this skews investment toward unsustainable activities. Support campaigns for meaningful transformations in economic and financial systems.
 - b) **Subsidies and markets** Inform the public and other actors of the adverse consequences of fossil fuel and agricultural subsidies that lead to environmental damage, and explore the impact of redirecting the financing of subsidies to sustainable activities.
 - c) **Investments** Highlight government spending and private sector investments that are unsustainable and those which are sustainable.
3. **Transform food, water and energy systems to meet growing human needs in an equitable, resilient and environmentally friendly manner**
 - a) **Access** Highlight the inequitable access to safe and affordable food, clean water and clean energy, and ways to improve access.
 - b) **Food and water** Provide information and raise awareness of the need for more sustainable practices in the agriculture-fisheries-forestry-water-energy systems. Support campaigns for meaningful transformations in the agricultural, water and energy sectors. Provide information on the health and environmental effects of different diets.
 - c) **Energy** Raise awareness of the benefits from and pathways for meaningful transformations in the energy sector.