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# A future we choose

Why investing in Earth now can lead to a trillion-dollar benefit for all

**Executive Summary**

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to a trillion-dollar benefit for all

## Executive Summary

# Acknowledgements


## GEO-7 Assessment Co-chairs

Edgar E. Gutiérrez-Espeleta, Nyovani Madise, Ying Wang, Robert Watson

## Authors

Tamiru A. Abiye, Ana Paula Aguiar, Peter Alexander, Barbara Amon, Apoorva Arya, Ghassem Asrar, Lindsay Beevers, Medani Bhandari, Meena Bohara, Gillian Bowser, David C. Broadstock, Monday Businge, Donovan Campbell, Kateřina Černý Pixová, Lynette Cheah, Leila Dagher, Vassilis Daioglou, Jonathan Davies, Mark Elder, Parfait M. Eloundou-Enyegue, Pierre Failler, Pedro Fidelman, Shinichiro Fujimori, Erica Brown Gaddis, Keisha Garcia, Elisabeth Gilmore, Sarah Green, Andres Guhl, Stephan Harrison, Gladys Cecilia Hernandez-Pedraza, Susie Ho, Min Hu, Madhav Bahadur Karki, Monica Kerretts-Makau, Indu K. Murthy, Mulako Kabisa, Mizanur Khan, Andrei Kirilenko, Kyung-Ah Koo, Jyotsna Krishnakumar, Joanna Kulczycka, Debora Ley, David Lopez-Carr, Paul Lucas, Clever Mafuta, Diego Martino, Sarah-Lan Mathez-Stiefel, Karina Miglioranza, Ruben Mnatsakanian, Rachid Mrabet, Kevin Nnanye Nwaigwe, Alice Odingo, S. Nadia Ouedraogo, Jacob Park, Jan Plesnik, Riya Rahiman, Adina Manuela Relicovschi, Henri Rueff, Aibek Samakov, Tek Sapkota, Heinz Schandl, Patrick Schröder, Jeff Seadon, Binaya Raj Shivakoti, George Florin Staicu, Paul Sutton, Gail Taylor, Audrone Telesiene, Catalina Turcu, Bruno Turnheim, Detlef van Vuuren, Sotiris Vardoulakis, Karen Helen Wiltshire, Xiyan Xu, Fang Yu, Pandi Zdruli, Eric Zusman

## Fellows

Aseel Ibrahim Mohammed Abo-Taleb, Tarik Alkharusi, Marianna Baslandze, Acasia Broomes, Victoria Del Pilar Chicmana Zapata, Maryam Eqan, Zhuang Han, Shaneica Lester, Jan Matuštík, Astride Messaga, Jimena Reyeros, Martina Rotolo, Soham Vaidya and all authors and fellows whose contributions in the GEO-7 main assessment report served as a basis for the GEO-7 Executive Summary

## Co-chairs of the GEO-7 Ad Hoc Open-Ended Meetings

Thuraya Said Al Sariri, Lorenzo Ciccarese, Alberto Capra, Miroslav Havránek, Anna Mampye

## Intergovernmental and Multi-stakeholder Advisory Group (IMAG) Bureau

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# Key Messages



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**Despite global efforts and calls for action, our planet has already entered into uncharted territory, facing global environmental crises of climate change, biodiversity loss, land degradation and desertification, and pollution and waste. These interconnected crises, which are undermining human well-being and primarily caused by unsustainable systems of production and consumption, reinforce and exacerbate each other and need to be addressed together.**

**The situation is worsening:**

- **The rate of global warming is likely to be higher than the central estimates of previous IPCC projections, increasing the risk of irreversibly passing several climate tipping points[1] within the next few decades**. These include major shifts in ocean circulation, accelerated ice sheet loss, widespread permafrost thaw, forest die-back, and collapse of coral reef ecosystems.
- **One million of an estimated eight million species are threatened with extinction, some within decades**. The populations of many more species are in decline, and their genetic diversity is being significantly eroded.
- **Between 20 and 40 per cent of land area was estimated to be degraded in 2022**. Between 2015 and 2019, at least 100 million hectares (the size of Ethiopia or Colombia) of fertile and productive land were degraded annually worldwide.
- **Annual solid waste currently exceeds 2 billion tonnes** and, given current trends, is projected to increase to 3.8 billion tons by 2050.

**These environmental crises are causing substantial economic and social damage,** including to infrastructure, transport, and basic services, harming jobs, livelihoods, economic growth and

[1] A tipping point is a critical threshold beyond which a system re-organizes, often abruptly and/or irreversibly.

security, and undermining human health and well-being, food, energy and water security for all people, with disadvantaged populations being disproportionally affected. These crises are already reversing socioeconomic development achievements by increasing poverty and inequalities, and decreasing life expectancy. They can no longer be viewed as simply environmental issues; they are also economic, development, governance, security, social, moral, and ethical issues.

**Most of the internationally agreed (or adopted) environmental goals and targets are unlikely to be met with existing policies and practices,** including those from the UNFCCC, Paris Agreement, the CBD, Kunming-Montreal Global Biodiversity Framework, and the UNCCD Strategic Framework 2018-2030, as well as World Health Organization (WHO) pollution standards. For example, almost all dimensions of biodiversity are projected to worsen, moving the world away from achieving the 2050 biodiversity targets of the Kunming-Montreal Global Biodiversity Framework. Depending on if and how current policies and nationally determined contributions are implemented, the global mean temperature is projected to increase by 2.4°C to 3.9°C above pre-industrial levels this century. These projections fall well short of achieving the long-term temperature goal of the Paris Agreement, which is to hold the increase in the global average temperature to well below 2°C above pre-industrial levels and pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels.

**Rising global resource consumption, including materials, energy, water and food, is primarily driven by increasingly resource-intensive lifestyles, especially in high-income countries, along with economic growth, demographic change and urbanization**. This increasing demand is being met using environmentally unsustainable production and consumption in the context of the current economic, financial, and governance systems, which themselves are unfit to meet these challenges sustainably. These lead to the ever-increasing pressures from land-use change, resource use and exploitation, emissions of greenhouse gases and pollutants, and invasive alien species. Collectively, these are the underlying causes of the interconnected global environmental crises of climate change, biodiversity loss, land degradation and desertification, and pollution and waste.

## Transformative solution pathways are possible – whole-of-government and whole-of-society approaches at scale and pace can enable environmental goals to be met and provide social and economic benefits.

**Achieving the internationally agreed (or adopted) environmental goals and targets requires transformation of the economic and financial, materials/waste, energy, and food systems – the human systems – and transformation of the way the environment system is managed for sustainability and resilience**.

**The GEO-7 scenario analysis shows that internationally agreed (or adopted) environmental goals can still be achieved, but will require unprecedented action**. There are multiple pathways to do so, with benefits for people and planet. This requires combining coherent and coordinated transformative solutions within and across systems – economic and financial, materials/waste, energy, food, and environment – and well-being and environmental goals, to minimize potential trade-offs and take advantage of synergies.

**A transformation framework is essential for the formulation and strategic implementation of solution pathways across systems, regions and scales**. Solution pathways need to focus on system-wide transformations, identifying what needs to be developed, phased out, avoided, and preserved. They should articulate near- and long-term solutions, anticipate and reduce

Credit: AlbertoCarrera/Envato

uncertainties, involve a plurality of actors and perspectives, and explicitly address the political nature of change.

**There is a rapidly narrowing window of opportunities to successfully embrace and implement the solutions needed to transform the systems**. Governments and intra- and intergovernmental organizations, working with the private sector, financial institutions, academia and civil society, need to:

- co-produce policies and solution pathways,
- develop and deploy appropriate technologies,
- provide the necessary level of financing, and
- motivate and accelerate institutional, social and cultural changes.

These need to be achieved at an unprecedented pace, scale, level of integration, and depth, while reforming existing powers, such as vested interests, and economic structures that perpetuate inequalities. While some progress is being made, it is not occurring at the pace and scale needed.

**The economic benefits of action exceed the costs of transformation, as the damages from the global environmental crises will become increasingly severe over the coming decades**. The overall macroeconomic annual benefits of transformation are estimated to begin around

2050 and increase to approximately US$20 trillion per year by 2070, and over US$100 trillion per year by 2100, accounting for more than 25 per cent of projected global GDP in 2100.

**Achieving environmental goals, alongside social and economic benefits, requires a whole-of-government and whole-of-society approach**. This involves identifying and capitalizing on solutions that benefit multiple systems simultaneously, and are just and equitable, ensuring participation of all agents of change, such as actors and networks of actors. It also involves changing attitudes and behaviours, reforming existing national and multilateral governance structures and taking into account diverse world views and knowledge systems.

**Indigenous Peoples' and local communities' knowledge, values, and ways of being contribute to transformations towards sustainable and just futures**. They offer concepts of human-nature relations based on ethics of care and ways of organizing economies that take a holistic approach to well-being. Drawing on sustainable stewardship practices and adaptation strategies, Indigenous Knowledge and Local Knowledge can provide concrete guidance on actions relating to care of territories and life, as well as in relation to energy, food, governance and economies.

## Transformation of the economic and financial systems will unlock transformations in the materials/waste, energy, and food systems, and improve environmental management.

**Transformation of the economic and financial systems is a prerequisite for transforming the other systems**, including:

- phasing out and repurposing environmentally harmful subsidies, of about US$1.5 trillion per year from energy, food and mining;
- internalizing social and environmental externalities into the prices of goods and services of about US$45 trillion per year from energy and food systems;
- moving beyond traditional measures of economic activity, and specifically gross domestic product (GDP) as it is conventionally measured, by including natural capital and human well-being in decision-making; and
- aligning financial flows with international environmental goals to transform the energy, materials/waste and food systems.

This would include delivering the estimated US$6-7 trillion per year of investment[2] needed to reach net zero greenhouse gas (GHG) emissions globally by 2050, as well as addressing an estimated gap of US$700 billion per year for implementing the Global Biodiversity Framework. This could be done while taking into account the needs of the poorest and most vulnerable parts of the population through compensatory mechanisms.

**Transforming the materials/waste system requires implementing a global circular economy, including:**

- designing out waste from production and consumption (e.g., in energy, food and water systems);
- shifting investments to deliver circularity in the economy, production and consumption;

[2] This represents about 6 or 7 per cent of 2025's GDP.

- developing effective markets for secondary materials;
- creating a transparent global trade system for circular goods and services; and
- inclusive societal transformation towards sustainable lifestyles.

This can significantly reduce waste generation and the economic losses. It can also help avoid significant increases in extractive activities for critical energy transition minerals, offering clear environmental co-benefits and addressing other issues, including the global plastic pollution crisis.

**Transforming the global energy system requires a multifaceted approach that simultaneously addresses energy access and poverty and aligns with internationally agreed (or adopted) environmental goals and targets, including:**

- diversifying energy production, including increasing use of renewable energy technologies, e.g., solar and wind, while simultaneously accelerating the phasing out of unabated fossil fuels;
- electrifying final energy services in transport, industry, housing and agriculture
- promoting efficient production and distribution;
- incentivizing demand-side management practices; and
- ensuring the sustainability of critical energy transition minerals.

**Transforming the food system requires actions from policymakers, regulators, the food industry, the financial sector, farmers, researchers, communities and individuals, including:**

- shifting to healthy and sustainable diets, including greater consumption of plant-based foods;
- adopting more sustainable and resilient food production practices;
- reducing food losses and waste and enhancing circularity across food systems;
- accelerating the development and uptake of novel alternative proteins, such as cultivated meat; and
- reforming food markets and trade, e.g., diversifying agribusiness supply chains and incentivizing environmentally responsible practices.

**Improved management of the environment system for sustainability and resilience requires actions, including:**

- protecting, conserving and restoring ecosystems and biodiversity, in conjunction with sustainable land management practices;
- adopting adaptive governance to safeguard the rights, access and benefits of Indigenous Peoples over their traditional lands, and draw on their knowledge;
- embracing the widescale implementation of nature-based solutions, to restore and maintain healthy socio-ecological systems; and
- ensuring the emerging bioeconomy is circular and sustainable.

## The design of solution pathways should be tailored for the socioeconomic-ecological context of each region.

**The global environmental crises are adversely affecting every region of the world, albeit with wide variability**, curtailing socioeconomic development, with the most severe consequences being experienced by the most vulnerable and disadvantaged populations. Within each region, sub-regional differences in vulnerability, capacity, and priorities should be recognized when tailoring transformation pathways.

**Regions are interlinked through human and natural systems driven by processes such as trade, investment, tourism, migration, species invasion, and ecosystem services flows, which can have benefits, such as international trade, as well as adverse impacts, for instance, the exploitation of labour and natural resources**. As the systems transform regionally, these dynamics can change. The solution pathways presented in GEO-7 for transforming the systems and their implications are specific to each region, which accounts for their common and differentiated but specific priorities. The identified levers of action are specific to the system being transformed, the underlying conditions and the priorities of the regions.

**Tailored solution pathways and system transformations are needed to address issues specific to each region or country** that consider their sociocultural, economic, development, environmental, governance and financial circumstances, as well as issues common to all regions.

**Recognizing that all countries care about sustainable economic growth**, high-income countries can more easily adopt ambitious green policies, reduce resource consumption, acknowledge the principle of common but differentiated responsibility, halt the export of negative environmental impacts, and leverage global sustainability through finance and technological capacity. Middle-income countries can embrace innovative infrastructure development and green policies. Low-income countries can overcome challenges such as hunger and poverty, improve livelihoods, build climate-resilient communities and infrastructure, while reducing emissions by leapfrogging outdated technologies and leveraging targeted investments and international support.

01

# Part 1: The Global Environmental Crises Threaten a Healthy Planet and Human Well-being

Credit: GreensandBlues/Envato

## 1.1 Introduction

The global environmental crises of climate change, biodiversity loss, land degradation and desertification, and pollution and waste, threaten human well-being and hinder progress towards achieving the Sustainable Development Goals (SDGs) and the internationally agreed (or adopted) environmental goals and targets. Addressing these crises requires system-wide transformative strategies and actions that provide economic prosperity while mitigating the environmental crises.

## 1.2 Climate change, biodiversity loss, land degradation, and pollution and waste have reached the point of constituting global environmental crises

### 1.2.1 The Earth's climate is warming and projected to continue to warm, and the world is failing to meet the Paris climate goals

**The Earth's climate has entered uncharted territory in human history. The 10 warmest years since records began have all occurred during the last decade** *(well established)*. The global average temperature of the Earth has warmed by at least 1.3°C since the industrial era began, with much higher regional variations. The last two years (2023-2024) were the warmest on record, with 2024 exceeding a global average temperature 1.55°C above pre-industrial levels. This warming has been largely driven by the atmospheric concentrations of greenhouse gases, which reached levels unseen in the last 800,000 years, and greenhouse gas emissions that hit a record high in 2023 {C.1.1, 2.3.3.1, 3.2.2}.

**Climate change is adversely affecting air, oceans and coasts, land and soils, and fresh water** *(well established)*. Acceleration of the global hydrological cycle is driving more extreme flooding, the melting of glaciers and sea ice, the warming of fresh waters and the oceans, and increases in sea levels. Sea surface temperature has warmed by an average of 0.9°C above pre-industrial levels. Climate-driven warming and drying are also contributing to increased frequency and intensity of wildfires, heatwaves, and drought. Ocean acidification is increasing globally due to elevated levels of atmospheric $CO_2$ {C.1.1, 5.2.1.6, 5.2.1.7, 6.3.2}.

**Current climate policies and commitments fall short of meeting the Paris Agreement long-term temperature goal of holding the global average temperature increase to well below 2°C above pre-industrial levels and pursuing efforts to limit this temperature increase to 1.5°C, averaged over one or more decades** *(well established)*. The global average temperature increase is likely to surpass 1.5°C above pre-industrial levels in the early 2030s. Without the implementation of current policies, the GEO-7 Current Trends Scenario projects a further increase to 3.9°C by 2100. While a continuation of the mitigation efforts implied by current policies is estimated to limit global average temperature increase to 2.9°C over the course of the century, full implementation and continuation of mitigation efforts implied by conditional nationally determined contributions could limit this increase to 2.4°C.[3] To hold global average temperature increase to 1.5°C above pre-industrial levels would require cuts in greenhouse gas emissions of 42 per cent by 2030 and 57 per cent by 2035, relative to 2019 levels {C1.1, 10.4.1, 11.4.1}.

**Recent high levels of warming and observed increases in the rate of warming suggest that the central estimates of IPCC climate projections may be underestimating the magnitude of human-induced global warming, with dire consequences for human well-being and nature** *(established but incomplete)*. The last decade's record high temperatures suggest that Equilibrium Climate Sensitivity, which refers to the amount of global surface warming that will occur in response to a doubling of atmospheric $CO_2$ concentrations compared to pre-industrial levels, may be higher than currently estimated. If equilibrium Climate Sensitivity is higher, then many climate-related impacts will be greater than currently estimated, and many climate-related tipping points (**Box ES 1.1**) will be breached much earlier than previously expected. Therefore, reducing emissions is imperative, as the consequences of not doing so could be even worse than models suggest {**Box 10.6**}.

### Box ES 1.1 Tipping points

Box ES 1.1 Tipping Points

Tipping points in the cryosphere could occur within decades to centuries. Loss of Arctic sea ice will alter the jet stream, changing the frequency and magnitude of extreme weather events. Complete collapse of the West Antarctic and melting of the Greenland ice sheets would lead to more than 10 metres of sea level rise. An abrupt thaw of permafrost would result in a substantial release of methane within a few years.

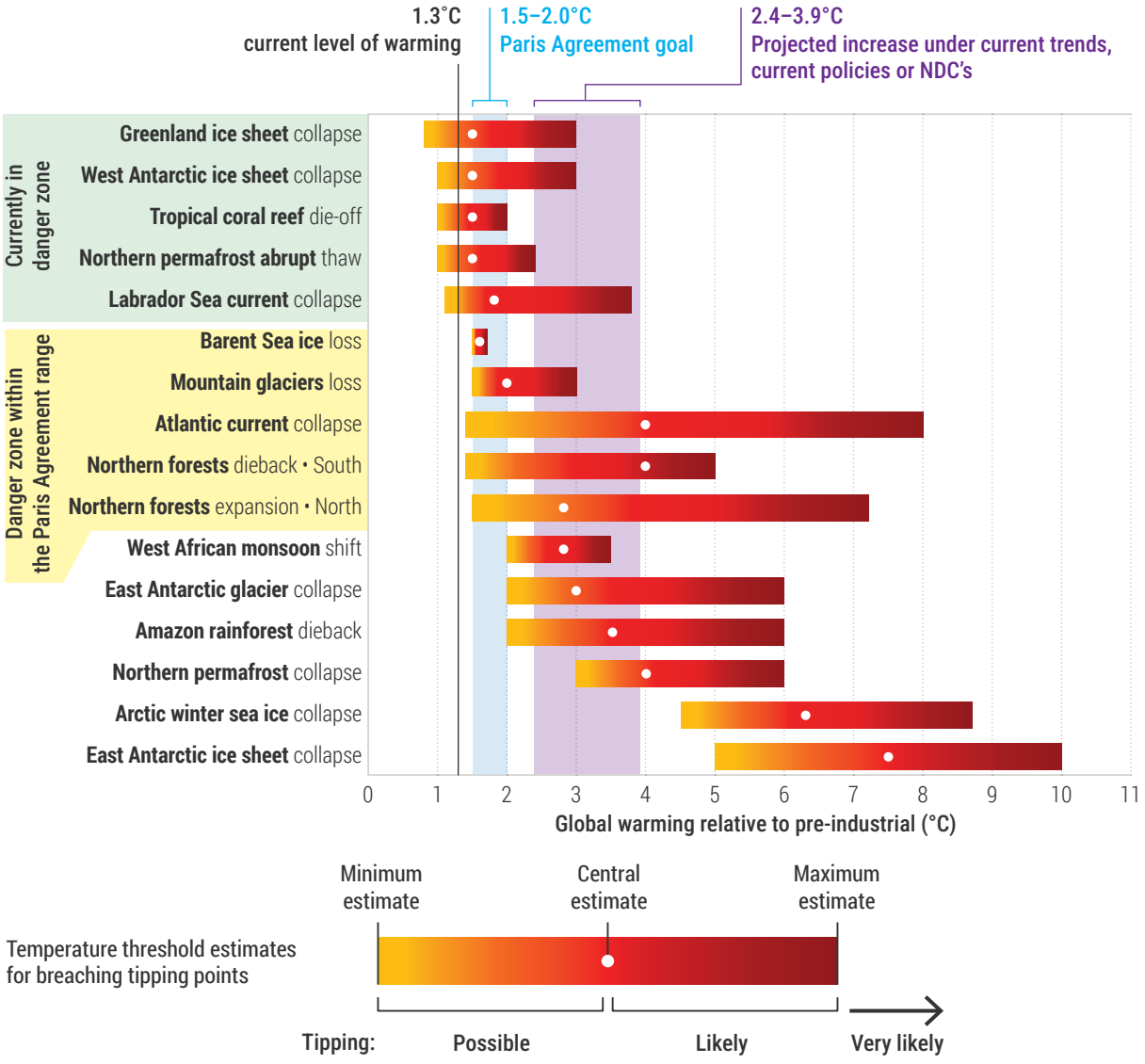
Tipping points in the biosphere could occur within years to decades. Dieback of the Amazon forest – driven by deforestation, land degradation, and climate change – would lead to its transition from a carbon sink to a source. In the ocean, under current warming trends, a global coral die-off is underway. Forecasts predict that this tipping point will already be passed at the latest by an sustained global warming of 1.5°C. A near-total loss of warm water corals may occur rapidly with a 2°C rise in temperature.

Tipping points in the ocean and atmospheric circulations could occur within years to decades and include shifts in intensity and timing of monsoons. Collapse of the Atlantic Meridional Overturning Circulation would result in expansion of Arctic Sea ice, a southward shift of the Intertropical Convergence Zone, increased ice melt in Antarctica, and rapid shifts in European and African climates {10.5}.

[3] All climate projections are with a 50 per cent chance.

**The Earth is approaching many climate-related tipping points {Box ES 1.1, 10.5}** *(well established)*. Tipping points—critical thresholds beyond which a system reorganizes, often abruptly and/or irreversibly—are a major concern. At least 25 Earth system tipping points have been identified. Crossing Earth system tipping points could have catastrophic impacts. Many tipping points are directly linked to climate change. The critical temperature thresholds are uncertain for some systems, but the likelihood of crossing climate tipping points increases with warming. In some cases, tipping points may be reached at low temperatures, while others are only likely at higher temperatures. Impacts of some tipping points may be felt almost immediately, while other impacts may be delayed for decades to centuries {**Figure ES 1.1**}. Several climate tipping points are expected to be exceeded within coming decades, even with urgent global action {10.5}.

**Figure ES 1.1: The risk of climate tipping points is rising rapidly as the world heats up**




Note: Crossing a tipping point is categorized as "possible" beyond its minimum temperature threshold, "likely" beyond its central estimate, and "very likely" beyond its maximum temperature threshold. Additional tipping points not shown in the diagram include: Congo & SE Asia rainforest dieback, savanna & grassland degradation, dryland degradation, lake eutrophication-driven anoxia, lake invasive species, kelp forest collapse, Southern Ocean Overturning Circulation / Antarctic Overturning, Indian summer monsoon collapse / shift to low-precipitation states and ocean hypoxia.

*Data source: McKay et al. (2022), UNEP (2024c), GEO-7 current trends scenario*
*Illustration: Modified from GLOBAÏA (2025)*

### 1.2.2 Continued loss of biodiversity – the diversity of life from genes to ecosystems – is eroding the resilience of natural systems

**The rate of biodiversity loss is increasing** *(well established)*. Genetic diversity has declined by an estimated 5–10 per cent since the industrial era began, with even greater losses in island ecosystems {C.1.2}. The population sizes of many species have fallen dramatically, and up to one million species are now at risk of extinction {4.3.4}. Some species, such as the Black Rhino, are considered functionally extinct due to their rarity, while many others have been lost completely in the past century. Several ecosystems are considered ecologically collapsed, and others are at risk of collapse. The loss of biodiversity is not slowing. Almost 60 per cent of the world's land surface is subject to moderate or intense human pressure {C.1.2}. In the oceans, many fisheries are no longer viable, warm water corals may be lost by the end of this century (**Box ES 1.1**), and ecosystems worldwide are being invaded by non-native species {6.5.5}. Loss of biodiversity erodes the provision of critical ecosystem services, including water, food, feed, fibre, and bioenergy, as well as the regulation of disease and climate, clean air, and the connection between people and nature.

**The world is not on track to meet the 2030 biodiversity targets of the Kunming-Montreal Global Biodiversity Framework, and urgent action is needed to achieve the 2050 biodiversity goals** *(well established)*. None of the 2020 Aichi biodiversity targets have been fully met, and biodiversity is projected to decline across almost all dimensions. The GEO-7 Current Trends Scenario projects mean-species abundance, a measure of biodiversity intactness, to decrease by around 1 per cent per decade between 2020 and 2050, compounding historic rates of loss since 1900. While land-use change is projected to remain the dominant driver of terrestrial biodiversity loss, climate change is projected to become increasingly important over the coming decades {4.5.4, 5.4.1, 6.7.2, 10.4.4}.

### 1.2.3 Despite some progress, pollution and waste continue to degrade natural systems

**Pollution from diffuse and unregulated sources is a pervasive and expanding threat to freshwater, terrestrial, and marine ecosystems** *(established but incomplete)*. Sediment pollution, primarily from land degradation, is increasing in 40 per cent of the world's largest rivers, and 173 large rivers are polluted by unregulated mining {6.2.1.3, 6.4.1}. The GEO-7 Current Trends Scenario projects that the total area of groundwater exceeding the WHO guideline for nitrate-nitrogen in drinking water (11.3 mg N/l) will grow from 5.0 $Mkm^2$ in 2020 to 5.7 $Mkm^2$ by 2050 {10.4.5}. The global annual volume of municipal solid waste currently exceeds 2 billion tonnes and is projected to increase to 3.8 billion tonnes by 2050 {4.3.1.6}.

**Globally ubiquitous plastic pollution is worsening and emerging contaminants have become major, largely uncontrolled sources of pollution that damage human and ecosystem health** *(established but incomplete)*. An estimated 1.1-4.9 million tonnes of plastic litter our oceans and production is projected to increase from 475 Mt in 2022 to 1200 Mt by 2060 (*well established*). Plastic pollution is responsible for health-related economic losses exceeding US$1.5 trillion annually {15.1.1}. Over 700 species ingest or become entangled in plastics {5.2.2.1}; plastics also transform into micro- and nano-plastics, negatively impacting both land and water ecosystems {4.3.1.3}. The growing list of emerging contaminants, including pharmaceuticals, personal care products, hormones, and poly- and perfluoroalkyl substances, poses significant threats to human and ecological health {6.4.1.4}.

**Ninety per cent of the global population is exposed to ambient concentrations of fine particulate matter ($PM_{2.5}$) above the WHO annual air quality guideline of 5 µg/m³, and 50 per cent is exposed to concentrations above 25 µg/m³** *(well established)*. $PM_{2.5}$ concentrations in cities declined from 2000 to 2019 in most regions {3.4.2, 3.5.3}. The GEO-7 Current Trends Scenario projects further decreasing $PM_{2.5}$ concentrations towards 2050, although the number of people exposed to concentrations above 25 µg/$m_3$ is projected to increase due to urbanization and population growth, particularly in cities in low-income countries {3.2.4, 10.4.2}.

**Implementation of existing international conventions has resulted in mixed success in reducing sources of pollution and waste** *(established but incomplete)* {3.5, 4.5.3}. The Montreal Protocol has phased out 98 per cent of ozone-depleting substances relative to 1990 levels, reversing ozone depletion and helping to prevent up to 0.5°C of global temperature rise by 2100. The Stockholm Convention has reduced concentrations of persistent organic pollutants, the Basel Convention has strengthened controls over the movement of hazardous waste, and the Rotterdam Convention has improved safety in the trade of hazardous chemicals. The Minamata Convention has largely been successful in phasing out the production and use of mercury and mercury-containing products globally. However, total accumulated atmospheric mercury concentrations remain 450 per cent above natural levels.

### 1.2.4 Land is being degraded globally, and this trend is projected to continue

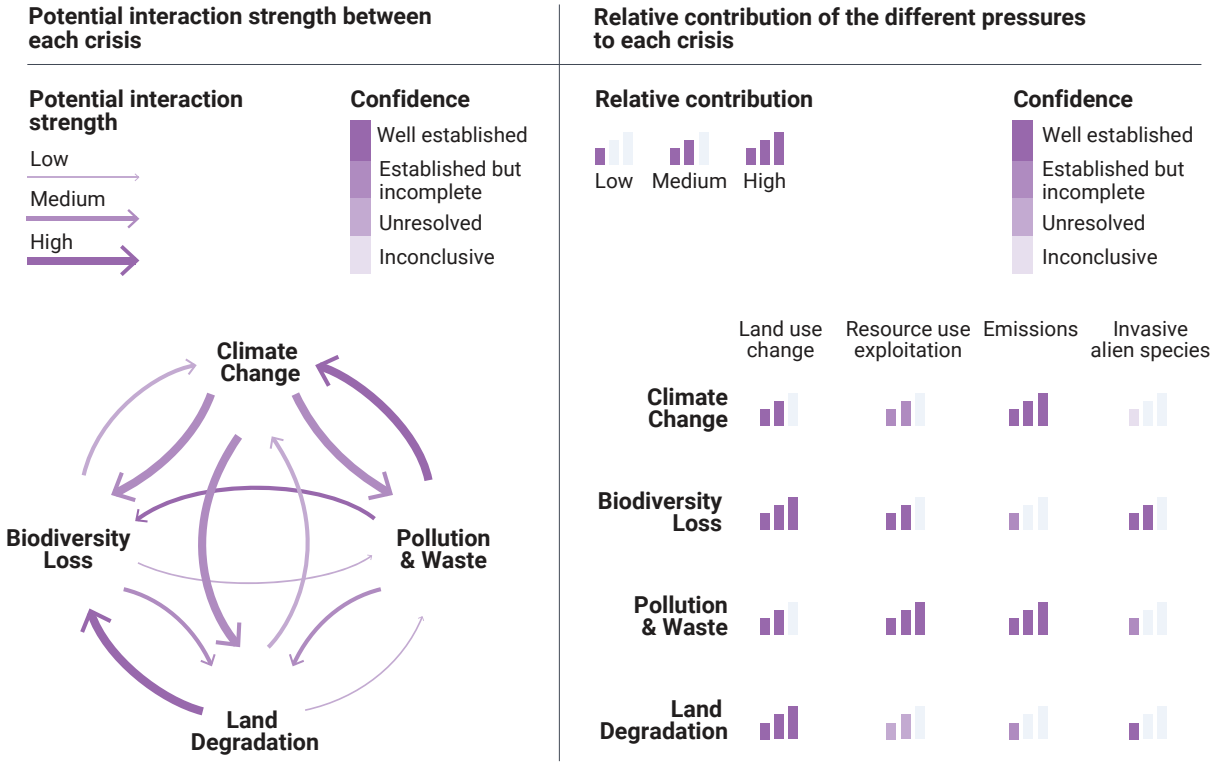
**Between 20 and 40 per cent of land area was estimated to be degraded in 2022** *(well established)*. Between 2015 and 2019, at least 100 million hectares (the size of Ethiopia or Colombia) of fertile and productive land were degraded annually worldwide mostly due to agricultural practices, deforestation, and associated land erosion. This means less land for nature, but also less land for cultivation, which threatens future food security {4.1, 4.3.2, 4.5, C.1.3}.

**The world is not on track to achieve the UNCCD land degradation neutrality target by 2030, despite voluntary commitments to restore over 450 million hectares of degraded land by 2030** *(well established)*. Land productivity is declining, land cover is changing for the worse, and soil organic carbon stocks are growing at a slower pace than is needed to achieve land degradation neutrality. The GEO-7 scenario analysis concludes that, at a global scale, land degradation will continue towards 2050, mainly from land-use change, including expanding cropland and urban areas, and unsustainable agricultural practices {4.5.1, 10.4.3}.

## 1.3 The global environmental crises are intricately interconnected and must be addressed together

**The global environmental crises interact across spatial and temporal scales, include complex feedbacks and must be addressed together (Figure ES 1.2)** *(well established)*. Many of the most challenging problems facing air, oceans and coasts, land and soils, and fresh water lie at the nexus of the global environmental crises (**Box ES 1.2**). Understanding their interactions helps to identify solution pathways that take advantage of multiple co-benefits and minimize negative trade-offs and unintended consequences.

**Figure ES 1.2: The interconnected global environmental crises of climate change, biodiversity loss, land degradation and desertification, and pollution and waste**




## 1.4 The drivers and pressures responsible for the global environmental crises are intensifying

### 1.4.1 Current and projected drivers of the global environmental crises are interconnected (Figure ES 1.3)

**Increasingly resource-intensive lifestyles are an important driver of intensifying global resource consumption**. Since 1960, per capita consumption has quadrupled, driven by rising incomes and a global shift towards more resource-intensive lifestyles, particularly in high-income countries. Consumption levels and forms vary significantly across and within countries, closely linked to development levels {2.2.5, 10.3}.

**Economic activity, demographic patterns and urbanization also drive resource consumption** *(established but incomplete)*. Global GDP grew from US$33.8 trillion in 2000 to US$111.3 trillion in 2024 (GDP at current US$ value)[4] and may double in size again by 2050. The human population increased from 6.1 billion in 2000 to 8.1 billion people in 2023, and it is projected to reach between 9.3–10.1 billion people by 2050 {2.2.1}. By 2050, 68 per cent of the global population is projected to be urbanized {2.2.4, 10.2}.

**Some aspects of governance contribute to the global environmental crises** *(well established)*. Governance failures often lead to and/or exacerbate environmental degradation, for example, undermining Indigenous Peoples' efforts to protect traditional lands and waters. {2.2.6}.

**Technology can be both a driver and a mitigator of environmental pressures** *(well established)*. Clean energy technologies, for instance, play a critical role in the transformation of the global

**Box ES 1.2 The environmental crises compound and intensify environmental issues in natural systems**

### AIR POLLUTION AND WILDFIRES

As of 2019, there was a 22 per cent increase in days with extreme fire danger across the global burnable land area. Climate-driven warming and drying result in the increased frequency and intensity of wildfires, which are now one of the largest sources of local and regional air pollution and an increasing source of GHG emissions. Vegetation cover loss from fire results in land degradation and freshwater pollution due to post-fire storm run-off. Wildfires primarily resulting from human activities can contribute directly to the loss of biodiversity and increase in invasive alien species in terrestrial ecosystems, and indirectly to losses of biodiversity in fresh water {3.4.3, 4.3.3.6}.

### LAND AND SOIL HEALTH

More than 24 billion tons of soil are lost annually, about 3.4 tons of soil per person globally, driven mostly by desertification, erosion, compaction, salinization, and acidification. Soils host half of the world's biodiversity, contain huge volumes of terrestrial carbon critical to climate mitigation, and maintain vital and productive agricultural systems. Land degradation and land-based sources of pollution further degrade soil health and contribute to sediment pollution in fresh waters {4.3.2, 4.3.3.2}. Land degradation and climate change are strongly linked to sand and dust storms that affect human health {3.4.6}.

### OCEAN ANOXIC ZONES

Combinations of climate-driven ocean warming and nutrient pollution from land degradation and agricultural run-off are increasing algal blooms, causing hypoxic or anoxic conditions in many coastal areas. The resulting anoxic zones, or "dead zones", damage marine bivalve and fish biodiversity and have expanded by 4.5 million $km^2$ since the mid-twentieth century {5.2.2.2}.

### FRESHWATER RESOURCES AND BIODIVERSITY

Climate change and water pollution contribute to water insecurity in many parts of the world, resulting in the need for new water storage reservoirs and associated large dam construction in river systems. However, dams fragment aquatic habitats, disrupt natural flow patterns, and interfere with fish migration, thereby threatening freshwater biodiversity. Land degradation increases sediment pollution and siltation in reservoirs, and the loss of water storage capacity results in the need for yet more reservoirs to be constructed {6.2.3, 6.5.3, 6.6.1}.

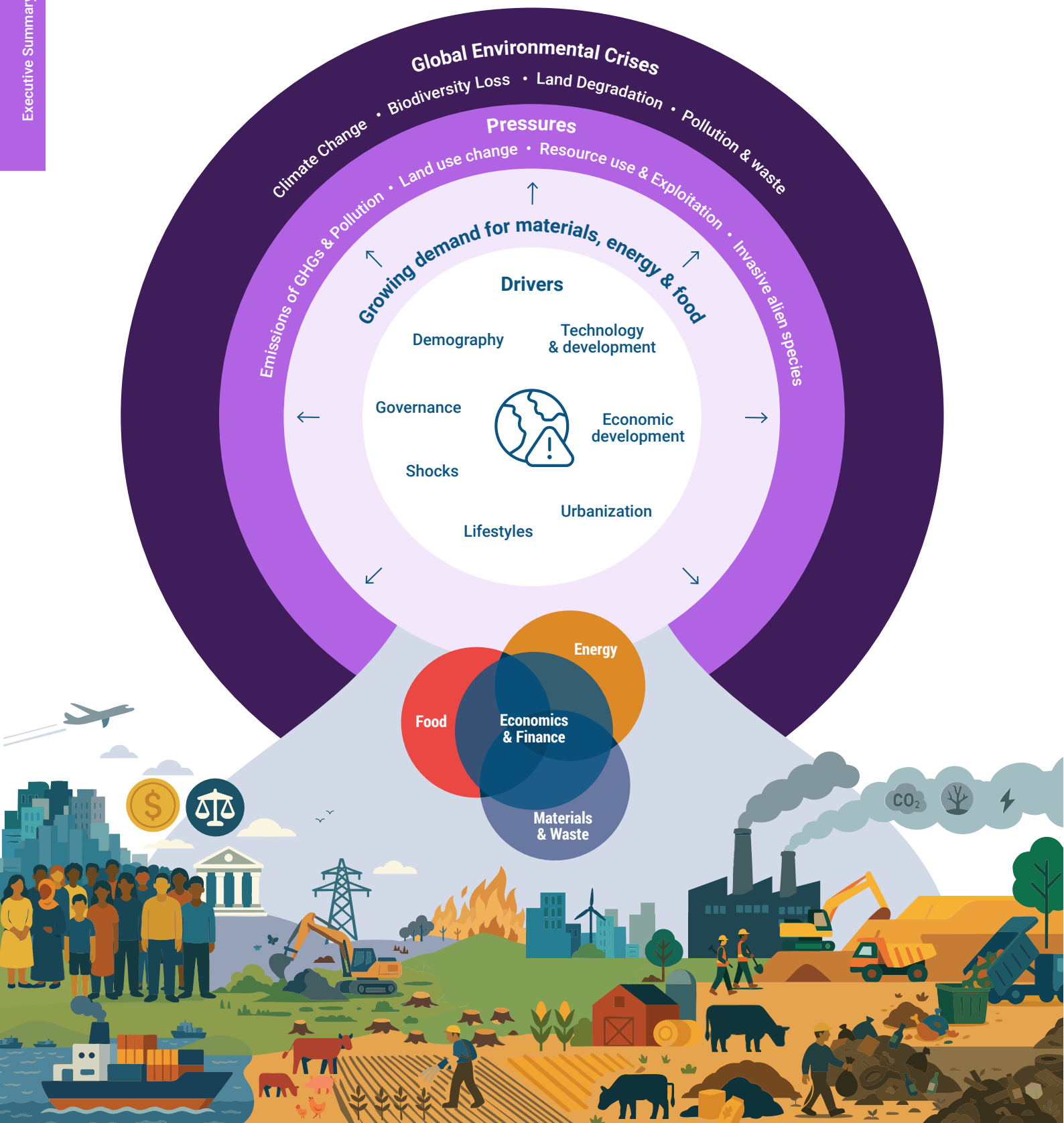
energy system. Advances in digital transformation, particularly in artificial intelligence, offer opportunities for improving resource efficiency but also raise new environmental concerns due to increased demand for electricity, energy and water consumption to power these technologies *(well established)* {2.2.3}.

**The non-linear impacts of shocks – largely unpredictable events that can be natural or human-caused – are both exacerbated by and contribute to the global environmental crises** *(well established)*. The number of armed conflicts has increased over the past decade and is

[4] https://data.worldbank.org/indicator/NY.GDP.MKTP.CD. (Accessed 25 July 2025).

**Figure ES 1.3: Transforming key human systems is essential to address the Global Environmental Crises**

The figure shows that the ensemble of drivers result in an ever-increasing demand for materials, energy and food, which is being met using environmentally unsustainable production and consumption systems, embedded in economic, financing and governance systems which themselves are unsustainable. This results in ever-increasing pressures of emissions of greenhouse gases and pollutants, land-use change, resource use and exploitation, and invasive alien species, which in turn are the underlying causes of the global environmental crises. Therefore, addressing the global environmental crises requires transforming the economics/finance, materials/waste, energy and food systems.



currently at record high levels. Armed conflict increases vulnerability by restricting livelihoods, food insecurity and displacement, and can exacerbate environmental degradation. Human-caused shocks in the form of oil spills and financial or public health crises, such as pandemics, can become disasters when pre-existing vulnerabilities, including weak institutions and capacities, are combined with the hazard {2.2.7}.

### 1.4.2 Pressures precipitating the environmental crises have intensified

**Humans have altered over 70 per cent of the global ice-free land cover** *(established but incomplete)* {4.1, C.1.2}. Land-use change is the dominant driver of terrestrial biodiversity loss. Cropland expansion accounted for about 30 per cent of observed change between 1992 and 2020. Cropland and forest plantation expansion are accompanied by deforestation in some regions, with implications for ecosystem services, Indigenous Peoples' livelihoods, and carbon sequestration {2.3.1}.

**The unsustainable exploitation of natural resources, including wildlife, mineral deposits, fossil fuel reserves, fresh water, wood and marine resources, exerts pressure on every environmental system** *(well established)* {2.3.2}. Overexploitation remains the primary pressure on biodiversity in the ocean, with 37 per cent of fish stocks classified as overfished {5.2.3.1}. On land, unsustainable timber harvesting and illegal wildlife trade are accelerating biodiversity loss {4.3.4.2}. Increasing demands for fossil fuels, critical raw materials, and common metals and minerals, spurred by growing population, urbanization and technology, are major sources of air, land and water pollution {C.1.5}.

**Global anthropogenic GHG emissions reached a record high in 2023 of 53 Gt $CO_2$ equivalent** *(well established)* {2.3.3}. GHG emissions are driving rapid climate change. Globally, approximately 79 per cent of emissions came from energy, industrial processes, transport, and buildings combined, and approximately 21 per cent from agriculture, forestry, and land-use change. The growth rate of GHG emissions was moderated by increased use of renewable and low-emission energy and by afforestation and reforestation efforts, but emissions from deforestation remain high {2.3.3}.

**The spread and rate of introduction of invasive alien species is increasing** *(well established).* Invasive alien species disrupt natural ecosystems and can act as vectors for diseases, aggravating biodiversity loss and land degradation. Over 3,500 alien species with negative impacts have been documented. Once established, invasive alien species are extremely difficult and costly to eradicate. Interactions with other pressures, including land-use change and climate change, exacerbate their spread {2.3.4}.

## 1.5 The environmental crises undermine human well-being, the economy, and the socioeconomic dimensions of the Sustainable Development Goals.

**The global environmental crises are damaging human well-being, undermining the achievement of the economic and social dimensions of all the SDGs, and imposing high economic costs** *(well established)*. Addressing environmental crises is necessary to put social and economic goals and targets back on track and minimize the scale, speed, and costs of environmental damage.

Credit: AlbertoCarrera/Envato

**Economic growth itself is being undermined by damage from the environmental crises** *(well established)* {7.2.8}. About half of the world's GDP, estimated to be US$114 trillion in 2025 using World Bank estimates of 2.3 per cent global GDP growth in 2025, is from sectors that are moderately or highly dependent on nature and its services. The loss of ecosystem services from 1997 to 2011 is estimated at US$4.3-20.2 trillion/year. Losses from recorded disasters (2000-2019) were US$2.97 trillion, and the Small Island Developing States' cumulative GDP loss from extreme weather, water hazards and climate change was about US$153 billion between 1970 and 2020. Health damage costs from air pollution were about US$8.1 trillion in 2019, about 6.1 per cent of global GDP (PPP adjusted) {7.2.8, 7.3} (SDGs 8, 9, 11, 17).

**The impact of the interlinked global environmental crises on economic growth is substantial and increasing over time** (*established but incomplete)*. Globally, the projected degradation of ecosystems will lead to a loss of services worth between US$10 trillion and US$44 trillion annually. The GEO-7 Current Trends Scenario projects climate change to reduce global GDP by 4 per cent in 2050, and 22 per cent by 2100 (median estimates). In contrast, holding the global average temperature increase to 1.5°C above pre-industrial levels could keep median GDP losses below 2 per cent throughout the century. These GDP impacts include, among others, losses due to reduced agricultural yields, damage to infrastructure and assets in coastal areas or floodplains, and reduced labour productivity. As these estimates do not include all climate change damages, tipping points and impacts from the other global environmental crises, the actual cost of inaction could be larger {C.1.2, 10.6.5, 11.5} (SDGs 2, 8, 11, 17).

**Environmental crises threaten jobs, livelihoods, decent work, and labour productivity** *(well established)* {7.2.8, 7.3}. In 2018, about 1.2 billion jobs – almost 40 per cent of global employment – directly relied upon ecosystem services, including 600 million in fisheries and aquaculture. The damage to infrastructure caused by environmental crises is also threatening jobs. Heat stress is projected to reduce total working hours worldwide by 2.2 per cent and global GDP by US$2.4 trillion in 2030, with more severe impacts after 2030. Environmental crises threaten jobs by damaging industry and infrastructure and disrupting supply chains (SDGs 1, 8).

**Multidimensional poverty is worsened by the global environmental crises, and some middle-income people are at risk of falling into poverty** *(well established)* {7.2.1}. The global environmental crises threaten access to safe water, housing, energy, food, health, education, decent work, and livelihoods, all of which are needed for poverty eradication. Degraded ecosystem services and goods are worsening subsistence-based livelihoods {SDGs 1, 3, 4, 5, 6, 8, 10, 11}.

**Energy security, including production and distribution, is compromised by the environmental crises** *(established but incomplete)* {7.2.7, Table 7.3}. Energy production and distribution of both fossil fuels and renewable energy are threatened by climate change-related disasters that damage energy production facilities and stress power grids. Climate-linked droughts reduce hydropower generation and the availability of cooling water for thermal power plants. Climate-linked landslides and floods threaten energy infrastructure in some regions. Air pollution harms some energy systems, for example, acid rain corrodes solar panels {SDG 7}.

**Food security globally is threatened by the global environmental crises** *(well established)* {7.2.2, Table 7.1}. The crises damage agricultural production and productivity, causing unreliable harvests, food scarcity, and price inflation. Over three-quarters of the world's food crop species rely at least partially on pollination by insects and other animals, representing 5-8 per cent of global food production. Agriculture and marine productivity are also being threatened by unsustainable agricultural management practices, climate change, biodiversity loss, pollution and water stress {SDG 2, 15}.

**Water security is also being endangered by the environmental crises** *(well established)* {7.2.6}. Changes in precipitation patterns and increased extreme weather in the form of heatwaves, floods and droughts are threatening water security. Pollution is contaminating water supplies, reducing the clean water supply for industry, agriculture, and households {SDG 6, 9}.

**Environmental crises are undermining human health** *(well established)* {7.2.3}. One-quarter of the global burden of disease results from environment-related risks.Climate-related premature mortality, heat-related health risks, malnutrition, gender-based violence, illnesses, and mental health issues are projected to increase with further warming, along with vector-borne, waterborne, and food-borne diseases. Pollution causes an estimated nine million premature deaths annually, with air pollution responsible for an estimated 8.1 million deaths in 2021, and billions of days lived with illness. Globally ubiquitous emerging contaminants in many water supplies have been linked to serious human health and environmental impacts {SDGs 3, 6}.

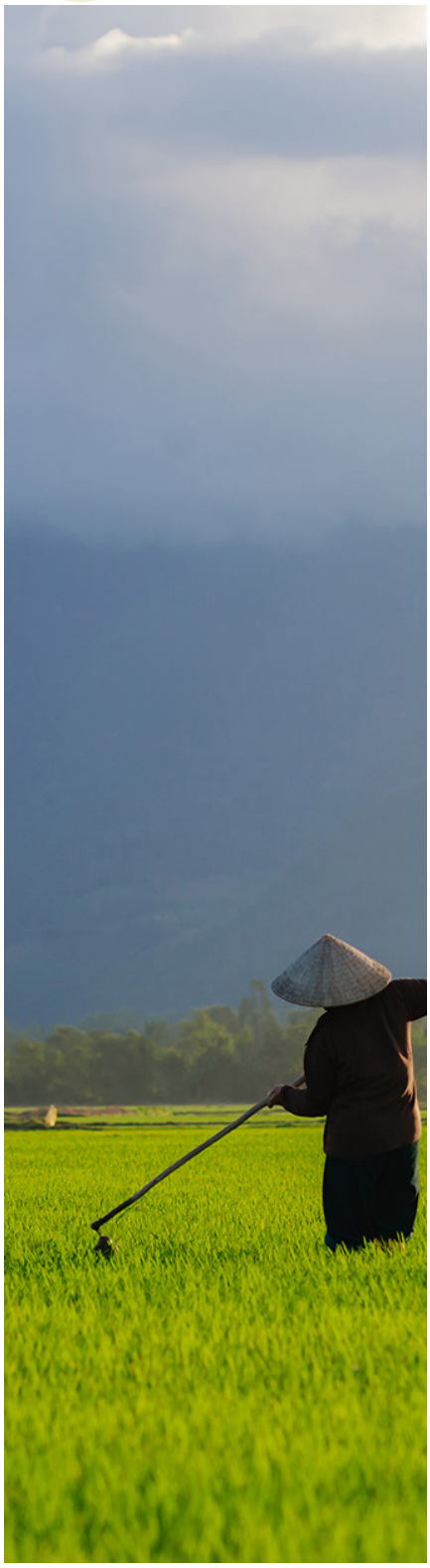
**Peace, justice and strong institutions are fundamental to moderating the adverse effects of the global environmental crises** *(very well established)* {7.2.15}. Environmental crises can undermine the capacity of governments to meet basic human needs and engage in protective measures for the environment. Where environmental degradation and hazards intersect

with conditions of armed conflict and fragility, populations can be trapped in conditions of vulnerability that can contribute to ongoing violence *(well established)*. Peacebuilding initiatives, including those that incorporate environmental aspects, can contribute to reducing armed conflict *(established but incomplete)*. Climate change threatens the homes and livelihoods of people due to drought, floods, and extreme storms. Between 2008 and 2016, over 21.5 million people per year were forced to move because of sudden weather events. Climate adaptation can reduce the level and duration of displacement (7.2.15) *(very well established)*.

**Environmental crises deepen inequalities and inequity, disproportionately impacting vulnerable and marginalized groups** *(well established)* {7.2.10}. Many vulnerable populations depend on natural ecosystems and resource-based economies for their livelihoods and well-being, which the environmental crises are threatening. The crises reinforce systemic barriers to social and economic security {SDGs 5, 10}.

**Gains in human well-being are increasingly threatened by the intensifying global environmental crises, negatively impacting gains in human health, food systems, and livelihoods** *(established but incomplete)*. Under the GEO-7 Current Trends Scenario, access to food, water and energy is projected to improve, poverty to be reduced, and health outcomes to improve, including under-5 mortality. Nevertheless, improvements are insufficient to achieve related SDG targets by 2030, and often not before 2050, and the intensifying global environmental crisis can undermine hard-won gains. Climate change is projected to significantly increase the exposure of billions of people to intensifying climate impacts, including heatwaves, heavy rainfall, and droughts. Global environmental crises negatively affect crop yields, undermining food security, through changes in temperature and precipitation patterns, increasing pollution of air and soils, reducing soil quality, and decreasing pollination and pest control. Additionally, the economic consequences of environmental degradation may slow poverty reduction and widen inequality between and within countries {Box 10.2, 10.4.1, 10.6.1, 10.6.2, 10.6.3, 10.6.4} {SDGs 1, 2, 3, 6, 7, 11}.

# 02 Part 2: Transformation to a Sustainable Environment



Credit: avanti_photo/Envato

**An environmentally and socio-economically sustainable and just future is achievable but would require unprecedented, coordinated, rapid, and innovative transformations across the economic and financial, materials/waste, energy, and food systems, while ensuring a resilient environment system.**

## 2.1 GEO-7 target-seeking scenarios

**Internationally agreed (or adopted) environmental goals and targets are achievable, where multiple pathways are possible, resulting in benefits for people and planet, all requiring integrated transformation across the systems {9-11}.**

a. **The scenario analysis shows that achieving environmental goals simultaneously while also improving human well-being requires unprecedented action, combining a range of transformative solutions across the systems** *(well established)*. The two GEO-7 target-seeking scenarios describe alternative combinations of transformative solutions based on diverging narratives of societal values and approaches to solving the global environmental crises while improving human well-being {**Box ES 2.1**}. They are not predictions or an endorsement of specific solutions, nor are they mutually exclusive, but rather act as a means to explore possible alternative futures, highlighting the extent of the required transformation, and the interactions across the five systems and environmental and human well-being goals {9.2}. For both pathways, the required changes across the systems are much larger than the projected level of change under a continuation of current trends {11.3; **Box ES 2.1**}.

b. **Coordinated effort across the interlinked systems is necessary to reduce the pressure on natural resources and the environment and to create enabling conditions that harness synergies across systems and goals and reduce potential trade-offs** *(well established)*. Both efficiency improvements and lifestyle changes away from wasteful and superfluous consumption reduce energy, land, and material demand, reducing pressures on natural resources and the environment {11.3}. Reducing energy demand aids rapid decarbonization of the energy system while curbing the required renewable energy expansion and associated

**Figure ES 2.1: GEO-7 New target-seeking scenarios**

To illustrate how the global goals can be achieved, GEO-7 developed two contrasting target-seeking scenarios. These scenarios combine alternative sets of solutions across five interlinked systems (detailed in Box 11.1 and 11.2). Comparing them to current trends shows the scale and effort required, concluding the need for unprecedented and coordinated action. The behaviour-focused transformation is driven by changes in society's values and norms towards sufficiency, accompanied by a significant decrease in consumption, particularly in affluent countries. The technology-focused transformation achieves goals by efficiency and clean-technology gains in an economically globalized, and commodified world.

**Selected global goals**

**Global Environmental Crises goals:**

- Limit global warming
- Protect biodiversity
- Improve air quality
- Achieve land degradation neutrality

**Human well-being goals:**

- End hunger
- Achieve universal access to safe drinking water and adequate sanitation
- Ensure universal access to modern energy services

| | | Current trends scenario | Behaviour-focused Transformation | Technology-focused Transformation |
|---|---|---|---|---|
| Unless otherwise stated all results present the change between 2020 and 2050 | | | | |
| Energy | Primary energy demand in 2050 (580 EJ/yr in 2020) | 827 EJ/yr | 327 EJ/yr | 518 EJ/yr |
| | of which renewables (44 EJ/yr in 2020) | 127 EJ/yr | 160 EJ/yr | 277 EJ/yr |
| Food | Change in pasture area | 3% decrease | 25% decrease | 15% decrease |
| | Annual growth rate of crop yields | 0.8% /yr | 0.7% /yr | 0.95% /yr |
| Environment | Change in natural area | 1% decrease | 8% increase | 4% increase |
| | Change in water withdrawals | 15% increase | 9% decrease | 4% decrease |
| Materials & Waste | Change in metals and mineral extraction | 62% increase | 20% decrease | 2% increase |
| | Metal and mineral recycling rate in 2050 | remain at 50% | increase to 55% | increase to 70% |
| Economics & Finance | Climate damage in 2050 (annual median estimate) | US$9.5 trillion (3.8% of global GDP) | Almost US$4 trillion (1.6 % of global GDP) | |
| | Macroeconomic benefits of transformation | — | Zero around 2050, more than US$100 trillion annually by 2100 (global GDP 25% greater) | |

infrastructure development and demand for critical energy transition minerals {11.3.1, 11.3.3, 16.2}. Addressing unsustainable production and consumption of animal-sourced foods, as well as food losses and waste, frees up large areas currently dedicated to feed and food production, enabling the land system to be a net carbon sink and for ecosystems to be conserved {11.3.2, 11.3.4}. These solutions act as important enablers for cross-system synergies, contributing to meeting climate, biodiversity, land degradation, and pollution goals, simultaneously {11.4, 15.3, 18.2}. However, some of the solutions might present significant trade-offs. For example, dependence on carbon dioxide removal technologies such as large-scale afforestation and use of bioenergy with carbon capture and storage could lead to land competition, threats to biodiversity, and the need for higher agricultural yields with associated pressures from water and fertilizer use {11.3.2, 11.4.1, 11.4.5, 11.4.6, 16.4, 17.4, **Box ES 2.4**}. Furthermore, dependence on changing lifestyles and diets requires a rapid and radical shift in people's attitudes and relation to nature {15.2.5, 17.2.1}. Integrated planning is therefore necessary to manage both synergies and trade-offs across systems and goals {11.7, 21.3}.

c. **The long-term benefits of actions which avoid economic damages caused by the global environmental crises vastly outweigh the costs of the transformation** *(established but incomplete)* {11.5.5, 13.2.2}. The macroeconomic costs implied in the GEO-7 target-seeking scenarios peak at US$3 trillion per year around 2040, approximately 1.5 per cent of the projected global GDP. This investment avoids future costs of inaction. After 2050, the economic damages of the global environmental crises will become increasingly severe. The overall macroeconomic annual benefits of transformation are projected to begin around 2050, increasing to US$20 trillion per year by 2070 and over US$100 trillion per year by 2100 –contributing to increasing future global GDP to over 6 per cent and 25 per cent, respectively {11.5.5}. These long-term benefits may be an underestimation as the calculated costs of inaction only account for climate change impacts, and do not include tipping points and impacts from the other global environmental crises {10.6.5}.

d. **System transformations bring multiple benefits for human well-being** *(established but incomplete)*. These benefits are achieved in part from cleaner air resulting from decarbonizing the energy system, dietary shifts away from animal-sourced foods, and improvements in agricultural practices. Furthermore, the reduced demand and competition for natural resources may make it easier to achieve universal access to safe drinking water and modern energy services, as well as poverty eradication. Cumulatively, these benefits allow for healthier and more productive societies, with over 9 million premature deaths avoided by 2050, increasing to over 50 million by 2100, reducing burdens on health systems and vulnerable populations {11.5}.

## 2.2 Theory and implementation of transformation

**The governance of human systems transformations requires breaking away from established unsustainable planning and decision-making, and envisioning new solution pathways, inclusive governance structures involving all relevant actors, as well as adequate evaluation procedures** *(established but incomplete)* {12.2, 13.6, 14.4, 21}.

a. **GEO-7 offers a new framework for designing interventions to facilitate system transformations** *(established but incomplete)*, combining theoretically grounded requirements for system transformation (6 principles) and operational steps for the development of solution pathways (7-step process) {12.4, 13.6, 13.8}. This framework

is designed to be future-proof and aims to ensure that the challenges, complexities and implications of system transformations are anticipated, accelerating the pace of deliberate transformative change at the system level and across temporal and spatial scales. This methodology is adaptive and integrates interdependencies, including synergies and trade-offs between and within systems. Through an iterative and holistic decision-making process, this methodology accounts for the possible effects of resistances, shocks and risks and provides guidance on designing transformative solution pathways. The 7-step methodology developed in GEO-7 focuses on the identification of system goals, solutions, levers, actors, and actions to be taken to achieve desired transformations {12.3, 13.6.3, 13.8.2, 13.8.4, **Figure ES 2.2**}.

b. **It is essential that the implementation of system transformations persists despite uncertain or unstable socioeconomic, political, or environmental conditions** *(established but incomplete)*. The 7-step methodology guiding systems transformations has been designed specifically to operate under shocks and crises {13.8.2}.

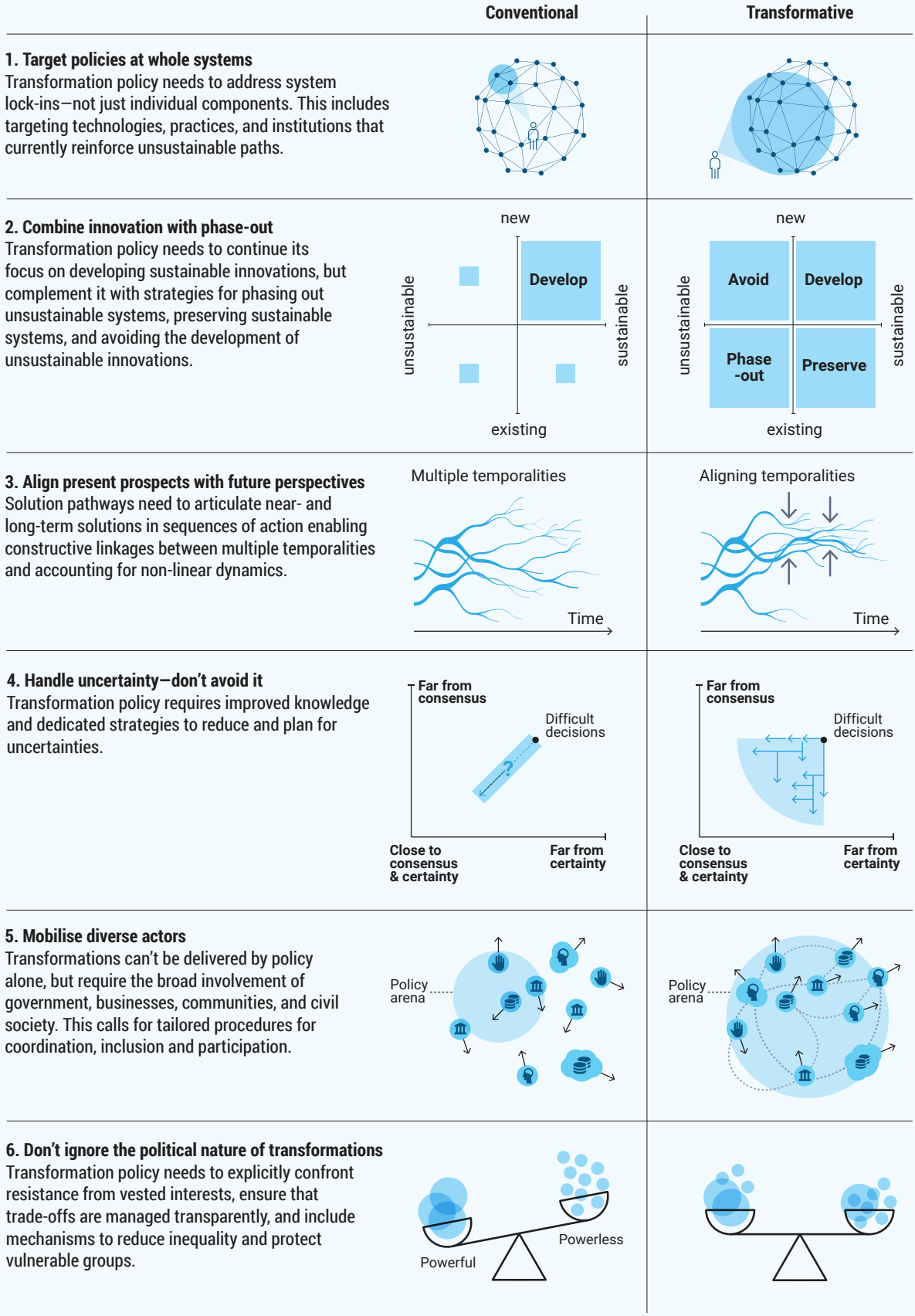
c. **There is a substantial body of multi- and interdisciplinary scientific knowledge, as well as Indigenous Knowledge and Local Knowledge, on how societal systems have been or can be transformed in a variety of sectors and contexts** *(well established)* {12.3; 13.4; IK&LK Chapeau D}. Three complementary scientific perspectives that can be applied to system transformation are:
   - a socio-ecological perspective that focuses on interactions of environmental components, such as climate and nature, and human components such as communities, cultural practices and institutions {12.3.1};
   - a socio-technical perspective that focuses on the mutual shaping of technology and society, commonly representing systems as bundles of technology, policies, industry and markets, science and culture {12.3.2}; and
   - a socioeconomic perspective that focuses on the interaction of economic and social systems, and related institutional responses to address externalities {12.3.3}.

d. **GEO-7 has combined key findings from socio-ecological, socio-technical, and socioeconomic perspectives {12.3} to propose six generic principles on system transformations (Figure ES 2.2) {12.4}, which, together with a 7-step process (Box ES 2.1) {13.6, 13.8, Figure ES 2.3}, enable the design of transformative solution pathways {13.6, 13.8, 14, 15, 16, 17, 18}.**

e. **These principles for transformation can be applied through domains of intentional action with five levers and a 7-step methodology** *(established but incomplete*) {12.5, 12.6, 13.6}. The five levers required to achieve transformation of complex systems are: governance, economic and financial, social and cultural that includes individual and collective action, knowledge and innovation, and capability. These levers can be used in combinations, enabling social actors to participate in system transformation and to generate options for action. Levers themselves may also need to be transformed {12.5; 12.6}, based on ongoing evaluation of the feedback process built into the 7-step methodology {13.8.4, 13.9}. **Figure ES 2.3** illustrates the relationship between the principles and the seven steps.

f. **Implementing transformative solution pathways requires a broad shift in governance systems** *(well established)*. For this implementation to be effective, it needs to translate long-term targets into shared options for change {12.7.3}, navigate change along with regular evaluation {12.7.4}, and legitimize change through socially acceptable processes {12.7.5}. There is evidence that positive shifts in this direction are emerging, such as the

**Figure ES 2.2: Six guiding principles for system transformation.**



new importance given to directionality and missions in the case of innovation policies. However, as yet they are restricted to specific areas such as climate change and have yet to lead to changes in the political cultures of leading institutions and organizations {12.6, 12.7}.

g. **Consideration of multiple perspectives, in particular marginalized ones, is essential to the governance of transformative change**, giving space for plural forms of knowledge and ways of being – especially those of Indigenous rightsholders and local communities with

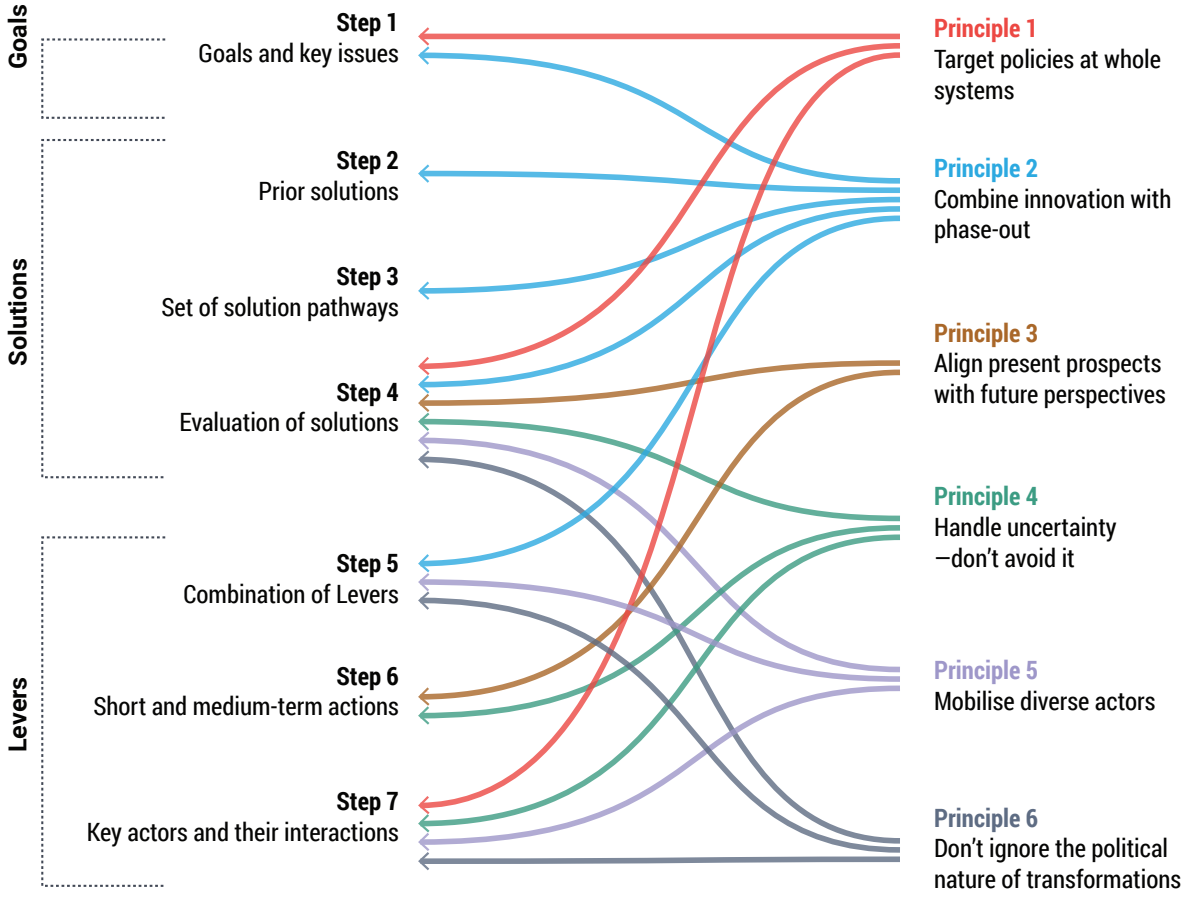
**Box ES 2.1 The 7-step methodology**

- **Step 1: Setting goals**
- **Step 2: Reviewing sources of past solutions**
- **Step 3: Identifying a set of solution pathways**
- **Step 4: Evaluating the identified solution considering the local context**
- **Step 5: Defining the combination of levers**
- **Step 6: Identifying the options for short and medium-term actions, and**
- **Step 7: Defining actors, their roles and interactions.**

Monitoring and evaluation operate across all steps {13.6, 13.8, 13.9}.

**Figure ES 2.3: Bridging principles and action: aligning steps for effective system transformation.**

This figure shows how the 7-step methodology integrates the 6 principles for system transformation into the development of solution pathways. Each step draws on a distinct set of principles to guide effective and coherent action.



deep connections to the land – and addressing the underlying causes of unsustainability, such as colonial modernities, while leaving no one behind {12.4.5, 12.5, IK&LK Chapeau A, IK&LK Chapeau C, IK&LK Chapeau D}.

## 2.3 Contribution of Indigenous Knowledge and Local Knowledge to transformation

**Indigenous Knowledge and Local Knowledge contribute to transformations towards sustainable and equitable futures. They offer concepts of human-nature relations based on ethics of care and associated sustainable stewardship practices and adaptation strategies. Instead of dismissing Indigenous ways of being and knowing, or seeking to integrate them into scientific framings, sustainability transformations can be better served by reparative actions which give greater space to Indigenous Peoples' perspectives in policy formulation and decision-making processes (Figure ES 2.4, IK&LK Chapeau D).**

a. **Indigenous Peoples, and communities that maintain historical connections to the land, rivers and the ocean often have a holistic and relational understanding of nature** *(well established)*. They attach deep cultural and spiritual values to nature and do not conceive of human society as being separate from it. They establish relational and reciprocal rather than instrumental connections to the lands, waters and nature, which are guided by ethics of care for territories and all life – human and non-human, animate and inanimate – and for ancestors, present and future generations. Indigenous holistic understanding of human-nature relations has significant potential for the design of transformations that are just, inclusive and plural, that address both environmental sustainability and human well-being and that inspire sustainability action {IK&LK Chapeau A, IK&LK Chapeau D, 2.1; 12.5; 14.1; 14.2; 16.2; 17.2.3; 17.3.1; 18.2.3; 18.2.5; 21.2; 21.4}.

b. **Indigenous Knowledge and Local Knowledge can provide concrete guidance on actions related to the care of territories and life, as well as in relation to energy, food, governance, and economies, in socially just and culturally appropriate ways** *(established but incomplete)*. Indigenous governance and stewardship of land and natural resources contribute to improving or maintaining biodiversity, water, land, and soil quality by enhancing ecosystem function and regeneration. Indigenous regenerative agroecological practices have a high potential to transform food systems, addressing not only global environmental crises but also issues of sustainability, equitable access to food, biocultural diversity, and health. Indigenous Knowledge and Local Knowledge systems' integrated approach to sustainable land, soil, and water management can provide entry points to climate change adaptation through the application of combined inclusive conservation measures in crop, livestock, and forestry sectors, and aquatic and marine ecosystems. Indigenous Peoples' concepts of human-nature relations based on ethics of care present positive ways of organizing economies that move away from extractivism and consumerism {IK&LK Chapeau D, IK&LK Chapeau E, 4.6, 7.2; 11.3.1; 11.3.2; 15.3.2; 17.2.1; 17.2.2;18.2.5}.

c. **Indigenous Peoples' traditional lands and territories support a large portion of the world's biological and cultural diversity** *(well established)*. Indigenous Knowledge and Local Knowledge sustain a multitude of adaptations, interspecific relations, and stewardship practices that contribute to environmental productivity, species abundance, distribution, and richness, as well as ecosystem functioning and social-ecological resilience, including climate regulation. Since biodiversity loss, land degradation, and cultural diversity loss are correlated, revitalizing Indigenous cultures and languages in their traditional territories can

Credit: Addictive_Stock/Envato

be crucial for the recovery of lands, waters, and the protection of biodiversity {2.1, IK&LK Chapeau D; 17.2.1; 17.2.2; 18.2.1; 18.2.3}.

d. **Compliance with rights of Indigenous Peoples as well as local communities, in line with national and international legislation, including free, prior and informed consent, is fundamental for the co-design and implementation of solution pathways for the energy, food, governance and economic systems in socially just and culturally appropriate ways** *(established but incomplete)*. Indigenous Peoples govern formally or customarily at least a quarter of the world's terrestrial surface. When designing solutions for system transformation, it is essential to respect the territorial rights, values, and practices of the affected communities. This can be done by enhancing co-design and participatory processes. Recognition and strengthening of governance structures that prevail among the Indigenous Peoples, as well as communities that maintain historical and spiritual connections to the land, are necessary to achieve social and environmental sustainability {IK&LK Chapeau D, 11.7.2, 13.4, 14.2}.

e. **Solution pathways design can draw on Indigenous Knowledge and Local Knowledge through processes of knowledge co-creation** *(established but incomplete)*. Inclusive planning involves reconciling the contributions, competing interests, and diverse views of multiple stakeholders in society, including Indigenous Peoples and local communities. Collaboration between Indigenous Peoples and local, regional, and national governments is essential in this regard. Knowledge co-creation from the inception of projects can be used to generate science that informs policy decisions rooted in real-world experiences. It could be applied to scenario analysis in the future, expanding the range of data used in models, helping to better represent changes occurring across different locations and ecological systems, and supporting the development of diverse future scenarios {13.8, 14.2, IK&LK Chapeau C, IK&LK Chapeau E}.

f. **Indigenous-led research can provide valuable insights for sustainability transformations across biocultural regions, drawing on their historical experiences and using a variety of livelihood and adaptation strategies to respond to environmental changes** *(well established)*. An Indigenous-led review of the effects and responses to environmental change across the seven UN-recognized sociocultural regions of Indigenous Peoples and their biocultural and livelihood subregions would be a first step in building comparative insights for regional adaptation and sustainability transformation. These results could inform the collection of qualitative and quantitative data to generate future scenarios of stewardship and adaptation at meaningful biocultural scales. International organizations and governments could assist knowledge-holders with this endeavour {IK&LK Chapeau E}.

**Figure ES 2.4 Sustainability transformation can be better served by reparative actions that give greater space to and include Indigenous Peoples' perspectives in policy formulation and decision-making processes.**

This figure shows Indigenous Peoples' perspectives on desired futures identified in the GEO-7 Indigenous Knowledge and Local Knowledge Dialogues

## 2.4 Transforming systems

**The deep interconnections between the systems (Figure ES 2.5) mean that systems transformation depends on the parallel co-development and co-implementation of the solutions, with diverse actors** {11.6; 11.7; 14.8; 15.1, 16.3, 17.4; 18.2; 21.2; 21.5}. Breaking policy silos, improved governance {12.4; 14.4; 16.3.1,18.2.5}, redefined economic and market infrastructures {14.4, 15.2, 16.3.3}, and revised financing and valuation principles that place the environment and human well-being first {14.3, 14.5, 14.6; 15.2.3, 16.3.5, 16.4, 17.4} are all critical to improving coordination between the systems *(well established)*. Solution pathways all require transformation of the economic and financial systems, which drive the materials/waste, energy, food and environment systems *(well established)* {12.5.1; 14.1, 16.2; 16.3; 17.2; 17.4; 18.3}.

## 2.5 Transforming the economic and financial systems

**Transforming the economic and financial systems would be massively accelerated by proper valuation of goods by pricing positive and negative externalities, reforming or redesigning macroeconomic and fiscal policies, unlocking private financial capital, and using non-price instruments {14.1.1}.**

a. **Transforming the economic and financial systems is essential to meet sustainability targets, with important synergies and implications for transforming the materials/ waste, food, and energy systems, as well as managing the environment sustainably** *(well established)* {14.1}. Tools, mechanisms, and solutions have been tested with mixed success, sometimes due to political economy or willingness barriers, and at other times due to a lack of institutional capacity or public awareness and acceptance. Some solution pathways are tried and successful but need scaling up (green/sustainable finance), while others did not reach their full and desired outcomes, such as carbon markets, thus calling for a thorough reconsideration and update to reach the desired socioeconomic and environmental goals {14.1.1; 14.1.2; 14.2.1}.

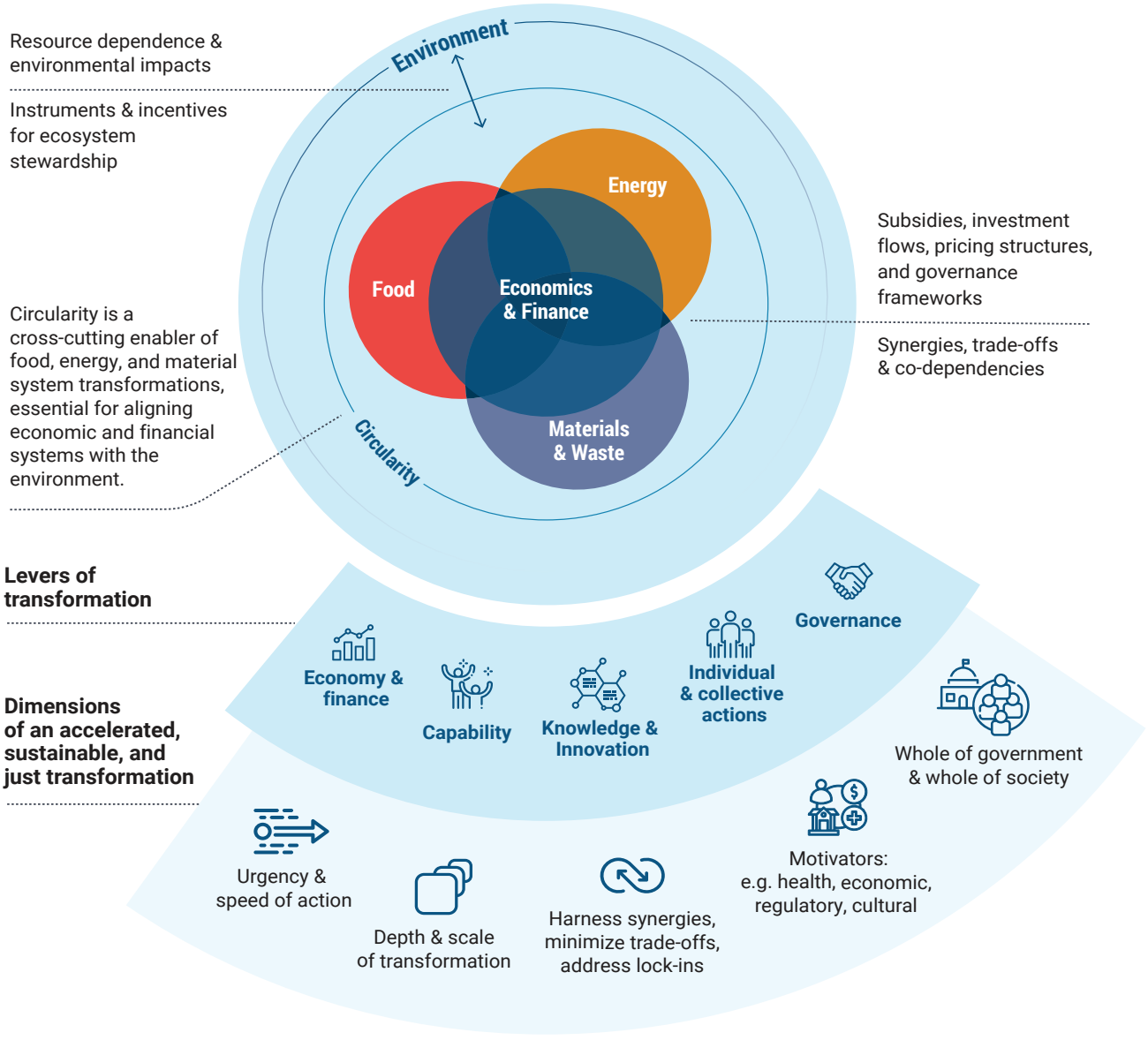
b. **Four solution pathways are identified to facilitate a timely, equitable, and steady transformation of the economic and financial systems** *(established but incomplete)*. They emerge from a long-standing scientific debate on economic and financial policies and mechanisms to enable a sustainability transformation. One pathway concentrates on the actions to price externalities adequately. Another relates to mainstreaming sustainability in multilevel and multilateral governance, macroeconomic and fiscal policy considerations. A third pathway focuses on the financial sector, emphasizing tools and frameworks for unlocking private financial capital to support environmental sustainability projects. The final pathway introduced concerns the role and use of non-price instruments to engender pro-sustainable norms, attitudes and behaviours.

c. **Economic externalities must be properly priced to reflect environmental and social impacts while addressing adverse welfare distributional impacts, both within and among countries. Local institutional capacities and implementation costs must be considered when pricing externalities** (*well established*) {14.3, 14.4}. Societal costs often exceed private or market costs, as the harmful effects of practices and policies are not taken into account. Externalities from energy and transport have an estimated annual value of US$25 trillion, exceeding revenues from these sectors. Negative externalities relating to health and environment are estimated for the global food system at around US$20 trillion versus US$9 trillion of food value in the markets {17.1}. Revenues raised through pricing

**Figure ES 2.5: Leveraging system interactions to accelerate transformations**

The **environment system** forms the foundation, with the **food, energy, and materials/waste systems** embedded within it, reflecting their dependence on and impact on

**The economics and finance systems** plays a central enabling role in the transformation of all systems. **Its transformation is a pre-requisite for effectively transforming the food, energy, and materials systems.** It shapes how these systems function and also influences environmental outcomes directly. Depending on how it is structured—it **can act as either an enabler or a constraint to transformation.**




**Transformation requires coherent and coordinated implementation of solutions and policies across systems**

Because these systems are deeply interconnected, transformation must be **coordinated, integrated—and accelerated.** The five levers of transformation create the enabling conditions for this process. The outermost ring reflects the dimensions across which transformation must accelerate—**depth, speed, integration, and reach**—, and how acceleration **can be motivated and governed.**

**Figure ES 2.6 Transforming systems: examples of solutions proposed in GEO-7**

Each system chapter elaborates on these solution pathways and the actions required to accelerate transformation.

### Economics & Finance

- Internalize environmental and social costs
- Reform subsidies to support sustainability
- Reflect long-term goals in economic planning
- Incentivize equitable and green economic activity
- Enhance inclusive and participatory decision-making

### Environment

- Protect and restore ecosystems and biodiversity
- Strengthen resilience and governance of socio-ecological systems
- Capitalize on Indigenous and local knowledge systems
- Invest in nature-based solutions for conservation, restoration and adaptation
- Promote sustainable bioeconomy and its infrastructure

### Food

- Shift to healthy and sustainable diets
- Reduce food loss and waste
- Promote sustainable and agroecological intensification.
- Secure land tenure and farmers' rights
- Strengthen local food systems and value chains
- Align agricultural subsidies with sustainability goals

### Energy

- Ensure universal access to clean energy
- Expand energy efficiency and demand-side measures
- Scale up renewable and low-carbon energy
- Phase out fossil fuel subsidies and investments
- Support just and inclusive energy transitions

### Materials & Waste

- Improve resource efficiency across sectors
- Promote circular design and production
- Reduce material use and consumption
- Extend product lifespans through reuse and repair
- Strengthen waste management, recycling, and infrastructure

externalities can be used to minimize the distributional impacts and achieve the required system transformation, both within and across country borders {14.3; 14.4}, and limit negative effects on the vulnerable and most marginalized in society, including Indigenous Peoples and local communities.

d. **Eliminating, phasing out or reforming incentives that are harmful to biodiversity, including subsidies and taxes, in a proportionate, just, fair, effective and equitable way, by substantially and progressively reducing them, contributes to addressing the current environmental crises** (*well established*) {14.3.1, 14.3.2}. In the same manner, phasing out inefficient fossil fuel subsidies that do not address energy poverty or just transitions also contribute to addressing the current environmental crises. The environmental and socioeconomic impacts of these policies on subsidies need to be addressed to ensure a contribution to sustainable development.

e. **Moving 'beyond GDP' to measure inclusive wealth, well-being and economic development** {14.4.2}. For instance, building on existing approaches for natural capital accounting, such as the UN System of Environmental-Economic Accounting, would better reflect the broader notion of progress for policy decision support. Therefore, decisions should take into account global environmental crises in decision-making.

f. **Scaling up the deployment of innovative tools for sustainable finance to fill in the financing gap** *(established but incomplete)* {14.5}. To foster green and sustainable finance, an opportunity to reorient public funds can be used to steer the private sector to place value on the environment and avoid environmental risks {18.2.1}. The estimated cost of delivering net zero GHG emissions by 2050 is US$200 trillion (approximately 7 trillion per year), and the Kunming-Montreal Global Biodiversity Framework recognized a biodiversity finance gap of US$700 billion per year. Sustainable finance frameworks have emerged, but they are fragmented by incomplete coverage or implementation within countries and incoherent connections across countries. Reducing fragmentation and enhancing compatibility is necessary through, for example, the adoption of standardized processes, common terminology, and shared taxonomies to achieve interoperability worldwide.

g. **Reducing the undue pressure for short-term financial and economic decision-making would allow for finance to prioritize environmental sustainability more effectively** *(established but incomplete)* {14.5.5}. Investments in environmental objectives typically require a long-term orientation, which contrasts with the prevailing emphasis on short-term returns. This benefits from a balanced and transparent approach, looking to leverage capital providers, capital seekers, insurance providers/facilities, policymakers and regulators {14.4.4; 14.5}.

h. **Using non-pricing approaches to promote behavioural change – labelling, education, and awareness-raising {16.2.2, 17.2.1} – is a necessary complement to price-based instruments for advocating environmental behaviour** *(well established)*. Non-pricing tools may include regulatory approaches that promote desired pro-environmental behaviours, information-based activities, research and development, and encourage self-regulation and governance, as well as foster people's ethics and moral values towards ecosystems. Opportunities exist to learn more from Indigenous Peoples, and from local communities that already practice nature-positive behaviours {14.3, 18.2.5, IK&LK Chapeau D}. As such, identifying, engaging, supporting and coordinating key actors and agencies, including Indigenous Peoples and local communities, will strengthen sustainability-driven governance *(well established)* {14.4; 18.2.5}. Governance could more purposefully

evolve from bottom-up, starting from the local to regional, national, transnational and global levels to serve coordinated action(s) for the sustainability transformations at various levels. Core actors and agencies, especially those that can financially propel the sustainability transformation, need to be identified, interconnected and jointly mobilized to serve the transition in a timely, just and equitable manner. Recognition and strengthening of local and Indigenous governance and customary ownership structures are necessary over lands, waters and territories to achieve sustainability outcomes both for people and ecosystems. Revised perceptions of risk are required, applying a holistic approach, to quantify environmental and sustainability risks connected with government, business, and investment decisions, ensuring full and effective participation at all levels.

## 2.6 Transforming the materials/waste system through circularity

**Transformation towards a circular economy and sustainable bioeconomy across all sectors and at all levels is one of the key solutions not only to reduce waste and pollution, but also to halt climate change, biodiversity loss and land degradation (***well established*). Reducing dependence on extractive economic activities by maintaining stocks of materials and increasing a circular flow of resources in the economy can contribute positively to socioeconomic development and sustainable provisioning systems {15.1.3; 18.1.3; 18.2.4}.

a. **The GEO-7 target-seeking scenarios highlight that a decrease in materials needs and increased circularity is required to significantly reduce global material demand** *(established but incomplete)* Through technological innovations and behavioural changes the GEO-7 target-seeking scenarios project global material demand to peak below 120 billion tonnes, compared to continued growth to 160 billion tonnes by 2050 when following current trends {11.3.3, 15.2, Box ES 2.1}.

b. **A circular-economy approach is needed to address global plastic pollution – an 80 per cent reduction of plastic waste by 2040 can potentially generate net savings and avoided external costs of US$1.2 trillion per year, totalling US$18 trillion cumulatively over the next 15 years** (*well established*). Downstream solutions such as recycling and waste management alone are insufficient to tackle plastic pollution. In addition, a combination of upstream solutions and regulatory measures to reduce unsustainable production and curb plastic demand through eco-design, reuse models, remanufacturing and product repair is the most cost-effective pathway to eliminate plastic pollution {13.2.2; 15.2.1, 15.2.5; 18.1.3; 18.2.1}.

c. **Designing waste out of production and consumption, and designing in circularity, requires transparency about what is contained in products, components, and materials** (*well established*). Transparency is also essential to ensure that products are non-toxic, suitable for re-use, and enable high-value recovery of materials {15.2.1}.

**The following five solution pathways have been identified to achieve the desired transformation of the materials/waste system:**

1. Implementing circular product design, transparency and traceability of products, components and materials to eliminate toxic substances and enable material recovery {15.2.1}

2. Creating fair and effective markets for circular goods and services across industries and global value chains {15.2.2}

3. Shifting investments from linear extractive economic activities to scale circular and regenerative business models {15.2.3; 18.1.3; 18.2.4}

4. Enabling a transparent and fair global trade system for circular goods and services {15.2.4}

5. Translating circularity aspirations into actionable societal goals {15.2.5}

**d. Implementing circular product design, along with transparency and traceability of products, components, and materials, is crucial for eliminating toxicants and recovering materials** (*well established*). Establishing product information systems and internationally harmonized circular product design and material processing standards can increase transparency of chemical and material compositions, such as plastics and electronics {15.1.3, 15.3.1}.

**e. Improving transparency about materials and prices of circular goods and services is a key requirement to enable traceability** (*well established*). Digital technologies such as product passports can play a crucial role in market transformation for circularity {15.2.1, 15.2.2}.

**f. Including informal sector stakeholders and decent work in waste management, repair, and upcycling is essential to ensuring a Just Transition to a circular economy, especially for women and Indigenous Peoples** (*well established*) {15.2.2}.

**g. Taxation reforms are needed that shift taxes from recycled materials, secondary resources and labour to non-renewable resources and waste** (*established but incomplete*). This will capture the true value of natural resources and the costs of extraction, thereby reducing market failures and negative externalities. Measures to compensate low-income groups accompanying these changes can ensure social equity {15.2.3; 14.3}.

**h. Building capacity within financial regulators, national institutions, and the finance sector to understand and assess the value of circular and nature-positive business models is essential to unlocking finance for the circular economy** (*well established*). Increasing investments for circular solutions requires new metrics and the disclosure of non-financial, nature-related information. This shift can be supported through the international harmonization and adoption of sustainable finance taxonomies, green bonds, and related instruments by central banks, regulators, and financial institutions {15.2.3; 14.5, 18.1.3; 18.2.1; 18.2.5}.

**i. The global illegal waste trade is a multibillion-dollar industry, with profits estimated at US$10-12 billion annually** (*well established*). Expanding existing mechanisms and international initiatives of law enforcement agencies is required to eliminate the criminal practice of waste dumping, particularly from developed countries to low-income countries. At the same time, embedding circularity provisions and sound material management in bilateral and regional trade agreements is a key mechanism for removing barriers to trade in circular goods and services (*established but incomplete*) {15.2.4; 18.2.1; 18.2.4; 18.2.5}.

**j. To make circular and sustainable lifestyles practical and widely adopted, it is essential to establish enabling infrastructure and policies that incentivize behaviours like**

Credit: chuyu2014/Envato

**sharing, take-back, repair, reuse, and rental schemes** (*well established*). Consumer protection rules are essential to ensure safety, quality and public trust in circular products. Increasing awareness and shifts in mindsets will support phasing out linear models and shift consumption patterns {15.2.5; 16.2.2; 18.2.1; 18.2.4}.

k. **By 2050, between 30-58 per cent of the demand for critical energy transition minerals such as lithium, cobalt, nickel, manganese, rare earth elements, platinum and copper could be met through secondary supply from recycling, upstream circular economy practices and technological innovations** *(established but incomplete*). The circularity of critical energy transition minerals will be essential for reducing the growing demand for primary materials and decreasing the need for mining. International coordination on regulations is needed to increase efficiency, reduce waste, and improve governance across mineral value chains {15.1.7, 16.2.4}. E-waste recycling offers significant economic opportunities for the recovery of critical materials. It is estimated that 62 million tons of e-waste were generated globally in 2022, with a global market potential of US$65.8 billion by 2026 (*well established*) {15.1.6; 15.2.1}.

l. **As of 2024, a total of 75 national circular economy road maps have been launched – up from four in 2016 – and more are under development** (*established but incomplete*). These road maps from governments introduce just under 3000 circular economy policies spanning 17 sectors, making it one of the fastest growing environmental policy categories worldwide over the next decade {15.1.4; 15.1.5; 15.1.6}.

## 2.7 Transforming the global energy system

**The transformation of global energy systems involves diversification of the energy-generation mix, decarbonization of the energy supply, demand management, and the development of socially and environmentally sustainable critical energy mineral value chains (well established). These transformations are associated with lower environmental pressures while also addressing energy access and energy poverty {16.2; 18.1.3}.**

a. **The GEO-7 target-seeking scenarios project rapid electrification, growth in low- and zero-carbon and negative-emission technologies, and continuing improvements in energy intensity.** Different scenarios show similar trends of increasing renewable energy and declining unabated fossil-fuel use, with a more than doubling of the electrification of final energy demand by 2050. Lower-energy-demand pathways rely less on bioenergy with carbon capture and storage (BECCS), whose large-scale deployment can raise sustainability concerns related to land and water use and biodiversity {16.2; 11.3; 11.4; 18.2.4; **Box ES 2.2**}.

b. **Limiting end-of-century warming to around 1.5°C relative to pre-industrial levels will involve rapid decarbonization, with more than 75 per cent of primary energy from low- or zero-carbon sources by 2050** *(very well established)*. Investment in grid systems is projected to approximately double by 2030 to about US$600 billion per year, supporting reliability and access *(well established)* {16.2.3}.

c. **Atmospheric carbon dioxide removal (CDR) options are critically important for achieving net-zero $CO_2$ emissions by mid-century and for pathways that limit end-of-century warming to around 1.5°C** *(well established)*. CDR compensates for residual emissions from hard-to-abate sectors. BECCS and biochar can provide net-energy outputs, whereas direct air capture with carbon storage (DACCS) and enhanced weathering increase net-energy demand. Large-scale deployment of biomass-based CDR options, especially BECCS, is associated with sustainability trade-offs related to land and water use, biodiversity, and social acceptance {16.2.3; 11.4.1; 18.2.4}.

d. **Replacing fossil fuels in harder-to-electrify sectors involves the development of markets for sustainable biofuels, green hydrogen, green ammonia, and green methane, which**

### Box ES 2.2 Widescale deployment of bioenergy

Widescale deployment of bioenergy has the potential to deliver multiple low-carbon energy solutions, including heat, power, and liquid biofuel, with or without formal designation as bioenergy with carbon capture and storage (BECCS). It may be an important technology in enabling net zero. However, the land use associated with this demand could be significant. The two target-seeking scenarios of GEO-7 both commit less than 100 million ha of land to BECCS, which is significantly less than earlier assessments. This provides a more realistic and achievable future land-use estimate for BECCS, alongside other carbon dioxide removal technologies that can be sustainably delivered. In contrast, the technical potential of several billion ha of bioenergy cropping is unlikely to be realized, because of limitations associated with sustainability trade-offs related to loss of biodiversity, water use and conflicts with land for food, for nature-based solutions, in direct land-use change, Indigenous territories and for inclusive conservation *(well established but incomplete)*.

**are at different stages of technological and commercial maturity** *(well established)*. Circular economy approaches are critical to reducing greenhouse gas (GHG) emissions in high-impact sectors. Hard-to-abate industries such as steel, cement, petrochemicals, and batteries rely on advances in resource efficiency and material recovery to lower their environmental footprint {16.2.3, 15.1.6}.

e. **Urgent and sustained reduction and transformation of energy consumption is necessary (virtually certain). Upgrading to high-efficiency appliances, higher-density urban centres, and public and active transport can reduce energy demand and provide co-benefits** *(very well established)*. Stricter minimum energy performance standards and passive building designs are effective solutions. Heat pumps can have positive impacts on energy usage, and installations can be supported by subsidies and regulations *(virtually certain)*. Policies and funding mechanisms that promote mixed land-use practices support public and active transport, avoid long-term carbon lock-in, and improve human well-being *(well established)*. Prioritizing populations in poverty, including those in informal settlements or with disabilities, can ensure equitable access to lower energy options *(established)* {16.2.2;16.4.1; 14.6; 14.6.4; 15.1.6}.

f. **Supporting behavioural change and collective action contributes to reducing energy use and addressing inequality** *(well established)*. Actions such as recycling, switching off equipment, and adjusting thermostats can reduce building energy demand by 5–30 per cent, depending on building type and region. Urban and rural renewable energy communities demonstrate how local ownership of energy systems can, in some contexts, enhance participation and resilience. Social movements focused on climate and energy justice have been associated with advancing awareness and engagement in transitions {16.2.1; 16.2.2; 16.4.2; 14.6; 15.2.5; 18.2.3}.

g. **Closing the energy poverty gap involves expanding access to modern and affordable electricity and clean cooking fuels at both household and community levels** *(very well established)*. Achieving universal energy access by 2030 is estimated to cost about US$45 billion per year, less than 2 per cent of global clean energy investment. Improved energy access supports progress toward multiple Sustainable Development Goals by enhancing basic services, health, education, and livelihoods. Stand-alone systems and mini- or micro-grids can provide a reliable electricity supply in areas not served by centralized systems. Incorporating social and cultural contexts has been shown to improve adoption rates of clean electricity and modern fuels *(well established)* {16.2.1, 18.2.3}.

h. **Reforming economic incentives and reducing subsidies for fossil fuel production and consumption can improve the economic competitiveness of low-emission energy systems** *(well established)*. In 2022, global fossil fuel subsidies were estimated at about US$7 trillion annually, equivalent to 7.1 per cent of global GDP. Internalizing the costs associated with carbon emissions, including through carbon pricing, estimates of the social cost of carbon, and other regulatory measures, has been shown to support decarbonization efforts {16.2.3; 16.3.3; 14.3.3}.

i. **Circularity in critical energy transition minerals (CETM) value chains can moderate negative environmental and social impacts** *(well established)*. The demand for CETMs is expected to increase fivefold between 2018 and 2050. At least 54 per cent of critical energy transition minerals are located on or near Indigenous Peoples' territories. Where trade-offs exist, the use of participatory and rights-based approaches can address inequities, especially for Indigenous Peoples and marginalized groups *(well established)* {16.2.4, 16.5, Box 16.1, 15.1.6, 15.3, 18.2.1, 18.2.4}.

Credit: © UNEP

j. **Leveraging public finance to de-risk and lower the cost of capital can stimulate greater private investment in energy transitions in many countries of the Global South** (well established). Targeted financial support and concessional finance in these regions have been associated with improved energy access, including for Indigenous Peoples and marginalized communities, when designed with local participation. Guarantee mechanisms have successfully attracted private investment in the Global South *(established)*. Development finance institutions and multilateral development banks can act as intermediaries between financial markets and borrowers, helping to reduce real and perceived risks, lower financing costs, and enhance investment flows through blended finance instruments and risk-sharing facilities *(well established)* {16.2.1; 16.3.3; 14.4; 14.5}.

k. **Sustainable and just energy transitions can contribute to climate change adaptation and the protection of ecosystems and biodiversity** *(well established)*. In some contexts, energy projects and related infrastructure have been associated with environmental injustices and rights-based infringements affecting some Indigenous Peoples and their territories, with adverse implications for biocultural diversity. Expanding energy access and reducing energy poverty can enhance the resilience of vulnerable populations, for example, by enabling early warning systems and supporting essential services *(very well established)* {Box 16.2; Box 16.3; 18.2.3}.

## 2.8 Transforming the global food system

**Addressing the global environmental crises needs a transformation of the food system through systemic changes across consumption, production, and trade. These include shifting to healthy and sustainable diets, improving the efficiency and resilience of food production, enhancing circularity across the food system, reducing food system losses and waste, increasing adoption of healthy and sustainable novel foods, and reforming food industry practices, market structure and trade {17.2, 18.1.2}.**

a. **The GEO-7 target-seeking scenarios highlight that improved agricultural practices, yield improvements, dietary changes and food waste reductions are key to relieving pressure on land and biodiversity and to achieving climate and air pollution goals** *(well established)*. Both scenarios present alternative food production strategies, ranging from highly intensified systems to mixed systems that combine Indigenous, local, and scientific knowledge. Pressure on agricultural production is reduced through dietary changes and less food loss and waste, limiting the need for agricultural land expansion. Dietary shifts that curtail the overconsumption of animal-sourced foods have the greatest impact, reducing land for pasture and feed while associated improvements enhance biodiversity, reduce surplus manure and associated pollution, decrease greenhouse gas and air pollution emissions, and provide significant health benefits. These changes, together with improved irrigation management techniques, can also substantially reduce water stress while providing adequate water for irrigation, as abatement of agricultural methane and ammonia emissions also contributes to reducing atmospheric pollution {11.3.2, 11.4.2, 11.4.4, 11.4.5, 11.4.6, 11.5.2, **Box ES 2.1**}.

b. **A sustainable food system significantly reduces greenhouse gas emissions, limits adverse impacts on biodiversity, avoids land and ocean ecosystem degradation, and air and water pollution, is resilient to shocks and stresses, ensures access to sufficient affordable and healthy food, provides equitable livelihoods and respects the rights of Indigenous Peoples** *(well established)*. Goals achieved by such a food system include close to zero loss of areas of high biodiversity importance {18.2.1}; achieving land degradation neutrality {18.2.1}; and eliminating surface and groundwater abstraction for agriculture beyond replenishment levels. Such a food system would achieve a 50 per cent reduction in all food system greenhouse gas emissions by 2050 and provide space for the adoption of land-based climate mitigation measures {16.2.2, 18.2.4} and other climate mitigation measures. Such a food system would provide food security, including, sufficient, healthy, safe, and affordable food for all; halt the rise in obesity and diet-related non-communicable diseases and end micronutrient deficiencies; ensure fair treatment of workers throughout the food system; while integrating Indigenous Knowledge and Local Knowledge in decision-making; and ensure resilience to shocks and stresses {17.1; 18.2.2, 18.2.3}.

c. **Making healthy and environmentally sustainable food affordable requires addressing poverty, rather than making current, often unhealthy, food cheaper** *(established but incomplete)*. Even though food productivity has outpaced population growth in the past 60 years, with lower real-terms food prices, 700-800 million people remain undernourished, and over one billion people are overweight or obese. Actions are needed to improve welfare payments and social safety nets and take actions where groups would otherwise be adversely impacted by the food system transformation, i.e., where internalised true costs raise food prices {14.3.2, 15.2.2}. In combination, such measures could reduce poverty and inequity {17.2.1; 17.3.3; 17.4}.

d. **Livestock's environmental footprint can be reduced by lowering overall demand for animal-sourced food and improving production practices** *(well established)*. Key strategies include improving the efficiency of livestock production practices and adopting regenerative practices that include practicing lower-intensity livestock production, improving animal feed to reduce GHG emissions, reducing food losses and waste, reforming subsidies and taxes, and encouraging dietary shifts towards more plant-based diets and alternative proteins. The scale and pace of change are currently too slow to meet environmental goals {17.2.1-5}.

**Five solution pathways have been identified to achieve the desired transformation of food systems, with each goal requiring a mix of pathways. All pathways require actions by multiple actors, including policymakers and regulators, non-governmental organizations, the food industry, the financial sector, and individuals.**

1. **Increased food production efficiency needs to be accompanied by changes in consumer behaviours, such as a shift in diets** *(well established)*. Key to this shift would be substantial reductions in the consumption of animal-sourced foods, particularly in high-income countries, with increased consumption of a diverse range of fresh and minimally processed foods, as well as reductions in overconsumption and consumer food waste. Without such changes, more efficient food production may achieve less than anticipated for the environment, and could exacerbate other adverse outcomes, such as obesity. Changes in consumer preferences, social norms and food environments, including food industry changes on how foods are formulated and marketed and the information provided to consumers, would support a shift to sustainable healthy diets {14.6, 15.2.5}. However, achieving these changes is more likely to require food prices that more fully reflect the environmental and health costs of producing and consuming those foods {14.3}, estimated to be about US$20 trillion per year, including US$7 trillion in environmental costs and US$11 trillion in human health costs. Supporting policies include improved targeting of subsidies, estimated to be currently more than US$1 trillion per year, and the use of consumer taxes and subsidies to align food prices with their true costs to society. This will make some foods, and especially animal-sourced foods, more expensive {17.1; 17.2.1; 17.4; 18.2.5}.

2. **Crop, livestock, and aquatic food production practices can be changed to be more efficient, resilient, and sustainable.** Development and deployment of high-performing crop and animal varieties/breeds resistant to heat, drought, salinity, and pests, combined with environmentally sustainable production systems, such as regenerative and nature-positive practices – conservation agriculture, integrated production systems, agroecological practices – and the use of locally adapted, Indigenous and underutilized species are potential approaches. Such approaches restore soil health, enhance water retention, reduce GHG emissions, reduce dependence on synthetic inputs, and support pollinators and other beneficial biodiversity. Achieving biodiversity goals will require a combination of both multifunctional land use and targeted conservation, underpinned by environmentally sustainable intensification in remaining agricultural areas {11.6, 18.2.1}. Capture fisheries and aquaculture production also require stronger implementation and enforcement of sustainable management practices {18.2.2; 18.2.3}.

3. **Reducing food losses and waste across the food system, including through circular approaches, would enhance food security and reduce environmental damage** *(well established)*. Food waste during retail and food service, and at the household level, accounts for 19 per cent of available food, with additional losses during production and harvest, transport, storage, and processing, leading to about 35 per cent loss overall. The amount of food that needs to be produced and associated environmental damage can be decreased by reducing these losses through combinations of behavioural and technical approaches across the food system. Adopting circular approaches, including nutrient recycling of waste and by-product streams, improves environmental outcomes (17.2.3; 15.3; 18.1.3; 18.2.5).

4. **Novel alternative proteins, including cultivated meat and fermentation-derived products, offer the potential to displace conventional animal-sourced foods and significantly cut GHG emissions – especially when produced using renewable**

**energy. This can also reduce land and water use and biodiversity loss, while meeting human nutritional needs; however, more research and investment are needed** *(established but incomplete)*. Uncertainty remains around the contribution and possible negative impacts that these novel foods could provide and when. Realizing the potential of novel alternative proteins that meet both health and sustainability goals would be supported by increased public and private investment, an internationally coordinated research programme, regulatory adjustments and consumer willingness to purchase, underpinned by evidence on safety, nutrition and environmental impacts {17.2.4, 18.2.4}.

5. **Reforming and strengthening regulation of the global food industry market structure and trade would support achieving the desired transformation** *(established but incomplete)*. Coordinated multinational policymaking is needed to regulate transnational corporations operating in the global food system. Better alignment of private incentives with societal outcomes can be achieved by repurposing food and agricultural subsidies and taxation, removing perverse incentives and internalizing health and environmental costs into food pricing. There is a need to strengthen regulation, including on food marketing, and to curb excessive market power through stronger competition policy and targeted structural measures {14.4, 17.2.1-3; 17.2.5; 17.3}.

## 2.9 Enabling a sustainable and resilient environment system for human well-being and nature

**The solution pathways assessed for the economic and financial, materials/waste, energy, and food systems are enabled by a sustainable and resilient environment system. This requires a combination of pathways and solutions to accelerate conservation and restoration of biodiversity and ecosystems, building resilience through socio-ecological and socio-technical approaches to ensure the restoration of natural capital, adaptation of societies and implementation of climate mitigation strategies.**

a. **GEO-7 target-seeking scenarios demonstrate that protection of existing ecosystems, restoration of degraded lands and improved agricultural practices are crucial to reversing biodiversity loss, halting land degradation, and addressing climate change** *(well established)*. Both transformation scenarios envision an increase in protected areas, ranging from 30 per cent with strict protection *(land-sparing)* to 50 per cent with more symbiotic relations between humans and nature *(land sharing)*. Both land-sparing and land-sharing approaches in the target-seeking scenarios can contribute to preventing the conversion of natural land and increasing the possibilities of tackling biodiversity loss. Furthermore, the conservation and expansion of natural lands enable them to act as important carbon sinks, contributing to climate change mitigation while improving natural capital. However, protection alone is not enough, it needs to be combined with more efficient and sustainable agricultural production to avoid food deprivation in vulnerable populations, which may arise from increased competition for land. This should be coupled with sustainable and resilient livelihood options for historical stewards, including Indigenous People as well as communities that have long-term connections to place {11.3.2, 13.4, 12.4.1, 12.4.4, 12.5, 12.6, 17.2.2, 17.2.3, **Box ES 2.1**}.

Credit: Milaspage/Envato

**Five solution pathways to achieve a resilient and sustainable environment system have been identified:**

1. **Protecting and conserving ecosystems and biodiversity, in conjunction with sustainable land management and marine spatial planning practices, is critical for the overall sustainability of the planet and implementation of the Kunming-Montreal Global Biodiversity Framework target 3, to conserve 30 per cent of land, water and seas, coupled with stronger measures to decrease pressures on nature** *(established but incomplete)*. Conservation and restoration of ecosystems and biodiversity require a broad mix of pre-existing and more innovative approaches for managing drivers and minimizing pressures on the environment, such that both quantity and quality of natural capital and ecosystem services can be enhanced. These include the expansion and interconnection of protected areas to create biodiversity buffers and corridors, including area-based conservation, conservation in traditional territories of Indigenous Peoples as well as local communities and stronger pollution control, including reducing plastic pollution and circular economic solutions {18.2.1; 15.1.6, 17.3.1}. Safeguarding the rights, access, and benefits of Indigenous Peoples over their traditional lands, who govern formally or customarily at least a quarter of the world's terrestrial surface *(well established)*. These lands support a large portion of the world's biological and cultural diversity, as well as Indigenous, traditional, and local knowledge systems {18.2.3; IK&LK Chapeau D, 13.5, 2.1.1, 17.3.1}.

2. **Widescale implementation of nature-based solutions (NbS), as defined by UN Environment Assembly Resolution 5.2, broadly focuses on sustainably managing natural and modified terrestrial, freshwater, coastal and marine ecosystems for effective delivery of ecosystem services, human well-being, resilience and biodiversity benefits, including enhancing the delivery of ecosystem services by supporting and improving natural and semi-natural systems** *(established but*

*incomplete)*. Implementing NbS in the majority of studies is an effective strategy for systems transformation that can enable a resilient and sustainable environment in the future, with multiple practices known and some already deployed. These include or involve enhancing ecosystem services such as soil regeneration and pollination; restoring ecosystems; regenerating production systems; practicing sustainable agriculture, aquaculture and fisheries {17.2.2}; using renewable energy and building urban green and blue infrastructure {16.2.3}; and adopting ecosystem-based adaptation (EbA) and ecosystem-based disaster risk reduction (Eco-DRR){18.2.2}.

3. **Integrating approaches to enhance socio-ecological systems resilience through upscaling locally led adaptation is crucial for driving transformative adaptation and minimizing adverse consequences from climate-induced multi-hazards (***established but incomplete)*. A mix of bottom-up and top-down adaptation strategies should leverage Indigenous Knowledge, traditional knowledge, and local knowledge of Indigenous Peoples as well as local communities to foster innovative creation and implementation of robust preparedness and response strategies against unprecedented multi-hazards. Locally led adaptation initiatives utilize the wealth of knowledge systems and experience that Indigenous Peoples, as well as local communities, possess regarding their environments, ensuring that the solutions developed are culturally appropriate and have community buy-in, which is crucial for their long-term success {18.2.3; 16.3, 17.3.5, IK&LK Chapeau E}.

4. **The acceleration of circularity and, in particular, the development and supply of innovative bio-feedstocks and deployment of a sustainable bioeconomy infrastructure are vital components of transformation** *(established but incomplete)*. This transformative change offers significant potential for less carbon-intensive production of food, materials, pharmaceuticals, and chemicals, including the valorization of waste streams. However, effective governance is required to ensure sustainability and avoid detrimental trade-offs, such as those with land for food, biodiversity, and natural capital. Fourteen national bioeconomy strategies and over 20 national bioeconomy-related strategies were developed by 2021 {Box 18.4}. The bioeconomy requires a significant increase in bio-based feedstock resources, with the exact requirement determined by how effectively municipal waste, crop residues, and other biomass streams can be utilized. Bioengineering for new plant, animal and microbial resources could produce multiple high-value chemicals, pharmaceuticals, fuels and materials, alongside novel products such as cultivated meat and plant-based proteins and medicines {18.2.4; 15.3, 16.2.2, 18.2.4}.

5. **Instituting a strong adaptive governance that works alongside the four solution pathways identified above, and integrating them across the materials/waste, energy and food systems, are required aspects of transformation. This embraces and accommodates multiple decisions and priorities that can be foundational for the scale-up and scale-out needed in transformative solutions** *(established but incomplete)*. These solutions are already known but are poorly connected or implemented and are ineffective at achieving the necessary goals in the absence of a strong governance arrangement. Adaptive governance, by connecting local communities and integrating Indigenous Knowledge and Local Knowledge with central policies for biodiversity conservation, CCA, and transformation to the circular bioeconomy, could be instrumental for addressing the key drivers and pressures on environment systems.

b. **The transformative potential of these proposed solution pathways largely depends on how levers and actors at different levels could be rapidly mobilized at scale and across a broad spectrum of socio-ecological systems** *(established but incomplete)*. Indigenous Peoples and other local communities experiencing historic relationships with nature and direct dependence on ecosystem services can play a key role in co-designing and executing solutions with other actors. Other public and private sector actors at local, national and international levels play important roles in facilitating access to the technology, finance, and capacity needed for implementing solutions, as well as in bridging the gaps between these levels' processes that tackle global-scale crises. Ongoing evaluation and feedback are key to success in the effective implementation of these transformative processes {18.3.1.4, 18.3.2.4, 18.3.3.3, 18.3.5, IK&LK Chapeau C}.



## 2.10 Accelerating transformation

**If internationally agreed** *(or adopted)* **goals and targets are to be met, current transformations across systems need to be accelerated in a sustainable manner that is inclusive and just for all. This requires systems to transform not just faster, but also at a greater scale and higher level of cross-system integration and depth** *(well established)*. Speed is critical because of the potential for irreversible environmental damage if urgent action is not taken; without scale, isolated or incremental transformation is unlikely to achieve widespread change. Integration and depth can multiply impact and reduce trade-offs, making transformation more efficient and pluralist {21.5.2}. Inclusion and justice are critical to ensure that efforts to accelerate do not leave anyone behind and widen equity gaps {21.5.3}.

a. **A whole-of-government and whole-of-society approach is critical for governing a sustainable acceleration to overcome potential losses, resistance from vested interests and differences in values, but also for framing new forms of multilateralism such as coalitions of the willing** *(established but incomplete)*. Such an approach can align ministries and sectors, build trust, and increase the social and political acceptability of acceleration, while also incorporating plural values, minimizing trade-offs, and maximizing synergies. No system and country can accelerate alone, and traditional multilateralism does not consistently reflect power asymmetries or the priorities of low-income countries. Hence, new forms of multilateralism can also be fostered by whole-of-government and whole-of-society approaches, reflecting a pragmatic shift towards making cooperation more targeted and more agile {21.5.3}.

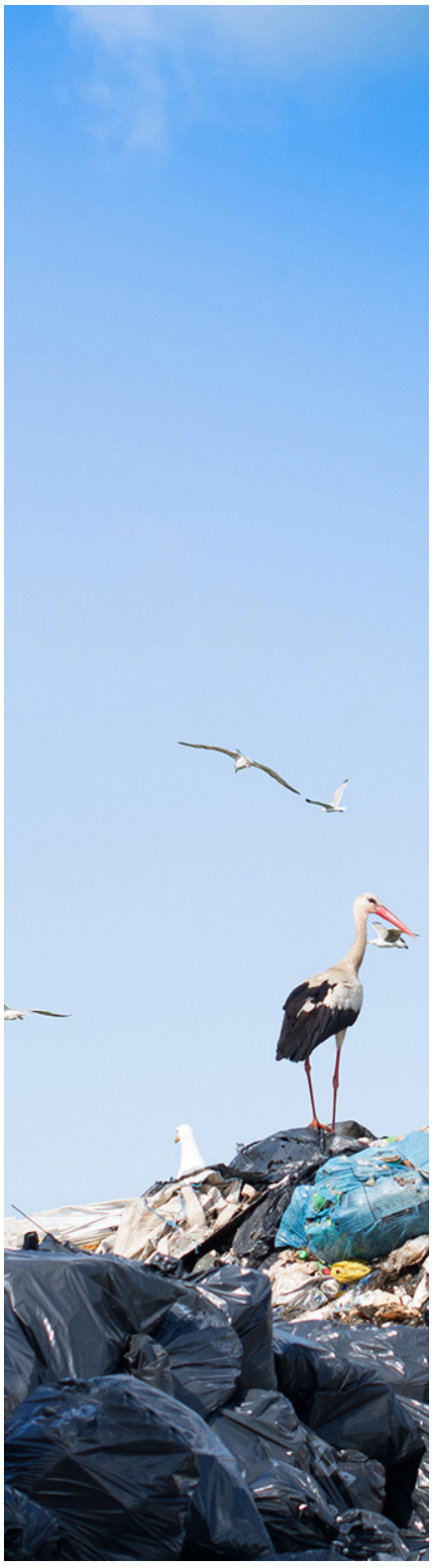
b. **Sustainable acceleration can be supported by three processes** ***(established but incomplete)*****:**

- **The co-production of transformative pathways: co-production reflects a whole-of-society approach to account for what is known and needed, aiming to build social and political legitimacy and lay the foundations for shared ownership and faster uptake** *(well established)*. Breaking cross-system lock-ins requires whole-of-government coordination {12.7}. It is also critical to turn such lock-ins into opportunities through a mix of multi-level strategies – including big plans, small wins, and rule changing across society and systems – while centering on the rights and resilience of the most marginalized to ensure acceleration happens in a just and inclusive manner {21.3}. Empowering diverse actors and aligning their interests can generate joined-up agendas, enhancing accountability and collective action, reducing the economic free-rider problem, and building trust to foster willingness to invest, share knowledge and take risks {21.1, 21.4, Figure 21.1}.

- **If transformation is to be accelerated, all agents of change – actors, networks, communities of interest and social movements – must be involved, and nature should be at the centre of decision-making, while various interests should be rebalanced to facilitate common portfolios** *(well established)*. Agents of change can support acceleration by disrupting cross-system lock-ins, challenging dominant pathways of development, and mobilizing resources to shift the status quo. Governments can establish policies, legislation and financing that drive transformation. Intergovernmental organizations can support new models of multilateralism and set ambitious global standards. The public can push for change as consumers, voters, investors, and activists. Civil society actors can connect people to power, hold institutions accountable, and advocate for justice and inclusion. Private businesses can produce environmentally conscious goods and make sustainable investments. Academia can generate policy-relevant knowledge and educate future leaders. Nature is foundational to the stability, productivity, and long-term sustainability of all human and ecological systems. Networks of actors, such as clubs of like-minded countries, can reduce gridlock and foreground joint action. Communities of interest and social movements can leverage their collective influence and moral authority {21.4.1}.
- **Rebalancing the interests of various agents is key to acceleration. Without it, those benefiting from the status quo may slow, block, or reverse progress** *(well established)*. Acceleration can create both winners and losers, and this should be actively managed, not ignored. It can be achieved by reforming existing governance frameworks that produce inequalities to ensure all agents have a voice, especially Indigenous Peoples and other marginalized groups or communities, by adopting rights-based approaches to help mediate social and political friction, and by ensuring greater accountability and transparency. These efforts may slow down decision-making and bring attention to politically sensitive trade-offs and vested interests in the short term. However, they are essential for building trust and legitimacy, gaining societal acceptance of solutions including controversial technologies and behavioural shifts, reducing state and society capture from individual interests, and driving performance and ambition in the medium and long term {21.4.1}. Addressing inequality, regional disparities, and other social concerns alongside environmental goals is central to avoiding trade-offs with human development objectives and ensuring that the benefits and costs of transformation and acceleration are equitably shared {11.5, 11.7, 21.5}.

c. **To encourage cooperation on joined-up agendas and common portfolios, the interests of different agents can be aligned by activating core motivators** *(established but incomplete)*. Motivators can be viewed as issues that resonate with agents by highlighting shared, immediate and tangible concerns that transcend system boundaries and self-interest and provide a compelling or morally persuasive rationale for acceleration. Health can be viewed as a universal motivator because concerns over a population's rising rates of obesity, diabetes and heart disease can act as a powerful catalyst for accelerating the transformation of the food, energy and economic systems. This can be achieved through reforms in agricultural practices, promoting clean air and active transportation policies, and supporting the well-being economy or health-in-all-economic policies. Likewise, economic stimulation can drive acceleration across systems and agents by shifting incentives, relocating capital and redefining value. In contrast, prevalent social norms, cultural values and beliefs of Indigenous Peoples as well as local communities can be deployed to shape behaviours, foster identity and cooperation, and provide a moral compass for acceleration {21.4.2}.

# 03 Part 3: Regional Solution Pathways



Credit: perutskyy/Envato

**The global environmental crises are affecting every region of the world, albeit to differing extents**. Annex 1 lists the priority issues that are curtailing socioeconomic development, which can be addressed using regionally specific transformational interventions.

Tailoring solution pathways and system transformations can account for issues common to all regions and issues specific to each region, considering their sociocultural, economic, development, environmental, governance and financial circumstances. The priorities were determined after an extensive literature review conducted by regional and global subject matter experts.

Individual countries in each region may also have more specific priorities, noting that solution pathways will be context-specific. The following options, identified through system transformation analysis and informed by the scenario analysis, outline solutions that are well-suited to the characteristics described, but may not be applicable in all contexts.

**Regional solution pathways can be:**

- designed so that the systems are transformed holistically and in an interconnected manner at a regional and subregional scale, considering human and natural systems around the globe are connected synergistically, called telecoupling, through international trade, migration, foreign investment, and flows of ecosystem services
- tailored to account for equity and socioeconomic disparities among and within regions
    - High-income countries can make the most significant contribution by reducing resource consumption and promoting global sustainability through financial and technological innovation.
    - Middle-income countries can balance economic growth with sustainability, embrace innovative infrastructure development, and green policies.
    - Low-income countries can overcome systemic challenges, such as hunger and poverty, by leapfrogging old technologies to improve livelihoods and build climate-resilient communities and infrastructure with international support and targeted investment.

**Figure ES 3.1: Tailoring system transformations to regional priorities**

Priorities were selected based on their relevance to a significant portion of a given region, their influence on at least two of the environmental crises, and their persistence within the region. Priorities are deemed unlikely to be addressed without an integrated approach for transformation

### Western Europe and Others

**Priorities**
- Biodiversity loss and ecosystem change
- Climate extreme events
- Pollution and waste

**Solutions**
**Finance:** Shift incentives, internalize costs
**Energy:** Smart grids, decarbonize industry
**Food:** Regenerative farming, circular chains
**Materials:** Eco-taxation, consumer reform
**Environment:** Triple renewables, SDG-aligned finance

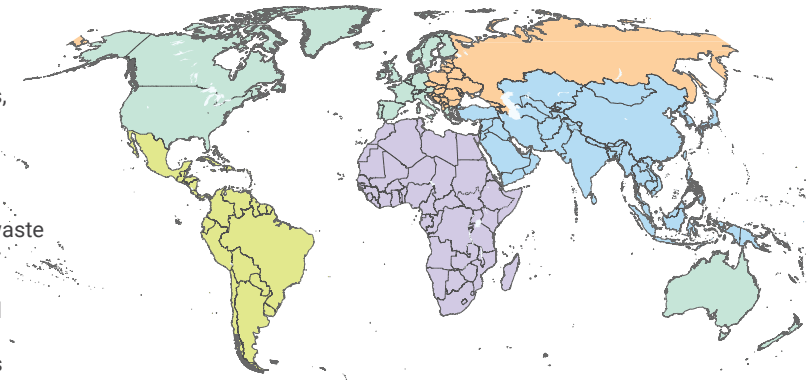
### Eastern Europe

**Priorities**
- Ecosystem services loss due to unsustainable agriculture
- Unsustainable energy systems impacts on climate and health
- Biodiversity loss due to weak management frameworks

**Solutions**
**Finance:** Green bonds, concessional lending
**Energy:** Decentralized renewables, housing retrofits
**Food:** Precision agriculture, reduce feed crops
**Materials:** Sector-wide targets, behavior shift
**Environment:** Corridor connectivity, rewilding

### All regions

**Finance:** Redirect subsidies, SDG-aligned finance
**Energy:** Renewable energy deployment, energy access
**Food:** Sustainable diets, agroecology, reduce food waste
**Materials:** Promote circular economy, waste recovery
**Environment:** Nature-based solutions, ecosystem restoration, protected areas



### Latin America and the Caribbean

**Priorities**
- Changes in land cover dynamics
- Changes in freshwater quality and availability
- Degradation of coastal and marine resources

**Solutions**
**Finance:** Green bonds, debt-for-nature
**Energy:** Solar/wind investment, cross-border grids
**Food:** Agroecology, no-deforestation chains
**Materials:** Organic waste reuse, circular innovation
**Environment:** Indigenous-led reforestation, NbS scale-up

### Africa

**Priorities**
- Unsustainable resource exploitation and use
- Ecosystem degradation
- Climate change and climate extremes

**Solutions**
**Finance:** Redirect debt, green finance
**Energy:** Solar + microgrids, clean cooking
**Food:** Agroecology, local protein
**Materials:** Repair/reuse, informal recovery
**Environment:** Forest restoration, carbon sinks

### Asia-Pacific

**Priorities**
- Climate change impacts on development and cultural heritage
- Land use change impacts on ecosystems
- Pollution and waste impacts on ecosystems and human health

**Solutions**
**Finance:** Tax polluters, concessional loans
**Energy:** Grid upgrade, green fuels
**Food:** Aquaculture reform, plant-based diets
**Materials:** Circular manufacturing, citizen action
**Environment:** Forest conservation, IK integration

- A combination of domestic and international public and private financing can be used, particularly by low-income countries, in the form of bundled and blended finance comprising grants and concessional loans, as well as financial mechanisms associated with environmental conventions.

## 3.1 Economic and financial systems

**Overview:** Improving management of environmental systems by transforming energy, material, and food systems requires a radical transformation of global financial, economic, and trade governance systems. All regions are highly diverse in their economic and financial conditions and systems. High-income countries can strengthen international tax norms, advance the effectiveness of the development banking system, and stimulate green technologies. Adapting regional approaches is crucial for highlighting the unique or distinctive elements of each region, including its capacities, vulnerabilities, and institutional frameworks. Middle-income countries can invest in sustainable infrastructure and account for environmental and health externalities, and low-income countries can overcome financial constraints for transforming their energy and agricultural systems with support from direct investment and debt relief {19.3; 19.8}.

**Africa: Redirecting national financial systems towards climate and sustainability goals can unlock this region's potential. This could involve innovative mechanisms that can attract private investment, bearing in mind and recognizing the importance of aid-related debt in the process, and using incentives to promote green behaviours and investments** *(established but incomplete)*. African countries can support this transformation through the continuity of the African Union's Continental Green Recovery Action Plan, including renewable energy and green finance reform {14.4.1; 14.2; 14.5; 20.4.2; 20.4.3}.

**Asia and Pacific: Subsidizing desired outcomes, such as zero-carbon initiatives, and taxing undesirable ones, such as putting prices on externalities, can support transformation alongside the integration of environmental and social costs into national development planning** *(established but incomplete)*. Working with Regional Development Banks' instruments – including concessional loans, equity investments, capacity-building, blended finance, green bonds, and investment advisory services – can be scaled up to deliver transitions to low-carbon economies, and increased investments in nature-based solutions {8.3.2; 8.3.3; 14.3, 14.4, 20.5.2, 20.5.3}.

**Eastern Europe: For European Union member states and candidate countries, aligning reforms with European Union directives and green policies can deliver transformations. Meanwhile, all countries in this region can implement distinct strategies consistent with the priorities of the region – supporting investments in renewable energy, promoting energy efficiency, and implementing certification and transparent financial systems** *(well established)*. Financial instruments, such as green municipal bonds, concessional lending, and European Union-aligned sustainability taxonomies, can be tailored to local contexts and facilitate public-private ventures. This can be combined with communication strategies towards transparent governance, to support scaling of nature-positive infrastructure and the transformation to a circular low-emission economy {8.4.4; 14.5; 20.6.2; 20.6.3}.

**Latin America and the Caribbean: Financial resilience requires scaling green finance, including sustainable bonds, climate risk insurance, community-led green investments, and debt-for-nature swaps** *(well established)*. Market interventions combined with expanded

institutional capacity within public and regional agencies are critical to the transformation, along with sustainable finance, community-led investments, and inclusive financial practices. Regional cooperation frameworks, such as development banks and sub-regional environmental agreements, can also play a key role in mobilizing resources and knowledge exchange {14.4; 14.5; 20.7.2; 20.7.3}.

**Western Europe and Others Group: Governments can shift public and private investment away from consumption with short-term returns towards public goods with long-term returns, such as healthy ecosystems and protected areas** *(established but incomplete)*. Solutions include internalizing externalities or "getting prices right", reducing risks associated with foreign direct investment in low-income countries, debt cancellation, and the development and expansion of existing financial tools for redistribution and investments, such as green bonds and finance or "getting incentives right" {14.3; 14.4; 14.6; 20.8.2; 20.8.3}.

## 3.2 Materials/waste system

**Overview:** Material production and consumption patterns remain unsustainable in all regions. Achieving the Sustainable Development Goals will remain unattainable without drastic shifts towards material circularity. Further strengthening global frameworks to ensure harmonization can have a positive impact. High- and middle-income countries can transform to less resource-intensive production and consumption, while encouraging sustainable lifestyles. Middle-income countries can invest in resource-efficient buildings and infrastructure as they grow. Low-income countries can prioritize waste management through regulatory frameworks and effective citizen participation, leveraging the informal sector for resource recovery {15.1;15.2; 19.4}.

**Africa: Sustainable material production and consumption can conserve Africa's finite resources, given that demand is projected to rise by 150 per cent by 2050** *(established but incomplete*). Countries transforming to circularity in Africa can access multilateral and blended finance, such as the Africa Circular Finance Facility. The resulting economic growth, job creation, cost savings, improved efficiency, market opportunities, and increased resilience can outweigh the challenges. Circularity presents opportunities for promoting reuse, resale, repair, and recycling {8.2.3;19.5.3; 4.3.1.6; 15.2.3, 20.4.2, 20.4.3}.

**Asia and Pacific: Circularity transformations in manufacturing, construction, food, packaging, e-waste and plastic waste can reduce, reuse and recycle materials to lessen environmental impacts** *(well established but incomplete)*. Adopting circularity solutions can improve waste collection, segregation, and material recovery. Regulatory frameworks and effective citizens' participation can facilitate and accelerate circularity transformation {8.3.2; 8.3.5; 15.2; 20.5.2; 20.5.3; Figure 20.10}.

**Eastern Europe: Developing binding resource use targets for all sectors, beyond the current focus on municipal, construction and demolition waste, can benefit circularity transformations** *(established but incomplete)*. For effective transformations to circularity, monitoring of waste management, resource extraction, and the physical and chemical processing of ores is critical. Behavioural changes can play a key role in reducing overconsumption and lowering material footprints {8.4.3; 8.4.4; 15.2.5}.

**Latin America and the Caribbean: Targeted actions that drive resource efficiency, waste reduction, and sustainable growth across all sectors can assist systems' transformation**

*(well established)*. The region's per capita material footprint is projected to reach 14–25 tons, well above the recommended sustainability threshold of 6–8 tons. Domestic waste, dominated by organic materials, creates opportunities for the innovative transformation of biogas generation and organic fertilizer, reducing pollution and GHG emissions {8.5.3; 8.5.4; 8.5.5; 15.3; 20.7.2; 20.7.3}.

**Western Europe and Others Group: Material use reduction can be implemented across all industry sectors by disincentivizing planned obsolescence, promoting design for durability, repairability and robust product standards, and increasing ecotaxation to accelerate circularity** *(established but incomplete)*. The shift towards green consumerism, prioritizing sustainable and eco-friendly products and services, can be supported by improved technologies, including digital tools, regulatory oversight of advertising messages, and emerging market reforms. Similarly, behaviour change that uses financial incentives and ecotaxation to support a shift towards sustainable lifestyles can support the transformation {8.6.5; 20.8.2; 20.8.3; 15.2.5}.



## 3.3 Energy system

**Overview:** All regions, to varying degrees, can pursue the repurposing of fossil fuel subsidies, a phase-down of fossil fuels, and a phase-out of coal. Coupled with a transformation to renewable energy with upgraded transmission and distribution systems, including smart grids, and improved end-use efficiency through a combination of technological advances and changes in demand management and behaviour. Decentralizing microgrids can increase energy access and reduce energy poverty, while also introducing the use of modern biomass for cooking. High-income countries can mobilize substantial private sector investment for the transformation to a low-carbon economy by developing effective policies, regulatory frameworks and support systems. Low and middle-income countries can repurpose fossil fuel subsidies and use international aid to underpin the initial high costs of sustainable infrastructure and technologies. Innovative financial mechanisms can be used to support positive energy transformations globally through targeted renewable energy subsidies and other methods. In all regions, there is a need for resilient energy infrastructure. Adapting regional approaches is key to highlighting the unique or distinctive elements of each region, such as capacities, vulnerabilities, and institutional frameworks.

**Africa: Rural electrification and decentralized grids can support energy access and transformation, which can be delivered through the deployment of solar, wind and geothermal energy to complement existing and potential hydropower development** *(well established)*. Clean cooking solutions and electricity access solutions can assist fuel shifts at the household level. Demand management can be achieved through financial incentives, such as energy-efficient appliances, and taxation in the form of carbon credits or subsidy redirection to reduce upfront costs {8.2.2; 8.2.3; 8.2.4; 16.2.1; 16.2.2; 16.4.2; 20.4.2; 20.4.3}.

**Asia and Pacific: Energy transformation can be supported through a strengthened grid infrastructure to allow inclusion of hydrogen and biofuels, alongside other renewable technologies such as modern fuels to replace unsustainable biomass and kerosene for cooking, and the development of off-grid and microgrid solutions to support community initiatives** *(well established)*. Behavioural change in consumption and use of more efficient technologies can help reduce growing demand. Private sector involvement through enabling financial policies and regulations to support middle-income countries to leapfrog to a green economy is recommended {16.2.1; 16.3.2; 20.5.2; 20.5.3; Figure 20.5}.

**Eastern Europe: Repurposing subsidies and closing the energy poverty gap, promoting clean transport, and investing in energy efficiency and renewable energy can support energy transformation** *(well established)*. Incentives for decentralized green energy production and supporting civic energy can encourage the breakup of energy monopolies and regulate unfair pricing {8.4.3; 16.3.2; 16.2.3; 16.3.3; 20.6.2; 20.6.3; Figure 20.15}.

**Latin America and the Caribbean: Utilizing the high potential of wind and solar energy, along with bioenergy, harnessed through regional cooperation and cross-border transmission lines** *(well established)*. Such cooperation will alleviate vulnerability risks of hydroelectric energy production due to climate change and drought-induced water scarcity. Closing the energy-poverty gap through increased access to electricity and modern cooking fuels can assist. Increased investment through repurposing financial incentives can reduce the upfront cost of production, and improved efficiency of renewables can relieve potential social impacts {8.5.4; 8.5.5; 16.2.1; 16.2.3; 16.3.3; 20.7.2; 20.7.3}.

**Western Europe and Others Group: Decarbonization can be achieved through the transformation to renewable energy, green hydrogen, and sustainable energy fuels, with the deployment of CDR technologies, electric mobility, and enhanced energy efficiency** *(well established)*. Primary actions to transform the energy system include ending fossil fuel subsidies, implementing large-scale smart grids, and achieving efficiency gains in energy consumption and production. Countries can curtail demand and consumption through financial mechanisms such as carbon tariffs/tax, alongside incentivizing energy transformations {8.6.4; 8.6.5; 16.2.2; 16.2.3; 16.3.3; 20.8.2; 20.8.3}.

## 3.4 Food system

**Overview:** Food system transformation across regions can be supported by an integrated shift towards sustainable diets, sustainable agricultural intensification, climate-resilient and precision agriculture, inclusive governance, and circular value chains across all regions. Food system transformations should consider environmental, social and economic dimensions. All countries can revitalize the farming profession and explore growing underutilized crops. High-income countries can pursue agroecological practices and regenerative agriculture, while promoting sustainable and healthy plant-based diets, minimizing food waste, leveraging technology innovation, and promoting regional food products which can help deter food insecurity and malnutrition. Middle-income countries can counter the rise in meat and dairy overconsumption by returning to traditional foods, using new technologies and improving crops and livestock. Low-income countries can invest in agricultural infrastructure and promote agroecological practices to enhance soil quality and increase yields. Underpinning all solutions are inclusive governance reforms, which are critical to ensuring equity and resilience {19.6}.

**Africa: Transforming food systems can incorporate integrated governance, agroecological intensification, and the inclusion of Indigenous and local knowledge to achieve improved nutrition, ecosystem resilience, and better rural livelihoods** *(well established)*. Reducing food loss through technology, infrastructure, and supply chain management is important. Scaling underutilized and nutritious crops, along with increasing productivity through sustainable intensification, can support food security. Combining nomadic and stable livestock systems improves protein yield and carbon efficiency, particularly in arid regions like the Sahel and East Africa {8.2.1; 8.2.2; 8.2.3; 8.2.4; 8.2.5; 17.2.3; 17.2.2; 17.2.4; 20.4.2; 20.4.3}.

**Asia and Pacific: Equitable and climate-resilient food systems can be achieved through healthy diets, reducing food loss and urban waste, and reforming aquaculture practices. Sustainable aquaculture practices and inclusive governance that secures food access amid rapid urbanization and land pressure are central to this outcome** *(established but incomplete)*. By reducing the growing demand for meat and dairy, the region can shift to culturally appropriate, plant-based diets that value Indigenous food systems. Integrating smallholders into modern retail systems could support local food market regulation to discourage food waste {8.3.2; 8.3.3; 8.3.4; 8.3.5; 17.2.5; 17.2.3; 20.5.2; 20.5.3; Figure 20.6}.

**Eastern Europe: Sustainable intensification, reducing dependence on feed crops, and revitalizing community and smallholder base farming can support transformation. Dietary change through promotion of plant-based diets can reduce the pressure on the environment** *(well established)*. Incentivizing businesses towards positive environmental goals and internalizing environmental costs and health externalities in food prices, while revitalizing smallholder and community-based farming systems, contributes to food security, biodiversity conservation, and rural livelihoods {8.4.2; 8.4.4; 17.2.1; 17.2.5; 20.6.2; 20.6.3}.

**Latin America and the Caribbean: Scaling agroecology, securing land rights, managing food loss and waste, and prioritizing behavioural pathways that enhance nutrition while restoring ecosystems can contribute to a just and resilient food system** *(well established)*. Enhancing circularity and reducing dependence by minimizing external inputs, such as chemicals and fertilizers, are near-term goals. Sustainable food production strategies include urban agriculture in the Caribbean, precision farming in Central America, and no-deforestation supply chains in South America. Financial mechanisms such as taxes and incentives, regional cooperation, and gender-inclusive policies are important for equitable and sustainable food systems {8.5.3; 8.5.4; 8.5.5; 17.2.2; 17.2.5; 20.7.2; 20.7.3}.

**Western Europe and Other Countries: Agriculture and food system transformation can be achieved through sustainable dietary shifts, agroecological practices, sustainable intensive and precision agriculture, and circular supply chains** *(well established)*. Supporting sustainable dietary shifts, encouraging plant-rich diets, scaling-up cultured meat production, and implementing food-environment reforms, using fiscal tools such as taxes and incentives, can promote the transformation and enforce retail and household waste legislation. Combining circular supply chain strategies with prosumer engagement and local food systems and aligning purchasing behaviours with sustainability outcomes can increase trust in food labelling and traceability mechanisms {8.6.2; 8.6.3; 8.6.4; 17.2.4; 17.2.5; 17.2.3; 20.8.2; 20.8.3}.

## 3.5 Environment system

**Overview:** Nature-based solutions, including nature-positive climate actions coupled with regional and transboundary cooperation, can lead to sustainable conservation, strengthening synergies between climate and biodiversity actions. Initiatives like green value chains, REDD+, payment for ecosystem services, and community-based forest management can be scaled up across regions to deliver transformational change. High-income countries can impose carbon tariffs on imports while reducing consumption and waste. Middle-income countries can account for environmental and health externalities in planning and development decisions. Low-income countries can promote sustainable land use and forest conservation through community-led conservation programmes {19.7; 20.4; 20.5; 20.6; 20.7; 20.8}.

**Africa: Land degradation and deforestation can be slowed by embracing technology for environmental monitoring, building capacity, increasing carbon sequestration through reforestation, and reducing greenhouse gas emissions while enhancing climate adaptation** *(well established)*. To limit warming to 1.5°C, initiatives such as carbon capture of 2.3 Mt annually by 2050 through over 700 million ha of forest land, along with conserving carbon-rich ecosystems, building a circular sustainable bioeconomy, and adopting sustainable agriculture are desirable {18.2.1; 18.2.4; 20.4.2; 20.4.3; 8.2.1; 8.2.2; 8.2.4}.

**Asia and Pacific: Prioritizing technological innovation and energy efficiency are key strategies for emissions reduction, playing vital roles in ecological management** (*well established)*. Integrating climate resilient agroforestry, sustainable forest management, and conservation practices using Indigenous Knowledge, traditional knowledge and local knowledge can improve the ecological integrity of agriculture and forest ecosystems and preserve their biodiversity, lands and territories. Transformative change in the oversight of natural and managed ecosystems can address ecosystem degradation, alleviate poverty, and promote sustainable lifestyles. Incorporating environmental and health externalities in national development planning could offer a path towards sustainable development {18.2.1, 18.2.3; 20.5.2.3; 8.3; 19.7.2; 20.5.3.5; 8.3.3; 20.5.2; 20.5.3}.

**Eastern Europe: Adopting nature-inspired infrastructure to protect water resources and implementing biodiversity conservation can reduce land degradation** *(well established)*. Addressing land degradation can be delivered by investing in connectivity through green corridors, riparian zones, and rewilded landscapes, as well as integrating watershed management to enhance ecosystem services and strengthening both individual and community activism {18.2.1; 18.2.2; 8.4.4; 8.4.5; 8.4.1; 8.4.2; 8.4.3; 20.6.2; 20.6.3}.

**Latin America and the Caribbean: Adopting transformational pathways for management of ecosystems, achieving net-negative emissions driven by reforestation, regenerative agriculture, and Indigenous-led ecological stewardship** *(well established)*. Measurable gains in forest stability, carbon sequestration, and biodiversity recovery – surpassing global trends – can be achieved through scaling ecosystem restoration actions and nature-inspired infrastructure using sustainable financing mechanisms {18.2.1; 18.2.2; 8.5.3; 8.5.4; 20.7.2; 20.7.3}.

**Western Europe and Others Group: Implement agroecological practices, land restoration and protected areas management to combat biodiversity loss. Increasing renewable energy production and doubling energy efficiency would help to mitigate the adverse impacts of extreme events by 2030** *(well established)*. Transforming financial systems can facilitate international cooperation on climate initiatives, clean technology innovation and sharing, and SDGs, creating a more unified and inclusive global response to environmental challenges {18.2.3; 18.2.4; 20.8.2; 20.8.3; 8.6.2; 8.6.4}.

# Annex 1: Regional Priorities



The priorities were determined after an extensive literature review conducted by regional and global subject matter experts. Priorities were selected based on their relevance to a significant portion of a given region, their influence on at least two of the environmental crises, and their persistence within the region. Priorities are deemed unlikely to be addressed without an integrated approach for transformation.

| Region | Priorities |
|---|---|
| **Africa** | Unsustainable resource exploitation and use<br>• Socioeconomic and environmental consequences of overexploitation and underutilization<br>• Intense logging, mining, overfishing, and agricultural expansion degrade forests, soils, and marine ecosystems<br>• Weak infrastructure, limited access to capital, and markets result in underutilized land, water, and energy resources<br><br>Ecosystem degradation<br>• Jeopardizing biodiversity, essential ecosystem services, and human well-being from severe stress to terrestrial, freshwater, and marine ecosystems<br>• Rapid urbanization, agricultural encroachment, infrastructure expansion, and extractive industries drive deforestation and wetland loss<br>• Untreated wastewater, plastic pollution, and oil spills damage Africa's coasts and coral reefs<br><br>Climate change and climate extremes<br>• Warming 1.5 times faster than the global average<br>• Intensification of droughts, floods, and cyclones<br>• Climate variability has slashed agricultural productivity by 34 per cent since 1961 |
| **Asia and Pacific** | Climate change impacts on development and cultural heritage<br>• Coal accounts for 53 per cent of power generation<br>• Forty-three per cent of Asia and Pacific countries are among the most vulnerable to climate change disasters globally<br>• Endangering the cultural identity of Indigenous Peoples as well as local communities<br><br>Land-use change impacts on ecosystems<br>• Conversion of one-sixth of the forest area to agriculture and pastureland between 1990 and 2020<br>• Loss of over 40 per cent of global inland wetlands between 1700 and 2020 and 45 per cent of the vertebrate population in 45 years<br>• Restoration and recovery of ecosystems and biodiversity<br><br>Pollution and waste impacts on ecosystems and human health<br>• Largest solid waste-producing region globally, generating over 800 million tons annually<br>• Five Southeast Asian countries are among the top 10 countries globally, generating the highest volumes of mismanaged plastics<br>• Eighty per cent of the global microplastics found in natural ecosystems contributed by Asian countries |

| Region | Priorities |
|---|---|
| **Eastern Europe** | Loss of ecosystem services due to unsustainable agriculture<br>• Land degradation, mainly due to the transformation of farming systems, has accelerated deterioration of ecosystem services<br>• Farming lacks resilience to climate change and land degradation<br>• Farm intensification and abandonment lead to biodiversity loss<br><br>Unsustainable energy system impacts on climate and health<br>• Reliance on fossil fuels and energy-inefficient technologies has led to climate and health impacts, creating social challenges<br>• Air pollution remains a major health concern due to high concentrations of particulate matter and benzo[a]pyrene<br>• Deindustrialization was accompanied by risky environmental legacies at former production sites<br><br>Biodiversity loss due to weak management frameworks<br>• Habitat loss despite a strong network of protected areas, due to mismanagement, underfinancing and lack of law enforcement<br>• Climate change, land degradation and pollution remain a threat<br>• Armed conflicts are an important environmental threat, often compounding other negative trends |
| **Latin America and the Caribbean** | Changes in land cover dynamics<br>• Per capita agricultural land has increased by 49 per cent (2000-2019), contributing significantly to land degradation<br>• Deforestation has slowed, but still generates significant pressure on landscape change<br>• 541,000 tons of waste are generated daily, while recycling rates stand at 4.5 per cent<br><br>Changes in freshwater quality and availability<br>• Agricultural and livestock activities account for 70 per cent of freshwater demand<br>• Water changes driven by extreme climate events impact key economic sectors<br>• Large consumption of agrochemicals affects surface and groundwater quality<br><br>Degradation of coastal and marine resources<br>• Extreme climate events are impacting ecosystem dynamics in coastal and marine ecosystems<br>• Macro and microplastics are the primary source of marine pollution<br>• Southern cone countries have a positive annual trend in wild fisheries, while Central America, northern South America and the Caribbean have negative values |
| **Western Europe and Others Group** | Biodiversity loss and ecosystem change<br>• Rapid range shifts of native and non-native species across latitudinal and longitudinal gradients<br>• Biodiversity loss negatively impacts biocultural heritage<br>• Arctic and subarctic regions face dramatic changes in ice coverage and permafrost, coupled with range shifts for marine mammals and fisheries<br><br>Climate extreme events<br>• Frequency and intensity of extreme climate events have tripled over the last 50 years<br>• Climatic disruptions interact with non-climate drivers, such as governance systems, poverty, inequality, and demography<br>• Climate extremes damage cultural and biocultural resources and impact livelihoods for local communities<br><br>Pollution and waste<br>• Extraction, use, and disposal of materials driving waste and pollution<br>• Air quality has been consistently improving, but remains a significant concern<br>• Excess nutrient pollution depleting oxygen in aquatic systems |

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