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Global assessment of biodiversity and ecosystem services

Summary for policymakers of the global assessment report on biodiversity and ecosystem services

Note by the secretariat

1. In section III of decision IPBES-4/1, the Plenary of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) approved the undertaking of a global assessment of biodiversity and ecosystem services in accordance with the procedures for the preparation of the Platform's deliverables, set out in annex I to decision IPBES-3/3, and as outlined in the scoping report for a global assessment of biodiversity and ecosystem services set out in annex I to decision IPBES-4/1.

2. In response to that decision, an expert group has produced a set of six chapters and a summary for policymakers. The summary for policymakers is set out in the annex to the present note, and the six chapters and their executive summaries are set out in document IPBES/7/INF/1. An overview of the process followed for the production of the global assessment report is set out in document IPBES/7/INF/2.

3. At its seventh session, the Plenary will be invited to approve the summary for policymakers. It will also be invited to accept the chapters of the report and the executive summaries, which will be revised following the seventh session to ensure consistency with the summary for policymakers as approved.

* Reissued for technical reasons on 8 April 2019.

* IPBES/7/1/Rev.1.

Annex

Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services

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KEY MESSAGES

A. Nature underpins and sustains quality of life, but its contributions to people are deteriorating worldwide

Nature and the contributions it provides are fundamental for the existence and richness of human life on Earth. While more food, energy and materials than ever before are now being supplied to people everywhere, this is increasingly at the expense of nature's ability to provide such material contributions in the future and frequently undermines nature's regulating and non-material contributions. From genes to species, biodiversity – humanity's common heritage and safety net – is declining fast. The global environmental commons of land, ocean, atmosphere and biosphere, upon which humanity as a whole depends, are being altered to an unparalleled degree, with cascading impacts on regional and local ecosystems.

A1 The contributions that people derive from nature are fundamental for the existence and richness of human life on Earth, and most of them are not fully replaceable. Nature plays a critical role in providing food and feed, energy, medicines and genetic resources and a variety of materials fundamental for people's physical and cultural continuity. For example, more than 2 billion people rely on wood fuel to meet their primary energy needs, an estimated 4 billion people rely primarily on natural medicines for their healthcare and some 70 per cent of drugs used for cancer are natural or bioinspired products. Nature, through its ecological and evolutionary processes, sustains the quality of the air, fresh water and soils on which humanity depends, distributes fresh water, regulates the climate, provides pollination and pest control and reduces the impact of natural hazards. For example, more than 75 per cent of global food crops, including highly nutritious fruits and vegetables and some of the most important cash crops in low- and middle-income countries (such as coffee and cocoa) and high-income countries (such as almonds), rely on animal pollination. Marine and terrestrial ecosystems are the sole sinks for anthropogenic carbon emissions, with a gross sequestration of 5.6 gigatons of carbon per year (the equivalent of some 60 per cent of global fossil fuel emissions). Nature underpins all dimensions of human health and contributes to non-material aspects of quality of life – inspiration and learning, physical and psychological experiences, and supporting identities – that are central to quality of life and cultural integrity, even if their aggregated value is difficult to quantify. Nature is essential to keeping humanity's options open in a changing world. Most of nature's contributions are co-produced by nature and people, but while anthropogenic assets – knowledge and institutions, technology infrastructure and financial capital – can enhance or partially replace those contributions, many of them are irreplaceable.

A2 Nature's contributions to people are often unequally distributed, and different demands create trade-offs among contributions, both in their production and in their appropriation by society. Benefits and burdens associated with nature's contributions are distributed and experienced differently among social groups, countries and regions. Because optimizing for certain benefits impedes the production of others, many ecological changes benefit some people at the expense of others, just as changes in technological and institutional arrangements enable access by some actors at the expense of others. For example, although food production today is sufficient to satisfy global needs, approximately 11 per cent of the world's population is undernourished. The great expansion in the production of food, fibre and bioenergy has occurred at the cost of many other contributions to human quality of life.

A3 Since 1970, material contributions of nature to people have generally increased, but regulating and non-material contributions have declined (14 of 18 analysed contributions). Over the past 50 years**,** agricultural production, fish harvest, bioenergy production and harvest of materials have increased, while virtually all regulating and non-material contributions have declined. For example, agricultural crop production has increased approximately threefold since 1970. Raw timber production has increased 45 per cent, reaching some 4 billion cubic metres in 2017, with the forestry industry providing about 45 million jobs. Meanwhile, however, indicators of contributions associated with ecosystem regulation, such as soil organic carbon or pollinator diversity, have declined, suggesting that such gains are not sustainable, with important implications. For example, land degradation has reduced agricultural productivity in 23 per cent of the global terrestrial area and between US$235 billion and US$577 billion in annual global crop output is at risk as a result of pollinator loss. Moreover, loss of coastal habitats reduces coastal protection, which increases the risk for the 100–300 million people living in coastal areas below the 100-year flood level.

A4 Human actions have now significantly altered nature across most of the globe, more so in terrestrial, freshwater and coastal ecosystems than in the open ocean. Today, 75 per cent of the terrestrial environment, 40 per cent of the marine environment and 50 per cent of streams are severely

altered. Although the rate of forest loss has slowed at the global scale, forest area and tree cover continue to decline rapidly in the highly biodiverse tropics, where the loss of unaltered forest landscapes has even started to accelerate. The average abundance of native species in most major terrestrial biomes has fallen by at least 20 per cent, mostly since 1900, potentially affecting ecosystem functioning. The richness and abundance of marine organisms, from primary producers (such as diatoms) to top predators (such as sharks and killer whales), are also declining, and approximately half the live coral cover on coral reefs has been lost since the 1870s.

A5 **It is certain that more species are threatened with extinction now than at any other time in human history**. Independent lines of evidence point to an imminent rapid acceleration in the global rate of species extinction, which is already tens – if not hundreds – of times higher than it has been on average over the last 10 million years, even if drivers do not intensify. Between half a million and one million species are estimated to be threatened with extinction, many within decades.

A6 **Globally, the variety of populations, crop and livestock landraces and species is decreasing, and biological communities across regions are, on average, becoming simpler and more similar (biotic homogenization is occurring)**. On land, endemic (narrowly-distributed) species have typically seen larger-than-average changes to their habitats and shown faster-than-average declines. Fewer varieties of plants and animals are being cultivated, raised, traded and maintained around the world, despite many efforts, including those of indigenous peoples, local farmers, herders and pastoralists. For example, around 560 of the domesticated breeds of mammals (approximately 10 per cent) had become extinct by 2016, and at least 1,000 more are threatened. In addition, many of the wild relatives of crops – which are important for long-term food security – lack formal protection. Biotic homogenization has also been driven by thousands of invasive species spreading across the world, disrupting many of the ecosystems they invade.

A7 **Biological evolution in response to anthropogenic drivers of change can be rapid, occurring over a period that may span between several years and decades, or even more rapidly for microbes and other short-lived organisms.** Management strategies can therefore deliberately influence adaptive evolution, including protecting vulnerable species and reducing the impact of unwanted species (such as weeds, pests or pathogens), many of which are already showing evolutionary change, with significant consequences for human and animal health, agriculture and biodiversity conservation.

B. Direct and indirect drivers of change have accelerated during the past 50 years

The rate of global change during the past 50 years is unprecedented in human history. The direct drivers of change in nature with the largest global impact have been (in decreasing order) changes in land and sea use, direct exploitation of organisms, climate change, pollution and invasive alien species. Those five direct drivers result from an array of underlying causes – the indirect drivers of change – which are in turn underpinned by social values. Prominent indirect drivers include increases in population and per capita consumption, changes in nature deterioration per unit of consumption due to technological innovation and, critically, governance and accountability. Trade has shifted where goods are produced, contributing to new opportunities for economic development, but also increasing inequities in both economic development and environmental burdens.

B1 **In terrestrial and freshwater ecosystems, land use change is the direct driver that has had the largest relative impact on nature since 1970, followed by direct exploitation of animals and plants (mainly logging and hunting). In the oceans, direct exploitation of organisms (mainly fishing) has had the largest relative impact, followed by land/sea use change**. The total amount of land transformed for various human uses has increased by 7 per cent in the past 20 years and half of the agricultural expansion has occurred at the expense of forests that until recently showed very little human imprint. Direct exploitation of fish, shellfish and other organisms, land/sea use change (mostly coastal infrastructure development, including for aquaculture) and land-based pollution have increased nearly everywhere over the past three decades.

B2 **Human-driven climate change is increasingly exacerbating the impact of other direct drivers on nature and society**. It is estimated to have caused warming of approximately 1.0 degree Celsius by 2017 relative to pre-industrial levels, with temperatures currently rising by 0.2 degrees Celsius (±0.1degree Celsius) per decade. The fastest changes have been observed in flat landscapes at higher latitudes. The frequency and magnitude of extreme weather events have increased in the past 50 years, while the global average sea level has risen at a rate of over 3 mm per year over the past two decades.

B3 **Nature managed by indigenous peoples and local communities is under increasing pressure, but is generally declining less rapidly in indigenous peoples' land.** Indigenous peoples manage

and/or have tenure rights over at least 28 per cent of global land area, including at least 40 per cent of the area that is formally protected, and some 37 per cent of all remaining terrestrial areas with very low human intervention. In addition, a diverse array of farmers, fishers, herders, ranchers and foresters under various property regimes manage significant shares of nature, but those areas are facing disproportionally expanding energy and transportation infrastructure and commodity production. Such factors negatively affect local lifestyles, values and the transmission of knowledge and capacity to adapt to changing socioecological conditions.

B4 **In the past 30 years, global trade has increased eightfold, coupled with a six-fold increase in the global economy, and the demand for living materials from nature has doubled to meet the increasing demands of a growing global population (which has nearly doubled) and of ever more distant consumers, shifting the environmental burden of consumption and production across regions**. Increasing demand for material goods (such as food, timber and fibre) in higher- income and middle-income countries is often satisfied by production in distant, lower-income countries. Moreover, such exchanges are often negotiated between actors and institutions of unequal power, which affects the distribution of the benefits and long-term costs. In the past 50 years, countries at different income levels have experienced unequal trade-offs in terms of both economic growth and nature deterioration.

B5 **Current incentive structures in local, regional and global governance largely favour environmentally damaging private activities rather than conservation or restoration; great potential for positive ecological and social outcomes lies in eliminating harmful subsidies and introducing regulations with strategic combinations of negative and positive incentives.** Direct and indirect subsidies to fisheries, agriculture (including fertilizers and pesticides), livestock raising, forestry, mining and energy production (including fossil fuels and biofuels) are associated with inefficient production and waste, social inequalities, overexploitation of nature and overconsumption. Removal of such subsidies often faces resistance from vested interests.

B6 **Exclusion, scarcities and/or unequal distribution of nature's contributions to people can fuel social instability and conflict in many areas of the world**. Conflicts linked to land, water or other resources may arise from interactions between availability of and control over nature's contributions, as well as context-specific property rights arrangements, sociopolitical stability or violence. Armed conflict also has a direct physical impact on ecosystems, beyond its destabilizing effect on societies and indirect impacts associated with population displacement and economic activities.

C. Short-term goals for protecting nature and achieving sustainability cannot be met by current trajectories, but goals for 2030, 2050 and beyond can be achieved through transformative change[2]

The achievement of most short-term goals for nature and sustainability, such as those embodied in the Aichi Biodiversity Targets, the 2030 Agenda for Sustainable Development and the Paris Agreement under the United Nations Framework Convention on Climate Change, is compromised by the rapid deterioration of nature and many of its contributions to people. Those deterioration trends continue or are accentuated in many longer-term plausible future scenarios of indirect drivers (such as population growth, economic growth and technological development). In contrast, plausible scenarios that include transformative change, especially in the production and consumption of energy and food, low-to-moderate population growth and nature-friendly climate adaptation and mitigation, are compatible with the Sustainable Development Goals and the 2050 Vision for Biodiversity.

C1 **Implementation of policy responses and actions to conserve nature and manage it more sustainably has progressed, but not sufficiently to stem the direct and indirect drivers of nature deterioration. It is therefore likely that most of the Aichi Biodiversity Targets for 2020 will be missed**. Some of the Aichi Targets will be partially achieved, such as those related to the spatial extent of terrestrial and marine protected areas, identification and prioritization of invasive alien species, national biodiversity strategies and action plans and the Nagoya Protocol.[3] In addition, only one quarter of the goals across six global agreements relating to nature and the protection of the global environmental commons (the Convention on the Conservation of Migratory Species of Wild Animals, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the Convention concerning the Protection of the World Cultural and Natural Heritage, the International Plant Protection Convention, the United Nations Convention to Combat Desertification in Those

[2] A fundamental, system-wide reorganization across technological, economic and social factors, including paradigms, goals and values.

[3] Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity.

Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa and the Convention on Wetlands of International Importance especially as Waterfowl Habitat) are on track.

C2 **Substantial negative trends in nature and its contributions to people will undermine progress towards 35 of the 44 assessed targets of the Sustainable Development Goals related to poverty, hunger, health, water, cities, climate, oceans and land** (Sustainable Development Goals 1, 2, 3, 6, 11, 13, 14, and 15). Negative trends are also apparent for other goals in which nature plays a role, such as in education, reducing inequalities and promoting peace and justice (Sustainable Development Goals 4, 5, 10 and 16); however, the links of such goals to nature cannot be fully assessed owing to gaps in current targets, knowledge and data. Furthermore, achieving the goals related to energy, economic growth, industry and infrastructure and responsible consumption and production (Sustainable Development Goals 7, 8, 9 and 12), as well as targets related to poverty, food security and cities (Sustainable Development Goals 1, 2 and 11), could have substantial positive or negative impacts on nature and therefore on the achievement of other Sustainable Development Goals.

C3 **Areas of the world projected to experience some of the most acute trade-offs from global changes in climate, biodiversity and nature's contributions to people are also home to large concentrations of indigenous peoples and many of the world's poorest communities.** In addition to climate change, some of those areas are also facing growing resource extraction, commodity production, climate change mitigation programmes and energy infrastructure, with consequences for local livelihoods and health. Negative impacts include continued loss of subsistence and livelihoods from ongoing deforestation, mining and the spread of commercial agriculture (Aichi Target 5 and Sustainable Development Goal 15) and unsustainable fishing practices (Aichi Target 6 and Sustainable Development Goal 14) and impacts on health from pollution and water insecurity (Aichi Target 8 and Sustainable Development Goals 6 and 12). Those negative impacts influence not only local livelihoods, but also the ability of indigenous peoples and local communities to manage and conserve wild and domestic biodiversity and nature's contributions to people, which is also relevant to broader society (Aichi Targets 7, 9, 11 and 13 and Sustainable Development Goals 2, 12, 14 and 15). Indigenous peoples and local communities have been proactively confronting such challenges in partnership with each other and with an array of other stakeholders, including in co-management systems, local and regional monitoring networks, and through revitalizing and adapting local management systems. Regional and global scenarios would benefit from an explicit consideration of the views and perspectives of indigenous peoples and local communities (which are currently absent), their knowledge and understanding of large regions and ecosystems, and their desired future development pathways.

C4 **The negative trends in nature and its contributions to people are projected to continue to 2050 and beyond in all scenarios except those that include transformative change, due to the projected impact of increasing land-use change, exploitation of organisms and climate change**. Impacts arising from pollution and invasive alien species are likely to exacerbate those trends. There are large regional differences in the patterns of future biodiversity loss and changes in nature's contributions to people, with the largest projected impacts in the tropics and the global South. The magnitude of impacts and the differences between regions are much greater in scenarios with rapid increases in consumption or human population than in scenarios based on sustainability.

C5 **Climate change is projected to become increasingly important as a direct driver of changes in nature and its contributions to people, interacting with other direct drivers.** The future impacts of climate change relative to land-use change and direct exploitation of organisms varies among scenarios and regions, but they are projected to become more severe in the coming decades. Impacts on the distribution of species in a 2 degree Celsius temperature rise scenario are expected to be at least twice as high as the impacts of a 1.5 degree Celsius rise. The impacts on coral reefs are expected to be an order of magnitude worse with a 2 degree Celsius rise than with a 1.5 degree Celsius rise. Therefore, limiting global warming to below 2 degrees Celsius is expected to substantially reduce the adverse impacts on nature and its contributions to people.

D. Nature can be conserved, restored and used sustainably while simultaneously meeting other global societal goals through proven solutions and transformative change

Societal goals – including those for food, water, energy, health and the achievement of a good quality of life for all while tackling climate change and conserving nature – can be achieved through rapid and improved deployment of existing policy instruments and bold decisions for transformative change. Commitment to mutually supportive international goals and targets, inclusive and adaptive management approaches and arrangements, multi-sectoral planning and

strategic policy mixes can help to transform public and private sectors to achieve sustainability at the local, national and global level.

D1 The global environmental commons can be safeguarded through enhanced international cooperation to promote transformative change. The review and renewal of agreed environment-related international goals and targets represent opportunities to create the conditions for promoting transformative change across levels. Furthermore, safeguarding the global environmental commons depends on advancing and aligning local, national and international sustainability efforts, and addressing mismatches between the local and regional levels of governance so that individual and collective actions together result in the reversal of deterioration at the global level.

D2 Risks related to inevitable uncertainties and complexities in transformations towards sustainability can be reduced through governance approaches that are integrative, inclusive, informed and adaptive. Such approaches typically take into account the synergies and trade-offs between societal goals and alternative pathways and recognize a plurality of values, diverse economic conditions, inequity, power imbalances and vested interests in society. They also involve stakeholders in the coordination of policies across sectors and the creation of strategic place-based mixes of proven policy instruments. Proven policies include the expansion of the current network of protected areas, the protection of watersheds, and incentives and sanctions to reduce pollution. Risk-reducing strategies typically include learning that is based on a combination of existing and emerging knowledge. For example, the knowledge that biological evolution responds rapidly to anthropogenic drivers can be used to enhance the adaptive evolution of endangered or keystone species while reducing the adaptive evolution of weeds, pests and pathogens.

D3 Five main interventions ("levers") can generate transformative change by tackling the underlying indirect drivers of nature deterioration. These are as follows: (1) developing incentives for environmental responsibility and removing perverse subsidies; (2) reforming sectoral and segmented decision-making to promote integration across sectors and jurisdictions; (3) taking pre-emptive and precautionary actions to mitigate the deterioration of nature and monitoring their outcomes; (4) managing for robustness in the face of uncertainty and complexity; and (5) strengthening the rule of law and the implementation of environmental laws and policies.

D4 These levers are especially likely to yield transformation towards sustainability when directed at the following eight key leverage points: (1) fostering visions of a good quality of life that do not entail ever-increasing material consumption; (2) lowering total consumption and waste; (3) unleashing existing values of responsibility to effect social norms for sustainability; (4) overcoming income and gender inequalities; (5) ensuring inclusivity and basic human rights in conservation; (6) accounting for nature deterioration in economic activities and international trade; (7) ensuring responsible technological and social innovation and investment regimes; and (8) promoting education and maintenance of different knowledge systems.

D5 Recognizing the rights, knowledge, institutions and values of indigenous peoples and local communities and promoting their participation in environmental governance often enhances their quality of life, as well as nature conservation and restoration. Co-management regimes involving indigenous peoples and local communities can be an effective way to safeguard nature and its contributions to people, incorporating locally attuned management systems and indigenous and local knowledge. The positive contributions of indigenous peoples and local communities to sustainability can be facilitated through public recognition of land, resource and self-determination rights; the application of the principle of free, prior and informed consent; and improved collaboration, benefit sharing and co-management arrangements with local communities.

D6 Feeding humanity and enhancing the conservation and sustainable use of nature are complementary goals that can be achieved together through sustainable agricultural and aquacultural systems, the safeguarding of remaining key native habitats and ecological restoration. Specific actions beyond the levers include promoting sustainable and ecological intensification, applying cross-sectoral integrated management and multifunctional landscape planning, supporting context-appropriate climate change mitigation and adaptation, conserving genetic diversity and associated agricultural biodiversity, learning from indigenous and local sustainable practices, reducing food waste, empowering producers and consumers to transform value chains and facilitating sustainable dietary choices. As part of integrated landscape planning, restoration can offset current degradation and save many endangered species, but it is less effective if delayed.

D7 Sustaining fisheries and conserving marine species and ecosystems can be achieved through a coordinated mix of interventions on land and in the oceans, including multi-level coordination on the use of open oceans. Specific actions beyond the levers include implementing ecosystem-based

fisheries management with spatial planning and fishing quotas, removing derelict equipment, expanding effectively implemented coastal and marine protected areas, reducing point and non-point source pollution to halt anthropogenic deoxygenation, managing marine microplastic and macroplastic pollution through effective waste management and extended producer responsibility, controlling the spread of invasive alien species and reducing carbon dioxide emissions. It is also important to implement and enforce global agreements for responsible fisheries and for the reduction of illegal, unreported and unregulated fishing.

D8 **While land-based mitigation activities, including reducing deforestation, restoring nature and improving management of agricultural systems, have high potential for climate change mitigation, the large-scale deployment of bioenergy plantations and afforestation of non-forest ecosystems are likely to offset the positive effects.** Land-use actions alone will not be sufficient to limit global warming to well below 2 degrees Celsius and closer to 1.5 degrees Celsius above pre-industrial levels, but they are essential, alongside strong actions to reduce greenhouse gas emissions from fossil fuel use and cement production. They can also contribute to climate adaptation. However, large-scale bioenergy plantations with carbon capture and storage and widespread afforestation of non-forest ecosystems would have negative impacts on biodiversity and would threaten food and water security and local livelihoods, including by intensifying social conflict.

D9 **Nature-based and nature-friendly solutions can be cost-effective for meeting Sustainable Development Goals in cities, which are crucial for global sustainability.** Solutions include safeguarding and retrofitting green and blue infrastructure, such as green spaces, biodiversity-friendly water bodies, urban agriculture, roof-top gardens and expanded and accessible vegetation cover into existing urban areas and new developments. Decentralized green technology solutions can complement large-scale "grey infrastructure" in areas such as flood protection, temperature regulation, cleaning of air and water and the provision of energy, locally-sourced food and the health benefits of interaction with nature. Solutions also include designing cities and supporting infrastructure (including roads and railways) to allow for public transport and walkable human settlements.

D10 **A key constituent of sustainable pathways is the reform of global financial and economic systems to engineer a global sustainable economy.** That implies incorporating the reduction of inequalities into development pathways, reducing overconsumption and addressing the environmental externalities of economic activities, from the local to the global scale. Such reform could be enabled through a mix of policies and tools (including incentive programmes, certification and performance standards) and more internationally consistent taxation, supported by multilateral agreements and enhanced environmental monitoring. It would also entail a shift beyond standard economic indicators such as gross domestic product to include those able to capture more holistic, long-term views of economics and quality of life. Adjusting for distortions created by harmful subsidies includes making credits or transfers conditional on environmental and social metrics (as in some climate-mitigation or conservation programmes) and removing price distortions affecting unsustainable resource uses.

BACKGROUND

A. Nature underpins and sustains quality of life, but its contributions to people are deteriorating worldwide

1. **In addition to its intrinsic value, nature underpins quality of life by providing basic life support for humanity, as well as material goods and spiritual inspiration (*well established*) {2.3.1, 2.3.2}. Most contributions from nature come from interactions between nature and people, requiring the use of various types of anthropogenic assets (*well established*) {2.3.2}** (figure 1). Nature's contributions to people (NCP) are co-produced by biophysical processes and ecological interactions and by anthropogenic assets such as knowledge, infrastructure, financial capital and technology and the institutions that mediate them {2.3.3}. There are large variations, however, in both access to nature's contributions and their impact on different social groups (*established but incomplete*) {2.3.5}. Furthermore, increases in the production of some of nature's contributions are linked to declines in others (figure 2) {2.3.2, 2.3.5}, which also affects people differentially (*well established*). For example, clearing of forest for conventional agriculture has increased the provision of food and feed (NCP 12) and other materials important for people (such as natural fibres, timber and ornamental flowers: NCP 13) but has reduced contributions as diverse as pollination (NCP 2), climate regulation (NCP 4), water quality regulation (NCP 7), opportunities for learning and inspiration (NCP 15) and the maintenance of options for the future (NCP 18). However, very few large-scale systematic studies exist on those relationships {2.3.2}.

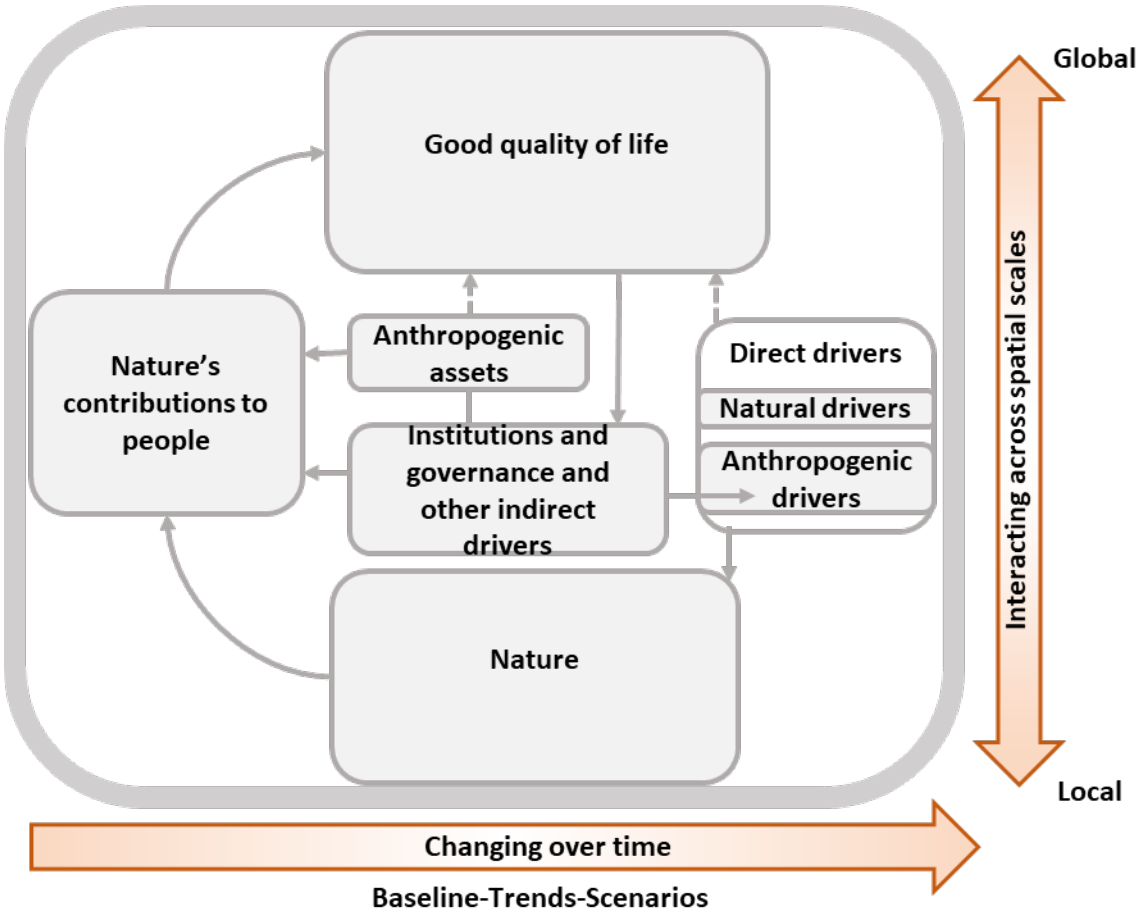


Figure 1. The IPBES Conceptual Framework (shown here in a simplified version) describes the major links between people and nature around which this assessment is organized. The boxes in the grey panel and arrows denote the elements of nature and society that are the main focus of this assessment. The elements are inclusive categories that were identified as meaningful and relevant to all stakeholders involved in IPBES during a participatory process, including various disciplines of the natural and social sciences and the humanities, as well of other knowledge systems, such as those of indigenous peoples and local communities. The solid arrows denote influence between elements, while the dotted arrows denote links that are acknowledged as important but are not the main focus of IPBES.[4]

[4] Decision IPBES-2/4.

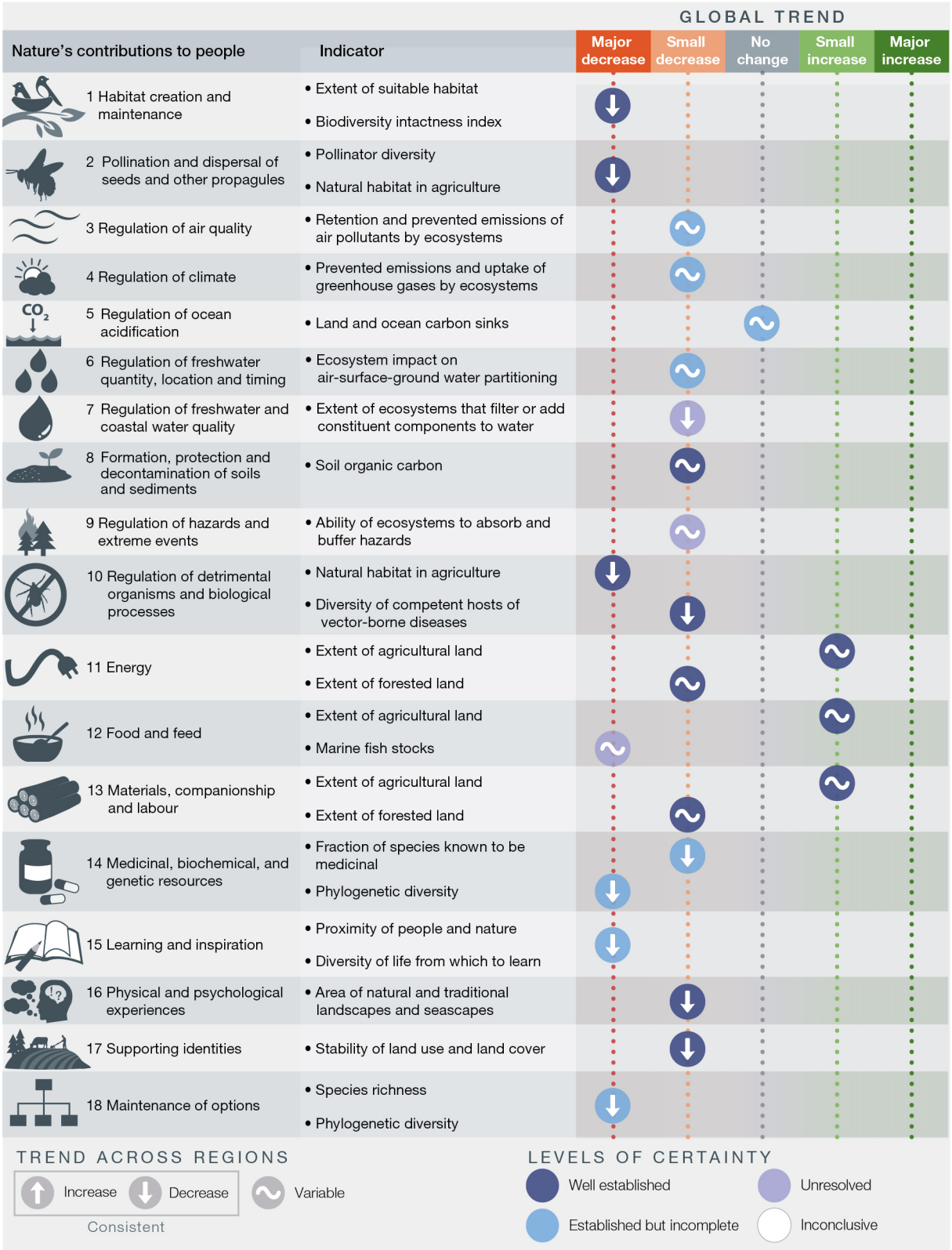


Figure 2. Trends in the ability of nature to sustain contributions to good quality of life. The potential for nature to contribute to people's quality of life in a sustainable manner has declined for almost all the NCP analysed. Each symbol is located in a column illustrating the global trend for each NCP indicator. For many NCP, trends are not globally uniform; the ~ symbol indicates that despite the overall global trend indicated, certain parts of the world are experiencing trends in opposing directions. Many NCP have two indicators; for NCP indicators with market value (such as energy, food and feed, and materials), total production has increased, while indicators of long-term sustainable production have decreased, except for the extent of agricultural land. Data supporting global trends and variations come from a systematic review of over 2,000 studies. {Chapter 2, NCP appendix 1 contains references to the key papers supporting these findings.}

2. **Many of nature's contributions to people are essential for human health (*well established*) and their decline thus threatens a good quality of life (*established but incomplete*) {2.3.4}.** Nature provides a broad diversity of nutritious foods, medicines and clean water {2.3.5.2, 3.3.2.1, 3.3.2.2 (Sustainable Development Goal 3)} and can help to regulate disease and the immune system {2.3.4.2}, reduce levels of certain air pollutants (*well established*) {2.3.4.2, 3.3.2.2} and improve mental health through exposure to green spaces (*established but incomplete*) {2.3.2.2, 2.3.4.2, 3.3.2.2 (Sustainable Development Goal 3)}. At the same time, biodiversity is the origin of most infectious diseases and strains of resistant bacteria (*well established*). Zoonotic diseases are significant threats to human health, with vector-borne diseases accounting for approximately 17 per cent of all infectious diseases and causing an estimated 700,000 deaths globally per annum {3.3.2.2}. Emerging infectious diseases in wildlife, domestic animals, plants or people can be exacerbated by human activities such as land clearing and fragmentation (*established but incomplete*) {3.3.2.2}. The deterioration of nature and consequent disruption of benefits to people has both direct and indirect implications for public health (*well established*) {2.3.5.2} and can exacerbate existing health inequalities (*established but incomplete*) {2.3.4.2}. Shifting consumption towards a greater diversity of foods, especially fish, fruit, nuts and vegetables, significantly reduces the risk of non-communicable diseases, which are currently responsible for more deaths globally than all other disease risks combined, affecting low-, middle- and high-income countries alike (*well established*) {2.3.4.2, 2.3.5.2 (NCP 2 and 12)}.

3. **Only poor substitutes are available for many contributions of nature. Some contributions of nature are not substitutable (*well established*)**. The loss of phylogenetic diversity, for example, can permanently reduce future options, such as wild species that might be domesticated as new crops {2.3.5}. People have created substitutes for other contributions of nature, but many of them are imperfect or financially prohibitive. For example, high-quality drinking water can be realized either through ecosystems that filter nutrients or through human-engineered water treatment facilities. Similarly, coastal flooding from storm surges can be reduced either by coastal mangroves or by dikes and sea walls. In both cases, however, built infrastructure can be extremely expensive, incur high future costs and fail to provide synergistic benefits such as nursery habitats for edible fish or recreational opportunities. More generally, human-made alternatives often do not provide the full range of benefits provided by nature's contributions.

4. **Humanity is a dominant global influence on terrestrial, freshwater and marine ecosystems (*well established*) {2.2.5.2}** (figure 3). **The past 50 years have seen a rapid decline in the area of terrestrial and marine ecosystems in which ecological and evolutionary processes still operate with minimal human intervention** (***established but incomplete***). Such ecosystems have declined by an average of 47 per cent in terms of overall extent and condition (*established but incomplete*) {2.2.5.2.1} and most continue to decline, many by at least 4 per cent per decade, with sensitive ecosystems such as wetlands and old-growth forests declining even faster (*established but incomplete*) {2.2.5.2.1}. In terrestrial "hotspots" of endemic species, natural habitats have generally undergone greater reductions in extent and condition and tend to be experiencing more rapid ongoing decline on average than other terrestrial regions {2.2.5.2.1}. Globally, the net rate of loss of forests not managed for timber or agricultural extraction has halved since the 1990s, largely because of net afforestation in temperate and high latitudes; high-biodiversity tropical forests continue to dwindle, and global forest area is now only approximately 68 per cent of the estimated pre-industrial level. Forests and natural mosaics sufficiently undamaged to be classed as "intact" (defined as being larger than 500 km^2 where satellites can detect no human pressure) were reduced by 7 per cent between 2000 and 2013, shrinking in both high-income and low-income countries, but particularly rapidly in the tropics {2.2.5.2.1}.

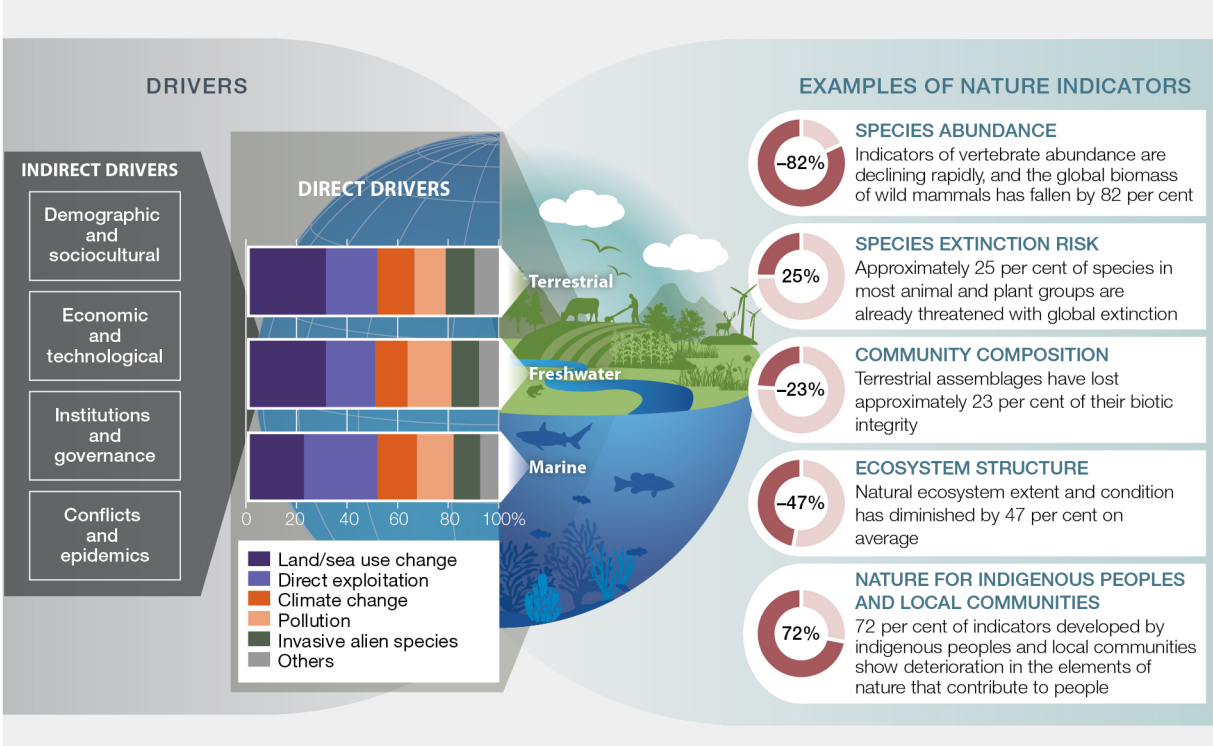


Figure 3. A range of direct drivers – all caused by changes in human societies – affect almost every aspect of nature. Land and sea use change and direct exploitation account for more than 50 per cent of the global impact on land, in fresh water and in the sea, but each driver is dominant in certain contexts. The colour bands represent the relative global impact of direct drivers on (from top to bottom) terrestrial, freshwater and marine nature as estimated from a global systematic review of studies published since 2005. The circles illustrate the extent of the changes in selected aspects of nature, based on a global synthesis of indicators.

5. **Marine ecosystems across the world, from coastal to deep sea, now show the influence of human actions, with coastal marine ecosystems showing some of the largest historical losses of extent and condition and some of the most rapid ongoing declines (*established but incomplete*) {2.2.5.2.1, 2.2.7.15}** (figure 3). Mangrove forests have been reduced to less than 25 per cent of their natural extent and seagrass meadows are decreasing in extent by over 10 per cent per decade. Nearly all shallow coral reefs – among the world's most biodiverse ecosystems – show significant deterioration, and live coral cover on reefs has nearly halved in the past 150 years. Loss and deterioration of such coastal habitats reduces their ability to protect coasts, and the people who live there, from storms.

6. **The global rate of species extinction is already tens, if not hundreds, of times higher than the average rate over the past 10 million years and is accelerating (*established but incomplete*) {2.2.5.2.4}** (figure 4). Human actions have already driven at least 680 vertebrate species to extinction since 1500, including the Pinta Giant Tortoise in the Galapagos in 2012, even though successful conservation efforts have saved other species, such as the Arabian Oryx and the Przewalski's Horse {3.2.1}. Like extinction, the threat of extinction is also accelerating: in the best-studied taxonomic groups, most of the total extinction risk to species has arisen in the past 40 years (*established but incomplete*) {2.2.5.2.4}. The proportion of species currently threatened with extinction averages some 25 per cent across the many terrestrial, freshwater and marine vertebrate, invertebrate and plant groups that have been studied in sufficient detail to support an overall estimate (*established but incomplete*) {2.2.5.2.4, 3.2}. More than 40 per cent of amphibian species, almost a third of reef-forming corals, sharks and shark relatives and over a third of marine mammals are currently threatened {2.2.5.2.4, 3}. The proportion of insect species threatened with extinction is a key uncertainty, but available evidence supports a tentative estimate of 10 per cent {2.2.5.2.4}. Those proportions suggest that, of an estimated 8 million animal and plant species (5.5 million of which are insects), 1 million are threatened with extinction {2.2.5.2.4}. A similar picture also emerges from an entirely separate line of evidence. Habitat loss and deterioration have reduced global terrestrial habitat integrity by 30 per cent; combining that with the longstanding relationship between habitat area and species numbers suggests that around 9 per cent of the world's estimated 5.9 million terrestrial species – more than 500,000 species – have insufficient habitat for long-term survival, so can be considered to be "dead species walking" unless their habitats are restored {2.2.5.2.4}.

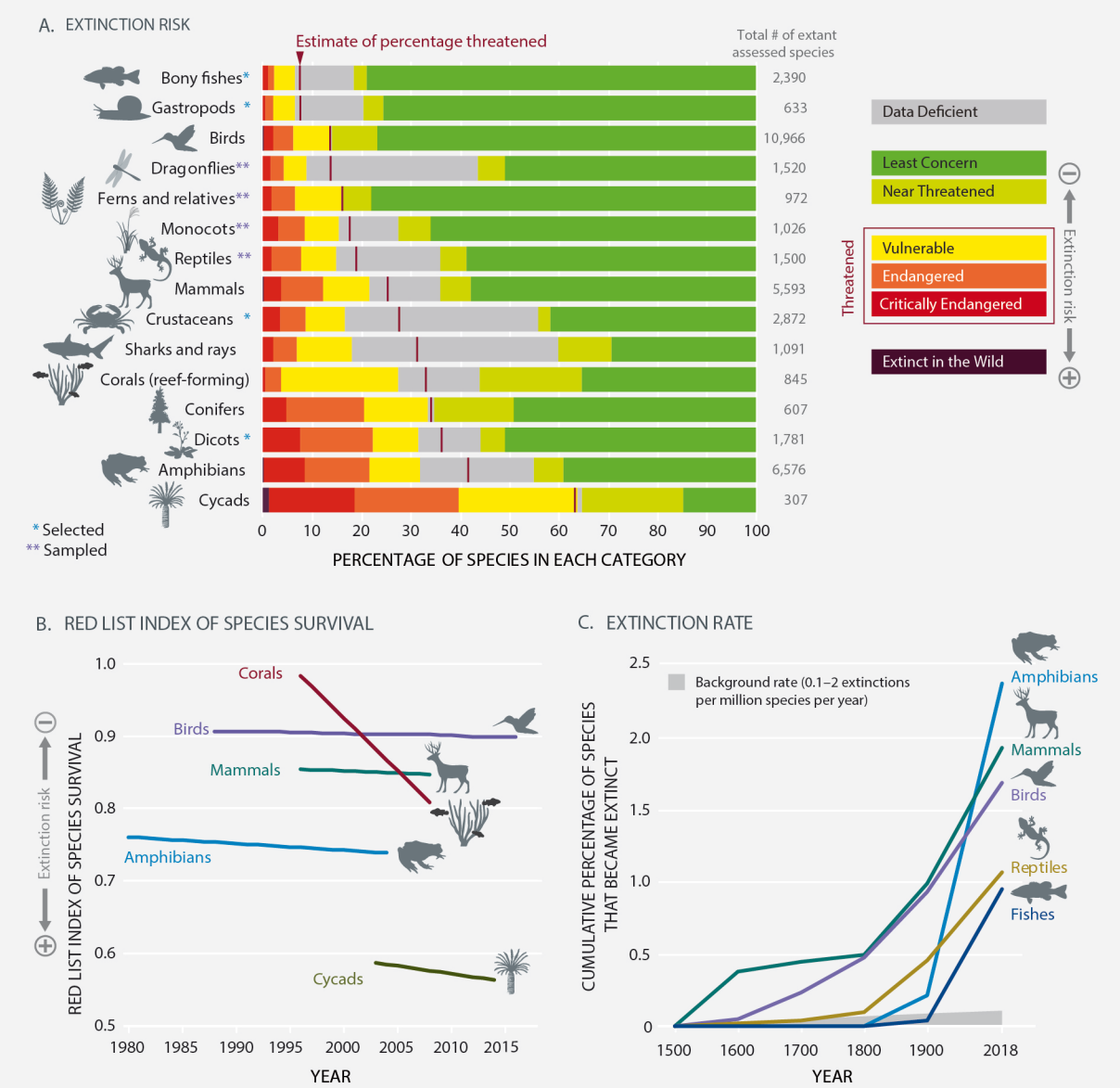


Figure 4. For those groups of species for which data are available, a substantial proportion are threatened with extinction and overall trends are deteriorating, with extinction rates accelerating sharply in the past century. (A) Percentage of species threatened with extinction in different taxonomic groups that have been assessed comprehensively or through a sampled approach for the International Union for Conservation of Nature List of Threatened Species. Species are grouped into taxonomic classes, with the exception of reef-forming corals (which includes species from classes Hydrozoa and Anthozoa), Pteridophytes (which includes classes Lycopodiopsida and Polypodiopsida) and Dragonflies (Order Odonata within the class Insecta). Groups are ordered according to the vertical dark red lines, which indicate the best estimate for the percentage of extant species considered threatened, assuming that data deficient species are as threatened as non-data deficient species. The numbers to the right of each bar represent the total number of extant species assessed for each group. The taxonomic subsets included in the groups labelled "selected" are available at http://www.iucnredlist.org/about/summary-statistics. (B) Red List Index of species survival for taxonomic groups that have been assessed for the Red List of Threatened Species at least twice. A value of 1 is equivalent to all species being categorized as Least Concern; a value of zero is equivalent to all species being classified as Extinct. (C) Extinction rates per century since 1500 for vertebrate groups. Fishes includes bony fishes, cartilaginous fishes and lampreys. Rates for Reptiles and Fishes are likely to be underestimates, as not all species in these groups have been assessed. The range of background rates of extinction is based on 0.1- 2 extinctions per million species per year. [5]

7. **The number of crop varieties and animal breeds in use has been reduced sharply as a result of land use change, knowledge loss, market preferences and large-scale trade (*well established*) {2.2.5.2.6, 2.2.5.3.1}**. Domestic varieties and breeds are the result of selection,

[5] Gerardo Ceballos et al., "Accelerated modern human-induced species losses: Entering the sixth mass extinction", *Science Advances*, Vol. 1, No. 5 (June 2015) and references therein.

sometimes over centuries or millennia, and tend to show a high degree of adjustment to local conditions (*well established*) {2.2.4.4}. Agricultural genetic diversity has declined, mainly through extinction of races and varieties (*well established*) {2.2.5.2.6}. By 2016, approximately 10 per cent of domesticated breeds of mammals were recorded as extinct, as well as some 3.5 per cent of domesticated breeds of birds (*well established*) {2.2.5.2.6}. Many hotspots of agrobiodiversity and crop wild relatives – essential for maintaining a pool of genetic variation of crops and thus for the long-term resilience of agricultural production and food systems in the face of a changing environment – are under threat (figure 5) or not formally protected. They represent critical reservoirs of genes and traits that may provide resilience against future climate change, pests and pathogens and may improve current heavily depleted gene pools of many crops and domestic animals {2.2.3.4.3}. The lands of indigenous peoples and local communities, including farmers, pastoralists and herders, are often important areas for in situ conservation of the remaining varieties and breeds (*well established*) {2.2.5.3.1}.

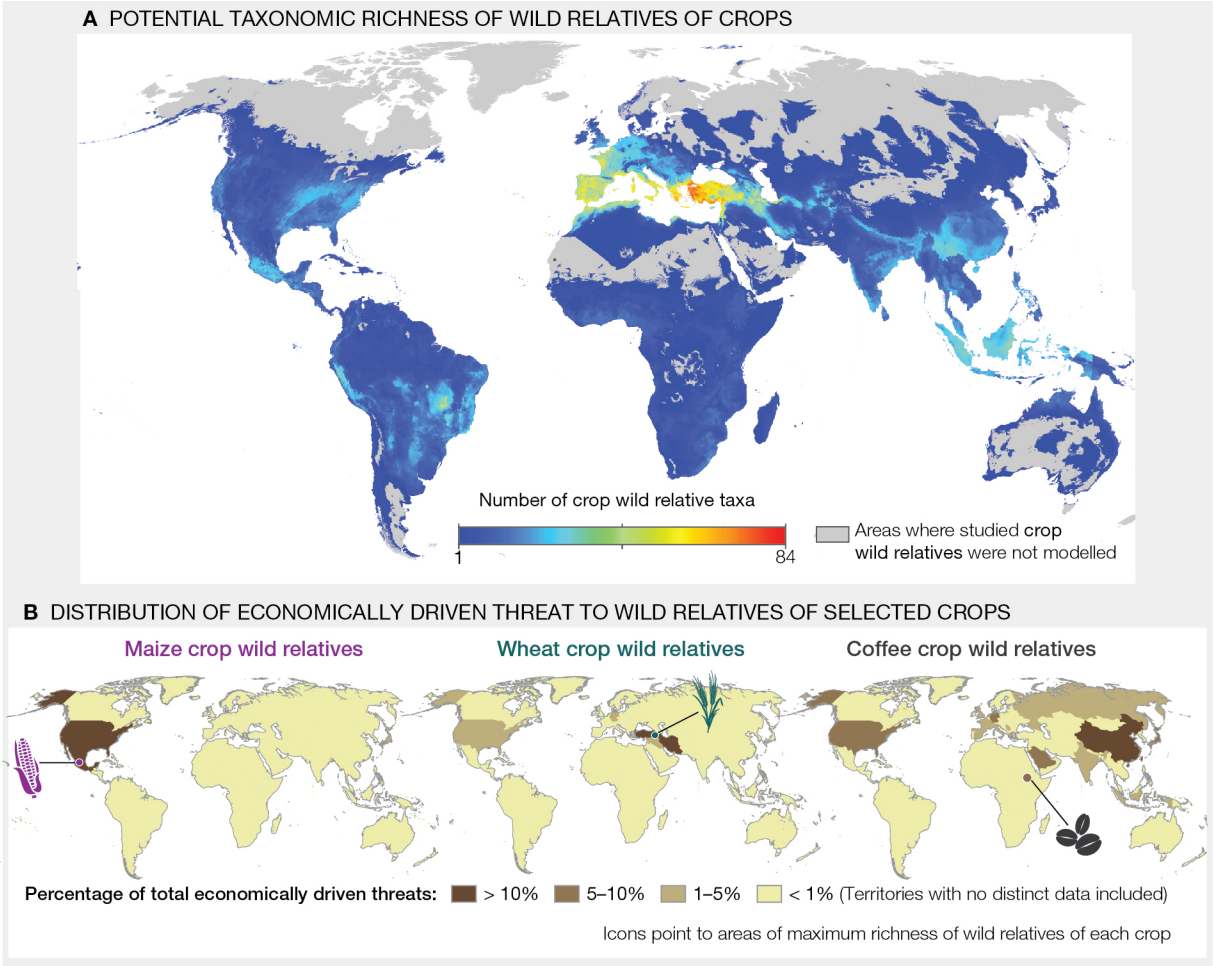


Figure 5. Economic activities, from local to global, threaten hotspots of biodiversity of crop wild relatives. The ancestral species or other close evolutionary relatives of present-day crops are essential for maintaining a pool of genetic variation of crops and thus for the long-term resilience of agricultural production and food systems in the face of a changing environment. (A) Global map overlapping potential distribution models for more than 1,000 taxa of the wild relatives of over 80 crops[6] {2.2.3.4.3}. The colour gradient of richness of crop wild relatives indicates greater (red) to lower (blue) overlap of potential distribution of crop wild relatives in the same geographic area, grey denoting no data. The assessment of consumption-based drivers for the threat to crop wild relatives was carried out using global input-output analysis[7] and a global input-output database.[8] Consumption-based driver assessment assigns environmental impacts not to the primary economic activity that directly drives the impact, but also to the final consumer who ultimately benefits from the corresponding activity.

[6] Redrawn from: Castañeda-Álvarez, N.P. et al., "Global conservation priorities for crop wild relatives", *Nature Plants*, Vol. 2 (March 2016).

[7] Miller, R.E. and Blair, P.D., *Input-Output Analysis: Foundations and Extensions*, 2nd ed. (New York, Cambridge University Press, 2009).

[8] Lenzen, M. et al., "International trade drives biodiversity threats in developing nations", *Nature*, Vol. 486, No. 7401 (June 2012), pp. 109–112.

The threats to the hotspots of wild relatives of (A) maize, (B) wheat and (C) coffee are depicted for illustration. Assessment of threats to maize wild relatives is based on information provided by the "Safeguarding Mesoamerican crop wild relatives" project.[9]

8. **Human-driven changes in species diversity within local ecological communities vary widely, depending on the net balance between species loss and the influx of alien species, disturbance-tolerant species or other human-adapted species or climate migrants (*well established*) {2.2.5.2.3**}. Even though human-dominated landscapes are sometimes species-rich, their species composition is markedly altered from that in natural landscapes (*well established*) {2.2.5.2.3, 2.2.7.10, 2.2.7.11}. As a result, local terrestrial ecosystems worldwide are estimated to have lost at least 20 per cent of originally present biodiversity on average, with hotspots of endemic species tending to have lost even more (*established but incomplete*) {2.2.5.2.3}. The traits of species influence whether they persist or even thrive in human-modified ecosystems (*well established*) {2.2.3.6, 2.2.5.2.5}. For example, species that are large, grow slowly, are habitat specialists or are carnivores – such as great apes, tropical hardwood trees, sharks and big cats – are disappearing from many areas. Many other species, including those with opposite characteristics, are becoming more abundant locally and are spreading quickly around the world; across a set of 21 countries with detailed records, the numbers of invasive alien species per country have risen by some 70 per cent since 1970 {2.2.5.2.3}. The consequences of all these changes for ecosystem functioning and nature's contributions to people are potentially significant, varying within and between regions, and still understudied (*established but incomplete*).

9. **Many organisms show ongoing evolutionary change over years to decades in response to anthropogenic drivers (*well established*) {2.2.5.2.5, 2.2.5.2.6}*;* management decisions that take those evolutionary changes into account will be noticeably more effective (*established but incomplete*) {Box 2.5}.** This contemporary evolution, which has long been recognized in microbes, viruses, agricultural insect pests and weeds (*well established*), is now being observed in all major taxonomic groups (animals, plants, fungi and microorganisms). Such changes are known to occur in response to hunting, fishing, harvesting, climate change, ocean acidification, soil and water pollution, invasive species, pathogens, pesticides and urbanization (*established but incomplete*) {2.2.5.2.5}, but management strategies typically assume that evolutionary changes occur only over much longer time periods and thus ignore them. These policy considerations span many spheres in which management actions designed to slow or speed evolution can dramatically change outcomes. Insects and weeds evolve resistance to pesticides and herbicides, yet management strategies such as refuges can dramatically slow that undesirable evolution (*well established*). Commercial fish populations have evolved to mature earlier under intensive harvesting, which can be minimized by mandating changes in fishing gear or size limits (*established but incomplete*) {2.2.5.2.5}. Climate change favours the evolution of earlier reproduction in many organisms, which can be facilitated through the introduction of individuals from populations already adapted to such conditions (*established but incomplete*) {2.2.5.2.5}. Mosquitoes rapidly evolve resistance to efforts to control them, but evolutionarily informed management actions can dramatically slow that undesirable evolution (*established but incomplete*) {2.2.5.2.5}. Contemporary evolution similarly shapes – and can be manipulated or otherwise managed to shape – many other policy concerns, including pollination and dispersal, coral persistence in the face of ocean acidification, water quality, pest regulation, food production and options for the future (*established but incomplete*).

B. Direct and indirect drivers of change have accelerated during the past 50 years

10. **Today, humans extract more from the Earth and produce more waste than ever before. Globally, land use change is the direct driver with the largest relative impact on terrestrial and freshwater ecosystems, while direct exploitation of fish and seafood has the largest relative impact in the oceans (*well established*)** (figure 3) **{2.2.6.2}. Climate change, pollution and invasive alien species have had a lower relative impact to date, but are accelerating (*established but incomplete*) {2.2.6.2, 3.2, 4.2}.** Agricultural expansion, half of which has been at the expense of intact forests that until very recently showed very little human intervention {2.1.13}, has occurred primarily in the tropics (100 million hectares from 1980 to 2000), resulting mainly from cattle ranching in Latin America (approximately 42 million hectares) and plantations in South-East Asia (approximately 7.5 million hectares, of which 80 per cent is oil palm) {2.1.13}. Urban areas have more than doubled since 1992. Approximately 60 billion tons[10] of renewable and non-renewable resources {2.1.2} are being extracted each year, nearly doubling since 1980, with the per capita consumption of materials rising by 15 per cent {2.1.6, 2.1.11, 2.1.14}. This appropriation of the Earth is accompanied by an

[9] www.psmesoamerica.org/en/.

[10] All references to "tons" are to metric tons.

unprecedented amount of waste products: since 1980, greenhouse gas emissions have doubled {2.1.11, 2.1.12}, raising average global temperatures by at least 0.7 degrees Celsius {2.1.12}, and plastic pollution has increased tenfold {2.1.15}. Over 80 per cent of global wastewater is being discharged back into the environment without treatment, while 300–400 million tons of heavy metals, solvents, toxic sludge and other wastes from industrial facilities are dumped into the world's waters each year {2.1.15}. Fertilizers enter coastal ecosystems, producing more than 400 hypoxic zones which affect a total area of more than 245,000 km^2 {2.1.15}.

11. **On land, land use change and associated pollution are compounded by three main sectors: agriculture (including crops and livestock), logging and mining (*well established*).** Over one third of the world's land surface and nearly three-quarters of freshwater resources are devoted to crop or livestock production {2.1.11}. Crop production occurs on some 12 per cent of total ice-free land. Grazing occurs on about 25 per cent of total ice-free lands and approximately 70 per cent of drylands {2.1.11}. Approximately 25 per cent of the globe's greenhouse gas emissions come from land clearing, crop production and fertilization, with animal-based food contributing 75 per cent to that figure. Intensive agriculture has led to increases in food production at the cost of declines in multiple regulating and non-material contributions from nature, although good environmental practices are increasing. Small landholdings (less than 2 hectares) contribute approximately 30 per cent of global crop production and 30 per cent of the global food supply, using around a quarter of agricultural land and usually maintaining rich agrobiodiversity {2.1.11}. Between 1990 and 2015, clearing and wood harvest contributed to a total reduction of 290 million hectares (6 per cent) in native forest cover, while the area of planted forests grew by 110 million hectares (51 per cent) {2.1.11}. Industrial harvest is falling in some high-income countries, but rising in upper-middle and lower-middle-income countries[11] {2.1.11}. Illegal forestry supplies 10–15 per cent of global timber, rising to 50 per cent in certain areas, worsening both revenues for private and State owners and livelihoods for the rural poor. Mining on land has increased dramatically and, while still using less than 1 per cent of the Earth's land, has had significant negative impacts on biodiversity, emissions, water quality and distribution, and human health {2.1.11}. Approximately 17,000 large-scale mining sites, mostly managed by international corporations, exist in 171 countries {2.1.11}.

12. **In marine systems, fishing has had the single most important impact on biodiversity in the past 50 years (*well established*) {2.1.11, 2.2.6.2}** (figure 3). Global fish catches have been sustained by expanding fishing geographically and penetrating ever-deeper waters (*well established*) {3.2.1}. An increasing proportion of marine fish stocks are fished at unsustainable levels (33 per cent in 2015), whereas 60 per cent are maximally sustainably fished and 7 per cent are underfished (*well established*) {Box 3.1}. Industrial fishing, concentrated in a few countries and corporations {2.1.11}, covers at least 55 per cent of the oceans, largely concentrated in the northeast Atlantic, the northwest Pacific and upwelling regions off South America and West Africa (*established but incomplete*) {2.1.11}. Small-scale fisheries account for more than 90 per cent of commercial fishers (over 30 million people), as well as nearly half the global fish catch (*established but incomplete*). In 2011, illegal, unreported or unregulated fishing represented up to one third of the world's reported catch (*established but incomplete*) {2.1.11}. Since 1992, regional fisheries bodies have been incrementally adopting sustainable management principles to address the depletion of marine fisheries (*established but incomplete*) {2.1.11} and reduce by-catch {3, box 3.3}.

13. **The direct driver with the second highest relative impact on the oceans is changes in use of the sea and coastal land (*well established*)** (figure 3) {2.2.6.2}. Coastal habitats, including estuaries and deltas critical for marine biota and regional economies, have been severely affected by both sea use change (offshore: for example, aquaculture, mariculture and bottom trawling) and land use change (onshore: for example, land clearance and urban sprawl along coastlines). Pollution from land sources is becoming a major driver. Ocean mining, which has been increasing, with 6,500 offshore oil and gas installations in 53 countries, may expand as ice melts in the Arctic and Antarctic regions {2.1.11}. Carbon dioxide emissions to the atmosphere are leading to rapid rise in the acidity of the ocean (ocean acidification), with the ecosystems of the subarctic Pacific and western Arctic Ocean being particularly affected. Plastic microparticles and nanoparticles, often broken down from larger pieces, are entering food webs. Coastal waters hold the highest levels of metals and persistent organic pollutants from industrial discharges and agricultural runoff, poisoning coastal fish harvests. Severe effects of excess nutrient inputs are more concentrated in certain locations, damaging fish and seabed biota. The dynamics of ocean and airborne transport of pollutants mean that the harm

[11] Countries are classified according to World Bank income categories: low, lower-middle, upper-middle and high. Income is measured using gross national income per capita, in US dollars, converted from local currency using the World Bank Atlas method.

from inputs of plastics, persistent organic pollutants, heavy metals and ocean acidification is felt worldwide.

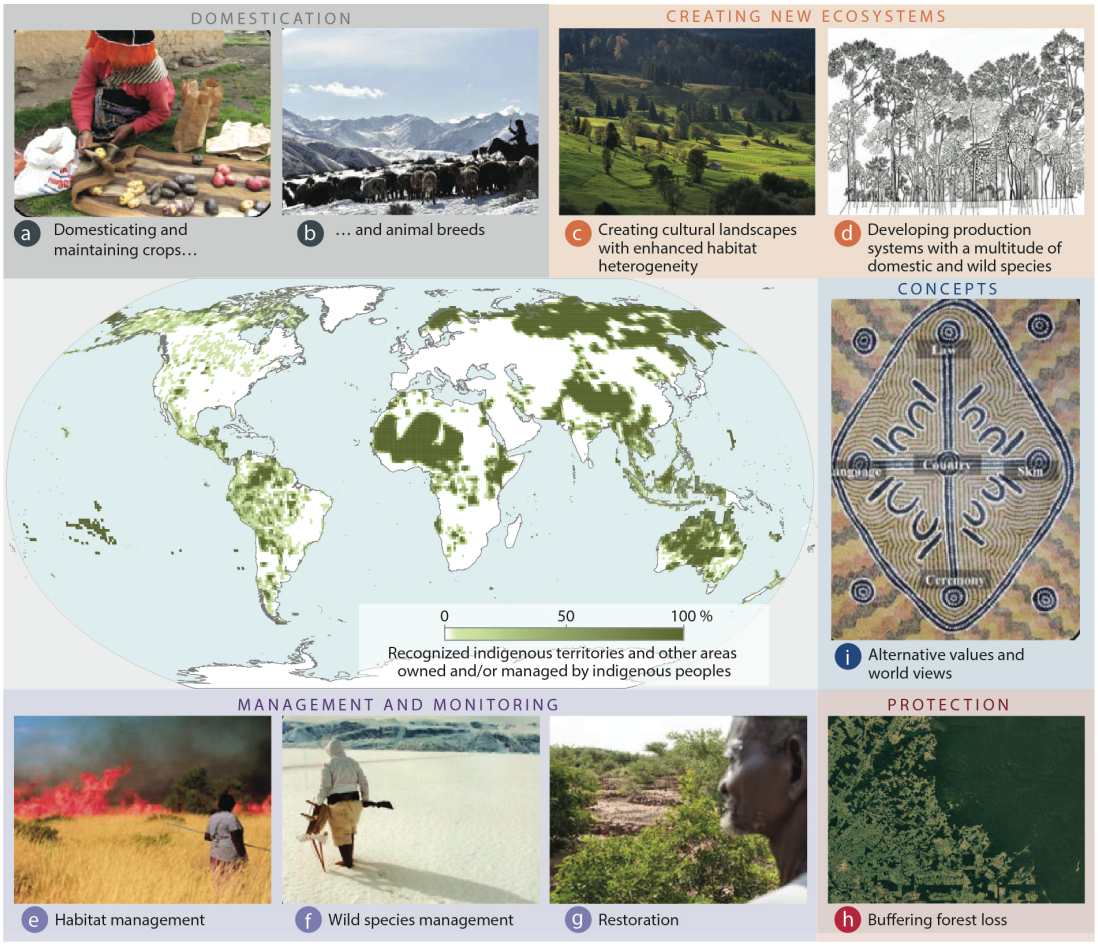
14. **Climate change is already having an impact on nature from genes to ecosystems and poses an increasing risk owing to the accelerated pace of change and its interactions with other direct drivers (*well established*) {2.1.12, 2.1.18, 2.2.6.2}**. Shifts in species distribution, changes in phenology, altered population dynamics and changes in the composition of species assemblage or the structure and function of ecosystems are already evident {2.2.5.3.2, 2.2.5.2.3, 2.2.6.2} and are accelerating in marine, terrestrial and freshwater systems (*well established*) {2.2.3.2}. Almost half (47 per cent) of terrestrial flightless threatened mammals and one quarter (23 per cent) of threatened birds may have already been negatively affected by climate change in at least part of their distribution (for example, birds in North America and Europe have shown strong indications of climate change in their population trends since the 1980s) (*established but incomplete*) {2.2.6.2}. Ecosystems such as tundra and taiga and regions such as Greenland, that until now have remained least affected directly by people, are increasingly experiencing the impacts of climate change {2.2.7.5}. Large reductions and local extinctions of populations associated with climate change are already widespread {2.2.6.2} among animals (both vertebrates and invertebrates) and in freshwater systems, indicating that many species are unable to cope locally with the rapid pace of climate change and that their continued existence will depend on the extent to which they are able to disperse and track suitable climatic conditions {2.2.5.2.5}.

15. **Due to an unprecedented expansion of infrastructure development, extensive areas of the planet are being opened up to new environmental threats (*well established*) {2.1.11}**. The total length of paved roads globally is projected to increase by 25 million kilometres by 2050, with nine tenths of all road construction occurring in low-income and middle-income countries. The total number of dams has escalated in the past 50 years and there are now approximately 50,000 large dams (defined as higher than 15 metres) and approximately 17 million reservoirs (larger than 0.01 hectares) worldwide {2.1.11}. New roads, highways, hydroelectric dams and oil and gas pipelines can come with high environmental and social costs, including deforestation, biodiversity loss, land grabbing, population displacement, social disruption and, in many cases, violation of the customary rights of indigenous peoples and local communities. On the other hand, infrastructure can also bring with it positive spillovers associated with new economic opportunities, increased efficiency and innovation, depending on how it is conceived and implemented (*well established*) {2.1.11}.

16. **Long-distance transportation and tourism have grown dramatically in the past 20 years, with both positive and negative consequences for nature (*established but incomplete*).** That includes a threefold increase in travel, especially from high-income and upper-middle-income countries. The rise in airborne and seaborne transportation of both goods and people has increased pollution and resulted in a significant increase in invasive alien species (*well established*) {2.1.15}. Furthermore, between 2009 and 2013, the carbon footprint from tourism rose 40 per cent to 4.5 gigatons of carbon dioxide: 8 per cent of total greenhouse gas emissions are from transport and food consumption related to tourism {2.1.11, 2.1.15}. The demand for nature-based tourism, or ecotourism, also has risen, with mixed effects on nature and local communities {2.1.11}.

17. **Much of the world's terrestrial wild and domesticated biodiversity lies in areas managed and/or held by indigenous peoples and local communities and other long-term land managers (*well established*)** (figure 6) {2.2.4}**. In spite of efforts at all levels, and despite the fact that nature on indigenous lands is declining less rapidly than elsewhere, biodiversity, as well as the knowledge associated with its management, is deteriorating (*established but incomplete*) {2.2.4, 2.2.5.3}**. Despite a long history of resource use and conservation conflicts related to various waves of colonial expansion and land appropriation for parks and other uses {3.2} (*well established*), indigenous peoples and local communities often manage their landscapes and seascapes in ways that have been adjusted to local conditions over generations and that often remain compatible with, or actively support, biodiversity conservation by "accompanying" natural processes with anthropogenic assets (*established but incomplete*) {2.2.4, 2.2.5.3.1} (figure 4). Community-based conservation institutions and local governance regimes have been shown to be equally effective or sometimes more effective than formally established protected areas in avoiding habitat loss (*established but incomplete*), with several studies highlighting the positive contributions made by indigenous peoples and local communities in buffering deforestation (*well established*) {6.3.2, 2.2.5.3}. In many regions, however, the lands of indigenous peoples are becoming islands of biological and cultural diversity surrounded by areas in which nature is considerably more deteriorated (*established but incomplete*) {2.2.5.3}. Among the local indicators developed and used by indigenous peoples and local communities, 72 per cent show negative trends in nature (*established but incomplete*) {2.2.5.3.2}. The major trends observed include the following: a general decrease in resource availability and increase in time needed or distance travelled to harvest resources; decreases in population size of many culturally

salient species; the arrival of newcomer species as climate changes; colonization by new pests and invasive alien species; losses in natural habitats, especially forests and grazing lands, and the deterioration of remnant ecosystems and their productivity; and a decline in the health condition and body size of wild animals. A more detailed global synthesis of trends in nature observed by indigenous peoples and local communities is hindered by the lack of institutions that gather local data, aggregate them and synthesize them into regional and global summaries {2.2.2}.



Source: Painting in (i) by Daniel Rockman Jupurrurla.[12] Reproduced under the Creative Commons licence.

Figure 6. Contributions of indigenous peoples and local communities to the enhancement and maintenance of wild and domesticated biodiversity and landscapes. Indigenous and local knowledge systems are locally based, but regionally manifested and thus globally relevant. A wide diversity of practices actively and positively contribute to wild and domestic biodiversity through "accompanying" natural processes with anthropogenic assets (knowledge, practices and technology). Indigenous people often manage the land and coastal areas based on culturally specific world views, applying principles and indicators such as the health of the land, caring for the country and reciprocal responsibility. As lifestyles, values and external pressures change with globalization, however, unsustainable practices are becoming increasingly common in certain regions. The central map represents recognized indigenous territories and other areas owned and/or managed by indigenous peoples (see disclaimer).[13] Topics and pictures in the figure aim to illustrate, not represent, the types and diversity of the following contributions of indigenous peoples and local communities to biodiversity: (a) domestication and maintenance of locally adapted crop and fruit varieties (potatoes, Peru) and (b) animal breeds (rider and sheep, Kyrgyzstan) {2.2.4.4}; (c) creation of species-rich habitats and high ecosystem diversity in cultural landscapes (hay meadows, Central Europe) {2.2.4.1-2}; (d) identification of useful plants and their cultivation in high-diversity ecosystems (multi-species forest garden, Indonesia) {2.2.4.3}; (e)-(f) management and monitoring of wild species, habitats and landscapes for wildlife and for increased resilience (e) - Australia, (f) - Alaska) {2.2.4.5-6}; (g) restoration of degraded lands (Niger) {3.2.4}; (h) buffers for deforestation in recognized indigenous territories (Amazon basin, Brazil) {2.2.4.7}; (i) offering alternative concepts of relations between humanity and nature (Northern Australia). **Disclaimer**: Areas used and managed by local communities based on customary practices are not shown, as no data are available at the global level. The estimates presented here show lands that have been identified as owned and/or managed by indigenous peoples in publicly available documents,

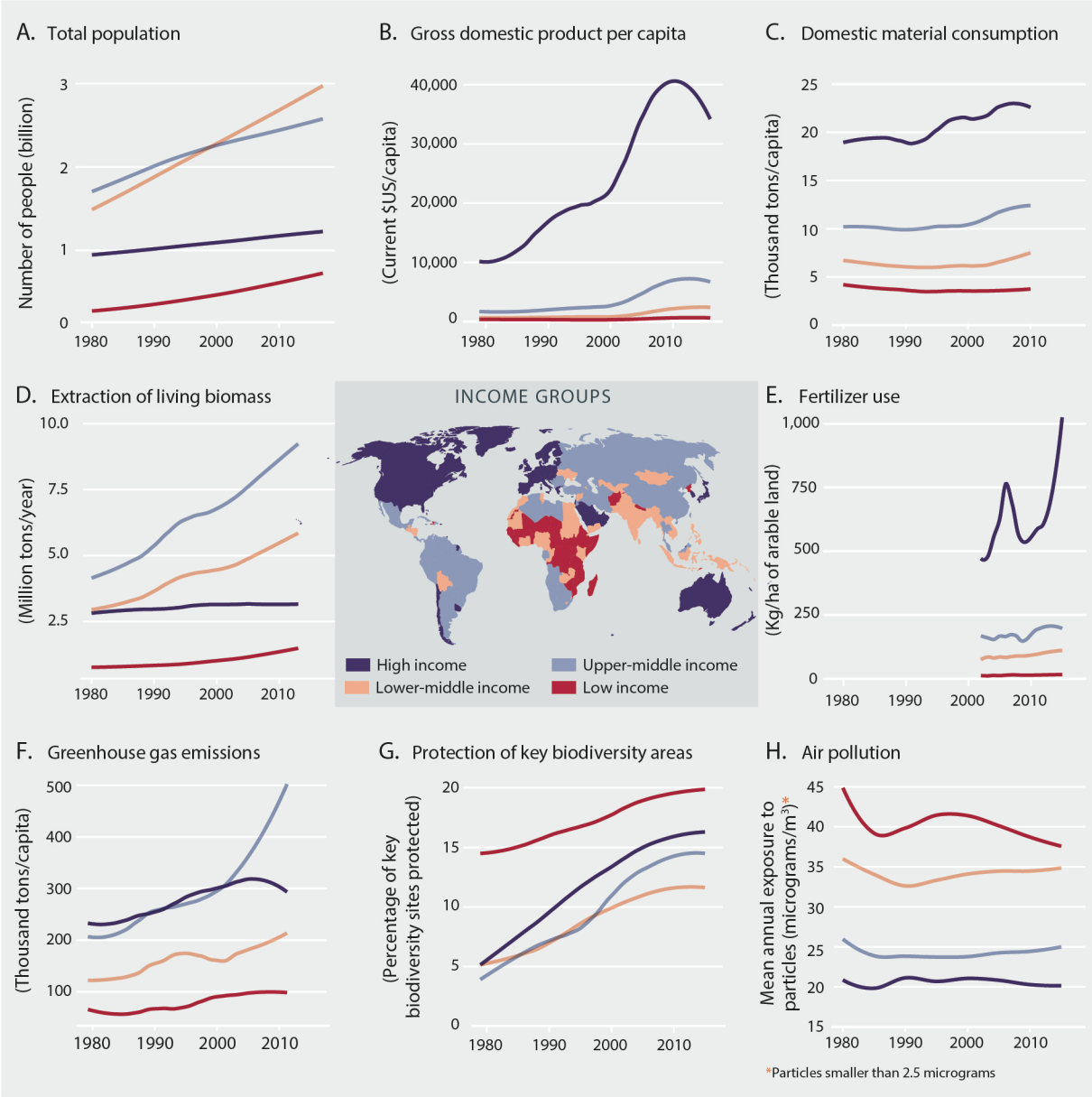
[12] In W. J. Pawu-Kurlpurlurnu et al., "Ngurra-kurlu: A way of working with Warlpiri people", DKCRC Report 41 (Alice Springs, Desert Knowledge Cooperative Research Centre, 2008).

[13] In Stephen Garnett et al., "A spatial overview of the global importance of Indigenous lands for conservation", *Nature Sustainability*, Vol. 1 (July 2018) pp. 369–374.

but do not necessarily constitute the total area over which indigenous peoples continue to exercise customary rights or to which they retain a cultural connection. This area may be larger than illustrated.

18. **This unprecedented human appropriation of the Earth is underpinned by a set of demographic and economic indirect drivers that have risen in scale and that interact with each other in complex ways (*well established*) {2.1.6}**. The global human population has been growing, increasing from 3.7 to 7.6 billion since 1970. The largest increases are in Africa and in low-income countries {2.1.4}. Per capita consumption also has grown and is also unequal. Lifestyles and access to resources vary greatly across and within regions, with direct consequences for nature and people. Per capita gross domestic product is 50 times higher and rising faster in high-income countries than in low-income countries. Approximately 600 million people face food insecurity in Africa and Asia and 40 per cent of the global population lacks access to clean, safe drinking water. Environmentally based health burdens (such as air and water pollution) are also more prevalent in low-income countries {2.1.2., 2.1.15}.

19. **Distant areas of the world are increasingly connected, with processes such as consumption and economic and governance decisions generating flows of information, energy, materials and waste, shifting consumption footprints across countries with unequally distributed burdens and benefits, which in many cases leads to acute social conflict (*established but incomplete*)** (figure 7). Even as per capita consumption has risen for higher-income and rapidly growing upper-middle-income countries {2.1.2, 2.1.6}, higher-income countries in general have maintained their agricultural output, water usage and forest cover over the past 50 years {2.1.6, 2.1.11}. That has been achieved by importing crops and other resources from middle-income countries {2.1.6}, where nature and most of its contributions other than marketed food, fibre and timber (for example, habitat maintenance, water, climate and air quality regulation) have declined (figures 2 and 7). More than 2,500 conflicts over fossil fuels, water, food and land are currently occurring across the planet. Lower-income countries, which tend to be rich in natural resources, have experienced more conflict, exacerbating environmental degradation and lowering growth in gross domestic product, evidenced by the fact that today, environmental migrants number several million {2.1.2, 2.1.4}. Local communities are expelled from the land or threatened by deforestation, mining or the expansion of industrial logging, with at least 1,000 environmental activists and journalists killed between 2002 and 2013 {2.1.11, 2.1.18}. Today, a handful of corporations or financiers often control large shares of the flows in any market, as well as capital assets that rival the total revenues of the vast majority of countries {2.1.6}. For example, it is estimated that funds channelled through tax havens support 70 per cent of the known vessels implicated in illegal, unreported and unregulated fishing and 68 per cent of the foreign capital being invested in the soy and beef sectors and leading to the transformation of the Amazon.



Sources: A, B, E and H: data.worldbank.org; C and D: materialflows.net; F: data.oecd.org; G: keybiodiversityareas.org.

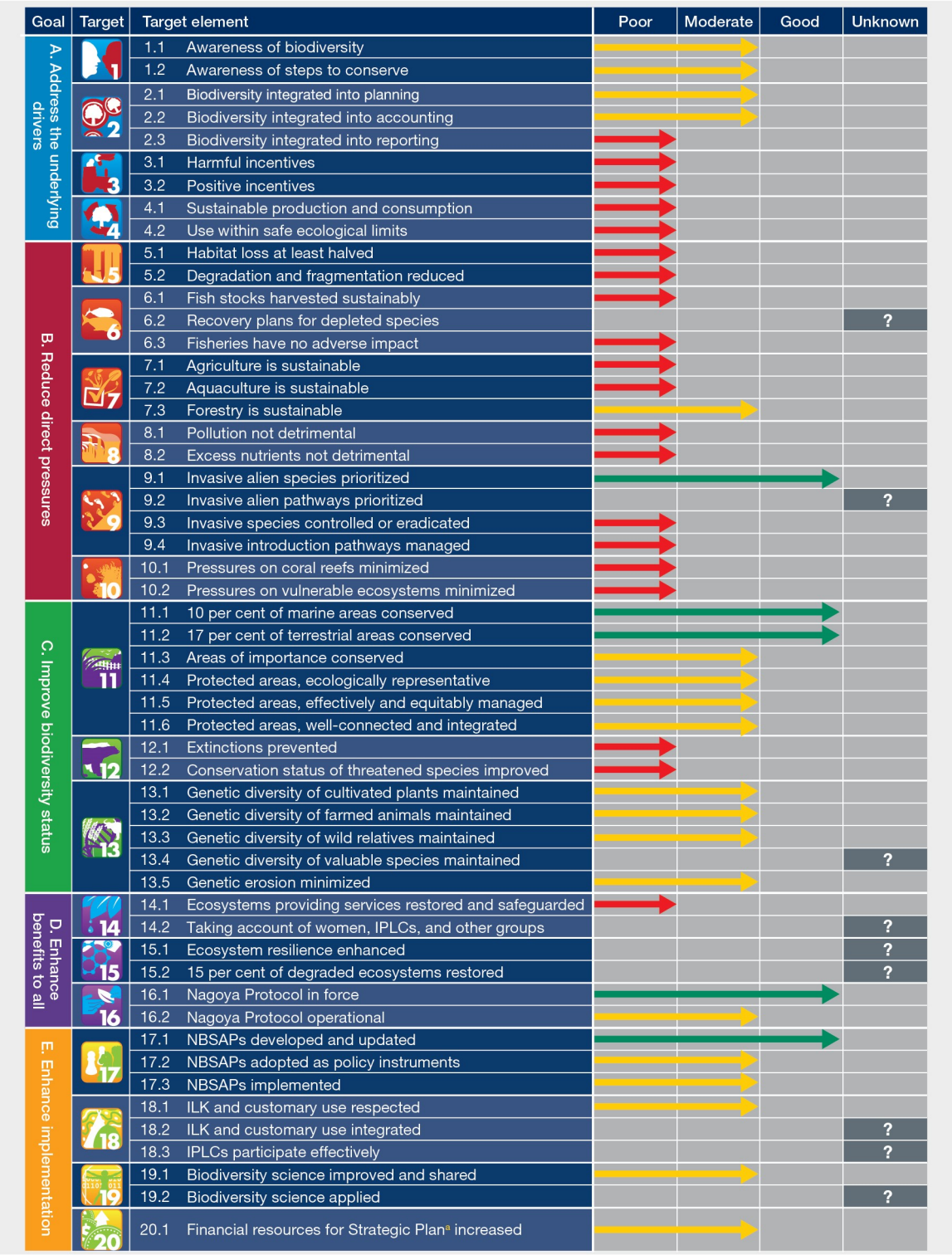
Figure 7. Development pathways since 1980 have been highly unequal, both within and between countries. The increasing trade connections between countries have led to trade-offs between societal and environmental goals, which in turn have resulted in consumption footprints being exported from higher-income countries to lower-income countries. To meet the needs of larger, fast-growing populations, largely in middle-income countries (A), as well as those of increasingly more affluent populations in high-income countries (B), who have the highest per capita consumption of materials (C), materials from nature are increasingly being extracted and exported from middle-income countries (D). Local and global environmental impact on nature is consequently increasing, with the highest fertilizer use in high-income, highly technified countries (E) and the greatest impact on the global atmosphere (greenhouse gas emissions) from high-income countries, with upper-middle-income countries close behind in terms of increasing greenhouse gas emissions(F). Protection of key biodiversity areas has been rising and is highest in low-income countries, where it has been largely financed with international funds (G), while inhabitants of low-income countries, where environmental regulation is often poorer, are exposed to twice as much air pollutants (H). Countries are classified according to World Bank income categories.

20. **There has been little progress at the global scale towards eliminating or phasing out subsidies harmful to biodiversity (*well established*) {2.1, 3, 5, 6.4}**. Subsidies include direct incentives (such as financial transfer, subsidized credit or tax abatements) and indirect incentives, such as prices of commodities and industrial goods that often hide environmental and social costs. In some cases, they have encouraged overproduction, deforestation, overcapacity in the fishing and forestry sectors, urban sprawl and the wasteful consumption of water. It is estimated that in 2015 financial support to agriculture that is potentially environmentally harmful amounted to US$100 billion in countries within the Organization for Economic Cooperation and Development, although agricultural

subsidy policy reforms aimed at reducing pesticides and unsustainable practices have already been introduced with some success in some countries {6.4.5}. Fossil fuel subsidies account for US$345 billion globally, resulting in an overall cost of US$5 trillion, including nature deterioration externalities, with coal accounting for 52 per cent of post-tax subsidies, petroleum for 33 per cent and natural gas for 10 per cent {2.1.9.1.2}. In the fisheries sector, capacity-enhancing subsidies, which may have a negative impact on nature, constitute 57 per cent of the US$35 billion spent on support measures {5.3.2.5}.

C. Short-term goals for protecting nature and achieving sustainability cannot be met by current trajectories, but goals for 2030, 2050 and beyond can be achieved through transformative change

21. **There has been good progress towards the components of 4 of the 20 Aichi Targets under the Strategic Plan for Biodiversity 2011–2020 and moderate progress towards some components of another 7 targets, but for 6 targets poor progress has been made towards all components, while there is insufficient information to assess progress towards some or all components of the remaining 3 targets (*established but incomplete*) {3.2}. Overall, the state of nature continues to decline (12 of 16 indicators show significantly worsening trends) (*well established*) {3.2}** (figure 8)**.** Greater progress has been made in implementing policy responses and actions to conserve nature and use it more sustainably (22 of 34 indicators show significant increases) than in addressing the drivers of biodiversity loss (9 of 13 indicators show significantly worsening trends) (*well established*) {3.2}. The greatest progress has been made in identifying and prioritizing invasive alien species (Aichi Target 9), conserving 10 per cent of coastal and marine areas and 17 per cent of terrestrial and inland water areas (Aichi Target 11), bringing the Nagoya Protocol into force (Aichi Target 16) and developing national biodiversity strategy and action plans (Aichi Target 17). However, while protected areas now cover 15 per cent of terrestrial and freshwater environments and 7 per cent of the marine realm, they only partly cover important sites for biodiversity and are not yet fully ecologically representative and effectively or equitably managed (*well established*) {3.2}. While within Aichi Target 12 (preventing extinctions) some species have been brought back from the brink of extinction, species of all taxonomic groups with quantified trends are moving towards extinction at an increasing rate (*well established*) {3.2}. The least progress has been made towards Aichi Target 10 (addressing drivers with an impact on coral reefs and other ecosystems vulnerable to climate change; *established but incomplete*) {3.2}. Anthropogenic drivers of biodiversity loss, including habitat loss as a result of land use and sea use change (addressed by Aichi Target 5), agriculture, aquaculture and forestry (Aichi Target 7), fishing (Aichi Target 6), pollution (Aichi Target 8) and invasive alien species (Aichi Target 9), are increasing, despite efforts to meet the Aichi Targets (*established but incomplete*) {3.2}.



Abbreviations: ILK: indigenous and local knowledge; IPLCs: indigenous peoples and local communities; NBSAPs: national biodiversity strategies and action plans.

[a] Strategic Plan for Biodiversity 2011–2020.

Figure 8. Summary of progress towards the Aichi Targets. Progress towards target elements is scored as "Good" (substantial positive trends at a global scale relating to most aspects of the element), "Moderate" (the overall global trend is positive but insubstantial or insufficient, or there may be substantial positive trends for some aspects of the element but little or no progress for others, or the trends are positive in some geographic regions but not in others), "Poor" (little or no progress towards the element or movement away from it; while there may be local, national or case-specific successes and positive trends for some aspects, the overall global trend shows little or negative progress) or "Unknown" (insufficient information to score progress).

22. **Conservation actions have been successful in preventing the extinction of some species (*established but incomplete*).** For example, conservation investment during the period between 1996 and 2008 reduced the extinction risk for mammals and birds in 109 countries by 29 per cent per country on average, while the rate of deterioration in extinction risk for birds, mammals and amphibians would have been at least 20 per cent higher without conservation action in recent decades. Similarly, it is likely that at least 6 species of ungulate would now be extinct or surviving only in captivity without conservation measures. At least 107 highly threatened birds, mammals and reptiles are estimated to have benefited from invasive mammal eradication on islands {3.2.2}. Although still few and spatially localized, such cases show that with prompt and appropriate action, it is possible to reduce human-induced extinction rates (*established but incomplete*) {2.2.5.2.4, 4}. There are, however, few other counterfactual studies assessing how trends in the state of nature or pressures upon nature would have been different in the absence of conservation efforts (*well established*) {3.2}.

23. **As explicitly expressed in several of the Sustainable Development Goals, such as those on clean water, climate action, life below water and life on land (Sustainable Development Goals 6, 13, 14 and 15), nature and nature's contribution to people directly underpin their achievement (*well established*) {3.3.2.1}. Nature also plays an important, complex role in the Sustainable Development Goals related to poverty, hunger, health and well-being, sustainable cities and clean and affordable energy (Sustainable Development Goals 1, 2, 3, 7, 11) (*established but incomplete*) {3.3.2.2}** (figure 9)**.** Several examples illustrate these interdependencies between nature and the Sustainable Development Goals. For example, nature and its contributions may play an important role in reducing vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters, although anthropogenic assets are also involved (*established but incomplete*). Nature's underpinning of specific health targets varies across regions and ecosystems, is influenced by anthropogenic assets and remains understudied. The relationship can sometimes be positive and other times be negative, as in the case of certain aspects of biodiversity and infectious diseases. Nature directly underpins the livelihoods of indigenous peoples and local communities and the rural and urban poor, largely through direct consumption of, or income generated by, trade in material contributions such as food and energy (*well established*). Such contributions are generally underrepresented in poverty analyses (*established but incomplete*). Nature and its contributions are also relevant to goals for education, gender equality, inequalities and peace, justice and strong institutions (Sustainable Development Goals 4, 5, 10 and 16), but the current focus and wording of targets obscures or omits their relationship to nature (*established but incomplete*).

Sustainable Development Goal	Target (abbreviated)	Recent status and trends in aspects of nature and nature's contributions to people that support progress towards target			
		Insufficient progress	Negative	Unknown	Uncertain relationship
No poverty	1.1 Eradicate extreme poverty				U
	1.2 Halve the proportion of people in poverty				U
	1.4 Ensure that all have equal rights to economic resources		↓		
	1.5 Build the resilience of the poor		↓		
Zero hunger	2.1 End hunger and ensure access to food all year round	→			
	2.3 Double productivity and incomes of small-scale food producers	→			
	2.4 Ensure sustainable food production systems		↓		
	2.5 Maintain genetic diversity of cultivated plants and farmed animals	→			
Good health and well-being	3.2 End preventable deaths of newborns and children				U
	3.3 End AIDS, tuberculosis, malaria and neglected tropical diseases				U
	3.4 Reduce premature mortality from non-communicable diseases			?	
	3.9 Reduce deaths and illnesses from pollution			?	
Clean water and sanitation	6.3 Improve water quality		↓		
	6.4 Increase water use and ensure sustainable withdrawals		↓		
	6.5 Implement integrated water resource management	→			
	6.6 Protect and restore water-related ecosystems		↓		
Sustainable cities and communities	11.3 Enhance inclusive and sustainable urbanization		↓		
	11.4 Protect and safeguard cultural and natural heritage	→			
	11.5 Reduce deaths and the number of people affected by disasters		↓		
	11.6 Reduce the adverse environmental impact of cities		↓		
	11.7 Provide universal access to green and public spaces		↓		
Climate action	13.1 Strengthen resilience to climate-related hazards		↓		
	13.2 Integrate climate change into policies, strategies and planning	→			
	13.3 Improve education and capacity on mitigation and adaptation			?	
	13a Mobilize US$100 billion/year for mitigation by developing countries			?	
	13b Raise capacity for climate change planning and management			?	
Life below water	14.1 Prevent and reduce marine pollution		↓		
	14.2 Sustainably manage and protect marine and coastal ecosystems	→			
	14.3 Minimize and address ocean acidification		↓		
	14.4 Regulate harvesting and end overfishing	→			
	14.5 Conserve at least 10 per cent of coastal and marine areas	→			
	14.6 Prohibit subsidies contributing to overfishing		↓		
	14.7 Increase economic benefits from sustainable use of marine resources		↓		
Life on land	15.1 Ensure conservation of terrestrial and freshwater ecosystems		↓		
	15.2 Sustainably manage and restore degraded forests and halt deforestation		↓		
	15.3 Combat desertification and restore degraded land		↓		
	15.4 Conserve mountain ecosystems	→			
	15.5 Reduce degradation of natural habitats and prevent extinctions		↓		
	15.6 Promote fair sharing of benefits from use of genetic resources	→			
	15.7 End poaching and trafficking		↓		
	15.8 Prevent introduction and reduce impact of invasive alien species		↓		
	15.9 Integrate biodiversity values into planning and poverty reduction	→			
	15a Increase financial resources to conserve and sustainably use biodiversity	→			
	15b Mobilize resources for sustainable forest management		↓		

Figure 9. Recent status of and trends in aspects of nature and nature's contributions to people that support progress towards achieving selected Sustainable Development Goals and their targets. "Insufficient progress": the overall global status and trends are positive but insubstantial or insufficient, or there may be substantial positive trends for some relevant aspects but negative trends for others, or the trends are positive in some geographic regions but negative in others; "Negative": poor status or substantial negative trends at a global scale; "Uncertain relationship": uncertain relationship between the trends and progress towards achieving the target; "Unknown": insufficient information to score the status and trends. None of the targets scored "Positive" (that is, good status or substantial positive trends at a global scale).

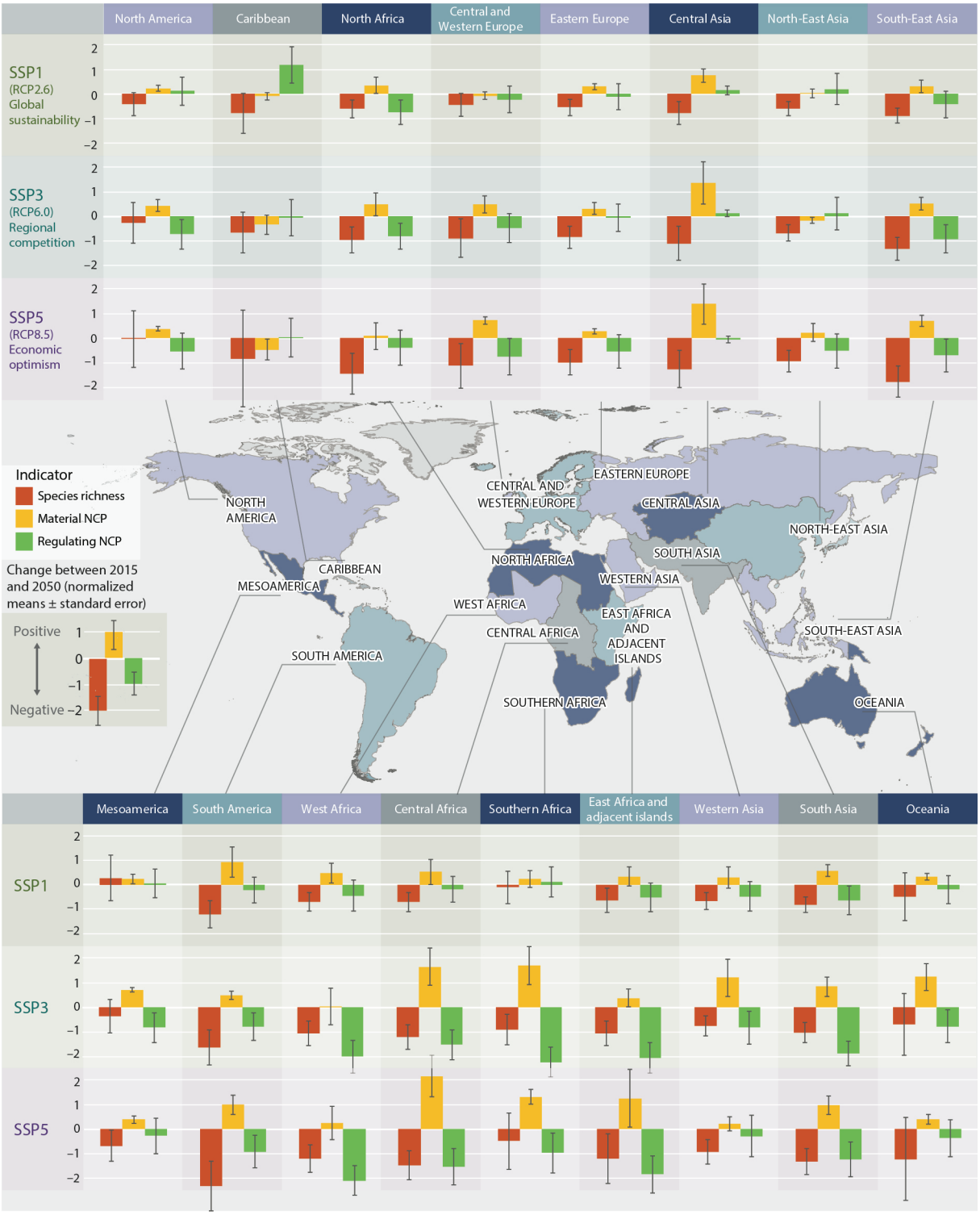
24. **Our ability to meet the Sustainable Development Goals and achieve the 2050 Vision for Biodiversity can be enhanced if climate change impacts are taken into account in the definition of future targets (*well established*) {3.2, 3.3}**. For example, climate change is projected to greatly increase the number of species under threat, with fewer species expanding their ranges or experiencing more suitable climatic conditions than the number of species experiencing range contraction or less suitable conditions (*established but incomplete*) {4.2, 3.2}. The impacts of climate change on the effectiveness of protected areas calls for the re-evaluation of conservation objectives, but there are currently few protected areas whose objectives and management take climate change into account (*established but incomplete*). The Sustainable Development Goals for poverty, health, water and food security and sustainability targets are closely linked through the impacts of multiple direct drivers, including climate change, on nature and nature's contributions to people and good quality of life. In a post-2020 global biodiversity framework, greater emphasis on the interactions between Sustainable Development Goal targets {4.6, 3.7} may provide a way forward for achieving multiple targets, as synergies (and trade-offs) can be considered. Future targets are expected to be more effective if they take into account climate change, action to adapt to climate change and the potential consequences of climate change mitigation policies on biodiversity {4.6, 3.7}.

25. **The adverse impacts of climate change on biodiversity are projected to increase with increasing warming, so limiting global warming to 2 degrees Celsius or, ideally, well below that will have multiple co-benefits for nature, nature's contributions to people and quality of life; however, land-based mitigation measures to achieve that objective are projected to have significant impacts on biodiversity (*established but incomplete*) {4.2, 4.3, 4.4, 4.5}.** All climate models show that limiting human-induced climate change to below 2 degrees Celsius requires immediate, rapid reductions in greenhouse gas emissions or relying on substantial carbon dioxide removal from the atmosphere. However, the land areas required for bioenergy crops (with or without carbon capture and storage), afforestation and reforestation to achieve the targeted carbon uptake rates are projected to be very large {4.2.4.3., 4.5.3}. The environmental impact of large-scale afforestation and reforestation depends to a large degree on prior vegetation cover and the tree species planted (*established but incomplete*). Likewise, large bioenergy crop areas are expected to compete with areas set aside for conservation and food production (*established but incomplete*). Consequently, large-scale land-based mitigation measures are projected to jeopardize the achievement of other Sustainable Development Goals that depend on land resources (*well established*) {4.5.3}. In contrast, the benefits of avoiding deforestation can be significant for biodiversity (*well established*) and are expected to have co-benefits for local communities (*established but incomplete*) {4.2.4.3}.

26. **Biodiversity and regulating NCP are projected to decline further in most scenarios of global changes over coming decades, while material NCP with current market value (food, feed, timber and bioenergy) are projected to increase (*well established*) {4.2, 4.3}** (figure 10). The projected effects of climate change and land use change on terrestrial and freshwater biodiversity are mostly negative, increase with the degree of global warming and land use change and have an impact on marine biodiversity through increased eutrophication and deoxygenation of coastal waters (*well established*) {4.2.2.3.2, 4.2.3, 4.2.4}. Climate change and business-as-usual fishing scenarios are expected to worsen the status of marine biodiversity (*well established*) {4.2.2.2, 4.2.2.3.1}. Climate change alone is projected to decrease ocean net primary production by between 3 and 10 per cent and fish biomass by between 3 and 25 per cent (in low and high warming scenarios, respectively) by the end of the century (*established but incomplete*) {4.2.2.2.1}. Whether or not the current removal of nearly 30 per cent of anthropogenic carbon dioxide emissions by terrestrial ecosystems continues into the future varies greatly from one scenario to the next and depends heavily on how climate change, atmospheric carbon dioxide and land use change interact. Important regulating contributions, such as coastal and soil protection, crop pollination and carbon storage, are projected to decline (*established but incomplete*) {4.2.4, 4.3.2.1}. In contrast, food, feed, timber and bioenergy production substantially increase in most scenarios (*well established*) {4.2.4, 4.3.2.2}. Scenarios that include substantial shifts towards sustainable management of resource exploitation and land use, market reform, globally equitable and restricted animal protein consumption and reduction of food waste and losses result in low loss or even recovery of biodiversity (*well established*) {4.2.2.3.1, 4.2.4.2, 4.3.2.2, 4.5.3}.

27. **The magnitude of impacts on biodiversity and the differences between regions are much greater under scenarios with rapid increases in consumption or human population than under scenarios where such increases are moderated by a focus on global or regional sustainability (*well established*)** (figure 10)**.** Sustainability scenarios result in substantially lower food, feed and timber production, but this arises primarily from lower demand for animal protein in those scenarios rather than insufficient supply of food and other material NCP (*well established*) {4.1.3, 4.2.4.2, 4.3.2, 4.5.3}. The general patterns at the global level – namely declines in biodiversity and regulating contributions versus increases in the production of food, bioenergy and materials – are evident in

nearly all subregions {4.2.2, 4.2.3, 4.2.4, 4.3.3}. For terrestrial systems, most studies indicate that South America, Africa and parts of Asia will be much more significantly affected than other regions, especially in scenarios that are not based on sustainability objectives (see figure 10 as an example). That is due in part to regional climate change differences and in part to the fact that scenarios generally foresee the largest land use conversions to crops or bioenergy in those regions {4.1.5, 4.2.4.2}. Regions such as North America and Europe are expected to have low conversion to crops and continued reforestation {4.1.5, 4.2.4.2}.



Abbreviations: NCP: nature's contributions to people; RCP: representative concentration pathway; SSP: shared socioeconomic pathway.

Figure 10. Land-use and climate change are projected to have an impact on biodiversity and nature's material and regulating contributions to people between 2015 and 2050, with large differences between regions and scenarios. Projections are based on three land use and climate change scenarios developed in support of Intergovernmental Panel on Climate Change assessments. SSP1 is a "global sustainability" scenario combined with low greenhouse

gas emissions (RCP2.6; top panel); SSP3 is a "regional competition" scenario combined with high emissions (RCP6.0; middle panel); and SSP5 is an "economic optimism" scenario combined with very high emissions (RCP8.5; bottom panel). Multiple models were used with each of the scenarios to generate the first rigorous global-scale model comparison estimating the impact on biodiversity (change in species richness across a wide range of terrestrial plant and animal species at regional scales; shown in red), material NCP (food, feed, timber and bioenergy; shown in yellow) and regulating NCP (nitrogen retention, soil protection, crop pollination, crop pest control and ecosystem carbon; shown in green). The bars are the normalized means of multiple models and the whiskers indicate the standard error of the mean.

28. **Climate change impacts also plays a major role in regionally differentiated projections of biodiversity and ecosystem functioning. Substantial climate change-driven shifts of terrestrial biome boundaries, in particular in boreal and subarctic regions and (semi-)arid environments, are projected for the coming decades; a warmer, drier climate will reduce productivity in many places (*well established*) {4.2.4.1}**. In contrast, rising atmospheric carbon dioxide concentrations can be beneficial for net primary productivity and enhance woody vegetation cover, especially in semi-arid regions (*established but incomplete*) {4.2.4.1}. For marine systems, fish populations are projected to move poleward due to ocean warming, so local species extinctions are expected in the tropics (*well established*) {4.2.2.2.1}. However, that does not necessarily imply an increase in biodiversity in the polar seas, because of the rapid rate of sea ice retreat and the enhanced ocean acidification of cold waters (*established but incomplete*) {4.2.2.2.4}. Along coastlines, the upsurge in extreme climatic events, sea level rise and coastal development is expected to cause increased fragmentation and loss of habitats. Coral reefs are likely to undergo more frequent extreme warming events, with less recovery time in between, causing massive bleaching episodes with high mortality rates (*well established*) {4.2.2.2.2}.

D. Nature can be conserved, restored and used sustainably while other global societal goals are met simultaneously through proven solutions and transformative change

29. **The biodiversity-relevant Sustainable Development Goals and the 2050 Vision for Biodiversity cannot be achieved without transformative change, the conditions for which can be put in place now (*well established*) {2, 3, 5, 6.2}** (figure 11). An increasing awareness of connectivity in the environmental crisis and the resulting new ethics for interactions between humans and nature support that change. In the short term (before 2030), all decision makers can contribute to the sustainability transformation, including through improved implementation and enforcement of effective existing policies and regulations, where appropriate, and the removal and reform of harmful existing policies (*well established*). Additional measures are necessary in the long term (up to 2050) to enable transformative change to address the indirect drivers that are the root causes of nature deterioration (*well established*), including changes in social, economic and technological structures within and across nations {6.2, 6.3, 6.4}.

30. **Transformative change calls for cross-sectoral thinking and approaches** (figure 11)**. Sectoral policies and measures can be effective in particular contexts, but often fail to account for spillover effects in other locations or for other dimensions of sustainability, and can exacerbate inequalities (*well established*).** Cross-sectoral approaches, including landscape approaches, integrated watershed and coastal zone management, marine spatial planning, bioregional scale planning for energy and new urban planning paradigms, offer opportunities to reconcile multiple interests, values and forms of resource use, provided that they recognize trade-offs and uneven power relations between stakeholders (*established but incomplete*) {5.4.2, 5.4.3, 6.3, 6.4}.

31. **Transformative change needs innovative governance approaches that incorporate existing approaches such as integrative, inclusive, informed and adaptive governance. While such approaches have been extensively practised and studied separately, it is increasingly recognized that together they can contribute to transformative change (*established but incomplete*) {6.2}.** They help to address governance challenges that are common to many sectors and policy domains and create conditions for implementing transformative change. Integrative approaches, such as mainstreaming across government sectors, are focused on the relationships between sectors and policies and help to ensure policy coherence and effectiveness (*well established*). Inclusive approaches help to reflect a plurality of values and ensure equity (*established but incomplete*), including through rights-based approaches, which recognize human and ecocentric rights (including animal rights and rights of nature) (*established but incomplete*). Informed governance entails novel strategies for knowledge production and co-production that are inclusive of diverse values and knowledge systems (*established but incomplete*). Adaptive approaches, including learning, monitoring and feedback loops, contribute to preparing for and managing the inevitable uncertainties and complexities associated with social and environmental changes (*established but incomplete*) {6.2, 5.4.2}.

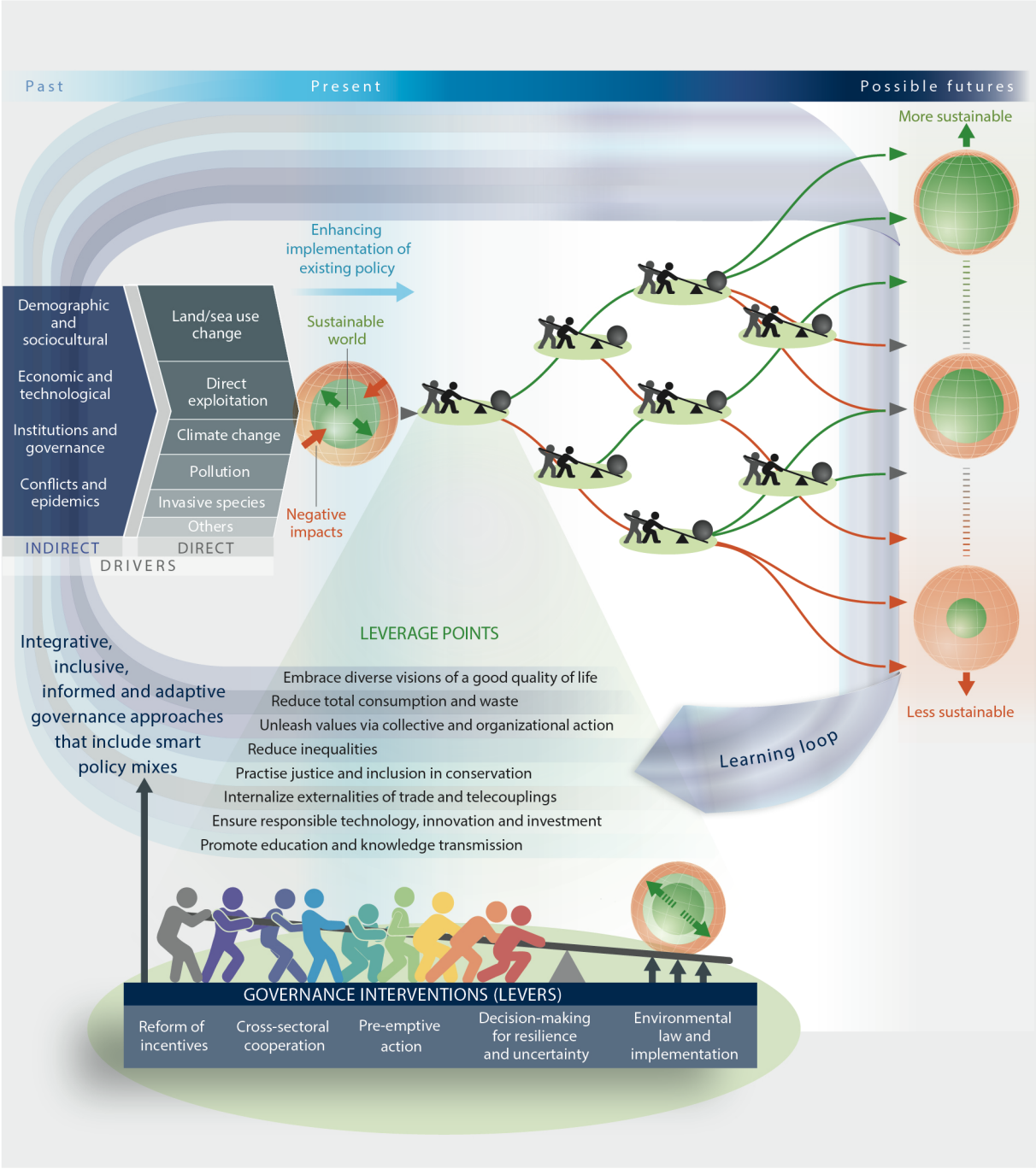


Figure 11. Transformative change in global sustainability pathways. Collaborative implementation of priority governance interventions (levers) targeting key points of intervention (leverage points) could enable transformative change from current trends towards more sustainable ones, including those needed to meet commitments and goals under major international policy agreements such as those in the 2030 Agenda and the Sustainable Development Goals. Implementing existing and new instruments through place-based governance interventions that are integrated, informed, inclusive and adaptive, using strategic policy mixes and learning from feedback, could enable global transformation.

32. **The synthesis of evidence for key constituents of pathways to sustainability suggests a group of five overarching types of management interventions, or levers, and eight leverage points for transformative change** (figure 11). Those levers and leverage points are presented in key messages D3 and D4 above. While used metaphorically, the notion of levers and leverage points recognizes that complex global systems cannot be manipulated in a simple manner, but that in certain cases, specific interventions can be mutually reinforcing and generate larger-scale changes towards achieving shared goals. For example, changes in laws and policies can enable and underpin changes in resource management and consumption and, in turn, changes in individual and collective behaviour and habits can facilitate the implementation of policies and laws {5.4.3}.

33. **Changing and reducing consumption and waste, particularly among affluent sectors of society, is already recognized by individuals and communities worldwide as central to environmental sustainability and social justice. While actual reductions have been limited, actions already being taken at different levels can be improved, coordinated and scaled.** Those include introducing regulations aimed at internalizing the true costs of production and consumption (such as penalties for wasteful or polluting practices), sector-based circular economic models (to minimize resource extraction and waste), environmental and social certification of market chains and incentives for virtuous practices and innovation. Importantly, they also involve a change in the social narrative of what a good life entails – decoupling the idea of a good and meaningful life from ever-increasing material consumption. All those approaches are more effective when they are mutually reinforcing. Actions that help to unleash, voluntarily, existing social values of responsibility in the form of individual, collective and organizational actions towards sustainability can have a powerful and lasting effect in shifting behaviour and cultivating stewardship as a normal social practice (*established but incomplete*) {5.4.1.2, 5.4.1.3, 6.4.2, 6.4.3}.

34. **Expanding the current network of protected areas, both terrestrial and marine, is important for safeguarding biodiversity (*well established*), particularly in the context of climate change. Conservation outcomes also depend on adaptive governance, strong societal engagement, effective and equitable benefit-sharing mechanisms, sustained funding, and monitoring and enforcement of rules (*well established*).** National Governments play a central role in supporting primary research and effective conservation and multi-functional landscape and seascape use. The latter include planning ecologically representative networks of interconnected protected areas and managing trade-offs between societal objectives that represent diverse worldviews and multiple values of nature (*established but incomplete*) {6.3.2.3, 6.3.3.3}. Safeguarding protected areas into the future also entails enhancing monitoring and enforcement systems, managing biodiversity-rich land and sea beyond protected areas, addressing property rights conflicts and protecting environmental legal frameworks against the pressure of powerful interest groups. In many areas, conservation depends on building capacity and enhancing stakeholder collaboration, involving indigenous peoples and local communities, and proactively using instruments such as landscape-scale and seascape-scale participatory scenarios and spatial planning, including transboundary conservation planning (*well established*) {5.3.2.3, 6.3.2.3, 6.3.3.3}. Implementation beyond protected areas includes, for instance, confronting illegal wildlife trade through effective enforcement throughout the commercialization chain. Such actions include establishing a global enforcement agency for CITES, prioritizing wildlife crime in criminal justice systems, using community-based social marketing to reduce demand and implementing strong measures to combat corruption at all levels (*established but incomplete*) {6.3.2.3}.

35. **Integrated landscape governance entails a mix of policies and instruments that together ensure nature conservation and restoration, sustainable production (including of food and energy), sustainable forest management and infrastructure planning and address the major drivers of nature deterioration (*well established*) {6.3.2, 6.3.6}.** Policy mixes harmonized across sectors, levels of governance and jurisdictions can account for ecological and social differences across and beyond the landscape, build on existing forms of knowledge and governance and address trade-offs between tangible and non-tangible benefits in a transparent and equitable manner (*established but incomplete*). Managing landscapes sustainably can be better achieved through multifunctional, multi-use, multi-stakeholder and community-based approaches (*well established*), using a combination of measures and practices, including: (a) protected and other conservation areas; (b) reduced impact logging; forest certification; payment for ecosystem services and reduced emissions from deforestation and landscape degradation; (c) support for restoration; (d) transparent monitoring; (e) addressing of illegal activities and (f) effective implementation of multilateral environmental agreements and other relevant international agreements (*well established*) {6.3.2.3, 6.3.2, 6.3.2.4}.

36. **Feeding the world in a sustainable manner, especially in the context of climate change and population growth, entails the transformation of food systems in order to ensure adaptive capacity, minimize environmental impacts, eliminate hunger and contribute to human health and animal welfare (*established but incomplete*) {5.3.2.1, 6.3.2.1}. Pathways to sustainable food systems entail land use planning and management of both the supply/producer and the demand/consumer sides of food systems (*well established*) {5.3.2.1, 6.3.2.1, 6.4}.** Options for sustainable agricultural production are emerging in, for example, the application of agroecological principles, integrated landscape planning and watershed management, and sustainable intensification, including integrated pest management, conservation agriculture, integrated crop and biodiversity, pasture and forage, trees, irrigation management and small or patch systems. These practices are being implemented in 29 per cent of all farms worldwide, representing 9 per cent of agricultural land

globally, and could be enhanced through well-structured regulations, incentives and subsidies and removing distorting subsidies {2.3.5.2, 5.3.2.1, 5.4.2.1, 6.3.2}. Ensuring the adaptive capacity of food production incorporates measures that conserve the diversity of genes, varieties, cultivars, breeds, landraces and species which also contribute to diversified and culturally-relevant nutrition. Essentially, this refers to further improvement and harmonization of existing global mechanisms of genetic material conservation and transfers, and support for indigenous peoples and local communities, farmers, herders and pastoralists managing agrobiodiversity in situ (*well established*) {6.3.2.1}. In relation to supply chains, incentives and regulations can contribute to positive changes at both the production and consumption ends of supply chains, such as the creation, improvement and implementation of standards, certification and moratorium agreements and the reduction of harmful subsidies. Regulatory mechanisms should also address the risks of co-option and lobbying, where commercial or sectoral interests work to maintain monopolies and control or to limit restrictions on pesticides and chemical inputs {5.3.2.1}. Economic alternatives are also important, including extension services, technical assistance and well-designed payment for ecosystem services programmes {5.4.2.1}. Options that need the engagement of all actors along the length of the food system (including producers, the public sector, civil society and consumers) include collaborative on-farm research, the promotion of low-impact diets and the localization of food systems. Such options contribute to reduced demand for animal products and the reduction of food waste (*established but incomplete*) {5.3.2.1, 6.3.2.1}.

37. **Ensuring sustained food provision in the oceans while protecting biodiversity entails policy action to apply ecosystem-based fisheries management and spatial planning (including the implementation and expansion of marine protected areas) and, more broadly, to address long-term stressors such as climate change, pollution and ocean acidification (*well established*) {5.3.2.5, 6.3.3}**. Scenarios show that pathways to sustainable fisheries entail conserving and/or restoring marine ecosystems, rebuilding overfished stocks (including through targeted limits on catch or fishing efforts and moratoria), reducing pollution (including plastics), managing destructive extractive activities, eliminating harmful subsidies and illegal, unreported and unregulated fishing, adapting fisheries management to climate change impacts and reducing the environmental impact of aquaculture (*well established*) {4, 5.3.2.5, 6.3.3.3.2}. Marine protected areas have demonstrated success in both biodiversity conservation and improved local quality of life when managed effectively and can be further expanded through larger or more interconnected protected areas or new protected areas in currently under-represented regions (*established but incomplete*) {6.3.3.3.1}. Evidence suggests that improved fisheries management could contribute to offsetting many of the negative effects of climate change. Major pressures on coasts (including development, land reclamation and water pollution) demonstrate the need for marine conservation outside protected areas, such as integrated coastal zone planning (*well established*) {6.3.3.3}. Other measures to expand multisectoral cooperation on coastal management include corporate social responsibility measures, building and construction standards and eco-labelling (*well established*) {6.3.3.3.2, 6.3.3.3.5}. Additional tools include conservation financing (for example, payment for ecosystem services, biodiversity offset schemes, blue-carbon sequestration, cap-and-trade programmes, green bonds and trust funds) and new legal instruments such as the proposed internationally binding instrument under the United Nations Convention on the Law of the Sea on the conservation and sustainable use of marine biodiversity in areas beyond national jurisdiction (*established but incomplete*) {6.3.3.2, 6.3.3.1.3, 5.4.2.1, 5.4.1.7}.

38. **Sustaining fresh water in the context of climate change, rising demand for water extraction and increased levels of pollution involves both cross-sectoral and sector-specific interventions that improve water use efficiency, increase storage, improve water quality and minimize disruption of natural flow regimes (*well established*) {6.3.4}.** That involves addressing fragmentation in national, bilateral and multilateral river basin management regimes, as such fragmentation limits the effectiveness of the law of transboundary watercourses and watershed management in general, and inclusive water governance, which fosters equity among water users (*well established*) {6.3.4}. Promising interventions include practising integrated water resource management and landscape planning across scales, guiding and limiting the expansion of agriculture and mining, slowing and reversing de-vegetation of catchments, and mainstreaming practices that reduce erosion, sedimentation and pollution run-off and minimize the impact of dams (*well established*) {6.3.4.6}. Sector-specific interventions include improved water-use efficiency techniques (including in agriculture, mining and energy), decentralized (for example, household-based) rainwater collection, locally developed water conservation techniques and water pricing and incentive programmes (such as water accounts and payment for ecosystem services programmes) {6.3.4.2, 6.3.4.4}. With regard to watershed payment for ecosystem services programmes, their effectiveness and efficiency can be enhanced by acknowledging multiple values in their design, implementation and evaluation and setting up impact evaluation systems (*established but incomplete*) {6.3.4.4}. Investment in infrastructure is important, especially in developing countries,

but it must be undertaken in a way that takes into account ecological function and the careful blending of built and natural infrastructure {5.3.2.4, 6.3.4.5}.

39. **Meeting the Sustainable Development Goals in cities and making cities resilient to climate change entails solutions that are sensitive to social, economic and ecological contexts. Integrated city-specific and landscape-level planning, nature-based solutions and built infrastructure and responsible production and consumption can all contribute to more sustainable and just cities.** Urban planning approaches to promote sustainability include encouraging compact communities, designing nature-sensitive road networks and creating low impact (from an emissions and land use perspective) transportation systems, including active, public and shared transport {5.3.2.6, 6.3.5}. However, given that most urban growth between now and 2030 will take place in the Global South, major sustainability challenges include addressing, creatively and inclusively, the lack of basic infrastructure (water, sanitation and mobility), the absence of spatial planning and limited governance capacity and financing mechanisms. Those challenges also offer opportunities for locally-developed innovation and experimentation, creating new economic opportunities. A combination of bottom-up and city-level efforts, by public and private, community and Government partnerships can be effective in promoting low-cost and locally-adapted solutions. Nature-based options include combining grey and green infrastructure (such as wetland and watershed restoration and green roofs), enhancing green spaces through restoration and expansion, promoting urban gardens, maintaining and designing for ecological connectivity and promoting accessibility for all (with benefits for human health), disseminating new, low-cost technologies for decentralized waste water treatment and energy production, and creating incentives to reduce over-consumption {6.3.5}. Integrating cross-sectoral planning at the local and landscape levels is important, as is involving diverse stakeholders (*well established*). Particularly important at the regional scale are policies and programmes that promote sustainability-minded collective action {5.4.1.3}, protect watersheds beyond city jurisdiction and prevent the isolation of ecosystems and wildlife through incompatible surrounding land uses. At the regional scale, cross-sectoral approaches to mitigating the impact of infrastructure and energy projects entail support for comprehensive environmental impact assessment and strategic environmental assessment of local and regional cumulative impacts {6.3.6.4, 6.3.6.6}.

40. **Decision makers have a range of options and tools for improving the sustainability of economic and financial systems (*well established*) {6.4}** (table SPM.1). Achieving a sustainable economy involves making fundamental reforms to economic and financial systems and tackling poverty and inequality as vital parts of sustainability (*well established*) {6.4}. Governments can reform subsidies and taxes to support nature and its contributions to people, with the removal of harmful subsidies and perverse incentives as a first step, maintaining transfers where they are socially and environmentally relevant (*established but incomplete*) {6.4.1}. At the international level, options for reacting to the challenges generated by displacement of the impacts of consumption and production on nature include both rethinking established instruments and developing new instruments to account for distant impacts. Trade agreements and derivatives markets can be reformed to promote equity and prevent deterioration of nature (*established but incomplete*) {6.4.4}. Alternative models and measures of economic welfare (such as inclusive wealth accounting, natural capital accounting and a degrowth paradigm) are increasingly considered as possible approaches to balancing economic growth and conservation of nature and its contributions and recognizing trade-offs, value pluralism and long-term goals (*established but incomplete*) {6.4.5}. Structural changes to economies are also key to shifting action over long time scales, including technological and social innovation regimes and investment frameworks that explicitly internalize environmental externalities, including by paying for damage mitigation (*well established*) {5.4.1.7}. Although market-based policy instruments such as payments for ecosystem services, certification and biodiversity offsetting have increased in use, their effectiveness is mixed and they are often contested; thus, they should be applied and designed innovatively for context (*established but incomplete*) {5.4.2.1, 6.3.2.2, 6.3.2.5, 6.3.6.3}. The global internalization of environmental externalities – including those associated with long-distance trade – is considered both an outcome and a constituent of global sustainable economies (*well established*) {5.4.1.6, 6.4}.

Table SPM.1. Aspirations and governance approaches for sustainability and possible actions and pathways for achieving them. The appropriateness and relevance of different aspirations and approaches vary according to place, system, decision-making process and scale. The list of actions and pathways in the following table is not exhaustive, but rather illustrative, using examples from the assessment report.

Aspirations and governance approaches for sustainability	Possible actions and pathways
Mainstream principles for **integrative management** of nature and nature's contributions to people in policies and actions	• Implement **cross-sectoral and nexus approaches** that consider linkage and interconnections between sectoral policies and actions • **Apply existing policy instruments that promote integrative management** by enhancing them and using them **strategically and synergistically** and across multiple scales • Promote **mainstreaming of biodiversity** across multiple sectors, including by facilitating nature-based solutions • **Encourage planning and management for sustainability at the landscape and seascape level** so that landscapes and seascapes will be able to contribute to meeting multiple human needs in the long term while reducing pressure on natural habitats • **Reform and develop incentive structures** (including disincentives), **remove** harmful subsidies and improve fairness in regulations and incentive programmes, encouraging integrative management at every scale • **Strengthen** international and domestic **laws and policies** • **Increase the effectiveness of current and future international biodiversity targets and goals** (such as those of the post-2020 global biodiversity framework and of the Sustainable Development Goals), which could be achieved by considering the following: (a) The availability and feasibility of existing and new indicators (b) Clearer language around quantitative elements (c) Socioeconomic and cultural contexts to a greater degree (d) Climate change impacts and responses (e) The increased awareness of the connectivity in the environmental crisis and resulting new ethics for interactions between humans and nature (f) Improved implementation and enforcement of existing policies and regulations (g) Changes in social, economic and technological structures within and across nations, in order to address drivers
Promote **participatory governance approaches and stakeholder engagement** and the inclusion of **indigenous peoples and local communities** in governance	**General** • **Recognize and enable the expression of different value systems** and diverse interests while formulating policies and actions **Indigenous peoples and local communities** • Enable **full and effective participation** of indigenous peoples and local communities in conservation, restoration and management of land and water over which they have rights or control • **Build greater respect and recognition** of the rights, formal and informal institutions, practices and knowledge systems of indigenous peoples and local communities and other long-term land managers, recognizing the principle of **free, prior and informed consent** to ensure equity and benefit-sharing • Enhance education and learning, and **ensure the maintenance and transmission of crucial knowledge** • **Build collaborative partnerships** among indigenous peoples and local communities, other stakeholders, policymakers and scientists to generate novel ways of conceptualizing and achieving transformative change towards sustainability

Aspirations and governance approaches for sustainability	Possible actions and pathways
Practise **informed governance** for nature and nature's contributions to people	• **Improve documentation of nature and the registration and assessment of natural capital** • **Improve implementation, monitoring and enforcement** through better documentation and information-sharing and regular, informed and adaptive readjustments to ensure transparent and enhanced monitoring • Advance knowledge co-production for informed decision-making that enhances the legitimacy and effectiveness of environmental policies
Ensure **adaptive management** of ecosystems and landscapes	• Enable **locally tailored choices about conservation and development** that account for uncertainty in environmental conditions, scenarios of climate change and societal context, including poverty, inequality and cultural differences • Promote **transparency and accountability in decision-making** and responsiveness to assessments, monitoring and new knowledge • Promote **awareness-raising activities** around the principles of adaptive management • Pilot and test **well-designed policy innovations**
Address linkage between drivers and impacts across distances (**telecouplings**[14])	**General** • Incorporate environmental and socioeconomic **externalities** into public and private decision-making • Incorporate transboundary flows into national natural capital accounting **Specific** (a) Trade: create **new supply-chain interventions** that reduce the impact on nature and thus the displacement of environmental burdens and externalities (b) Tourism: promote **effective, efficient and environmentally and socially sensitive tourism** (c) Water: minimize the negative impact of water transfer (viz. virtual water) (d) Invasive alien species: safeguard against accidental introduction (e) Environmental flows: maintain environmental flows for biodiversity and ecosystem function
Managing sustainable and multifunctional landscapes and seascapes and some of the actions they may entail	
Produce and **consume food** sustainably	• **Transform food systems for** sustainable production (a) Apply agroecology principles and practices for sustainable intensification and multifunctional landscapes, including cross-sectoral integrated landscape and watershed management • Conserve the diversity of genes, varieties, cultivars, breeds, landraces and species • **Facilitate sustainable food consumption** (a) **Expand food market transparency** (b) **Improve food distribution** and the localization of food systems (c) Promote **responsible trade** (d) **Regulate and reform commodity and supply chains** in various sectors at both the production and consumption ends through standards, certification and moratorium agreements (e) **Reduce food waste and improve food storage**
Integrate multiple uses for **sustainable forests**	• Promote **multifunctional, multi-use, multi-stakeholder and community-based approaches** to governance and management to achieve sustainable forest management • Support **reforestation and restoration** of degraded forest habitats • **Promote and strengthen community-based management and co-management**, with due recognition of the knowledge and rights of indigenous peoples and local communities and with clear and secure tenure rights for local users • **Reduce the negative impact of logging** and forestry by improving and implementing **forest certification, payments for environmental services and REDD+** (reducing emissions from deforestation and forest degradation) and **addressing illegal logging** • **Increase efficiency in forest product use**, including incentives for adding value to forest products

[14] Telecoupling is defined as socioeconomic-environmental interactions over distances (Liu et al., 2013). It is an umbrella concept that encompasses various types of distant interactions, such as international trade, tourism, migration, foreign investment, species invasion, payments for ecosystem services, water transfer, information dissemination, knowledge transfer, and technology transfer (Liu et al., 2015).

Aspirations and governance approaches for sustainability	Possible actions and pathways
Safeguard and effectively manage terrestrial and marine protected areas	• Support **effectively managed, expanded, ecologically and climate-ready representative networks** of well-connected protected areas and other multifunctional conservation areas (a) **Target expansion** to key biodiversity areas and other important sites for present and future biodiversity (b) Prioritize **transboundary conservation planning** and **enhance monitoring and** enforcement systems • **Expand, connect and effectively manage marine protected areas** (a) Target priority and important sites for marine biodiversity (b) **Strengthen and improve surveillance** and investment in scientific research (c) Control the spread of invasive alien species • **Use extensive, proactive participatory landscape-scale spatial planning** to prioritize land uses that balance and further safeguard nature in protected areas (a) Manage protected areas for biodiversity or other conservation efforts while maintaining ecosystem functioning (b) Include perspectives of climate-driven species shifts and ecosystem transformations • Manage biodiversity beyond protected areas, protect environmental legal frameworks against the pressure of powerful interest groups and **strengthen the design and implementation of safeguard policies** to ensure that business operations and investments do not have a negative impact on conserved areas • Aim for governance diversity, tailored to local conditions (a) Develop robust and inclusive decision-making processes, including **co-management schemes, local empowerment and formal recognition of indigenous peoples and local communities** and their rights over their territories, and better **benefit-sharing mechanisms** • **Mobilize and raise the level of financial support** for conservation (a) Improve and expand financing for conservation through a variety of innovative options, including the private sector
Ensure **sustainable governance and management of seascapes, oceans and marine systems**	• Support shared and **integrated ocean governance**: (a) Strengthen regional high seas cooperation to address major threats from rapidly emerging industries (b) Encourage **collaboration** between international organizations to monitor remote ocean fisheries and highly migratory species (c) Promote **new global instruments,** such as the proposed internationally binding instrument under the United Nations Convention on the Law of the Seas on the conservation and sustainable use of marine biodiversity of areas beyond national jurisdiction (d) Mainstream biodiversity and sustainability in **existing sectoral regulatory agencies,** such as shipping authorities and regional fisheries management organizations • Promote the **conservation and/or restoration** of marine ecosystems (a) Rebuild overfished stocks (b) Eliminate illegal, unreported and unregulated fishing (c) Manage destructive extractive activities and reduce by-catch (d) Encourage ecosystem-based fisheries management • **Facilitate integrated coastal planning and restoration** (a) Use consideration of ecosystem rehabilitation (b) Support remediation and multifunctionality of coastal structures, such as breakwaters and marinas (c) Integrate **ecological (functionality) concerns into the planning phase of coastal construction** (d) **Expand multi-sectoral cooperation** by increasing and improving corporate social responsibility measures and regulation in building and construction standards, and eco-labelling and best practices • Encourage effective **fishery subsidy reform strategies** (a) Create positive incentives for the fishing industry (b) Remove perverse subsidies to change current practices (c) Remove derelict and inefficient gear to reduce pollution • **Reduce the environmental impact of aquaculture**: engage in **corporate social responsibility activities**, certification and best practices in fisheries and aquaculture production methods

Aspirations and governance approaches for sustainability	Possible actions and pathways
	• **Control and/or reduction of plastic and other** point and nonpoint source **pollution**; managing marine microplastic and macroplastic pollution through effective waste management and extended producer responsibility • **Increase ocean conservation financing using the following tools:** (a) Payment for ecosystem services (b) Biodiversity offset schemes (c) Blue-carbon sequestration (d) Cap-and-trade programmes (e) Green bonds and trust funds
Improve freshwater management, protection and connectivity of upstream and downstream ecosystems	• **Integrate water resource management and landscape planning across scales** (a) **Increase protection and longitudinal connectivity** of freshwater ecosystems (b) Support **transboundary water management** (c) Incorporate **regional analyses of the water cycle** (d) Recognize the **functional interdependencies** between rural and urban demands and **understand conflicting interests** for water uses • **Support inclusive water governance** (a) **Assess the opportunities for cooperation** between all users (b) **Support co-management regimes for collaborative water management** and **foster equity** between water users (c) Create a space for **stakeholder engagement and transparency** to minimize environmental, economic and social conflicts, as well as risks • Mainstream practices that **reduce soil erosion, sedimentation and pollution run-off** (a) Include guidance and **limitations on the expansion of agricultural land and mining** (b) Slow and reverse **deforestation of catchments** (c) Develop **water-efficient agricultural practices** (d) Engage in **water restoration schemes, including through incentives such as payment for ecosystem services and water accounting** • **Address the fragmentation and low ambitions of freshwater policies** (a) **Coordinate** national regulatory frameworks, policy guidance, institutional arrangements and water quality standards (b) **Set benchmarks** for improving performance and attracting investment (c) Develop and monitor **standards for water quality and abstraction** (d) **Collect and monitor data** on water abstraction and water management • **Increase water storage** by using the following: (a) A mix of groundwater recharge, wetlands protection and dams that minimize disruption of flow regimes (b) Alternative storage techniques (c) Restrictions on groundwater abstraction • Promote **investment in water projects with clear sustainability criteria** (a) Experiment with **pricing policies that respect the human right** to safe drinking water (b) Invest in clean and environmentally sound **technology**
Build sustainable cities that address critical needs while conserving nature	• Engage in **sustainable urban planning** that **reduces the impact of cities** (a) Encourage strategically distributed population density, including infilling plans that revitalize urban economies and **compact communities for newly planned areas** (b) Discourage car use and fuel-powered transport in general and promote public transportation and sustainable transportation systems (c) Develop energy-efficient buildings and building codes (d) Encourage alternative business models (e) Promote **sustainable consumption** (less waste and lower energy use) **through** low-carbon and low-resource lifestyles • Incorporate cities into **regional planning** (a) Ensure that watersheds are protected (b) Ensure that biodiversity areas do not become isolated through incompatible use of surrounding land (c) Ensure that city expansion towards key regional biodiversity sites does not undermine site conservation

Aspirations and governance approaches for sustainability	Possible actions and pathways
	• **Strengthen urban governance at the local and landscape levels** (a) **Promote stakeholder engagement,** including of businesses and other organizations, in protecting public goods (b) **Enable transdisciplinary planning** to link sectors and departments • **Promote nature-based solutions** (a) Promote, safeguard or retrofit **green and blue infrastructure** while improving grey infrastructure (b) Maintain and design for **ecological connectivity within urban spaces** (c) **Improve access to green spaces that promote engagement with nature** • **Increase access to urban services for low-income communities** (a) Ensure access to sustainable water management, integrated sustainable solid waste management, clear water, sewage systems, safe and secure shelter and transport
Ensure **sustainable energy and infrastructure** projects and production	• Develop **sustainable strategies, standards and guidelines for sustainable renewable energy and bioenergy projects** (a) Integrate **sustainability criteria** and **internalize the impact of projects** on nature (b) Strengthen and enforce **biodiversity-inclusive environmental impact assessments,** laws and guidelines • **Promote innovative financing and ensure compensation** for environmental and social impact (a) **Strengthen biodiversity compensation policies** for development and infrastructure loss with respect to energy (b) Design/redesign **incentive programmes and policies** to promote bioenergy systems that optimize trade-offs between biodiversity loss and benefits • **Support community-based management and decentralized sustainable energy production** (a) **Ensure respect for the rights of indigenous peoples and local communities** to land, resources and water (b) Encourage **the inclusion of citizens in planning for renewable energy production and distribution** • **Reduce energy demand** (a) Reduce consumption through changes in lifestyle (b) Improve energy efficiency and promote decentralized clean energy production (c) **Foster the introduction of new clean energy technologies**
Improve the sustainability of economic and financial systems	• **Promote sustainable production** (a) Implement **sustainable sourcing** practices (b) **Design for sustainability** (c) Encourage **circular economy** models (d) **Support corporate social responsibility** (e) Adopt **life-cycle assessments** (f) Promote **sustainable public procurement** • **Adopt alternative measures of economic welfare that include** long-term human well-being and nature conservation • **Encourage policies that combine poverty reduction** with measures to increase the provision of nature's contributions and the protection of nature • **Reform subsidies** by removing harmful subsidies and perverse incentives and encourage nature-friendly incentives • Monitor trade agreements and derivatives/futures markets that **promote equity and prevent the deterioration of nature** in distant regions • **Improve market-based policy instruments,** such as payment for ecosystem services, certification and biodiversity offsetting, specifically designed for application in a variety of contexts • **Reduce excess consumption** (a) Support **consumer campaigns** to reduce overconsumption (b) Make creative use of **public policies and regulations such as taxes, subsidies and bans** that also contribute to reducing the cost of wasteful use of resources such as water and energy