2. What is happening to our environment and how have we responded?

2.1 Drivers of environmental change, megatrends and governance challenges

Human population dynamics or trends, particularly population pressure, and economic development have been acknowledged for many decades as the primary drivers of environmental change (*well established*). More recently, rapid urbanization and accelerating technological innovation have been additional influences. There are wide disparities globally in the consumption and production patterns that lie behind those drivers. {2.1.1, 2.2}

Those driving forces are also strongly intertwined, complex, and spread widely and unevenly across the world (*well established*). They are megatrends, developing at speeds with which responses by established governance structures at all levels – urban and rural, local, national, regional, global and supranational – are thus far insufficient to keep pace. {2.1.1}

The global population in 2018 is some 7.5 billion, with median projections estimating nearly 10 billion by 2050 and nearly 11 billion by 2100 (United Nations figures) (*well established*). Increases in life expectancy and reductions in infant and other mortality mean that population growth rates will continue to remain positive in all regions except Europe and certain parts of Asia. Unequal access to education, and lack of empowerment of women, as well as their lack of access to sexual and reproductive health services, all contribute to high birth rates. Without changes in production and consumption patterns, population growth will continue to increase environmental pressures. {2.3, 2.3.4, 2.1.1}

Urbanization is happening at an unprecedented rate globally and cities have become the foremost drivers of economic development across the world (*well established*). More people, especially in emerging and developing economies, are living in cities and towns, and the world's urban population is expected to rise to 66 per cent by 2050 (*well established*). Approximately 90 per cent of city growth will occur in Africa and Asia. Africa is the most rapidly urbanizing region, and is also the region expected to experience the highest population growth (*well established*). Some 30 per cent of urban residents globally have no access to basic services or social protection, with poor women in low-income urban neighbourhoods being particularly vulnerable. {2.4, 2.4.3}

Almost all coastal cities of any size and small island developing States are increasingly vulnerable to rising sea-levels, floods and storm surges caused by climate change and extreme weather events (*established but incomplete*). In general, those cities in developing countries that are urbanizing most rapidly are in a more vulnerable situation. In contrast, sustainable urbanization can represent an opportunity to increase citizens' well-being while decreasing their environmental impact. Lower-impact urban lifestyles can be facilitated by improved governance, infrastructure, services, sustainable land-use planning and technological opportunities. Investment in rural areas can reduce pressure to migrate. {2.4.4, 17.3}

Economic development has lifted billions of people out of poverty and enhanced access to health and education in most regions of the world (*well established*). Nevertheless, the "Grow now, clean up later" economic approach used in certain regions has not accounted for climate change, pollution or degraded natural systems. That approach has also contributed to increasing inequality within and between countries and will ultimately be more costly. It will not be able to sustainably support 10 billion healthy, fulfilled and productive people in 2050 without profound and urgent changes in consumption and production patterns. {2.5.1}

Decoupling of environmental degradation and resource use from economic growth and associated production and consumption patterns is required for achievement of the Sustainable Development Goals (*well established*). Partial decoupling between environmental pressures and economic growth can already be observed for some impacts and resources in certain countries. Further decoupling requires the scaling-up of existing sustainable practices and more fundamental transitions in the ways in which we produce, consume and dispose of goods and materials across society. Those transitions are likely to be more effective if supported by long-term, comprehensive, science-based targets that provide the objective basis for future directions and actions. {2.5.1}

The growth in technological innovation since the 1990s has been unprecedented, both globally and historically, bringing many benefits to people's lives, but has also had some negative consequences (*established but incomplete*). Some technological and social innovations can reduce the environmental pressures associated with unsustainable consumption and production**.** Enhancing access to existing environmental technologies that are adapted to domestic circumstances could help countries to achieve environmental objectives more quickly. Application of precautionary approaches, according to international agreements (where applicable), to new technological innovations can reduce unintended negative consequences for human and ecosystem health. {2.6.2, 2.6.3, 2.6.4}

Countries that prioritize low-carbon, resource-efficient practices may gain a competitive advantage in the global economy (*established but incomplete*). Well-designed environmental policies and appropriate technologies and products can often be implemented in tandem at limited or no cost to growth and competitiveness and can expand the capacity of countries to develop and diffuse innovative technologies. That may be positive for employment and development, while reducing greenhouse gas emissions and, ultimately, facilitating sustainable development (*established but incomplete*). {2.5.1}

Climate change is a priority issue affecting both human systems, including human health, and natural systems – air, biological diversity, freshwater, oceans and land – and which alters the complex interactions between those systems (*well established*). Historical and ongoing greenhouse gas emissions have committed the world to an extended period of climate change (*well established*), which is leading to global warming of air and ocean; rising sea-levels; melting glaciers, permafrost and Arctic sea ice; changes in carbon, biogeochemical and global water cycles; food security crises; fresh water scarcity; and

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more frequent and extreme weather events. Higher atmospheric concentrations of carbon dioxide also lead to ocean acidification and affect the composition, structure and functionality of ecosystems. Time is running out to prevent irreversible and dangerous impacts of climate change. Unless greenhouse gas emissions are radically reduced, the world is on course to exceed the temperature threshold set out in the Paris Agreement under the United Nations Framework Convention on Climate Change. That makes climate change a global driver of environmental, social, health and economic impact and heightened society-wide risks. {2.7.3}

Society-wide risks associated with environmental degradation and climate change effects are generally more profound for people in a disadvantaged situation, particularly women and children in developing countries (*established but incomplete*). Many of the impacts outlined above are serious or irreversible and may lead to loss of livelihood, increased morbidity and mortality, and economic slowdown, and have greater potential for violent conflict, human mass migration and decreasing social resilience. Measures for more effective adaptation are now urgently required, especially for populations and regions which are in a vulnerable situation. {2.7.3}

The increasing scale, global reach and speed of change in those drivers of environmental change pose urgent challenges for managing environmental and climate change problems (*well established*). In many domains, our scientific understanding of adverse, increasingly high impact is becoming more widespread, as is the understanding that the nature of change may sometimes be irreversible. The thematic priorities addressed by GEO-6 have been chosen and analysed with that context in mind and the summaries by theme have been organized to provide decision-makers with the most crucial insights within themes, including links to drivers and optional avenues for action. {2.7.3}

2.2 The state of the environment

2.2.1 Air

Emissions generated by human activity continue to alter the composition of the atmosphere, leading to air pollution, climate change, stratospheric ozone depletion and exposure to persistent, bioaccumulative and toxic chemicals (*well established*). {5.3}

Air pollution is the main environmental contributor to the global burden of disease, leading to between 6 million and 7 million premature deaths (*well established*) and welfare losses estimated at US$5 trillion annually (*established but incomplete*). Air pollution exposure, especially to fine particulate matter, is highest for urban residents in some countries with rapid urbanization trends (*established but incomplete*) and for the approximately 3 billion people who depend on burning fuels such as wood, coal, crop residue, dung and kerosene for cooking, heating and lighting (*well established*). The elderly, very young, ill and poor are more susceptible to the impact of air pollution (*well established*). {5.2.4, 5.4.1}

Globally, decreasing emission trends from local air pollutants in certain sectors and regions have been offset by larger increases in others, including some rapidly developing countries and areas of rapid urbanization (*well established*). Available data indicate that emissions decrease significantly when regulations are put in place. {5.2} International agreements have been successful in addressing specific chemicals. Both improvement of energy efficiency and pollution control techniques may be used to achieve lower air pollutant emissions. As controls have been placed on power plants, large industrial facilities and vehicles, the relative contribution of other sources, including agriculture, domestic fuel use, construction and other portable equipment, and forest or open fires, has grown in importance (*established*). Electricity generated from non-renewable resources and the fossil fuel production and consumption sectors ("energy") is the largest anthropogenic emitting sector of SO_2 and non-methane volatile organic compounds and the main emitting sector of other air pollutants, including greenhouse gases.

Global increases in anthropogenic greenhouse gas emissions and climate impacts have occurred, even while mitigation activities have taken place in many parts of the world. Globally, economic and population growth continue to be the most important drivers of increases in CO_2 emissions from fossil fuel combustion. Atmospheric concentrations of long-lived greenhouse gases continue to increase, driven primarily by fossil fuel extraction and use for electricity generation, industry and transport, although they are also affected by land use, land-use change, agriculture and forestry (*well established*). The evidence of current global climate change is unequivocal (*well established*). Since 1880, the global average surface temperature has increased by between approximately 0.8 degrees Celsius and 1.2 degrees Celsius (*very likely*). Eight of the ten warmest years on record have occurred within the past decade (*virtually certain*). If greenhouse gas emissions persist, global average temperatures will continue to increase at the current rate, crossing the temperature target agreed as part of the Paris Agreement between 2030 and 2052 (*very likely*). The Paris Agreement committed countries to holding the increase in the global average temperature to well below 2 degrees Celsius above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5 degrees Celsius above pre-industrial levels, recognizing that doing so would significantly reduce the risks and impact of climate change. Current nationally determined contributions, presented in Paris in 2015, constitute only one third of the mitigation required to establish a least-cost pathway for staying well below 2 degrees Celsius (*well established*). {2.2, 2.7, 4.2.1, 5.2, 5.3.4} To maintain a good chance of remaining well below a 2 degrees Celsius temperature increase, emissions need to drop by between 40 and 70 per cent globally between 2010 and 2050, falling to net zero by 2070. {2.7.4}

Achieving the goals set out in the Paris Agreement requires transformational changes leading to deep reductions in greenhouse gas emissions and the balancing of emission sources and sinks (*established but incomplete*). In addition to emissions reductions for CO_2 the main anthropogenic greenhouse gas, decreasing emissions of short-lived climate pollutants (also called forcers), specifically black carbon, methane, tropospheric ozone and hydrofluorocarbons, provide opportunities to limit warming in the short term and are a critical component of an integrated climate change mitigation and air-quality management programme. However, since long-lived greenhouse gases dominate climate forcing in the long term, decreasing emissions of short-lived climate pollutants in the short term needs to be combined with mitigation of long-term greenhouse gases. (*well established*). {4.2.1, 5.3.4} Non-CO_2 emissions in pathways

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that limit global warming to 1.5 degrees Celsius show deep reductions that are similar to those in pathways limiting warming to 2 degrees Celsius.[2]

Government capacity and political will to manage air pollution and climate change varies significantly (*well established*). Some regions have well-developed systems of national-to-local policies and compliance and enforcement programmes (*well established*), although ambition levels in terms of both scope and policy may differ. In other regions, international agreements or national legislation may exist, but implementation and compliance and enforcement are often affected by weak national-to-local institutional capacity (*established but incomplete*). Future policy efforts can build upon renewed attention to those issues in international forums and several decades of experience with various governance strategies in different countries. Between 1998 and 2010, there was a five-fold increase in the number of national climate laws (more than 1,500 laws and policies worldwide) and by 2012 those laws covered 67 per cent of all emissions (*well established*). Some city and subnational governments are leading the way with benefits for other parts of their countries (*well established*). {5.4, 5.5, 12}

2.2.2 Biodiversity

A major species extinction event, compromising planetary integrity and Earth's capacity to meet human needs, is unfolding. Biodiversity refers to the diversity of living things at the genetic, species and ecosystem levels. It helps to regulate climate, filters air and water, enables soil formation and mitigates the impact of natural disasters. It also provides timber, fish, crops, pollination, ecotourism, medicines, and physical and mental health benefits (*well established*). {6.1, 6.4.2}

Environmental and human health are intricately intertwined, and many emerging infectious diseases are driven by activities that affect biodiversity (*established but incomplete*). Changes to the landscape (through natural resource extraction and use, for example) can facilitate disease emergence in wildlife, domestic animals, plants and people. Zoonoses are estimated to account for more than 60 per cent of human infectious diseases. {6.1, 13.1; boxes 6.1, 13.1}

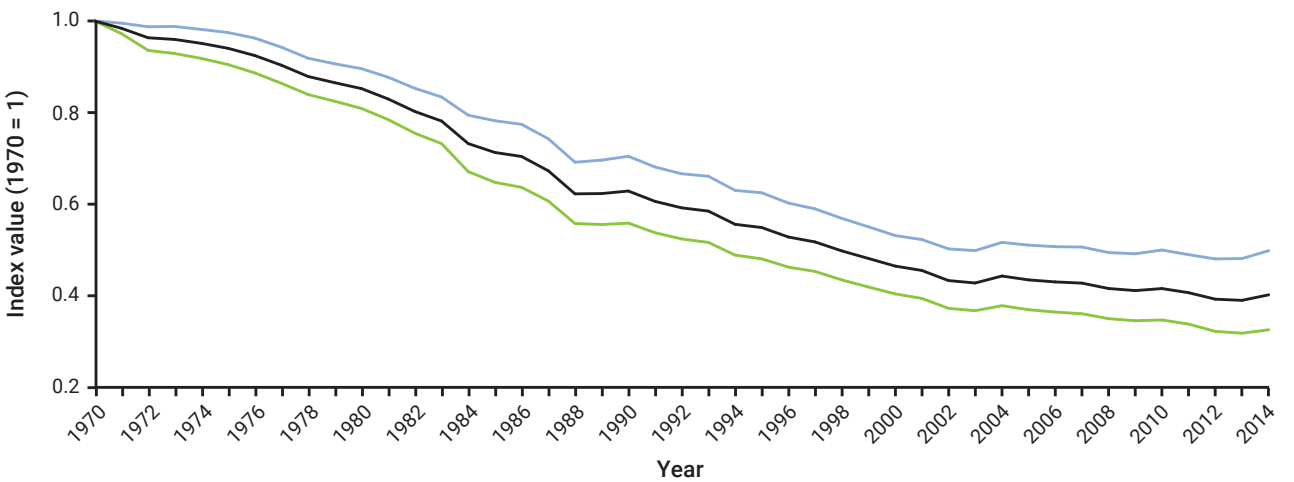
Genetic diversity is declining, threatening food security and the resilience of ecosystems, including agricultural systems and food security (*well established*). {6.5.1}

Populations of species are declining and species extinction rates are increasing. At present, 42 per cent of terrestrial invertebrates, 34 per cent of freshwater invertebrates and 25 per cent of marine invertebrates are considered at risk of extinction. Between 1970 and 2014, global vertebrate species population abundances declined by on average 60 per cent (*well established*). Steep declines in pollinator abundance have also been documented. {6.5.2}

Ecosystem integrity and functions are declining. Ten out of every fourteen terrestrial habitats have seen a decrease in vegetation productivity and just under half of all terrestrial ecoregions are classified as having an unfavourable status (*well established*). {6.5.3}

Native and non-native invasive species threaten ecosystems, habitats and other species. The economic costs, both direct and indirect, amount to many billions of dollars annually. {6.4.2}

Figure SPM.2. Global Living Planet Index



Source: World Wide Fund for Nature and Zoological Society of London (2018).

Note: The centre line shows the index values, indicating a 60 per cent decline between 1970 and 2014, and the upper and lower lines represent the 95 per cent confidence limits surrounding the trend. This is the average change in population size of 4,005 vertebrate species, based on data from 16,704 times series from terrestrial, freshwater and marine habitats.

2 United Nations Intergovernmental Panel on Climate Change, 2018: Summary for Policymakers. In: Global warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. World Meteorological Organization, Geneva.

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Biodiversity loss is also an equity issue, disproportionately affecting poorer people, women and children. If current rates of decline continue, future generations will be deprived of the health benefits of biodiversity. The livelihoods of 70 per cent of people living in poverty directly depend on natural resources (*well established*). {6.1, 6.6.5; boxes 6.5, 13.2}

The critical pressures on biodiversity are habitat change, loss and degradation; unsustainable agricultural practices; the spread of invasive species; pollution, including microplastics; and overexploitation, including illegal logging and trade in wildlife. Illegal trade in wildlife, fisheries and forest products is worth between US$90 billion and US$270 billion per annum. There is evidence to suggest that climate change will pose the gravest threat in the future, as species, including disease vectors, migrate with temperature shifts (*well established*). {6.5}

Although governance efforts are progressing, greater efforts are required to achieve international objectives, such as the Aichi Biodiversity Targets within the United Nations Convention on Biological Diversity's Strategic Plan for Biodiversity 2011–2020, and the Sustainable Development Goals. Over 190 National Biodiversity Strategies and Action Plans have been submitted to the Convention, although their quality and reliability, as well their subsequent implementation, remains uneven; the Cartagena and Nagoya Protocols to the Convention provide a deeper governance context. There is increasing international collaboration between various law enforcement authorities in combatting illegal wildlife trafficking. {Annex 6-1}

The science-policy interface for biodiversity and the contribution that nature makes to people was strengthened in 2012 through the establishment of the Intergovernmental Platform for Biodiversity and Ecosystem Services. Parties to the Convention on Biological Diversity are negotiating the post-2020 global biodiversity framework. Negotiations under the United Nations Convention on the Law of the Sea continue towards an agreement on the sustainable use and conservation of marine biological diversity beyond national jurisdiction. {6.7.2, 6.7.4, 13.1}

Several multilateral environmental agreements provide additional governance architecture on biodiversity, including the Convention on Wetlands of International Importance especially as Waterfowl Habitat and the Convention on International Trade in Endangered Species of Wild Fauna and Flora. The continual updating of the International Union for Conservation of Nature Red List of Threatened Species and other independent monitoring efforts, such as the Global Biodiversity Information Facility, the consideration of the multiple values of biodiversity and the inclusion of the value of biodiversity in national economic valuation methods, will support and inform the implementation thereof. Furthermore, there is a pressing need to expand ecosystem assessments to better understand the global state of ecosystems and the trends therein. {6.5.3, 6.7.4, annexes 6.1 and 13.1}

Protecting species and ecosystems requires conservation of biological diversity, the sustainable use of its components, and the fair and equitable sharing of the benefits arising from the utilization of genetic resources (*well established*). Species and ecosystems are most effectively safeguarded through the conservation of natural habitats (*well established*) and there is clear evidence that conservation can help to reduce biodiversity loss. Implementation, management and representative coverage of different ecosystems within protected areas remains insufficient. Less than 15 per cent of terrestrial habitats, including inland waters, and less than 16 per cent of coastal and marine areas within national jurisdiction are protected areas. {6.7.3}

Biodiversity is slowly being mainstreamed or integrated into health, gender and other equity concerns through such efforts as the 2015–2020 Gender Plan of Action under the Convention on Biological Diversity and its relationship to the Convention's Strategic Plan for Biodiversity 2011–2020 and the achievement of the Aichi Biodiversity Targets (*well established*). Indigenous peoples and local communities play a key role in biodiversity protection by offering bottom-up, self-driven and innovative solutions, based on traditional knowledge and the ecosystem approach. However, protected areas can adversely affect indigenous communities if access to natural resources within protected areas is denied. {13.1}

***Ex situ* conservation of genetic material provides safeguards for maintaining adaptive potential, in particular of crop and agricultural species. Gene banks and seed collections complement in situ conservation of genetic resources, yet the conservation status of genetic diversity for most wild species remains poorly documented.** Yet accelerating biodiversity loss and the large, escalating costs of inaction, including numerous threats to human health, require an urgent increase in global investment in sustainable use and conservation, and the consistent integration of biodiversity concerns into all facets of economic and social development. {6.5.1, 13.2.4}

Greater focus on strengthening governance systems; improving policy frameworks through research; policy integration; implementation; and encouraging partnerships and participation, are all measures that have the potential to address the greatest pressures on biodiversity. Efforts to combat biodiversity loss must also address poverty eradication, food security challenges, gender inequality, systemic inefficiencies and corruption in governance structures and other social variables. Identification of the countries of origin of genetic resources, in accordance with the Convention on Biological Diversity and the Nagoya Protocol thereto, will help to ensure progress against the objectives of those instruments and the fair and equitable sharing of benefits arising from the commercial utilization of those resources with such countries. {6.8}

2.2.3 Oceans and coasts

The principal drivers of change facing oceans and coasts are ocean warming and acidification, ocean pollution and the increasing use of oceans, coasts, deltas and basins for food production, transportation, settlement, recreation, resource extraction and energy production (*well established*). The main impacts of those drivers are marine ecosystem degradation and loss, including death of coral reefs (*well established*), reduced marine living resources and the resulting disturbance of marine and coastal ecosystem food chains (*well established*), increased nutrient and sediment run-off (*well established*) and marine litter (*established but incomplete*). Those impacts interact in ways that are just beginning to be understood and their interaction may amplify their effect (*inconclusive*). If left unaddressed, there is a major risk that they will combine to produce a destructive cycle of degradation and that the ocean will no longer provide many vital ecosystem services (for example, livelihoods, income, health, employment, and aesthetic, cultural and religious values).

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More effective compliance, enforcement and other instruments are needed, as current efforts are not sufficient to achieve the aims of the Sustainable Development Goals, particularly Goal 14. Interventions based on emerging technologies, taking into account a precautionary approach, in accordance with international agreements (where applicable), and strategic management approaches, such as resilience-based management and ecosystem-based management, can contribute to improved conservation of marine ecosystems and marine living resources. {7.1, 14, 14.2.1, 14.2.3, 14.2.4}

A holistic, integrated monitoring and assessment of the marine environment needs to be fostered hand in hand with the implementation of pollution reduction measures to achieve and maintain the targets of "Good Environmental Status" of the marine environment, including harmonization of assessment criteria and methods at all levels. To be effective, such measures should be combined with actions to mitigate and adapt to climate change and reduce the input of pollution and litter to the oceans while promoting their conservation and sustainable use. {7.3.1, 7.3.2, 7.3.3}

The rate of human-induced release of greenhouse gases is driving rising sea levels, changes in ocean temperatures and ocean acidification. Coral reefs are being devastated by those changes (*well established*). Mass coral bleaching, induced by chronic heat, has damaged many tropical reefs beyond recovery (*well established*). The collective value of coral reefs has been estimated at US$29 billion per annum. The loss of coral reefs has an impact on fisheries, tourism, community health, livelihoods and marine habitats (*well established*). Interventions based on emerging technologies and sustainable management approaches (such as resilience-based management, integrated coastal zone management and ecosystem-based management) are key to building resilience and may help to preserve some areas of reef (*unresolved*), but Governments should prepare for a dramatic decline (if not a collapse) (*well established*) of coral reef-based industries and ecosystem services, as well as negative effects on food chains related to the decline and collapse of coral reefs. {7.3.1, 14.2.1}

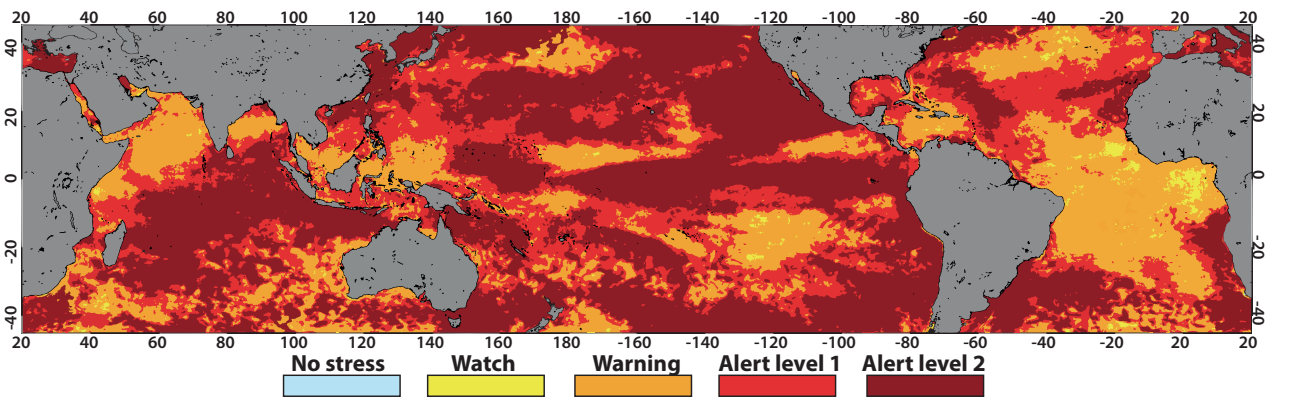
The oceans play an important role in the global economy and are likely to become increasingly important. Fisheries and aquaculture currently generate US$252 billion annually. Small-scale fisheries support the livelihoods of between 58 million and 120 million people (*established but incomplete*). Fish provide 3.1 billion people with over 20 per cent of their dietary protein and contain nutrients important for their health. Ensuring the sustainability of capture fisheries and aquaculture requires significant investment in monitoring, assessment and operations management and, in many cases, strong local community-based approaches. Investment in fisheries monitoring and gear technologies can improve selectivity of target species when harvesting and reduce habitat impact, both in ocean fisheries and aquaculture. {14.2.4}

Measures to minimize the effects of fishing on the ecosystem have had mixed success (*established but incomplete*). Where resource assessments and monitoring, control, and surveillance and enforcement measures are not available, overfishing and illegal, unreported or unregulated fishing continues and may be expanding (*established but incomplete*). {14.2.3, 14.4, 14.5}

Marine litter, including plastics and microplastics, is now found in all oceans, at all depths (*established but incomplete*). The scale and importance of the problem has received increasing attention in recent years, but there are still large gaps in knowledge. Current estimates suggest that input of plastic marine litter linked to domestic waste mismanagement in coastal areas amounts to some 8 million tonnes annually, (*established but incomplete*) 80 per cent of which originates from land-based sources. Marine plastic litter can result in a significant ecological impact from entanglement and ingestion, and can also act as a vector for the transport of invasive species and other pollutants (*established but incomplete*). Abandoned, lost or otherwise discarded fishing gear (ALDFG) is a major source of marine litter. Not only is ALDFG highly harmful, it also reduces numbers of fish stock and constitutes a significant economic threat, given its ability to damage maritime vessels, fisheries and ecosystem services. {7.3.3, 7.4.3}

The growing presence and abundance of microplastics has potential adverse effects on the health of both marine organisms (*established but incomplete*) **and humans** (*unresolved*). Furthermore, marine litter has a significant economic impact on a range of coastal sectors, such as tourism and recreation, shipping

Figure SPM.3. Map showing the maximum heat stress experienced during the 2014–2017 global coral bleaching event



Source: National Oceanic and Atmospheric Administration (2017).

Note: Alert level 2 heat stress indicates widespread coral bleaching and significant mortality; alert level 1 heat stress indicates significant coral bleaching; lower levels of stress may also have caused some bleaching.

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and yachting, fisheries, aquaculture, agriculture and human health (*established but incomplete*). The damage to fishing gear in Europe alone is estimated at more than US$72 million per annum and the cost of cleaning beaches is estimated at US$735 million per annum, a figure which is increasing (*established but incomplete*). {7.4.4}

Improving waste management, including recycling and end-of-life management, is the most urgent short-term solution to reducing input of litter to the ocean (*well established*). Longer-term solutions include improved governance at all levels, and behavioural and systemic changes that reduce plastic pollution from the production and use of plastic, and increase recycling and reuse. A holistic and evidence-based approach, taking into account the full life-cycle approach to waste management should be applied. Cleaning up coasts and beaches can provide environmental, social and economic benefits, and trapping surface litter in the ocean may be effective in small areas, but such efforts should not distract from action to stop litter entering the ocean. While many relevant international agreements exist, there is no global agreement that addresses the issue of marine litter and microplastics in a comprehensive and integrated manner. Coordination and cooperation between international bodies could be enhanced to progress international agreement. {14.2.2}

Policy-sensitive indicators used to track progress in addressing key pressures and drivers may not fully capture the multiple dimensions of pressures and drivers (*well established*). Area-based indicators, such as Aichi Biodiversity Target 11 on the coverage of marine protected areas under national jurisdiction, do not alone establish that such areas are effectively managed; nor can they guard against the impact of climate change or pollution (*well established*). Efforts to develop methods to evaluate the effectiveness of protected areas and their contribution to overall ocean health are therefore critical. The lack of standardization and compatibility between the methods used and the results obtained in various bottom-up projects makes an overall assessment of the status of marine litter across large geographic areas difficult (*well established*). {14.3, 14.3.1, 14.3.2, 14.3.3}

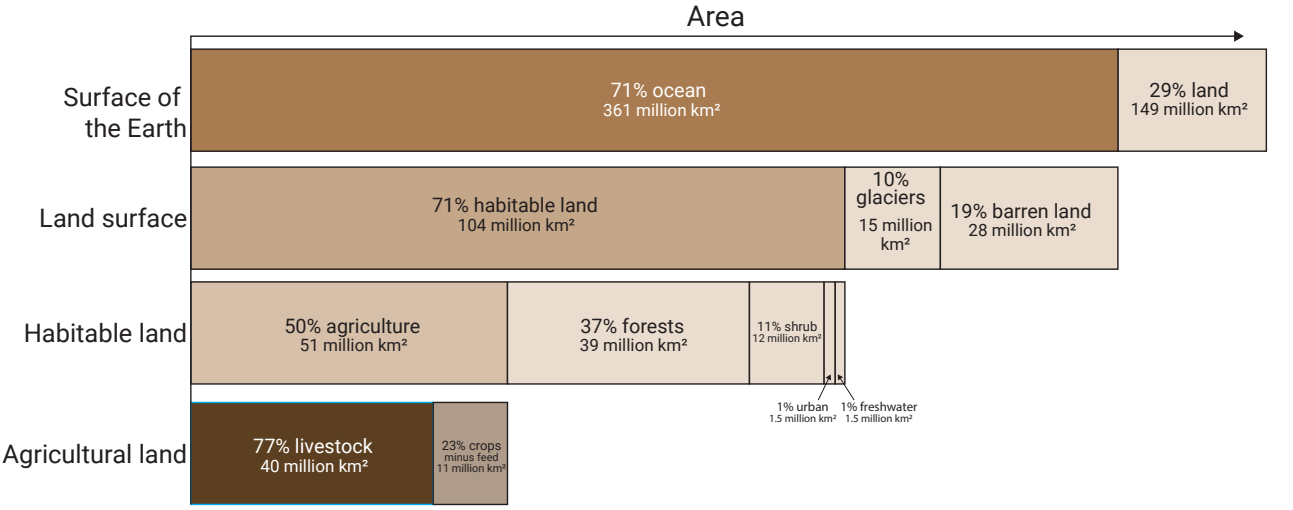
2.2.4 Land and soil

Food production is the largest anthropogenic use of land, using 50 per cent of habitable land (*well established*). Livestock production uses 77 per cent of agricultural land for feed production, pasture and grazing (*well established*) (see figure SPM.4). Furthermore, traditional livestock provides livelihoods for many indigenous and local communities. Sustainable land management can address food security while preventing the loss of the contribution made by nature and promoting gender and social equality (*established but incomplete*). Adequately feeding 10 billion people by 2050 will require an increase of 50 per cent in food production (*well established*), while some 33 per cent of global edible food is lost or wasted, of which approximately 56 per cent occurs in developed countries (*well established*). Increasing productivity has slowed down the expansion of agricultural land, but inefficient or unsustainable farming systems are often associated with environmental and soil degradation and biodiversity loss (*unresolved*), and an increase in crop specialization and distribution can raise the risk of poor harvests. {8.5.1, 8.5.3, 8.4.1}

Securing land rights for local communities can help to turn land assets into development opportunities and secure more sustainable use of land. For most people, land is their most important asset (*well established*). Women represent 43 per cent of those active in agriculture, yet they hold the title to less than 20 per cent of agricultural land. Insecure access to land resources hinders sustainable land management (*well established*). Indigenous and other forms of community-managed land could generate billions of US dollars' worth of ecosystem benefits through, among other things, carbon sequestration, reduced pollution, clean water and erosion control (*established but incomplete*). Those benefits could justify securing land tenure and the right to inheritance for women and indigenous and local communities. Decreasing the gender gap in access to information and technology, and access to and control over production inputs and land, could increase agricultural productivity and reduce hunger and poverty (*established but incomplete*). Policies

Figure SPM.4. Global surface area allocation for food production

The breakdown of the surface of the Earth by functional and allocated uses, down to agricultural land allocation for livestock and food crop production, measured in millions of square kilometres. The area for livestock farming includes land for animals, and arable land used for animal feed production.



Source: Food and Agriculture Organization of the United Nations (2017).

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empowering women, indigenous peoples, family farmers and pastoralists to ensure that those groups have secure access to land resources, fertilizers and other inputs, knowledge, extension services, financial services, markets, opportunities for adding value and non-farm employment can facilitate the achievement of the Sustainable Development Goals and reduce environmental impact (*established but incomplete*), increase agricultural productivity and contribute to reducing poverty and hunger (*well established*). {8.6, 8.5.3}

Land degradation and desertification have increased (*established but incomplete*), with land degradation hotspots covering approximately 29 per cent of global land, where some 3.2 billion people reside (*well established*). Investing in avoiding land degradation and restoring degraded land makes sound economic sense and the benefits generally far exceed the costs. {8.4.2}

Whilst the pace of deforestation has slowed, it continues globally. Furthermore, although many countries are now taking steps to increase their forest cover, it is primarily being done through plantations and reforestation (*well established*), which may not provide the same range of ecosystem services as natural forests. {8.4.1}

Urban clusters – meaning urban centres and their suburbs – have grown by a factor of approximately 2.5 since 1975 (*well established*), and in 2015 accounted for 7.6 per cent of global land, affecting, among other things, the hydrological cycle and soil functions, causing urban heat islands. {8.4.1}

Achieving the land-related Sustainable Development Goals requires adequate land and water resource management (*well established*). Innovative technologies, sustainable land management strategies, nature-based solutions and land-resource stewardship (such as sustainable forest management, agro-silvo-pastoral production systems, conservation agriculture, integrated crop production and agroforestry) can contribute to making agriculture sustainable. Payment for ecosystem services, land restoration and land titling need to be more effectively promoted and adopted. When compatible with local culture, such strategies contribute to better management and conservation of land resources (*well established*) and are integral for the reduction of hunger (Sustainable Development Goal 2). Economic incentives for agriculture, including distortive agricultural production subsidies, contribute to land degradation, and their reduction and removal will be important for the achievement of sustainable agriculture. {8.5.1}

Sustainable land-use planning and management can protect high-quality, fertile agricultural soil from competing interests, thus maintaining land-based ecosystem services such as food production, and preventing land from flooding and disaster. Frameworks targeting land degradation, such as the Land Degradation Neutrality initiative under the United Nations Convention to Combat Desertification, may also contribute to climate change mitigation and resilience (*well established*). Yet the policy framework on land management remains complex and incomplete. {8.4.1, 8.5.3, 8.5.4}

2.2.5 Fresh water

Population growth, urbanization, water pollution and unsustainable development are all increasing pressure on water resources across the world, and that pressure is further exacerbated by climate change. In most regions, slow-onset disasters, such as water scarcity, drought and famine, lead to increased migration (*well established*). Increasing numbers of people are also being affected by severe storms and floods. Increasing glacial and snowpack melt as a result of global warming will affect regional and seasonal water availability, especially in Asian and Latin American rivers, which provide water for some 20 per cent of the global population (*well established*). Changes to the global water cycle, including extreme events, are contributing to water quantity and quality problems, with impact distributed unequally across the world. {9.1, 9.1.2, 9.2}

In most regions, water quality has worsened significantly since 1990, owing to organic and chemical pollution, such as pathogens, nutrients, pesticides, sediments, heavy metals, plastic and microplastic waste, persistent organic pollutants and salinity. Some 2.3 billion people (approximately 1 in 3 of the global population) still lack access to safe sanitation (*likely*). Approximately 1.4 million people die annually from preventable diseases, such as diarrhoea and intestinal parasites, that are associated with pathogen-polluted drinking water and inadequate sanitation (*well-established*). {9.5, 9.5.7, 9.5.2}

Without effective counter-measures, human illnesses due to antimicrobial-resistant infections may become a major cause of death from infectious diseases worldwide by 2050 (*established but incomplete*). Water plays a key role in this, as antimicrobial-resistant bacteria are now found in sources of treated drinking water worldwide (*well-established*), stemming from antibiotics entering the water cycle through domestic sewage and industrial wastewater disposal, agriculture, intensive livestock rearing and aquaculture. In addition, various endocrine-disrupting chemicals are now widely distributed through the freshwater system on all continents (*well established*), with long-term impact on foetal underdevelopment and male infertility (*established but incomplete*). {9.5.1, 9.5.7}

On the positive side, 1.5 billion people gained access to basic drinking water services over the 15-year period from 2000 to 2015. However, women and girls still carry most of the physical burden of transporting water in many developing countries, reducing the time available for them to participate in productive activities and education. The positive impact of women being able to spend time on other activities should be widely acknowledged, since economic surveys indicate that they typically reinvest up to 90 per cent of their income in their families, improving family health and nutrition, and increasing access to schooling for their children. {9.7.1}

Worldwide, agriculture uses an average of 70 per cent of all fresh water withdrawals, rising to 90 per cent in many poorer countries. The competition for more water from cities and industry creates an imperative to improve the efficiency of agricultural water use while at the same time producing more food and using fewer and less harmful inputs (*well established*).

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Figure SPM.5. Summary of global progress in providing basic drinking water services and the disproportionate impact on women in sub-Saharan countries who still lack access to basic drinking water services

Source: UNICEF and WHO (2012); WHO and UNICEF (2017).

Many aquifers are depleting rapidly due to overabstraction for irrigation, drinking water, industrial and mining uses (*established but incomplete*). More sustainable management and better monitoring of surface and groundwater is urgently needed. {9.4.2, 9.9.5}

Promoting water-use efficiency, water recycling, rainwater harvesting and desalination is becoming increasingly important to ensure greater water security and more equitable water allocation for different users and uses. The agricultural sector needs substantial improvements in water-use efficiency and productivity. The industrial and mining sectors also have strong potential for increasing water-use efficiency, recycling and reuse, as well as for limiting water pollution. Broader adoption of water-sensitive urban design, including infrastructure to manage storm water, grey water, wastewater and managed aquifer recharge, would improve water management and urban water outcomes. {9.9, 9.9.3, 9.9.5}

Freshwater ecosystems are among the world's most biodiverse habitats and valuable natural infrastructures. Wetlands buffer against impact from climate change (both drought and floods) and improve water quality, but 40 per cent of all wetlands have been lost since 1970 through agricultural development, urbanization, infrastructure development and overexploitation of water resources. Severe consequences include the loss of inland fisheries, which affects the livelihoods of millions of people (*likely*). The total annual economic cost of wetland losses over the 15-year period from 1996 to 2011 has been estimated at US$2.7 trillion (*likely*). Greater investment, both public and private, would facilitate more sustainable wetland management and restoration. {9.6}

The decomposition, due to human intervention, of peatlands, a type of wetland that stores more carbon than all the world's forests combined, currently contributes approximately 5 per cent of annual global carbon emissions (*established but incomplete*). The thawing permafrost in boreal peatlands, agricultural conversion of some tropical peatlands and the transformation and loss of other peatlands are causing increased carbon emissions, infrastructure damage and wildfires. Protection and restoration of peatlands, including rewetting of drained peatlands, is an important climate change mitigation strategy. {9.6.2}

Innovative and integrated policy mixes are essential to manage interactions between water, food, energy, transport, climate change, human health and ecosystems. Good governance includes integrated water resource management, as illustrated by integrated flood risk management (*established but incomplete*), ecosystem-based approaches in subnational and transboundary basins (*well established*), circular economy and other approaches that promote sustainable consumption and production as one approach towards achieving sustainable development (*established but incomplete*) and substantive progress on decoupling water use from economic growth through increasing water efficiency (*established but incomplete*). Such approaches support improved land-use planning and cross-sectoral policy coordination between government departments (*well established*). {9.8, 9.9.4}

Social equity and gender equality remain key aspects for achieving Sustainable Development Goal 6 on fresh water (*well established*). Enhanced participatory processes will enable greater knowledge input from local and indigenous communities into decision-making (*well established*). Goal 6 can only be achieved by engaging the public, private and non-governmental sectors, civil society and local actors, and by taking into account other interlinked Sustainable Development Goals. {20.3, 9.10, 16.4}

Multilateral environmental agreements governing water resources and water-related ecosystem management and climate change can support the embedding of integrated water resource management in the rule of law through national and local legislation. Increased investment in the scope and rigour of standardized water data is essential to improve policy and governance for sound water management. {9.10}

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2.2.6 Cross-cutting issues

Several issues cut across all environmental themes. Some, such as human health, gender, urbanization and education, relate to people and livelihoods; others, such as climate change, polar regions, mountains and environmental disasters, are concerned with changing environments; and yet others, such as the use of resources, solid waste disposal, energy, chemicals and the food system, reflect the use of resources and materials. Those topics all have interdependent dynamics across environmental themes.

People and livelihoods

Environmental and social conditions interact to both support and damage human health (*well established*). Poor environmental conditions which can be changed ("modifiable conditions") cause approximately 25 per cent of global disease and mortality (*established but incomplete*). In 2015, environmental pollution caused some 9 million deaths (*established but incomplete*), in particular from outdoor and household air pollution, but also from contaminated water (*well established*). Environmental health effects take a particular toll on vulnerable or disadvantaged groups related to age (children and old people), ill-health, poverty (within and between countries) and race (*established but incomplete*). The risks are systemic and solutions need to be wide-ranging, tackling not only sources of pollution, but also aiming for co-benefits (*established but incomplete*). Major changes may be needed, with "Healthy Planet, Healthy People" potentially being central to our understanding of genuine progress. {4.2.1}

The scale and magnitude of global consumption, especially in urban areas, is affecting global resource flows and planetary cycles. Cities and their surrounding areas will continue to grow in both population and size and to act as generators of economic growth (*established but incomplete*). The process and prospect of that urbanization represent an enormous challenge for existing subnational governance structures, but also provide an opportunity to improve human well-being, with potentially decreasing environmental impact per capita and per unit of production (*inconclusive*). Given the current pace of urbanization, seizing this opportunity for future benefits depends on planning decisions made today (*well established*). {4.2.5}

Gender equality has a multiplier effect in advancing sustainable development, environmental protection and social justice (*well established*). All aspects of the environment, including drivers, pressures, impacts, perceptions, policies and responses, are shaped by gender relations and mutually constituted considerations of gender norms and responsibilities, and they shape one another. Bringing gender perspectives to bear on environmental policies and governance, especially by supporting participation, leadership and decision-making by women, ensures that new and different questions and viewpoints, as well as gender-disaggregated data, are integrated into environmental assessments (*well established*), and public resources are more likely to be directed towards human development priorities and investments. Decreasing the gender gap in access to information and technology can strengthen women's control over land and other resources. {4.2.3}

Education for sustainable development is essential for achieving the Sustainable Development Goals, promoting a more sustainable society and accommodating unavoidable environmental changes (*well established*). Significant progress has been made around the world in implementing education


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for sustainable development in all educational sectors (*well established*). However, scaling it up is essential so that it can be included as a core element of education system structures globally (*well established*). Policies that eliminate economic and gender barriers will improve access to education. Education for sustainable development can be scaled up by informal and non-formal education, including by the media. Community engagement and local (place-based) learning also have an important role to play. {4.2.4}

Changing environments

Climate change alters weather patterns, which in turn has a broad and deep impact on the environment, economics and society, threatening the livelihoods, health, water, food and energy security of populations (*well established*). In turn, that increases poverty (*well established*), migration, forced displacement and conflict (*established but incomplete*), with particular impact on populations in a vulnerable situation (*well established*). Negative effects are expected, even if the current warming is halted; for example, if the goal of limiting warming to 1.5 degrees Celsius is achieved, sea levels will still continue to rise. Those risks will be amplified under conditions of warming above the 1.5 degrees Celsius target established by the Paris Agreement (*established*). {4.3.1}

Increases in polar surface temperature are more than two times greater than the mean global temperature rise (*well established*). This amplified warming has cascading effects on other components of the polar climate system, with sea ice in the Arctic retreating, permafrost thawing, snow cover extent decreasing, and ice sheets, ice shelves and mountain glaciers continuing to lose mass (*well established*). {4.3.2} In turn, those effects have global repercussions, such as accelerated global sea level rises and the disturbance of climate and weather patterns.

The number of people affected by both slow and sudden-onset environmental disasters is increasing due to compounding effects of multiple and interacting drivers. Those drivers include climate change and environmental degradation, poverty and social inequality, demographic change and settlement patterns, increasing population density in urban areas, unplanned urbanization, unsustainable use of natural resources, weak institutional arrangements, and policies which do not take risks fully into account. Disasters undermine human security and well-being, resulting in loss and damage to ecosystems, property, infrastructure, livelihoods, economies and places of cultural significance, forcing millions of people to flee their homes each year. Disasters disproportionately affect some of the more vulnerable populations, including women. {4.2.2}

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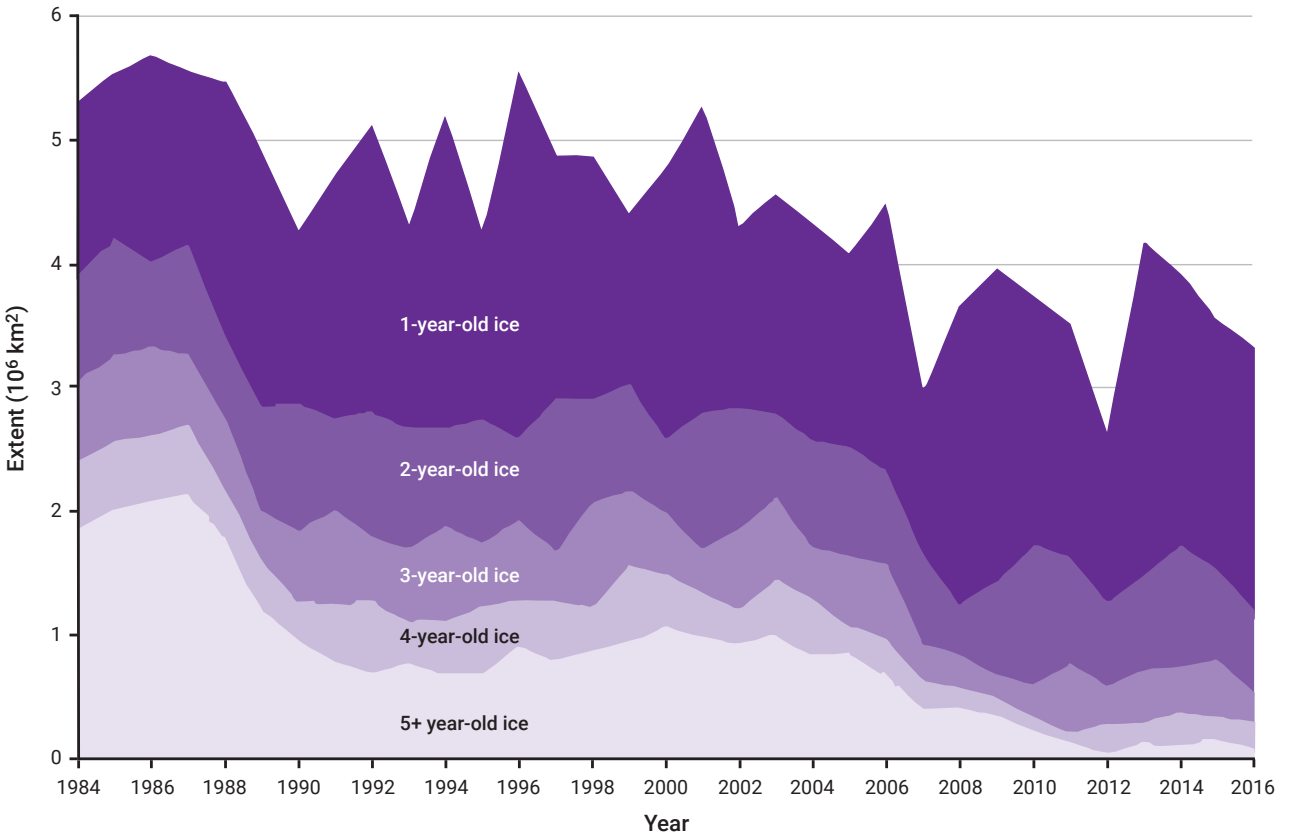
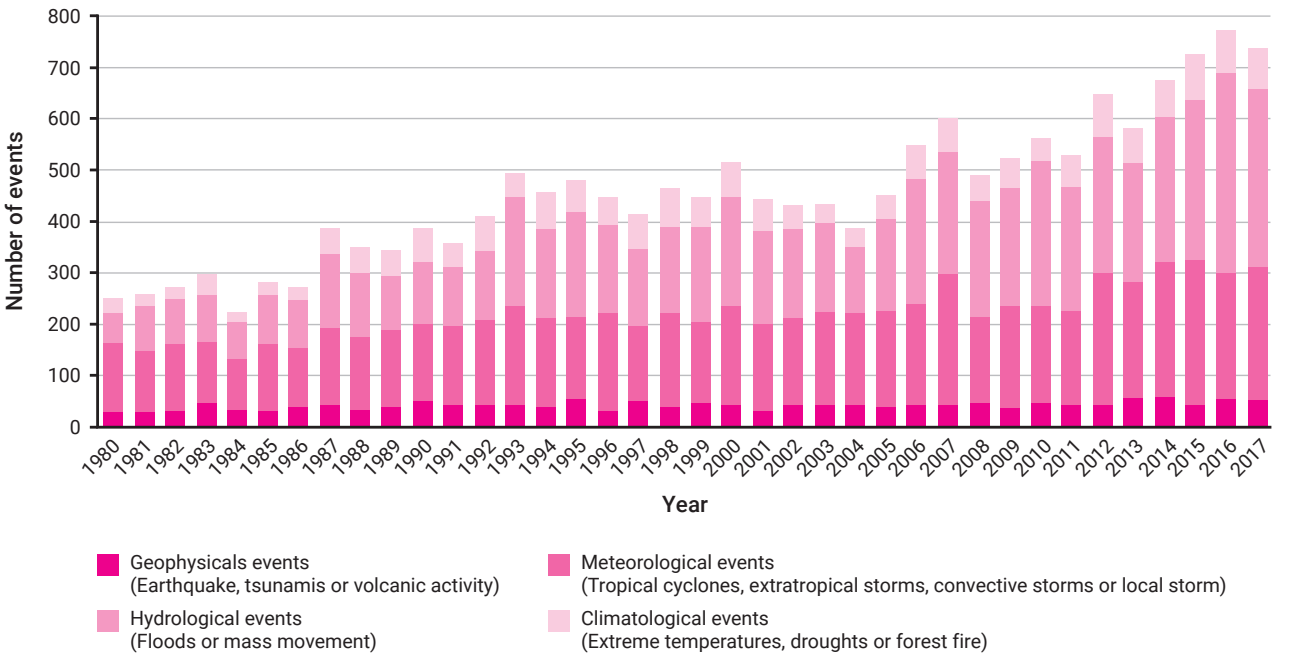
Figure SPM.6. Reduction in the extent of Arctic sea ice by age



Source: United States National Snow and Ice Data Center (2017).

Note: A few decades ago, a large proportion of Arctic sea ice survived the summer melt. In 1984, more than a third of sea ice was older than five years. Figure SPM.6 shows the sharp reduction in sea ice of that age since then.

Figure SPM.7. Trends in numbers of loss-related natural events



Source: Munich Re (2017).

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Resources and materials

Consumption rates and linear activities (extract-make-use-dispose) have increased resource exploitation beyond the recovery ability of ecological systems, with harmful consequences at all levels from the local to the global (*established but incomplete*). Globally, two out of every five people lack access to controlled waste disposal facilities. Inadequate and sometimes illegal practices include those related to food waste, e-waste, marine litter, waste trafficking and crime. Developed countries have policies in place to promote reduced waste and resource efficiency, while developing countries still face basic management challenges, such as uncontrolled dumping, open burning and inadequate access to services (*well established*). Sound policies for resource accounting and waste management in the context of broader sustainable consumption and production include a circular economy as one of the approaches to achieving sustainable development through reducing, reusing, remanufacturing and refurbishing products (*established but incomplete*). {4.4.1}

Global energy consumption is expected to rise significantly during the period from 2014 to 2040 (by as much as 63 per cent, according to one estimate), much of which is attributed to expected consumption in countries that currently depend on fossil energy sources (*very likely*). Equity and gender issues, such as universal access to improved final energy services, are still a problem that is far from being resolved. Despite the fast deployment and cost reduction of renewables and improvements in efficiency, without further and effective, ambitious measures, energy-related greenhouse gas emissions will result in the Paris Agreement temperature targets being missed (*very likely*). {4.4.2}

Despite the many benefits brought to humanity, in this, the most chemical-intensive era in history, the pollution that is associated with chemicals poses a global problem, because toxic substances can spread to the most remote environments, including to receiving water systems worldwide (*well established*). Products in everyday use contain toxic compounds that interfere with the health of humans, other species and the environment (*well established*). {4.3.3}

Multilateral environmental agreements and concerted national initiatives have made progress in addressing several of the most concerning chemicals. However, significant gaps in assessing and regulating harmful chemicals continue to exist, due, inter alia, to insufficient national legislation or enforcement to address associated risks and to missed innovation opportunities. Failure to address the risks posed by such chemicals can result in adverse impact on human health and the environment, with estimated costs amounting to hundreds of billions of US dollars (*established but incomplete*). Emerging issues requiring more science-based information, precaution, in accordance with international agreements (where applicable), and risk assessment and management include endocrine disruption, widespread antibiotic resistance and the use of nanotechnology. Global chemical safety requires best management practice in all countries, including the provision of access to information and public awareness (well established). Regulations, assessment and monitoring, and industry and consumer responsibility in informing and substituting the use of chemicals of global concern with safer alternatives when technically and economically feasible are needed {4.3.3}.

The food system, in response to growing and changing consumer demand, is increasing pressure on local ecosystems and the global climate (*well established*). Agriculture is the largest consumer of water and, when not sustainably managed, food production is a major driver of biodiversity loss and polluter of air, fresh water and oceans, as well as a leading source of soil degradation and greenhouse gas emissions. Changing environmental conditions and consumption patterns are both increasing such pressures and presenting new food security challenges, reflecting malnourishment, including in the form of overnourishment, as well as undernourishment. Providing nourishing and sustainable food for all, as envisaged in Sustainable Development Goal 2, remains challenged by climate change, natural resource constraints, demographic trends and national capacities, and necessitates significant changes in food production, distribution, storage, processing and consumption patterns (*well established*). {4.4.3}

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