Fact sheet - Biodiversity

Climate Change Impacts and Risks

Observed impacts

Climate change has altered marine, terrestrial and freshwater ecosystems all around the world (*very high confidence*). Climate change has caused local species losses, increases in disease (*high confidence*), and mass mortality events of plants and animals (*very high confidence*), resulting in the first climate driven extinctions (medium confidence), ecosystem restructuring, increases in areas burned by wildfire (*high confidence*), and declines in key ecosystem services (*high confidence*). Climate-driven impacts on ecosystems have caused measurable economic and livelihood losses and altered cultural practices and recreational activities around the world (*high confidence*).

Extreme climate events comprising conditions beyond which many species are adapted are occurring on all continents, with severe impacts (*very high confidence*). The most severe impacts are occurring in the most climate-sensitive species and ecosystems, characterized by traits that limit their abilities to regenerate between events or to adapt, and those most exposed to climate hazards (*high confidence*). {TS.B.2.1; ES-Ch2}

Future risks

Threats to species and ecosystems in oceans, coastal regions, and on land, particularly in biodiversity hotspots, present a global risk that will increase with every additional tenth of a degree of warming (*high confidence*). The transformation of terrestrial and ocean/coastal ecosystems and loss of biodiversity, exacerbated by pollution, habitat fragmentation and land-use changes, will threaten livelihoods and food security (*high confidence*). {TS.C.1; ES-Ch2}

Without urgent and deep emissions reductions, some species and ecosystems, especially those in polar and already-warm areas, face temperatures beyond their historical experience in the next decades (e.g., >20% of species on some tropical landscapes and coastlines at 1.5°C global warming). Unique and threatened ecosystems are expected to be at high risk in the very near term at 1.2°C global warming levels *(very high confidence)* due to mass tree mortality, coral reef bleaching, large declines in sea-ice dependent species, and mass mortality events from heatwaves. {TS.C.1.1; ES-Ch2}

(a) Observed impacts of climate change on ecosystems

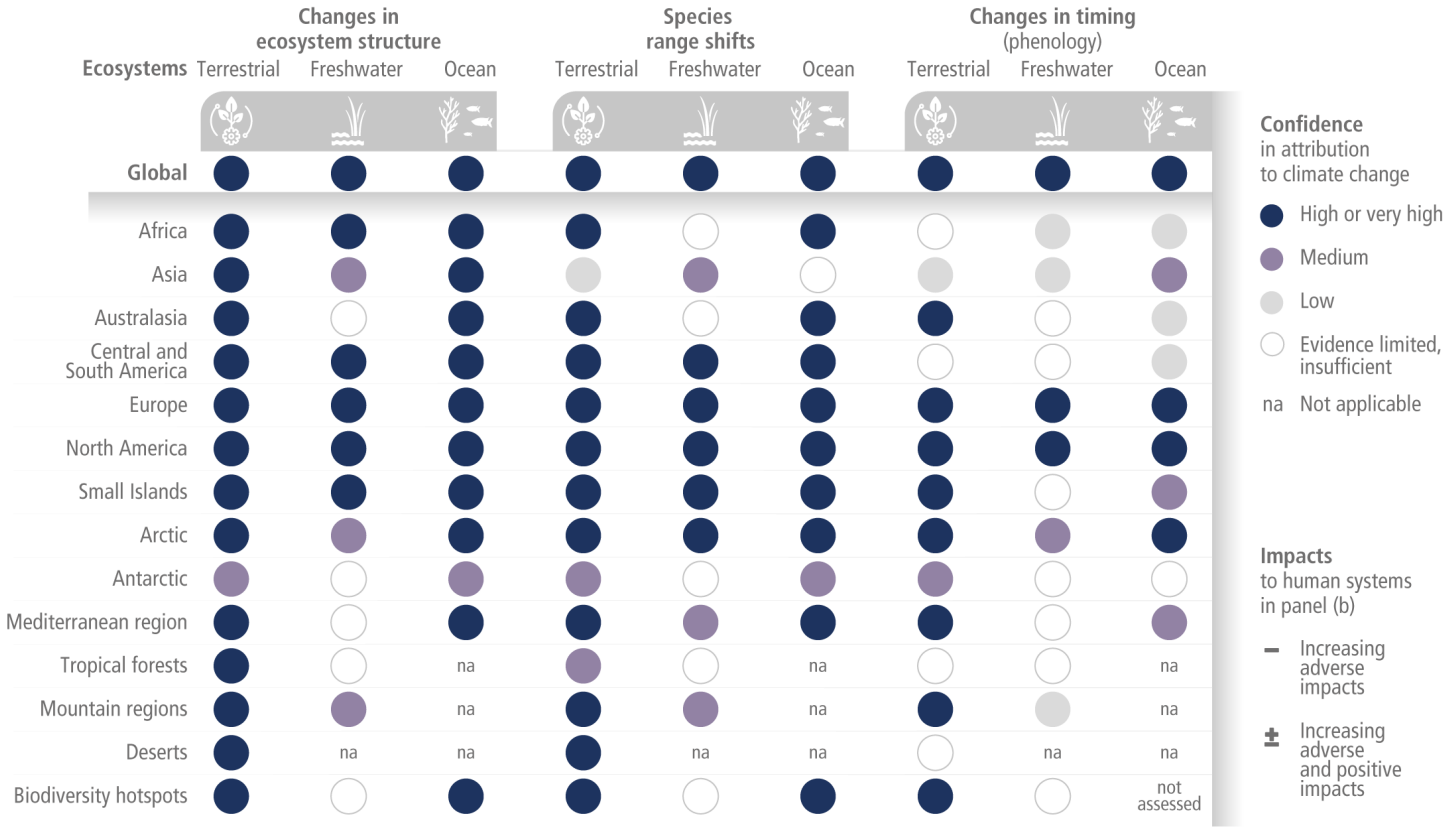

Figure 1: Observed global and regional impacts on ecosystems attributed to climate change. (a) Climate change has already altered terrestrial, freshwater and ocean ecosystems at global scale, with multiple impacts evident at regional and local scales where there is sufficient literature to make an assessment. Impacts are evident on ecosystem structure, species geographic ranges and timing of seasonal life cycles (phenology) (for methodology and detailed references to chapters and cross-chapter papers see SMTS.1 and SMTS.1.1). {Figure TS.3, panel (a)}

Species extinction

Climate-caused local population extinctions have been widespread among plants and animals, detected in 47% of 976 species examined and associated with increases in hottest yearly temperatures (*very high confidence).* The white sub-species of the lemuroid ringtail possum (*Hemibelideus lemuroides*) in Queensland, Australia, disappeared after heatwaves in 2005 (*high confidence*): intensive censuses found only 2 individuals in 2009. The Bramble Cays Melomys (*Melomys rubicola*), was not seen after 2009 and declared extinct in 2016, with sea-level rise and increased storm surge, associated with climate change, the most probable drivers (*high confidence*). {ES-Ch2}

At warming levels beyond 2°C by 2100, risks of extirpation, extinction and ecosystem collapse escalate rapidly *(high confidence*). Climate impacts on ocean and coastal ecosystems will be exacerbated by increases in intensity, reoccurrence and duration of marine heatwaves (*high confidence*), in some cases, leading to species extirpation, habitat collapse or surpassing ecological tipping points (*very high confidence*). {ES-Ch3}

The risk of species extinction increases with warming in all climate change projections for native species studied in hotspots *(high confidence*), being about ten-times greater for endemic species from 1.5°C to 3°C above pre-industrial levels (*medium confidence*). Very high extinction risk in biodiversity hotspots due to climate change is more common for endemic species than other native species (*high confidence*). For these endemic species, considering all scenarios and time periods evaluated, ~100% on islands, ~84% on mountains, ~12% on continents (*high confidence*) and ~54% in the ocean (notably the Mediterranean) (*low confidence*) are projected to be threatened with extinction due to climate change. {ES-CCP1}

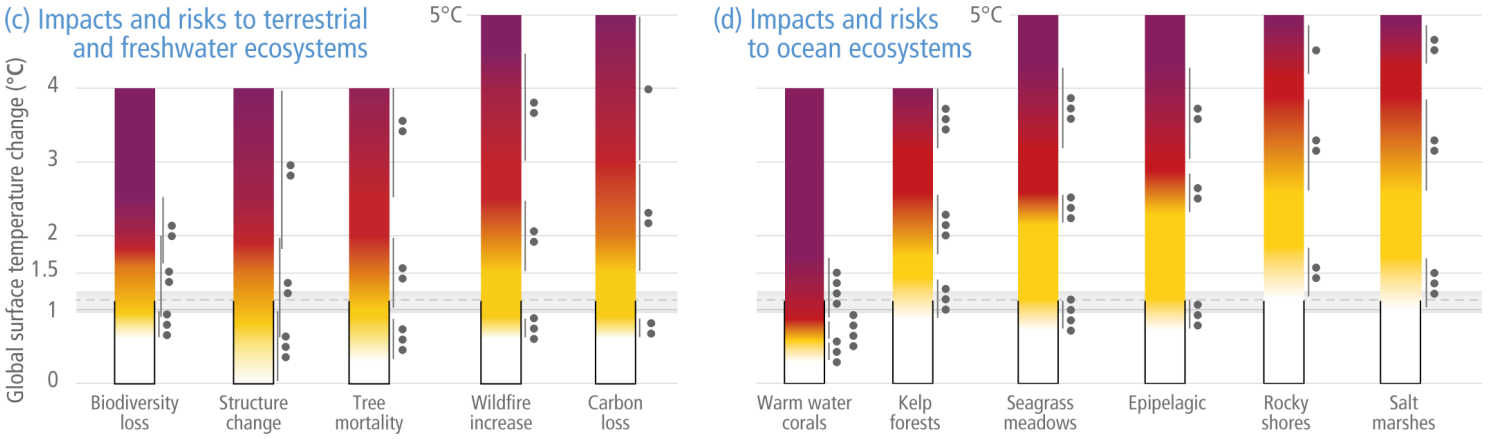

Figure 2: Synthetic diagrams of global and sectoral assessments. Diagrams show the change in the levels of impacts and risks assessed for global warming of 0-5°C global surface temperature change relative to pre-industrial period (1850-1900) over the range. Risks for (c) terrestrial and freshwater ecosystems and (d) ocean ecosystems. For c) and d), diagrams shown for each risk assume low to no adaptation. The transition to a very high risk level has an emphasis on irreversibility and adaptation limits. {Figure TS.4, panels (c) and (d)}

Sea level rise

Risks from sea level rise for coastal ecosystems and people are *very likely* to increase tenfold well before 2100 without adaptation and mitigation action as agreed by Parties to the Paris Agreement (*very high confidence*). Sea level rise under emission scenarios that do not limit warming to 1.5°C will increase the risk of coastal erosion and submergence of coastal land *(high confidence)*, loss of coastal habitat and ecosystems (*high confidence*) and worsen salinisation of groundwater (*high confidence*), compromising coastal ecosystems and livelihoods (*high confidence*). {ES-Ch3}

The ability to adapt to current coastal impacts, cope with future coastal risks and prevent further acceleration of sea level rise beyond 2050 depends on immediate implementation of mitigation and adaptation actions (*very high confidence*). {ES-Ch3}

Marine heatwaves

Marine heatwaves, including well-documented events along the west coast of North America (2013–2016) and east coast of Australia (2015–2016, 2016–2017 and 2020), drive abrupt shifts in community composition that may persist for years (*very high confidence*), with associated biodiversity loss (*very high confidence*), collapse of regional fisheries and aquaculture (*high confidence*) and reduced capacity of habitat-forming species to protect shorelines (*high confidence*). {ES-Ch3}

Some habitat-forming coastal ecosystems including many coral reefs, kelp forests and seagrass meadows, will undergo irreversible phase shifts due to marine heatwaves with global warming levels >1.5°C and are at high risk this century even in <1.5°C scenarios that include periods of temperature overshoot beyond 1.5°C (*high confidence*). Under SSP1-2.6, coral reefs are at risk of widespread decline, loss of structural integrity and transitioning to net erosion by mid-century due to increasing intensity and frequency of marine heatwaves (*very high confidence*). {ES-Ch3}

Biodiversity hotspots

All biodiversity hotspots are impacted, to differing degrees, by human activities (*very high confidence*). Climate change impacts are compounded by other anthropogenic impacts, including habitat loss and fragmentation, hunting, fishing and its bycatch, over-exploitation, water abstraction, nutrient enrichment, pollution, human introduction of invasive species, pests and diseases, all of which reduce climate resilience (*very high confidence*). {ES-CCP1}

Ecosystem services

Climate change is affecting ecosystem services connected to human health, livelihoods, and well-being *(medium confidence)*. Deforestation, draining and burning of peatlands and tropical forests, and thawing of Arctic permafrost have already shifted some areas from carbon-sinks to carbon sources *(high confidence)*. The severity and outbreak extent of forest insect pests increased in several regions (*high confidence*). Woody plant expansion into grasslands and savannas, linked to increased CO_2, has reduced grazing land, while invasive grasses in semi-arid land increased the risk of fire *(high confidence)*. {TS.B.1.5}

Ecosystem services that are at threat from a combination of climate change and other anthropogenic pressures include climate change mitigation, flood risk management, food provisioning and water supply *(high confidence)*. {ES-Ch2}

Wildfire

Regional increases in area burned by wildfires (up to double natural levels), tree mortality up to 20%, and biome shifts up to 20 km latitudinally and 300 m upslope, have been attributed to anthropogenic climate change in tropical, temperate and boreal ecosystems around the world *(high confidence)*, damaging key aspects of ecological integrity. {ES-Ch2}

Wildfires generate up to one-third of global ecosystem carbon emissions, a feedback that exacerbates climate change (*high confidence*). Increases in wildfire from levels to which ecosystems are adapted degrades vegetation, habitat for biodiversity, water supplies, and other key aspects of the integrity of ecosystems and their ability to provide services for people *(high confidence)*. {ES-Ch2}

Risk of wildfires increases with global temperature *(high confidence)*. With 4ºC warming by 2100 wildfire frequency is projected to have a net increase of ~30% *(medium confidence)*. {ES-Ch2}

Adaptation Options and Barriers

Increasing the resilience of biodiversity and ecosystem services to climate change includes minimising additional stresses or disturbances, reducing fragmentation, increasing natural habitat extent, connectivity and heterogeneity, maintaining taxonomic, phylogenetic and functional diversity and redundancy and protecting small-scale refugia where microclimate conditions can allow species to persist *(high confidence)*. {TS.D.4.2}

Ecosystem protection and restoration can build resilience of ecosystems and generate opportunities to restore ecosystem services with substantial co-benefits *(high confidence)*. {TS.D.4.1}

Potential benefits and avoidance of harm are maximized when Nature-based Solutions with safeguards are deployed in the right places and with the right approaches for that area, with inclusive governance *(high confidence)*. Taking account of interdisciplinary scientific information, Indigenous knowledge and local knowledge and practical expertise is essential to effective Ecosystem-based Adaptation *(high confidence)*. {TS.D.4.7; ES-Ch2}

Climate Resilient Development

Planetary health

Maintaining planetary health is essential for human and societal health and a pre-condition for climate resilient development (*high confidence*). Effective ecosystem conservation on approximately 30% to 50% of Earth's land, freshwater and ocean areas, including all remaining areas with a high degree of naturalness and ecosystem integrity, will help protect biodiversity, build ecosystem resilience and ensure essential ecosystem services *(high confidence*). In addition to this protection, sustainable management of the rest of the planet is also important. {TS.E.4; ES-Ch2}

Synergies

Available adaptation options can reduce risks to ecosystems and the services they provide but they cannot prevent all changes and should not be regarded as a substitute for reductions in greenhouse gas emissions (*high confidence*). Ambitious and swift global mitigation offers more adaptation options and pathways to sustain ecosystems and their services (*high confidence*). {TS.D.4.4; ES-Ch2}