CLIMATE CHANGE 2014

Impacts, Adaptation, and Vulnerability

Climate Change and Key Risks for the Ocean
From the Working Group II Fifth Assessment Report

ipcc
INTERGOVERNMENTAL PANEL ON climate change

Key regional risks from climate change for the ocean and the potential for reducing risk through mitigation and adaptation. Key risks result from high hazard, high vulnerability, and/or high exposure. They are identified based on assessment of the literature and expert judgments. Risk levels are estimated through the 21st century for the current state of adaptation and for a hypothetical highly adapted state. Risks to ecosystems = ■, fisheries = ■, humans and infrastrcture = ■. [WGII AR5 Table 30-3]

Climate-related drivers of impacts: Warming trend; Extreme temperature; Extreme precipitation; Precipitation; Damaging cyclone; Sea level; Ocean acidification; Hypoxia

Level of risk & potential for adaptation: Potential for additional adaptation to reduce risk; Risk level with **high** adaptation; Risk level with **current** adaptation

Key risk	Adaptation issues & prospects	Climatic drivers	Timeframe	Risk & potential for adaptation (Very low – Medium – Very high)
Changes in ecosystem productivity associated with the redistribution and loss of net primary productivity in open oceans. (*medium confidence*) [6.5.1, 6.3.4, Box CC-PP]	Adaptation options are limited to the translocation of industrial fishing activities due to regional decreases (low latitude) versus increases (high latitude) in productivity, or to the expansion of aquaculture.	Warming trend; Extreme temperature	Present Near term (2030 – 2040) Long term (2080 – 2100) 2°C 4°C	
Distributional shift in fish and invertebrate species, fall in fisheries catch potential at low latitudes, e.g., in EUS, CBS, and STG regions. (*high confidence*) [6.3.1, Box CC-MB]	Evolutionary adaptation potential of fish and invertebrate species to warming is limited as indicated by their changes in distribution to maintain temperatures. Human adaptation options involve the large-scale translocation of industrial fishing activities following the regional decreases (low latitude) versus (possibly transient) increases (high latitude) in catch potential as well as deploying flexible management that can react to variability and change. Further options include improving fish resilience to thermal stress by reducing other stressors such as pollution and eutrophication, the expansion of sustainable aquaculture and development of alternative livelihoods in some regions.	Warming trend; Extreme temperature	Present Near term (2030 – 2040) Long term (2080 – 2100) 2°C 4°C	
High mortalities and loss of habitat to larger fauna including commercial species due to hypoxia expansion and effects. (*high confidence*) [6.3.3, 30.5.3.2, 30.5.4.1-2]	Human adaptation options involve the large-scale translocation of industrial fishing activities as a consequence of the hypoxia-induced decreases in biodiversity and fisheries catch of pelagic fish and squid. Special fisheries may benefit (Humboldt squid). Reducing the amount of organic carbon running off of coastlines by controlling nutrients and pollution running off agricultural areas can reduce microbial activity and consequently limit the extent of the oxygen drawdown and the formation of coastal dead zones.	Warming trend; Hypoxia	Present Near term (2030 – 2040) Long term (2080 – 2100) 2°C 4°C	
Ocean acidification: Reduced growth and survival of commercially valuable shellfish and other calcifiers, e.g., reef building corals, calcareous red algae. (*high confidence*) [5.3.3.5, 6.1.1, 6.3.2, 6.4.1.1, 30.3.2.2, Box CC-OA]	Evidence for differential resistance and evolutionary adaptation of some species exists but is likely limited by the CO_2 concentrations and high temperatures reached; adaptation options shifting to exploit more resilient species or the protection of habitats with low natural CO_2 levels, as well as the reduction of other stresses, mainly pollution and limiting pressures from tourism and fishing.	Ocean acidification	Present Near term (2030 – 2040) Long term (2080 – 2100) 2°C 4°C	
Reduced biodiversity, fisheries abundance and coastal protection by coral reefs due to heat-induced mass coral bleaching and mortality increases, exacerbated by ocean acidification, e.g., in CBS, SES, and STG regions. (*high confidence*) [5.4.2.4, 6.4.2, 30.3.1.1, 30.3.2.2, 30.5.2, 30.5.3, 30.5.4, 30.5.6, Box CC-CR]	Evidence of rapid evolution by corals is very limited or nonexistent. Some corals may migrate to higher latitudes. However, the movement of entire reef systems is unlikely given estimates that they need to move at the speed of 10 – 20 km yr^{-1} to keep up with the pace of climate change. Human adaptation options are limited to reducing other stresses, mainly enhancing water quality and limiting pressures from tourism and fishing. This option will delay the impacts of climate change by a few decades but is likely to disappear as thermal stress increases.	Warming trend; Damaging cyclone; Extreme temperature; Ocean acidification	Present Near term (2030 – 2040) Long term (2080 – 2100) 2°C 4°C	
Coastal inundation and habitat loss due to sea level rise, extreme events, changes in precipitation, and reduced ecological resilience, e.g., in CBS and STG subregions. (*medium to high confidence*) [5.5.2, 5.5.4, 30.5.6.1.3, 30.6.2.2, Box CC-CR]	Options to maintain ecosystem integrity are limited to the reduction of other stresses, mainly pollution and limiting pressures from tourism, fishing, physical destruction, and unsustainable aquaculture. Reducing deforestation and increasing reforestation of river catchments and coastal areas to retain sediments and nutrients. Increased mangrove, coral reef, and seagrass protection and restoration to protect numerous ecosystem goods and services such as coastal protection, tourist value, and fish habitat.	Warming trend; Ocean acidification; Sea level; Extreme precipitation; Damaging cyclone	Present Near term (2030 – 2040) Long term (2080 – 2100) 2°C 4°C	
Marine biodiversity loss with high rate of climate change. (*medium confidence*) [6.3.1-3, 6.4.1.2-3, Table 30.4, Box CC-MB]	Adaptation options are limited to the reduction of other stresses, mainly to reducing pollution and to limiting pressures from tourism and fishing.	Extreme temperature; Ocean acidification	Present Near term (2030 – 2040) Long term (2080 – 2100) 2°C 4°C	
Decreased production of global shellfish fisheries. (*high confidence*) [6.3.2, 6.3.5, 6.4.1.1, 30.5.5, 30.6.2.1, Box CC-OA]	Effective shift to alternative livelihoods, changes in food consumption patterns, and adjustment of (global) markets.	Extreme temperature; Ocean acidification	Present Near term (2030 – 2040) Long term (2080 – 2100) 2°C 4°C	

Key risk	Adaptation issues & prospects	Climatic drivers	Timeframe	Risk & potential for adaptation
Global redistribution and decrease of low-latitude fisheries yields are paralleled by a global trend to catches having smaller fishes. (*medium confidence*) [6.3.1, 6.4.1, 6.5.3, 30.5.4, 30.5.6, 30.6.2]	Increasing coastal poverty at low latitudes as fisheries becomes smaller – partially compensated by the growth of aquaculture and marine spatial planning, as well as enhanced industrialized fishing efforts.		Present Near term (2030 – 2040) Long term (2080 – 2100) 2°C 4°C	Very low – Medium – Very high
Redistribution of catch potential of large pelagic-highly migratory fish resources, such as tropical Pacific tuna fisheries. (*high confidence*) [6.3.1, 6.4.3, Table 30.4]	International fisheries agreements and instruments, such as the tuna commissions, may have limited success in establishing sustainable fisheries yields.		Present Near term (2030 – 2040) Long term (2080 – 2100) 2°C 4°C	Very low – Medium – Very high
Variability of small pelagic fishes in EBUEs is becoming more extreme at interannual to multidecadal scales, making industry and management decisions more uncertain. (*medium confidence*) [6.3.2, 6.3.3, 30.5.2, 30.5.5, Box CC-UP]	Development of new and specific management tools and models may have limited success to sustain yields. Reduction in fishing intensity increases resilience of the fisheries.		Present Near term (2030 – 2040) Long term (2080 – 2100) 2°C 4°C	Very low – Medium – Very high
Decrease in catch and species diversity of fisheries in tropical coral reefs, exacerbated by interactions with other human drivers such as eutrophication and habitat destruction. (*high confidence*) [6.4.1, 30.5.3-4, 30.5.6, Box CC-CR]	Restoration of overexploited fisheries and reduction of other stressors on coral reefs delay ecosystem changes. Human adaptation includes the usage of alternative livelihoods and food sources (e.g., coastal aquaculture).		Present Near term (2030 – 2040) Long term (2080 – 2100) 2°C 4°C	Very low – Medium – Very high
Current spatial management units, especially the marine protected areas (MPAs), may fail in the future due to shifts in species distributions and community structure. (*high confidence*) [6.3.1, 6.4.2.1, 30.5.1, Box CC-MB]	Continuous revision and shifts of MPA borders, and of MPA goals and performance.		Present Near term (2030 – 2040) Long term (2080 – 2100) 2°C 4°C	Very low – Medium – Very high
Reduced coastal socioeconomic security. (*high confidence*) [5.5.2, 5.5.4, 30.6.5, 30.7.1]	Human adaptation options involve (1) protection using coastal defences (e.g. seawalls where appropriate and economic) and soft measures (e.g., mangrove replanting and enhancing coral growth); (2) accommodation to allow continued occupation of coastal areas by making changes to human activities and infrastructure; and (3) managed retreat as a last viable option. Vary from large-scale engineering works to smaller scale community projects. Options are available under the more traditional CZM (coastal zone management) framework but increasingly under DRR (disaster risk reduction) and CCA (climate change adaptation) frameworks.		Present * Near term (2030 – 2040) * Long term (2080 – 2100) 2°C * 4°C *	Very low – Medium – Very high
				**High confidence* in existence of adaptation measures, *Low confidence* in magnitude of risk reduction
Reduced livelihoods and increased poverty. (*medium confidence*) [6.4.1-2, 30.6.2, 30.6.5]	Human adaptation options involve the large-scale translocation of industrial fishing activities following the regional decreases (low latitude) versus increases (high latitude) in catch potential and shifts in biodiversity. Artisanal fisheries are extremely limited in their adaptation options by available financial resources and technical capacities, except for their potential shift to other species of interest.		Present Near term (2030 – 2040) Long term (2080 – 2100) 2°C 4°C	Very low – Medium – Very high
Impacts due to increased frequency of harmful algal blooms (*medium confidence*) [6.4.2.3]	Adaptation options include improved monitoring and early warning system, reduction of stresses favoring harmful algal blooms, mainly pollution and eutrophication, as well as the avoidance of contaminated areas and fisheries products.		Present Near term (2030 – 2040) Long term (2080 – 2100) 2°C 4°C	Very low – Medium – Very high
Impacts on marine resources threatening regional security as territorial disputes and food security challenges increase (*limited evidence, medium agreement*) [IPCC 2012, 30.6.5, 12.4-12.6, 29.3]	Decrease in marine resources, movements of fish stocks and opening of new seaways , and impacts of extreme events coupled with increasing populations will increase the potential for conflict in some regions, drive potential migration of people, and increase humanitarian crises.		Present Near term (2030 – 2040) Long term (2080 – 2100) 2°C 4°C	Very low – Medium – Very high
Impacts on shipping and infrastructure for energy and mineral extraction increases as storm intensity and wave height increase in some regions (e.g., high latitudes) (*high confidence*) [IPCC 2012, 30.6.5, 12.4-12.6, 29.3]	Adaptation options are to limit activities to particular times of the year and/or develop strategies to decrease the vulnerability of structures and operations.		Present Near term (2030 – 2040) Long term (2080 – 2100) 2°C 4°C	Very low – Medium – Very high

CBS = Coastal Boundary Systems; EBUE = Eastern Boundary Upwelling Ecosystems; EUS = Equatorial Upwelling Systems; HLSBS = High-Latitude Spring Bloom Systems; SES = Semi-Enclosed Seas; STG = Subtropical Gyres.

photo: Maeslant storm surge barrier in Rotterdam, Netherlands. © Asahi Shimbun / Getty Images