CLIMATE OVERSHOOT COMMISSION

Expected Impacts from Exceeding 1.5 °C and Climate Overshoot

The expected impacts from exceeding 1.5 °C and from climate overshoot are closely intertwined but not identical. Climate overshoot concerns global warming exceeding 1.5 °C and then later returning below that threshold. Thus, risks from climate overshoot depend on how long and by how much 1.5°C was exceeded–a limitless number of possible scenarios. Therefore, this brief summarizes current knowledge regarding expected impacts from global warming exceeding 1.5°C, without reference to magnitude or duration, followed by emerging knowledge regarding impacts specific to a temporary period of overshoot.

Impacts from Exceeding 1.5 °C

In general, risks and impacts from exceeding 1.5°C include:

- very high risks to unique and threatened systems including coral reefs, the Arctic and its indigenous peoples, mountain glaciers, biodiversity hotspots;
- high to very high risks from extreme weather events such as heatwaves, heavy rain, drought, wildfires, and coastal flooding;
- high to very high risks to terrestrial and freshwater ecosystems of biodiversity loss, structure change, and tree mortality;
- moderate to very high risk of disproportionate impacts on vulnerable groups;
- moderate to very high risks of significant global aggregate impacts such as monetary damages, lives affected, species lost, and ecosystem degradation;
- moderate to very high risks to public health including heat-related morbidity and mortality, ozone-related mortality, malaria, and dengue and other mosquito-borne diseases;
- moderate to very high risks of large-scale singular events (so-called “tipping points”) such as ice sheet disintegration, slowing of thermohaline circulation;
- moderate to very high risks to terrestrial and freshwater ecosystems of wildfire increase and carbon loss; and
- moderate to very high risks, in ocean ecosystems, to kelp forests, seagrass meadows, phytoplankton communities, rocky shores, and salt marshes.

Regional risks from exceeding 1.5 °C include (but are not restricted to):

- Small islands: loss of biodiversity and ecosystem services; loss and damage from extreme weather events; economic decline and livelihood failure; reduced habitability and increased displacement; and risk to water security
- North America: increase in human mortality and morbidity due to extreme weather events; degradation of ecosystems; risk to freshwater resources; risk to food and nutritional security; risks to livelihoods and economic activities; damage to transportation infrastructure; Lyme disease
- Europe: coastal and inland flooding; increase in human mortality and morbidity due to higher temperatures; disruptions to ecosystems; water scarcity (especially in southeastern Europe); crop losses
- Central and South America: risk to water security; severe health effects due to increasing epidemics; degradation of coral reef ecosystems; drought-induced risk to food security; loss and damage due to extreme events and sea level rise
- Australasia: degradation and loss of coral reef ecosystems; loss and damage due to sea level rise; reduced agricultural production; increase in heat-related mortality and morbidity; loss of Alpine biodiversity (in Australia); cascading impacts on human systems
- Asia: loss and damage due to flooding; biodiversity loss, habitat shifts, and ecosystem disruptions; coral mortality; degraded coastal fisheries; risk to food and water security
- Africa: biodiversity loss and degradation of ecosystems; reduced food production from crops, fisheries, and livestock, with associated risk to food security and loss of livelihood; risks to marine ecosystems and coastal communities; increase in human mortality and morbidity due to higher temperatures and infectious diseases; reduced economic output and increased inequality and poverty; risk to water and energy security

Global and regional risks from exceeding 1.5 °C can, to a limited degree, be characterized also according to how far in the future they are likely to arise. Near-term (2021-2040) risks and expected impacts include:

- high or very high risks of biodiversity loss for terrestrial, freshwater, coastal, and marine ecosystems;

- sea level rise causing encroachment on coastal settlements and infrastructure; and
- highest risks where temperatures are highest, along coastlines, and where systems depend on ice or seasonal rivers.

Mid- to long-term (2041-2100) risks include:

- very high risk of extinction for 3-14% of terrestrial species;
- very high risk of extinction risk 2% of endemic species in biodiversity hotspots;
- greater risks to water availability (including groundwater availability in small islands) and of water-related hazards;
- adverse impacts on freshwater ecosystems in many watersheds;
- increased direct flood damages;
- increased risks to food security and nutrition linked to weakened soil health and ecosystem services, increased pressure from pests and diseases, and degraded fisheries;
- significantly increased ill health and premature deaths including heat-related mortality;
- increased risks of food-borne, water-borne, and vector-borne diseases, in particular dengue;
- greater risks to cities, settlements, and infrastructure, including greater exposure to coastal floods;
- sea level rise will pose existential threats to some small islands and low-lying coastal areas;
- increased maintenance costs for urban infrastructure;
- increased disruptions to infrastructure, especially in permafrost and coastal areas;
- greater global aggregate economic damages, concentrated in developing countries; and
- greater human displacement including involuntary migration.

Increasingly, individual risks will interact with one another to pose compound risks and amplify impacts. Compound risks may, in turn, lead to risks cascading across sectors and regions.

Climate Overshoot

The IPCC defines “overshoot” as “pathways [that] exceed 1.5 °C global warming and then return to that level, or below, after several decades” (IPCC AR6 WGII SPM). The impacts from overshoot will be a function of the magnitude of overshoot–that is, how far above 1.5 °C temperatures rise–and the duration of overshoot.

In general, maximum geophysical impacts at global and regional levels are always higher in overshoot scenarios compared to 1.5° C scenarios without overshoot (Drouet et al. 2021). Such higher maximum impacts include:

- heatwave duration and frequency (especially in Africa and North America);
- major heatwave frequency (especially in Africa and North America);
- number of days suitable for air conditioning (entailing higher energy demand);
- number of days lost in cropping season (for maize, soybean, and spring wheat, and especially for rice and winter wheat);
- agricultural drought duration and frequency; and
- runoff extremes.

Similarly, global economic impacts - that is, climate impacts and mitigation costs - after 2050 are always higher in overshoot scenarios compared to 1.5° C scenarios without overshoot.

In this context, impacts on ecosystems will vary depending on ecosystem type. Low-resilience ecosystems, or those with limited capacity to adjust to climate change, may suffer irreversible impacts that will persist even if global temperatures return to 1.5 °C. Examples of low-resilience ecosystems at risk of irreversible impacts include polar and mountain ecosystems, coral reefs, and kelp forests.

Ecosystems that contain large amounts of carbon stored in biomass, will be at risk of releasing carbon dioxide because exceeding 1.5 °C will increase risks of, for example, wildfires, mass tree mortality, peatlands drying, and permafrost thawing. These additional emissions will remain in the atmosphere even if global temperatures return to 1.5 °C.

“Committed changes,” or sustained long-term ecosystem responses to climate change, could be triggered by overshoot. For example, at 1.6 °C, more than 10 percent of species are projected to become endangered. Like carbon loss from high-carbon ecosystems, loss of biodiversity is largely irreversible.

Specific features of human systems will also be particularly at risk from overshoot, including crop yields, infrastructure, low-lying coastal settlements, livelihoods, and cultural and spiritual values. Ecosystem-based adaptation measures will be at risk, threatening adaptation investment losses and leaving populations unprepared to cope with greater climate risks.

References

/ Drouet, L., et al. 2021. Net Zero-Emission Pathways Reduce the Physical and Economic Risks of Climate Change. Nature Climate Change 11: 1070-1076.

/ IPCC, 2022: Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama (eds.)]. Cambridge University Press. Cambridge University Press, Cambridge, UK and New York, NY, USA, 3056 pp., doi:10.1017/9781009325844.