G7 GERMANY
Science 7 Dialogue

Ocean and Cryosphere: The Need for Urgent International Action

Life as we know it depends directly or indirectly on the ocean.[1] By absorbing over 90% of excess heat and about 25% of total anthropogenic carbon dioxide (CO_2) emissions, the ocean has buffered humanity from the worst impacts of climate change yet and plays, thus, a central role in regulating climate.[2] Moreover, the ocean harbours an enormous amount of biodiversity and supplies oxygen, food and renewable energy. Ocean life provides coastal protection, contributes to human health and well-being, and supports cultural values, trade and tourism. The consequences of climate change are in particular seen in the high latitudes and altitudes. Hence, polar ocean and the cryosphere (including sea ice, glaciers, ice sheets, snow cover and permafrost as components) act as one of our planet's most efficient early warning systems for ongoing global warming and climate change.

While 60% of the ocean remains beyond national jurisdiction, the remaining 40% is in exclusive economic zones (EEZ) extending 200 nautical miles seaward from the shores. The G7 states account for about one third of that area, including some of the most productive and diverse ocean realms. At the same time, these states are responsible for over one fifth of direct greenhouse gas emissions worldwide[3] and an even larger share of historic emissions to date. Thus, the G7 states have a major responsibility for protecting the climate, the ocean and the polar regions.

Today, the ocean and the cryosphere are changing faster than ever before due to anthropogenic climate change. To better protect the ocean and the cryosphere we need to understand, monitor, manage, predict and mitigate future changes and their impacts on human societies and ecosystems.

It is imperative that action is taken to restore balance in the marine and polar systems. If action is not taken now, feedback processes will lead to irreversible and cascading effects on the global climate system.[4]

1 IOC-UNESCO, 2020. *Global Ocean Science Report 2020–Charting Capacity for Ocean Sustainability, Executive Summary.* [Isensee (ed.)], Paris, UNESCO Publishing (IOC Policy Series, 2020-1).

2 IPCC, 2019. Summary for Policymakers. In: *IPCC Special Report on the Ocean and Cryosphere in a Changing Climate* [Pörtner *et al.* (eds.)], Cambridge University Press.

3 European Commission, Joint Research Centre, Crippa *et al.*, 2020. *Fossil CO_2 and GHG emissions of all world countries: 2020 report.* Publications Office, https://data.europa.eu/doi/10.2760/56420.

4 IPCC, 2021. Summary for Policymakers. In: *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* [Masson-Delmotte *et al.* (eds.)]. Cambridge University Press.

Ice Loss and Sea Level Rise

The rapidly accelerating rate of ice loss in high mountains and polar regions – from glaciers and ice sheets – is one of the major self-reinforcing processes of climate change. Both in Antarctica and Greenland, ice loss has strongly accelerated over the past decades.[5] A source of growing scientific concern is the risk of crossing critical thresholds in ice sheet coverage if global warming exceeds 1.5°C, beyond which the current ice cover configuration would become unstable, and parts of the Greenland and Antarctic ice sheets might be irreversibly lost.[6] The rate of sea level rise has more than doubled in the last two decades. This is unprecedented. If emissions are not controlled, by 2100 the global mean sea level will rise by at least 1 m,[7] and even higher in some regions. This threatens the existence of unprotected shallow islands and coastal lowlands.

Ocean Change

The ocean plays a vital role in moderating contemporary human-induced climate change in absorbing about a quarter of anthropogenic CO_2 emissions. The ocean is warming and hence may give rise to abrupt and irreversible changes, such as destabilisation of ocean circulation patterns with potentially important impacts on global heat and energy transport as well as on regional climate. Sea ice decline, acidification, changes in stratification and oxygen content come with serious impacts on marine life, its food webs and migration. Change is faster than processes of natural adaptation. Marine species are on the move as a result of climate change, with many species shifting poleward. The marine ecosystems are being massively reorganised. Hence, the Earth's biogeochemical cycles and ecosystem services are affected as a whole.

Permafrost Thaw

Arctic permafrost is warming, and permafrost coasts are particularly vulnerable to rising air temperatures as rapid ground-ice melt and permafrost thawing accelerate coastal erosion. When sea ice declines, permafrost coasts are even more eroded by intensified wave action and storm surges. The reduced snow cover exposes the frozen ground to solar radiation for longer periods, accelerating permafrost thaw. Thawing permafrost promotes substantial microbial turnover of organic carbon and accelerates the emission of the greenhouse gases methane and CO_2 from formerly frozen soils. Current estimates put the freeze-locked reservoir of organic carbon at 1,307 gigatonnes,[8] which is 1.5 times larger than the current amount of carbon in the atmosphere (860 gigatonnes). Thus, widespread and deep permafrost thaw holds great potential to amplify global warming by extensive future greenhouse gas release.

Local and Global Impacts

Sea level rise already impacts people's livelihoods with the recession of shorelines and the increased frequency of flooding from storm surges, both leading to loss of coastal land and infrastructure, cultural heritage, natural resources and biodiversity. If unabated, this will lead to cascading socio-economic impacts worldwide, including the disruption to livelihoods and displacement of hundreds of millions of people.

Not only globally but also locally, the loss of ice has severe impacts on humans: the shrinking cryosphere in the Arctic and high-mountain areas has led to predominantly negative impacts on biodiversity, food security, water resources, water quality, livelihoods, health and well-being. For example, sea ice decline drastically affects marine wildlife and thus indigenous culture and traditional hunting and fishing techniques in the North. Permafrost decline is destroying human and industrial infrastructures at an accelerating pace.

Costs and benefits have been unequally distributed across populations and regions. Thus, integrating scientific knowledge for risk assessments and solutions across the grand challenges of climate, marine and cryosphere connectivity at a global level is a pressing need.

5 IPCC, 2019.

6 IPCC, 2019.

7 IPCC, 2021.

8 Hugelius *et al.*, 2014. Estimated stocks of circumpolar permafrost carbon with quantified uncertainty ranges and identified data gaps, *Biogeosciences,* 11, 6573–6593, https://doi.org/10.5194/bg-11-6573-2014.

Recommendations

In light of the severity, longevity and irreversibility of ongoing and future changes in the planet's cryosphere and ocean, sustained coordinated action must be taken now. We call on the G7 governments to provide the following leadership:

(1) Protect the ocean and the cryosphere by urgent and ambitious reductions in greenhouse gas emissions to achieve the goals of the Paris Climate Agreement.

- Accelerate the worldwide just transition to carbon-free societies to ensure substantive reductions in greenhouse gas emissions, and that countries are on track to achieve their 2030 climate goals, and to achieve net-zero emissions by 2050 at the latest.
- Include climate change impacts, which may unfold over longer time scales but are already triggered now (e.g. sea level rise), in all policy and infrastructure considerations.
- Include the ocean and the cryosphere in economic and environmental policies and ensure consistency with countries' climate targets.
- Enhance international collaboration to protect the sensitive Arctic and Antarctic regions and ensure the sustainable management of living and mineral resources.

(2) Strengthen the capacity of the ocean biosphere to contribute to climate change mitigation.

- Restore marine ecosystems and biological carbon sinks by effective conservation measures for marine life as it plays a valuable role in global ocean health.
- Significantly reduce emissions, pollution and overuse as a precondition for marine ecosystems and species to thrive, and for safeguarding their role in climate change mitigation and in providing coastal protection and food for humankind.
- Establish more effective and equitably managed, ecologically representative and well-connected systems of marine protected areas and other effective area-based conservation measures that cover at least 30% of the global ocean.

(3) Engage all forms of knowledge.

- Fund considerably more inclusive, international and interdisciplinary research into the state of the ocean and the cryosphere, into ways of restoring their health, and into ways of adapting to changes in their state.
- Halt and reverse biodiversity loss. Support the health and well-being of ecosystems. Develop innovative conservation and governance approaches based on sound environmental economics (including accounting for the damage and loss of biodiversity).
- Co-design research and include indigenous knowledge in both natural and social sciences.

(4) Enhance international scientific cooperation and data sharing for an Earth observation and forecasting system.

- Strengthen framework conditions for the advancement of Earth system science and prediction by improving education and research, facilitating systemic approaches. Ensure continuous, effective and efficient observation of the ocean and the cryosphere. Provide access to areas within national jurisdiction, e.g. within the 200-mile exclusive economic zones (EEZ).
- Increase international coordination, provide and share adequate infrastructures and capacities, including data and models, for sustained observations of ocean and cryosphere, particularly in the polar regions.
- Utilise advances in high performance computing and data science to address critical knowledge gaps. Build Earth observation systems and advance climate models through supercomputing to reach the scale of monitoring, forecasting and early-warning capabilities required to anticipate the specific consequences of climate change. International efforts are needed to coherently guide investments.

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