November 2019

THE ARCTIC AND ANTARCTIC

The frozen parts of the Earth, where water is found in its solid form, are known as the cryosphere. The cryosphere includes frozen sea, lakes and rivers, snow cover, glaciers, ice caps, ice sheets and frozen ground.

Two critically important parts of the cryosphere are found at the Earth's poles. The North Pole is covered by the Arctic Ocean where sea ice grows in the winter and shrinks in the summer. The ring of land around the Arctic Ocean is covered with snow and ice, including a thick ice sheet of ice covering Greenland.

At the South Pole is the icy continent of Antarctica – the land mass covered by a huge ice sheet, with shelves of floating ice extend into the ocean. The outer sections of ice break off to form icebergs (NSIDC, n.d.).

Glaciers and ice sheets cover around 10% of Earth's land mass (IPCC, 2019).

ROLE OF THE CRYOSPHERE

These immense parts of the cryosphere play a vital role in regulating the climate and ocean systems that sustain the Earth. They reflect heat from the sun, helping to regulate our planet's temperature. They store most of the world's freshwater. They help drive the Earth's system of circulating water in the ocean, which transports heat from the tropics toward the poles and increases the ability of the ocean to absorb carbon dioxide (CO_2) from the atmosphere.

But polar regions are also highly sensitive to human activity. The cryosphere is one of the first places where scientists are able to identify global changes in climate (NOAA, n.d.).

THE THREAT OF CO_2 EMISSIONS AND HEATING

The effects of anthropogenic (man-made) CO_2 emissions are already being detected across the polar regions. They are experiencing heating greater than the global annual average. Parts of the Arctic and Antarctic are heating three times as fast as other parts of our planet (Greenpeace, n.d.-a; IPCC, 2018). Despite occupying only 25% of the global ocean area, the Southern Ocean accounted for 35-43% of global ocean heat gain in the upper 2000m between 1970 and 2017 (IPCC, 2019).

The ocean around and under these areas is heating too. Some of the largest sea surface heating is taking place in the Arctic (Gattuso et al., 2015). Vast Antarctic glaciers are also being heated from below and making them less stable. There's also evidence that global warming has caused a shift in wind patterns that are ultimately bringing more warm ocean water into contact with the region's ice, affecting formation and loss (Holland et al., 2019).

Glaciers are losing ice faster than snow is falling to add new ice (Greenpeace, n.d.-a). In 2019, NASA reported that a section of Antarctica's Brunt Ice Shelf twice the size of New York is about to break off (NASA, 2019). Due to increases in surface air temperatures, June snow cover in the Arctic has declined by 13.4% per decade since 1967 which equates to a total loss of 2.5 million km^2 (IPCC, 2019).

The Intergovernmental Panel on Climate Change (IPCC) has found that the Greenland and Antarctic ice sheets have been losing mass at an increasing rate between 1992 and 2016 (IPCC, 2019). Arctic sea ice has decreased by 3.5%-4.1% per decade since 1979 and Antarctic sea ice has decreased by 1.2% to 1.8% per decade (IPCC, 2014).

Changes in sea ice extent in the Arctic since 1979 are unprecedented for at least 1000 years, with sea ice decreasing for all months of the year and September sea ice extent reducing by 12.8% per decade between 1979 and 2018 (IPCC, 2019).

Ocean acidification is also a threat. The ocean has absorbed 28% of humanity's CO_2 emissions since 1750 (Gattuso et al., 2015). When CO_2 dissolves in seawater, it forms carbonic acid and drives the seawater to acidity – with significant effects on ecosystems, particularly those species that require calcium carbonate to build their shells and skeletons, including mussels, clams, coral, oysters and plankton.

Colder waters are naturally lower in calcium carbonate concentrations, and many scientists believe that ocean acidification will affect food webs in the ocean around Antarctica first because calcium carbonate is already in short supply, and acidification will decrease levels further. The impact on cold-water corals, which are particularly vulnerable to ocean acidification, could be severe (ASOC, n.d.-a). Recent research in Scotland suggests that cold water deep water corals are in effect suffering from osteoporosis because of acidification (Heriot-Watt University, 2015).

IMPACTS

Sea level rise

The most obviously significant impact of global and ocean heating at the poles is sea level rise. According to the IPCC, marine ice sheet instability in Antarctica and loss of the Greenland ice sheet could result in the sea rising by many metres, and these instabilities could be triggered by a temperature rise of 1.5ºC (IPCC, 2018). Global sea level is already rising at a rate of 3.6mm per year (IPCC, 2019), and a modest imbalance between the input and output of ice could be a major contributor to this (ASOC, n.d.-b). Rapid ice loss from the Greenland and Antarctic ice sheets contributed 1.2mm per year to global sea level rise between 2012 and 2016 which is a 700% increase on the 1992-2001 period (IPCC, 2019).

Loss of biodiversity

Arctic and Antarctic species are dramatically impacted by climate breakdown as well. As both predators and prey change the timings of their movements and migrations because of changes to the climate, their interactions become de-synchronised. Krill – the keystone species of Antarctic waters – have moved four degrees of latitude south to seek more favourable conditions (Atkinson et al., 2019) as sea ice has decreased. Penguin populations have been declining in recent years due to reductions in krill populations and changing weather conditions in their traditional nesting areas (ASOC, n.d.-b).

Scientists have also warned that a warmer Antarctic could also attract new species of animals and plants, creating competition for Antarctic life that is specially adapted to icy temperatures (Fraser et al., 2018).

Effects on currents and climate

The melting of sea ice and glaciers, and the lack of new sea ice formation, could disrupt thermohaline circulation, which has an important effect on temperatures and climate. Warm waters are driven to the polar regions, where the formation of sea ice increases their salinity and density and they sink to the ocean depths. These deep waters move to the equator, where they warm up, become less dense, and rise back to the surface, completing the cycle. This conveyor belt system has a key role in redistributing Earth's heat from the tropics to the poles. Increasing arctic ice melt and resulting salinity changes could have a drastic influence on this process (Laffoley and Baxter, 2016).

Effect on populations
According to the IPCC, a global temperature rise of 1.5 °C and above would put at risk many disadvantaged, indigenous peoples and local communities dependent on agriculture or the ocean. Those living in Arctic regions may be at disproportionately higher risk (IPCC, 2018).

OTHER STRESSORS

As the Arctic and Antarctic suffer the effects of climate breakdown, there are other stressors that are reducing its resilience. Arctic oil drilling, for example, is threatening the people, wildlife and sensitive ecosystem of the region. Although the Obama administration made the Arctic Ocean off limits to offshore oil drilling for two years, those protections are at risk (Greenpeace, n.d.-b).

Overfishing is also a threat in both the Arctic and Antarctic. A Greenpeace investigation in 2018 revealed that krill-fishing companies are expanding operations in the Antarctic ocean, putting an entire food web at risk (Greenpeace, 2018).

REFERENCES

ASOC. (n.d.-a). Antarctic and Southern Ocean Coalition. Ocean Acidification. Available at: https://www.asoc.org/advocacy/climate-change-and-the-antarctic/ocean-acidification

ASOC. (n.d.-b). Antarctic and Southern Ocean Coalition. Climate Change and the Antarctic. Available at: https://www.asoc.org/advocacy/climate-change-and-the-antarctic

Atkinson, A. et al. (2019). Krill (Euphausia superba) distribution contracts southward during rapid regional warming. Nature Climate Change*, 9*(2), 142. doi: 10.1038/s41558-018-0370-z. Available at: http://pal.lternet.edu/docs/bibliography/Public/618lterc.pdf

Fraser, C. I. et al. (2018). Antarctica's ecological isolation will be broken by storm-driven dispersal and warming. Nature Climate Change, 8, 704–708. Available at: https://www-nature-com.vu-nl.idm.oclc.org/articles/s41558-018-0209-7

Gattuso, J.P. et al. (2015). Contrasting futures for ocean and society from different anthropogenic CO_2 emissions scenarios. Science 349 (6423). doi: 10.1126/science.aac4722. Available at: https://www.ncbi.nlm.nih.gov/pubmed/26138982?otool=inlvulib

Greenpeace. (2018). Licence to Krill: the little-known world of Antarctic fishing. Available at: https://storage.googleapis.com/planet4-international-stateless/2018/03/a73adc3b-krill-report-final-english-email-web-update.pdf

Greenpeace. (n.d.-a). What does climate change mean for the Arctic? Available at: https://www.greenpeace.org.uk/what-climate-change-means-for-the-antarctic/

Greenpeace. (n.d.-b). Arctic issues and threats. Available at: https://www.greenpeace.org/usa/arctic/issues/

Heriot-Watt University. (2015). Ocean acidification shakes the foundation of cold-water coral reefs. Available at: https://www.hw.ac.uk/news/articles/2015/ocean-acidification-shakes-the-foundation-of.htm

Holland, P.R. et al. (2019), West Antarctic ice loss influenced by internal climate variability and anthropogenic forcing. Nature Geoscience, 12th August 2019. Available at: https://www.nature.com/articles/s41561-019-0420-9

IPCC. (2014). Intergovernmental Panel on Climate Change. Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Available at https://www.ipcc.ch/report/ar5/syr/

IPCC. (2018). Intergovernmental Panel on Climate Change. 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. Available at: https://www.ipcc.ch/sr15/

IPCC. (2019). Summary for Policymakers. In: IPCC Special Report on the Ocean and Cryosphere in a Changing Climate [H.- O. Pörtner, D.C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, M. Nicolai, A. Okem, J. Petzold, B. Rama, N. Weyer (eds.)]. In press. Available at: https://www.ipcc.ch/srocc/home/

Laffoley, D. D. A., and Baxter, J. M. (Eds.). (2016). Explaining ocean warming: Causes, scale, effects and consequences. Gland, Switzerland: IUCN. doi: 10.2305/IUCN.CH.2016.08.en Available at: https://www.iucn.org/content/explaining-ocean-warming-causes-scale-effects-and-consequences

NASA. (2019). National Aeronautics and Space Administration. Countdown to Calving at Antarctica's Brunt Ice Shelf. Available at: https://www.nasa.gov/image-feature/countdown-to-calving-at-antarcticas-brunt-ice-shelf
NOAA. (2019). Is sea level rising? Available at: https://oceanservice.noaa.gov/facts/sealevel.html

NOAA. (n.d.). What is the cryosphere? Available at: https://oceanservice.noaa.gov/facts/cryosphere.html

NSIDC. (n.d.) National Snow and Ice Data Center. What is the Cryosphere? Available at: https://nsidc.org/cryosphere/allaboutcryosphere.html

Briefing prepared on behalf of the OneOcean initiative www.oceanprotect.org contact info@oceanprotect.org