September 2019

THE DEEP OCEAN

The deep ocean is defined as the sea and seabed below 200m because this is where light fades. It makes up 90% of the Earth's marine environment and is the largest biome (community of plants and animals living together in a particular climate) on the planet (DSCC, n.d.). Scientists and commentators have pointed out that although the deep sea is the Earth's largest habitat, it is also the most unexplored. More people have travelled into space than have travelled to the deep ocean (WWF, n.d.).

We do know is that the deep ocean is immensely important to Earth systems. At the same time extremely fragile, and increasingly vulnerable to the effects of human activity such as deep sea fishing, deep sea mining and plastics pollution.

At 200m below the surface, light starts fading rapidly. By 4,000m temperature hovers around freezing and there's no sunlight at all (Smithsonian, n.d.). Yet there is an astonishing variety of life: its biodiversity compares to the world's richest tropical rainforests (DSCC, n.d.).

Underwater mountains (seamounts) are home to cold-water coral reefs and forests, sponge beds and hydrothermal vents, as well as the many millions of species dependent on these. The ecosystems associated with hydrothermal vents are unique on the planet (DSCC, n.d.).

WHY THE DEEP OCEAN IS IMPORTANT

Recent scientific discoveries are revealing how important the deep ocean is to our planet. It is at the heart of Earth-climate systems, playing a central role in regulating currents and climate and storing the carbon that might otherwise cause global heating.

Carbon is stored in rocks, the atmosphere, soils and plants – and the ocean. Carbon in phytoplankton is incorporated in marine sediments as the organisms die and sink to the seabed, and then, over millennia, the carbon becomes stored in rocks. (O'Neill, 1998). The abyssal plains of the seabed are the flattest places on earth – because they are vast accumulations of carbon-rich sediment, sometimes over 5km thick, covering the rock below. Ocean sediments cover 70% of the planet's surface, forming the substrate for the largest ecosystem on Earth and its largest carbon reservoir (Dutkiewicz et al., 2015).

The deep ocean also plays a critical role in regulating the Earth's temperature by a process known as thermohaline circulation. This is a conveyor belt-like system in which colder, higher salinity waters sink to the deep ocean and move horizontally through the depths while surface waters move in to replace the sinking water. This creates a global current system, driving the movement of water around the ocean, mixing warm higher salinity waters from the surface with deep waters which are cooler and less saline (NASA, 2009; NOAA, n.d.).

Thermohaline circulation plays an important role in supplying heat to the polar regions, which in turn affects other aspects of the climate system such as solar heating.

WHY DEEP OCEAN ECOSYSTEMS ARE VULNERABLE

The deep ocean has been a still, dark, cold and static environment for millions of years. This makes its uniquely adapted ecosystems very vulnerable to interference and change.

Deep ocean habitats – the abyssal plains, hydrothermal vents and cold seeps, cold-water corals, seamounts and the deep-water column – all have distinct faunas with widely divergent ecological and life history characteristics.

Most deep sea species grow very slowly. They are late maturing, slow reproducing and endemic – which means they cannot easily recover from human disturbance and are exceptionally vulnerable to extinction. This vulnerability is recognised in United Nations resolutions and regulations, which require that the deep ocean be protected from harmful fishing activities (DSCC, n.d.).

Deep-sea coral and sponge communities are largely untapped sources of natural products with enormous potential as pharmaceuticals, enzymes, pesticides, cosmetics and other commercial products (DSCC, n.d.). Their loss would be a loss for humanity.

THREATS AND IMPACTS

Significant biological discoveries about the deep have been made in the last 30 years. Scientists now think there may be more species in the deep ocean than all the other environments on Earth combined - by some estimates, as many as 100 million species may live there (WWF, n.d.). But just as we are beginning to understand the deep ocean and its unique ecosystems, there is a danger that we will destroy them.

The main threats come from deep sea fishing, deep sea mining and global heating.

Deep sea fishing

As coastal and open-water fisheries become depleted, industrial fishing operations have increasingly turned to exploiting deep sea species. Industrial fishing now covers 55% of the ocean area (Kroodsma et al., 2018). The main method used is bottom trawling – dragging huge nets armed with steel plates and heavy rollers across the seabed, pulverising everything in their path to catch one or two species of commercial value. Biologically rich ecosystems such as seamounts are ploughed through, often crushing corals, sponges and other lifeforms and structures as they go.

According to the United Nations' World Ocean Assessment: "The documented widespread extent of deep-water trawl fisheries has led to pervasive concern for the conservation of fragile benthic [seabed] habitats. Moreover, on seamounts where trawling has been discontinued, little regeneration is observed even after five to 10 years and recovery may require centuries to millennia." (UN WOA, 2016)

In Alaskan waters alone, the US National Marine Fisheries Service estimated that over one million pounds of corals and sponges are removed from the seafloor every year by commercial fishing – roughly 90% by bottom trawlers (NMFS, 2001).

The depletion of deep-sea species, both targeted and caught as by-catch, is now a matter of international concern. According to the United Nations' World Ocean Assessment: "The vast majority of deep-water fisheries have been carried out unsustainably, or at least without satisfactory assessments of impacts and sustainability. This has led to the serial depletion of dozens of stocks…" (UN WOA, 2016).

Deep sea mining

Many companies are exploring the deep ocean with a view to beginning mining operations. The deep seabed between 1000 and 6000m deep contains large concentrations of metals of commercial interest such as copper, nickel, manganese, gold, lithium, platinum and rare earth elements. Demand comes from the high tech and renewable energy industries.

The International Seabed Authority (ISA), the global body established to regulate seabed mining in the international areas of the world's oceans, has issued exploration contracts for polymetallic nodules, polymetallic sulphides and cobalt-rich ferromanganese crusts in the deep seabed. These leases cover approximately two million km^2 of the seabed, potentially creating the largest mining operation on the planet (Schmidt, 2015).

Because deep sea mining is currently experimental, the exact nature of impacts remain unknown, but existing information has led many scientists to warn that mining could have a devastating effect. The MIDAS (Managing Impacts of Deep Sea Resource Exploitation) project, funded by the European Union, concluded that deep seabed mining would directly lead to:

- mortality of fauna living on mined substrate (surface which supports life);
- removal of substrate and habitat loss;
- habitat fragmentation;
- habitat modification (MIDAS, 2016).

It also concluded that there would be indirect impacts from the formation of sediment plumes, the potential release of toxic substances and noise and light pollution (MIDAS, 2016).

Heating

In the past 50 years, the ocean has absorbed 93% of excess heat generated by greenhouse gas emissions (Levitus et al., 2012). As the ocean warms, stratification in the upper layers increases, resulting in a reduction in the movement of nutrients from deeper layers (Gao et al., 2019).

Recent science has confirmed the vulnerability of the deep ocean to climate change. The long-term effects of ocean warming have been detected to a depth of at least 700m (Gattuso et al., 2015). And there is growing evidence of the influence of climatic events on deep sea ecosystems (DOSI, n.d.).

The heating of the deep ocean has clear implications for species evolved to live in the cold and for the thermohaline circulation system.

REFERENCES

DOSI. (n.d.). Deep-Ocean Stewardship Initiative. Climate Change. Available at: https://www.dosi-project.org/topics/climate-change/

DSCC. (n.d.). Discover the Deep Sea. Available at: http://www.savethehighseas.org/discover-the-deep-sea/

Dutkiewicz, A. et al. (2015). Census of seafloor sediments in the world's ocean. Geology, 43 (9): 795-798. Available at: https://pubs.geoscienceworld.org/gsa/geology/article/43/9/795-798/131939

Gao, K., Helbling, E.W., Häder, D-P. and Hutchins, D.A. (2012). Responses of marine primary producers to interactions between ocean acidification, solar radiation, and warming. Marine Ecology Progress Series, 470: 167-189. Available at: https://www.int-res.com/abstracts/meps/v470/p167-189/

Gattuso, J.P. et al. (2018). Contrasting futures for ocean and society from different anthropogenic CO2 emissions scenarios. Science 349 (6423), doi: 10.1126/science.aac4722. Available at: https://www.ncbi.nlm.nih.gov/pubmed/26138982?otool=inlvulib

Kroodsma, D. A. (2018). Tracking the global footprint of fisheries. Science, Vol. 359, Issue 6378, pp. 904-908. Available at: https://science.sciencemag.org/content/359/6378/904

Levitus, S. et al. (2012). World ocean heat content and thermosteric sea level change, 1955-2010. Geophysical Research Letters 39(10).

MIDAS. (2016). MIDAS Consortium. Managing Impacts of Deep Sea Resource Exploitation: research highlights,. Available at: https://www.eu-midas.net/news/midas-research-highlights-publication-now-available

NASA. (2009). The Thermohaline Circulation – The Great Ocean Conveyor Belt. Available at: http://svs.gsfc.nasa.gov/3658.

NMFS. (2001). National Marine Fisheries Service. Draft Programmatic Groundfish Supplemental EIS, Jan 2001, tables 4.7-4 and 4.7-5

NOAA. (n.d). Currents: Thermohaline Circulation. Available at: https://oceanservice.noaa.gov/education/tutorial_currents/

O'Neill, P. (1998). Environmental Chemistry. 3rd Edition, Blackie Academic and Professional, London, UK. Available at: https://www.amazon.co.uk/Environmental-Chemistry-3rd-Peter-Oneill/dp/0751404837

Schmidt, C.W. (2015). Going Deep: Cautious Steps toward Seabed Mining. Environmental Health Perspectives. September 2015, Volume 123, Issue 9. Available at: https://ehp.niehs.nih.gov/123-a234/

Smithsonian. (n.d.). The Deep Sea. Available at: https://ocean.si.edu/ecosystems/deep-sea/deep-sea

UN WOA (2016). The First Global Integrated Marine Assessment: World Ocean Assessment I. Available at: https://www.un.org/Depts/los/global_reporting/WOA_RegProcess.htm

WWF (n.d.) Life out of the sun. Available at: https://wwf.panda.org/our_work/oceans/deep_sea/

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