DOSI
DEEP-OCEAN STEWARDSHIP INITIATIVE

POLICY BRIEF
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Climate Change Considerations are Fundamental to Sustainable Management of Deep-Seabed Mining

Climate change is happening now and will continue to affect all seabed habitats targeted for deep seabed mining (DSM). Impacts can take the form of ocean warming, oxygen loss, increasing acidity, and altered food supplies. All of these climate drivers will transform life on the seafloor e.g., (*Fig. 1*) and in the water column, likely hindering the ability to recover from mining disturbance. Climate drivers and impacts from human activities may interact, requiring consideration of climate change in effective long-term management of deep seabed mining. Strategic planning, impact assessment and monitoring, spatial management, and full-cost accounting will need to be designed to effectively incorporate climate impacts to maintain key services provided by the ocean (*BOX 1*).

BOX 1

Why consider climate change?

a. To inform the adoption of measures to ensure effective protection of the marine environment
b. To ensure monitoring programs can differentiate climate impacts from mining impacts
c. To inform adaptive management of deep seabed mining in a dynamic environment
d. To ensure development of climate-concious spatial and non-spatial management measures
e. To maintain key regulating ecosystem services such as carbon fixation
f. To ensure the use of appropriate space and time scales for management
g. To better describe and understand cumulative, synergistic, or antagonistic climate impacts
h. To ensure full cost accounting in the extraction and processing of deep-sea minerals

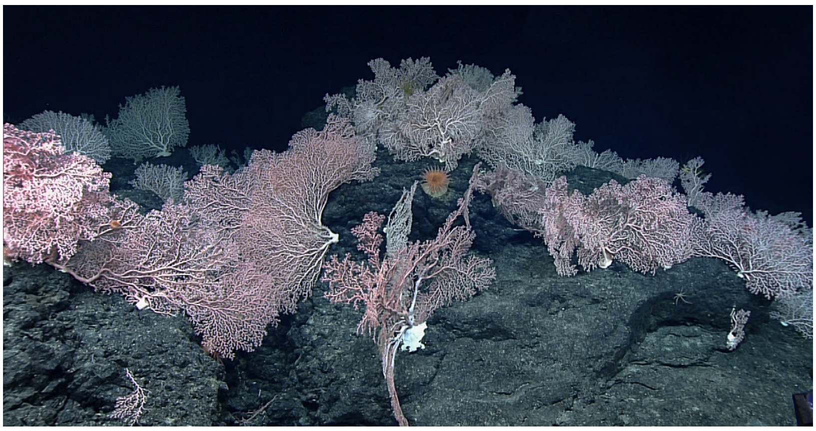

Fig 1 *Habitat-forming cold-water corals, seen at ~1800 metres on Mendelssohn Seamount, are characteristic of cobalt-rich crusts and other hardgrounds targeted for deep seabed mining. Ocean uptake of carbon dioxide has caused declining pH and carbonate saturation, which inhibits formation of coral skeletons and causes non-living parts to dissolve. Credit: NOAA OER.*

Climate change is already altering ocean conditions in all regions targeted for Deep Seabed Mining from the surface to the seafloor and environments will continue changing. For example, by 2040, deep-ocean conditions (food, temperature, oxygen and pH) in the Clarion Clipperton Fracture Zone will reach environmental levels not experienced for millennia. These changes in the basic components that drive life on the seafloor will be 2-10 times beyond current background variations (*Fig. 2*). By altering ocean characteristics such as temperature, dissolved oxygen, pH, circulation, mixing and productivity, climate change will likely lead to habitat loss, decreases in food, smaller organism size, reduced reproduction, and increased mortality. Circulation variation will alter connections among populations (connectivity) and affect recovery from mining disturbance. These changes will vary spatially and differ among APEIs and contractor areas. Environmental management and regional spatial planning should consider such changes, and develop management approaches that provide resilience to areas expected to endure the greatest changes, protect areas expected to experience the least changes, and ensure that spatial management incorporates areas representative of all future conditions. Management of deep-sea mining should include environmental objectives, targets and thresholds which incorporate this increased vulnerability.

In the future, impacts from climate change could interact with impacts from mining activities. These interactions may compromise the effectiveness of environmental management, and confound assignment of responsibility for impacts. For instance, climate-induced disappearance of a species could be confused with mining impacts. Contractors and sponsoring States will not want to be faced with liability for such species loss caused by climatic shifts. Hence the International Seabed Authority (ISA) will need to find a way (e.g. through preservation and impact reference zones) to differentiate impacts, such as species loss, directly caused by mining from those generated by climate change. Incorporating climate change throughout the Mining Code should improve understanding of impacts and could ultimately reduce potential liability for damages arising from climate changes. Climate-relevant local and regional baseline data are also critical to validate climate projections and can help avoid, mitigate, and reduce interactions with mining impacts.

Mining could also affect climate. Mining will affect deep-sea biota with resulting feedbacks on global carbon cycling, particularly in polymetallic nodule zones but also on seamounts and mid-ocean ridges. Disturbance of microbes and removal of animals, combined with changing temperature and oxygen depletion by sediment plumes, could alter midwater carbon transport and sediment sinks, important deep-sea ecosystem services that remove carbon from the biosphere. However, the magnitude of these effects are theoretical at this stage and need to be further assessed.

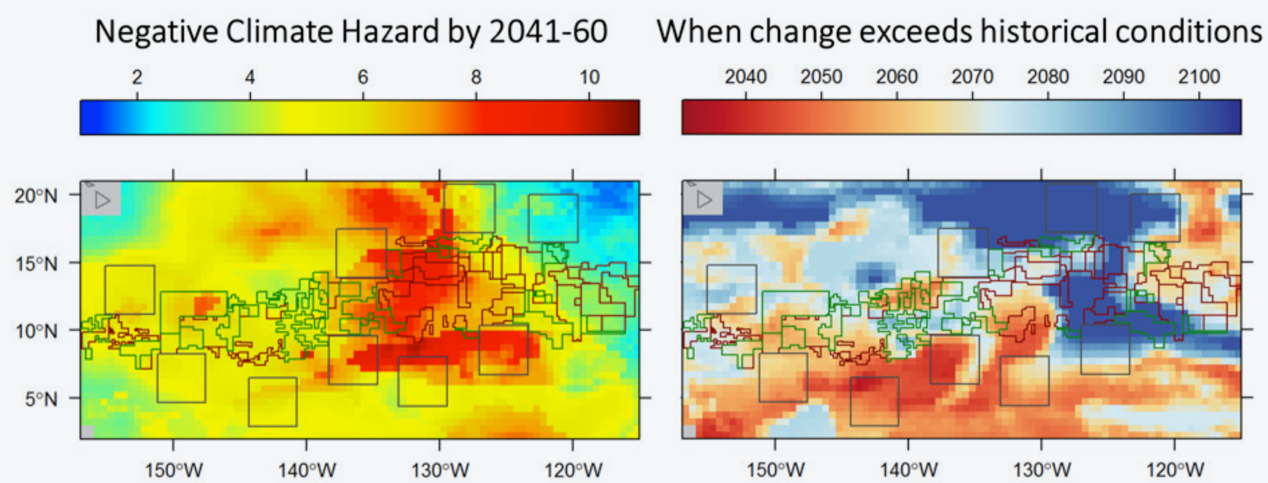

Fig 2 *Climate projections in a business as usual scenario for the Clarion Clipperton Fracture Zone illustrate strong regional differences, including among claims (brown), reserve areas (green) and APEIs (grey). Left – Negative climate hazard refers to the cumulative change in temperature, oxygen, pH and food supply (POC flux) relative to natural variability. Right – Year that the cumulative climate change exceeds conditions experienced historically.*

Current ISA regulations do not address climate change. Over the period since exploration applications were approved, the deep sea has already changed. The ISA should consider the dynamic state of marine ecosystems when translating the United Nations Convention on the Law of the Sea, particularly Part XI-XII and Annex III, into relevant regulations and ensure that all stakeholders in the Area understand and account for climate variability and vulnerability. Environmental impact assessments, monitoring, and regional environmental planning can address how changing oceans enhance risks of harmful effects to the marine environment. Fundamental is the evaluation of expected changes, using the best available scientific information, including detailed ocean climate modelling. Climate change mitigation and adaptation can improve environmental management and reduce the risk of environmental damage to the common heritage of humankind.

Regional Environment Management Plans should include climate change as a fundamental consideration in order to protect the marine environment and enhance ecosystem resilience under mining. Focused strategic goals should reflect this planning, such as protecting areas expected to experience the least change as climate refugia; shielding biodiversity from climate change impacts to facilitate adaptation and increase resilience; and representing the full spectrum of future conditions in a protected area network as a precaution and reference.

Developing effective management measures critically hinges upon understanding how climate change can impact deep-sea species, ecosystems, and processes. **Numerical models forecasting climate change impacts on deep seafloor and midwater ecosystems can be a valuable part of the management toolkit.** Such models can identify refugia, and resilient and representative areas. Additionally, models can predict the potential impact of climate change on larval supply and recruitment, and identify population sources and sinks under future conditions (*Fig. 3*). These complementary toolscan help us better understand the vulnerability and resilience of species to habitat loss and other forms of mining disturbance that climate change may exacerbate.

Environmental and biological data are sparse and difficult to obtain as a result of the large size and remoteness of the deep ocean. States, scientists, and industry can work together to address this gap. The ocean science community has identified key variables that inform and address climate change and its impacts in the context of deep-seabed mining. The data for such variables need to be systematically identified and generated using state-of-the-art observing systems. ISA, industry, academic and civil society support for open access to environmental data, and standard mechanisms of curation and validation will help ensure effective data archiving that retains its value for future generations.

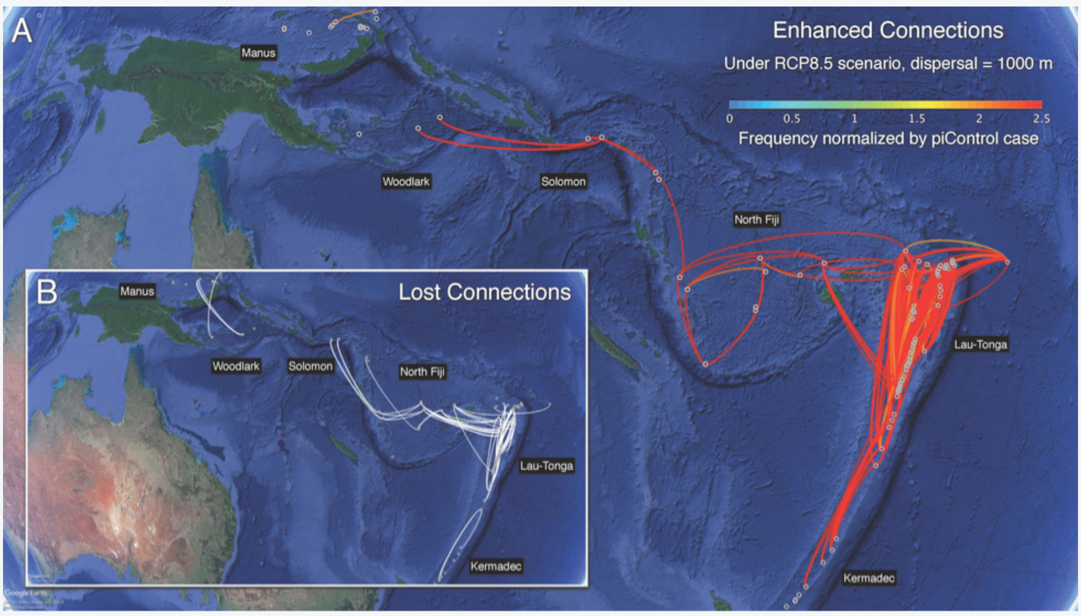

Fig 3 *Climate change will likely lead to changes in ocean circulation, which will in turn affect the ocean species that use the currents to migrate and disperse their young (connectivity). Population connectivity increases (A - red lines) and losses (B – white lines) under a business as usual climate scenario are shown for hypothetical larvae dispersing in the W. Pacific Ocean for 170 days at 1000m depth. Changes are projected for 2100 relative to pre-industrial times.*

Climate change cross-cuts ocean governance and therefore offers a unifying focus for an integrated approach across different multilateral agreements and sectors in line with the 2030 Agenda and Sustainable Development Goals. *Box 2* summarizes key actions for the ISA to consider in order to mainstream climate change.

BOX 2

Action items for the climate-mining nexus

- Recognize natural climate variability and ongoing change by incorporating climate projections and atmosphere-ocean connections into regulations, standards and guidelines of the Mining Code.
- Build APEI networks and monitoring plans to help delineate mining impacts as distinct from climate impacts using appropriate indicators measured on climate-relevant space and time scales.
- Consider synergistic effects of mining and climate in potentially altering ecosystem services when developing regulations to ensure effective protection of the marine environment from mining-related impacts as well as adopting precautionary measures and full-cost accounting of deep-sea mining.
- Build capacity and ocean literacy to incorporate climate change adaptation into environmental management of deep seabed mining, including training to use a diverse suite of models.
- Make climate-relevant (environmental and biological) data open access and enable their use for groundtruthing of climate models in regions targeted for mining.

Fig 4 *Bryozoa growing on polymetallic nodule from the sea floor. Image by A. Glover, T. Dahlgren, H. Wiklund*

Fig 5 *Foraminifera attached to polymetallic nodule from the Clarion-Clipperton Fracture Zone, Pacific. Image courtesy of Craig Smith, University of Hawaii, USA*

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ABOUT DOSI

The Deep-Ocean Stewardship Initiative seeks to integrate science, technology, policy, law and economics to advise on ecosystem-based management of resource use in the deep ocean and strategies to maintain the integrity of deep-ocean ecosystems within and beyond national jurisdiction.

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