Effects of Climate change to the ocean governance

Submitted by the International Seabed Authority

I. Key interactions between oceans and climate change

The deep ocean plays a major role in climate mitigation – removing heat and CO_2 from the atmosphere. This mitigation has led to a warming, acidification and deoxygenation of the ocean, including, and in some cases particularly, deep waters. These changes place stress on ocean ecosystems, acting to redistribute species, alter biodiversity and alter ecosystem services (*Levin and LeBris 2015, Sweetman et al. in press*). There are consequences for human livelihood and the planet's health (*Mora et al. 2013; Gattuso et al. 2015*).

II. Effects of climate change on the oceans, including environmental, social and economic implications, in particular, key issues that link climate change to deep seabed mining

1) Climate change is leading to alterations in ecosystem composition and function over time. In order to distinguish these effects from impacts of seabed mining, it will be necessary to incorporate climate variable monitoring into baseline studies (EIAs) and to monitor unperturbed areas. This may be a consideration in selecting reference areas. For example, oxygen declines could be attributed to plume effects (stimulating respiration) or the result of climate-induced warming (ocean deoxygenation).

2) Although further research is required, in some instances, seabed mining effects (direct disturbance, sedimentation, plume effects, toxic metal releases) may act cumulatively with climate change (warming, acidification, deoxygenation).

3) Climate-change induced stress may reduce resilience of species and ecosystems, slowing recovery from mining damage. For examples, warming increases energy demands and leads to food or oxygen shortages. Ocean acidification may disproportionately affect calcifying species, especially those using aragonite (deep-sea corals, molluscs). Deoxygenation slows colonization and recovery. It may be appropriate to identify the most climate- vulnerable assemblages.

4) The need for climate-refugia and migratory corridors may also be considered by ISA in developing regulations, and by contractors when designating mining areas and configurations.

III. Actions and activities that have been undertaken to address the effects of climate

change on the oceans and to foster climate-resilient sustainable development of oceans and seas

As an example of actions taken are the Areas of Particular Environmental Interest planned for the Mid Atlantic Ridge is incorporating current and projected climate change variables into its assessment of different scenarios. This template may be adopted in other planning activities.

IV. Any suggestions for further action in this regard to address the effects of climate change on the oceans.

1. Future Actions:

There is a strong need for expanded deep-ocean monitoring to:

1) Better document changing deep ocean conditions;
2) Develop a mechanistic understanding of the interactions between changes in the atmosphere, land, the upper ocean and the deep ocean;
3) Project future conditions and d) develop adaptation mechanisms via human activity in the deep sea. The IOC and the Deep-Ocean Observing Strategy (deepoceanobserving.org) could play a role. In this regard, the ISA may also offer monitoring opportunities at sites targeted for seabed mining, in APEIs, reference areas, or in areas subject to exploration activities.

2. Policy. Future actions should integrate climate change considerations and develop communication strategies and expertise that will allow the relevant international organizations to facilitate each other's actions in this regard.

References:

1. Gattuso, J. P. and 21 others. Contrasting futures for ocean and society from different anthropogenic CO_2 emissions scenarios. Science 349, DOI: 10.1126/science.aac4722
2. Levin, Lisa A. and Nadine Le Bris. Deep oceans under climate change. *Science* 350: 766-768. (2015)
3. Mora C, Wei C-L, Rollo A, Amaro, T., Baco, AR., Billett, D., Bopp, L., Chen, Q., Collier, M., Danovaro, R., Gooday, A.J., Grupe, B.M., Halloran, P.R., Ingels, J., Jones, D.O.B., Levin, L.A., Nakano, H., Norling, K., Ramirez-Llodra, E., Rex, M., Ruhl, H.A., Smith, C.R., Sweetman, A.K., Thurber, A.R., Tjiputra, J.F., Usseglio, P., Watling, L., Wu, and Wu, T., and , Yasuhura, M.. (2013) Biotic and human vulnerability to projected changes in ocean biogeochemistry over the 21st Century. PLoS Biology 11(10): e1001682. doi:10.1371/journal.pbio.1001682 (2013).
4. Sweetman, A.K., Thurber, A.R., Smith, C.R., Levin, L.A., Mora, C. Wei, C.L., Gooday, Jones, D.O.B., Rex, M. Yasuhara, M., Ingels, J., Ruhl, H.A., Frieder, C.A., Roberto, D., Wurzberg, L., Baco, A. Grupe, B.M., Pasulka, A. Meyer, K.S., Dunlop, K.M., Henry, L.A., Roberts, J.M., Major impacts of climate change on deep seafloor ecosystems. In press. Elementa