Oceans and the law of the sea

Report of the Secretary-General

Contribution from the Intergovernmental Oceanographic Commission of UNESCO (IOC)

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Summary

As a body with functional autonomy within the United Nations Educational, Scientific and Cultural Organization (UNESCO), the Intergovernmental Oceanographic Commission (IOC) acts as the UN system-wide focal point for ocean science and ocean services under the guidance provided by the resolutions, decisions and instructions of the IOC Assembly and reports periodically on its programme and activities to contribute to the Report of the Secretary-General on Oceans and the law of the sea. The report provides information on the topic of focus of the fourteenth meeting of the United Nations Open-ended Informal Consultative Process on Oceans and the Law of the Sea entitled “Impacts of ocean acidification on the marine environment”.

A. State of the Art – Ocean Acidification (OA)

The ocean has absorbed about one third of anthropogenic carbon dioxide (CO_2) emissions since the industrial revolution, greatly reducing the impact of this greenhouse gas on the climate. However, this massive input of CO_2 is generating widespread changes in the chemistry of seawater, especially on the carbonate system[1]. These changes are collectively referred to as “ocean acidification” because increased CO_2 lowers seawater pH (i.e., increases its acidity). Quantitatively, ocean acidity has increased by 30% since the beginning of the Industrial Revolution. According to geological records, this acidification is happening at rates not seen for the last 50 million years.

1. Impacts on the ocean

Ocean acidification (OA) is expected to impact ocean species to varying degrees. Photosynthetic algae and seagrasses may benefit from higher CO_2 conditions in the ocean, as they require CO_2 to live as do plants on land. On the other hand, studies have shown that a more acidic environment has a dramatic effect on some calcifying species.[2]

[1] Seawater carbonate chemistry is governed by a series of chemical reactions, which control the pH and act as a buffering system

[2] Any species using calcium carbonate to form exoskeletons or other internal and external structures such as some echinoderms (e.g. sea urchins), most molluscs, crustaceans, corals, as well as some phytoplanktonic species and macroalgae (e.g. genus Coralline)

When shelled organisms are at risk, the entire food web may also be at risk. Hence, shelled organisms in particular, such as oysters, mussels, corals and some phytoplankton species which are at the base of the ocean food chain, have been the species most targeted in scientific investigations. However, more recent research on experimental evolution to high CO_2 covers a broader range of marine organisms. While the majority of investigations continue to focus on single species/single stressor (CO_2) approaches, an increasing number of studies have included several stressors and/or have reported on ecosystem responses. Several major studies have demonstrated that environmental stress leads to decreasing biodiversity, and might also foster genetic adaptation.

OA influences photosynthesis, nitrogen fixation, respiration, and calcification, all of which affect species hierarchy and in turn might lead to shifts in species composition. In 2012 for the first time the scientific community presented the impacts of high CO_2 concentrations obtained during longer term experiments (up to 4 years). The results confirmed conclusions made from short term experiments, and revealed the ability of phytoplankton species to adapt to different pH/ CO_2 levels.

2. Socio-Economic Consequences of Ocean Acidification

Ocean acidification will have long-term implications for the global carbon cycle and climate, although the range and magnitude of biogeochemical and biological effects and their socio-economic impacts are currently too uncertain to accurately quantify. However, there is general agreement within the scientific community that such impacts are likely to be substantial.

Ocean acidification is not only progressively decreasing the ability of many organisms to build their shells, but will also increasingly affect ecosystem structure and function. Ocean acidification could trigger a chain reaction of impacts throughout the marine food web, beginning with larval fish and shellfish, which are particularly vulnerable. This may affect the multibillion-dollar fishing industry and threaten the food security of many of the world’s poorest countries. Many regions of the ocean may become inhospitable to coral reefs thus affecting food security, tourism, shoreline protection and biodiversity.

B. IOC activities – Ocean acidification

Awareness of this ‘other CO_2 problem’ has emerged only within the last decade, and more research is needed to develop meaningful projections on future impacts of OA on the ocean and coastal seas. While the investigation of single marine species has left the fledging stages, ecosystem responses are poorly understood.

IOC-UNESCO is involved in several international networks and organizations to facilitate the identification of thresholds beyond which marine ecosystems may not recover, and to promote international cooperation and coordinate programmes in research, services and capacity building. It does this in order to generate knowledge about the nature and resources of the ocean and coastal areas, and to apply this knowledge to improve management, sustainable development, protection of the marine environment, and decision making processes of States. One of IOC-UNESCOs missions is to enhance awareness of OA not only among scientists, but also by the public, stakeholders and decision makers.

1. A Blueprint for Ocean and Coastal Sustainability

Together with FAO, IMO and UNDP, IOC led the elaboration of an inter-agency report in preparation for the UN Conference on Sustainable Development (RIO+20) which was aimed to provide a statement on the role of the ocean in sustainable development, as well as an analysis of current challenges in ocean and coastal management around the world. The report which constituted one of the key UN inputs on the ocean into the Rio+20 process, formulates a number of tangible proposals, ten in total, towards ocean sustainability that should be regarded as priorities for consideration in the Rio+20 outcomes and beyond. In light of OAs present and future impacts on marine organisms and ecosystems, the report identifies it as one of the most important challenges that needs to be addressed by the international community. In particular, the report calls for the launch of a global inter-disciplinary program on ocean acidification risk assessment, the integration of the OA dimension within the UN Framework Convention on Climate Change (UNFCCC) negotiation processes, and for coordinated international research to better understand the impacts of OA on marine ecosystems.

2. RIO+20 – 'The Future We Want'

The outcome document from Rio+20, 'The Future we want', contained a number of decisions related to the ocean and specifically to OA. Importantly, the document recognizes the critical role the ocean plays in all three pillars of sustainable development, and the commitment of the international community "to protect, and restore, the health, productivity and resilience of oceans and marine ecosystems, and to maintain their biodiversity, enabling their conservation and sustainable use for present and future generations".
OA is mentioned in three paragraphs in the document (166, 176, and 190). In particular, these call for supporting initiatives that address ocean acidification impacts on marine and coastal ecosystems and resources. Building on the recommendations contained in the UN Blueprint Report (see item B.1.), the document highlights "the need to work collectively to prevent further OA, to enhance the resilience of marine ecosystems and of communities whose livelihoods depend on them, to support marine scientific research, monitoring and observation, and to enhance international cooperation".

3. International Coordination Centre for Ocean Acidification (IAEA Marine Environmental Studies Laboratory in Monaco)

The creation of a new Ocean Acidification International Coordination Centre, operated by the IAEA Marine Environmental Studies Laboratory in Monaco, was announced in June 2012. The OAICC role will be to facilitate, promote and communicate activities related to global actions on ocean acidification, including international observation, joint platforms and facilities, collaboration between natural and social sciences, exchange of students and scientists, joint experiments, definition of best practices, open-access bibliographic database, data management, capacity building and dissemination. The Centre will be supported by several IAEA Member States through the Peaceful Uses Initiative, and will be overseen by an Advisory Board consisting of leading institutions, including the IOC of UNESCO, the National Oceanic and Atmospheric Administration of the USA (NOAA), FAO, the Foundation Prince Albert II de Monaco, the OA-Reference User Group, as well as leading scientists and economists in the field.

4. International Workshop to Develop an Ocean Acidification Observing Network of Ship Surveys, Moorings, Floats and Gliders"

Organized and co-sponsored by the International Ocean Carbon Coordination Project (IOCCP; a joint project between the IOC and the Scientific Committee on Oceanic Research, SCOR), this Workshop was held at the University of Washington, June 26-28, 2012. The principal goals for the International Ocean Acidification Observing System are to: (i) provide the rationale and design of the components and location of an international carbon and ocean acidification observing network that includes repeat hydrographic surveys, underway measurements on volunteer observing ships, moorings, floats and gliders taking into account existing networks and programmed wherever possible; (ii) identify a minimum suite of measurement parameters and performance metrics for each major component of the observing system; (iii) develop a strategy for data quality assurance and data distribution; and (iv) determine requirements for program integration at the international level. Network outcomes are to provide globally distributed high quality near-real time, and data synthesis products that facilitate new research on OA, communicate status of OA and biological responses, and enable forecasting/prediction of OA conditions.

5. Second International Workshop, Bridging the Gap between Ocean Acidification Impacts and Economic Valuation, 11-13 November 2012

This workshop was organized by Scientific Centre of Monaco and the Marine Environmental Studies Laboratory of the International Atomic Energy Agency, and was held in collaboration with the Mediterranean Science Commission. Financial and organizational support was provided by the Prince Albert II of Monaco Foundation; the Monegasque Government; the French Ministry of Ecology, Sustainable Development and Energy; the Oceanographic Museum of Monaco; the *Société Monégasque des Eaux*; and the State Department of the USA. The Executive Secretary of IOC-UNESCO chaired the opening session and participated in the workshop. The workshop focused on the impacts of OA on fisheries and aquaculture and the resultant economic consequences. As agreed at the first workshop on this topic in 2010, it was concluded that meaningful and ongoing linkages between socio-economists and life scientists are necessary in order to develop accurate projections of OA impacts on marine ecosystems and fisheries and aquaculture. The workshop also discussed the risks posed by OA to markets and consumers that are dependent upon seafood and trade of marine resources, and agreed that viable options to mediate impacts on marine harvests and other coastal human activities are needed.

Recommendations and conclusions from the workshop will be included in the summary for policy makers which is in preparation.

6. Third International Symposium on the Ocean in a High-CO_2 World

The series of International Symposia on the 'Ocean in a high CO_2 World', co-organized by the IOC, SCOR and the International Geosphere-Biosphere Programme (IGBP), began in Paris in 2004, followed by Monaco in 2008 and Monterey in 2012. It aspires to be a regular scientific meeting on the topic of Ocean Acidification and a flagship symposium for the IOC.

The 3rd symposium in Monterey was attended by a total of 529 scientists from 34 countries. They presented new information about the ability and inability of organisms at different trophic levels to cope with decreasing pH levels. A policy day at the end of the meeting included the participation of HSH Prince Albert II of Monaco, Jane Lubchenco (Administrator, NOAA), Sam Farr (Congressman, CA) and representatives of Google and X-prize.

The conference clearly emphasized the need for combining the stressor CO_2 with other factors such as temperature, nutrient availability and hypoxia. Preliminary studies revealed that rising temperature and CO_2 levels can have positive effects (Arctic phytoplankton (diatoms)) or affect species antagonistically (seagrass). Mesocosm [3] experiments obtained shifts in community composition, reduced diversity, as well as direct and indirect CO_2 effects within the water column and sediments.

It should be noted that outreach to the scientific and public communities was exceptionally high, with journalists and teachers being given the opportunity to join the sessions and interact with scientists throughout the entire conference.

An Ocean Acidification summary for policy makers, coordinated by the IGBP and the IOC, is under preparation. The information in the summary will identify advances and significant findings in our understanding of ocean acidification.

7. Cooperation between the International Ocean Carbon Coordination Project (IOCCP) and IOC-UNESCO

Support for IOCCP activities is provided by the US National Science Foundation through a grant to the Scientific Committee on Oceanic Research (SCOR), and by IOC-UNESCO. The IOCCP convenes workshops and helps develop manuals on ocean carbon measurement methods and systems, for example, the Guide to Best Practices for Oceanic CO_2 Measurements. Those activities serve to improve OA investigations and the inter-comparability of ongoing experiments and studies worldwide. One major action during the year was an international time-series methods workshop, jointly convened by the IOCCP and the Ocean Carbon & Biogeochemistry (OCB) Program. It was held in November 2012 at the Bermuda Institute for Ocean Sciences (BIOS), home of the Bermuda Atlantic Time Series Study (BATS), which is one of the longest running ship-based biogeochemical time series.

Ocean time series are among the most valuable tools for oceanographers to observe trends, understand carbon fluxes and processes, and to demonstrate the crucial role that the carbon cycle plays in climate regulation and feedback. The workshop offered a platform to compare time series in order to avoid duplication, to adopt common standards and to

[3] **Aquatic mesocosms** are experimental water enclosures which are designed to provide a limited body of water with close to natural conditions, in which environmental factors can be realistically manipulated (mesocosm.eu)

maximize the utility of data. It focused specifically on the methods employed by the specific time series, aiming at enhancement of data comparability among sites.

The full workshop report will serve as a best practices road map for ship-based, biogeochemical time series to assist data inter-comparability across sites and ocean basins. It will include:

- tiered method recommendations (optimal, good, acceptable) for each parameter
- guidelines for comparing data generated using different methods
- information about what participating (and some non-participating) time series sites measure, what methods are used, and how to access the data

Currently IOC is working on a new compilation of existing biogeochemical time series and has put together the 33 sites presented at the Workshop with others from the North Atlantic (including the Baltic and the Mediterranean Seas). In total, 125 biogeochemical time series have been compiled from around the world, which could be the embryo for a monitoring network for standardized measurement of ocean acidification.