

Ocean Acidification: A Hidden Risk for Sustainable Development

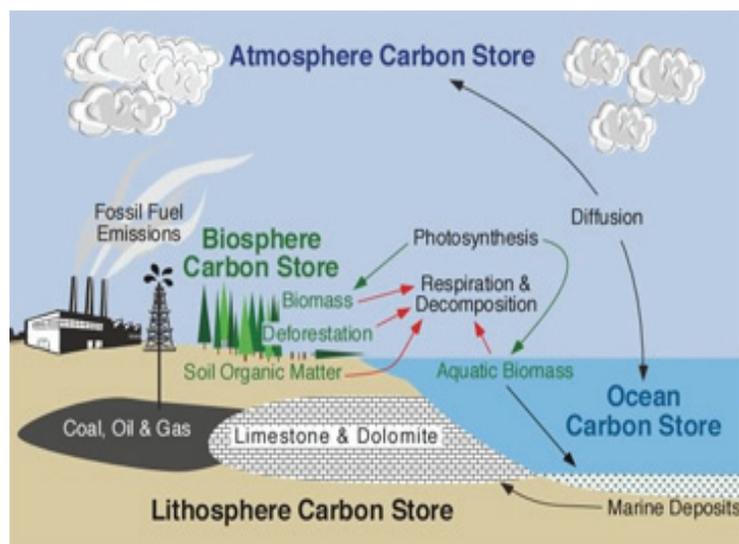
The issue of climate change currently holds the attention of the international community. Worsening emissions predictions and a perception that impacts are occurring more rapidly than anticipated have heightened concerns. While awareness has grown about a wide range of adverse climate change impacts, ‘ocean acidification’ and its potential harm to the environment, socio-economic systems, and developing countries is little known outside of a small group of scientists, mostly comprising oceanographers. Efforts to raise wider attention to the issue have only recently begun including by the secretariat of the Convention on Biological Diversity, the Intergovernmental Panel on Climate Change (IPCC), and the United Nations Environmental Programme.

The oceans are a fundamental component of the global carbon cycle, shown in Figure 1, and act as a

sink for carbon dioxide emissions. Most of the world’s carbon resides in the oceans, and critical exchanges take place between the surface ocean and the atmosphere, and between the upper ocean and the deep ocean. Experts have long recognized the importance of the oceans in absorbing CO₂ emissions, and therefore reducing the share that accumulates in the atmosphere; it is estimated that 25-30 per cent of cumulative anthropogenic CO₂ emissions have been absorbed by the oceans. Although long assumed to provide an almost bottomless sink for these emissions, recent scientific findings have pointed to adverse impacts of increasing concentrations of carbon dioxide in the oceans. The ocean chemistry has been changing as a result of carbon dioxide absorption, a phenomenon that has come to be known as ocean acidification¹. The Inter-academy Panel on International Issues representing 70 academies of science worldwide has recently highlighted that ocean acidity has increased by 30 per cent in the past 200 years. They note that if current trends continue, by mid-century oceans will be more acidic than they have been for tens of millions of years. Figure 2 shows historical and projected pH and CO₂ levels in the oceans if present trends continue. Furthermore, the Panel indicates that these trends in ocean chemistry are irreversible for many thousands of years, and the biological consequences could last much longer.

While potentially dramatic, the effects of ocean acidification on marine life, and ultimately

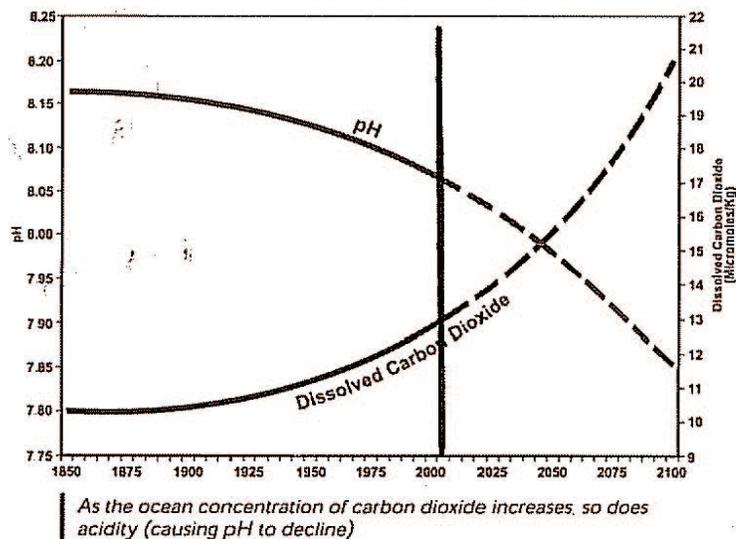
Figure 1:
The Global Carbon Cycle



Source: PhysicalGeography.net/Fundamentals, Chapter 9, available at <http://www.physicalgeography.net/fundamentals/images/carboncycle.jpg>

¹ When CO₂ dissolves in surface seawater it reacts with water to form a weak carbonic acid (H₂CO₃). Carbonic acid dissociates into bicarbonate ions (HCO₃⁻) and hydrogen ions (H⁺). The release of hydrogen ions decreases the pH (increases the acidity) of surrounding waters. Acidity is a measure of the concentration of H⁺. A pH decrease of 1 unit means a 10-fold increase in the concentration of H⁺, or acidity.

Figure 2:
Historical and projected pH and Dissolved CO₂



Source: Based on Turley, et.al, Reviewing the Impact of Increased Atmospheric CO₂ on Oceanic pH and the Marine Ecosystem, Defra-08.qxd, (2005) available at <http://www.hm-treasury.gov.uk/d/ExeterpaperProofsTurelyetal.pdf>

decline in calcification, raising concerns that irreversible changes in marine ecosystems have already begun.

Fundamental ecological ocean processes will be affected as many marine organisms depend directly or indirectly on calcium-saturated waters and are adapted to current levels of seawater pH for physiological and metabolic processes such as calcification, growth and reproduction.

Most vulnerable communities

Coastal communities relying on marine based ecosystem services for a significant portion of their livelihoods will bear the impacts of increases in ocean acidification soonest as the marine fish catch decreases and marine biodiversity declines. Small island developing states (SIDS) and coastal communities are often characterized by a high dependence on fishing and fish-processing industries and tourism, and will suffer both in terms of economic and food security. Currently the fishing industry contributes more than 6 per cent of GDP in SIDS and in some developing countries with a high proportion of coastal communities such as Namibia, Ghana and Senegal. Marine-based tourism, particularly important to many SIDS economies, will be adversely affected by declines in coral reefs and biodiversity if current trends continue.

their socio-economic effects, are not yet completely understood. However, many ocean experts, including 155 scientists from 26 countries, have expressed alarm at recent findings on the sensitivity of corals to higher acidity and the weakening of shell formation by shellfish. Shell weights of *pteropods* (tiny marine organisms classified under zooplankton) and *foraminifera* (single-celled organisms with shells), both playing important roles in the food chain, in the Southern Ocean have measurably declined during the past two decades. More broadly, pteropods and foraminifera provide food for animals ranging from tiny krill to whales and including salmon, mackerel, herring and cod. Entire marine ecosystems will be affected with entire segments of the food chain disappearing.

Coral reefs, economically and biologically important marine ecosystems, already threatened by increasing sea surface temperatures and associated bleaching, therefore face additional threats from ocean acidification if atmospheric CO₂ concentrations continue to increase at current rates. Coral calcification rates have declined in recent decades, although attributing causes for these impacts among multiple drivers, including warming, pollution and acidification, is difficult. Corals in the Great Barrier Reefs have shown a recent

In a larger sense, threats to the foundation of the marine food web pose serious concern for all relying on the marine fishing industry for livelihoods and/or as a source of nutrients. Since 1990 the global marine fish catch has averaged 80-85 million tons annually and has provided livelihoods for over 500 million people, 90 percent of whom live in developing countries. Moreover fish is the main source of animal protein for more than one billion people and is the most important source, often the lowest priced, of animal protein in developing countries. Declines in marine biodiversity, especially segments on the fish food chain, will impact daily diets and the ability of many millions to secure caloric and protein needs.

Role of the United Nations and the international community

The United Nations General Assembly plays an essential role in ocean policy development and is charged with undertaking an annual review and evaluation of the implementation of the United Nations Convention on the Law of the Sea and other developments relating to ocean affairs and the law of the sea, including in relation to oceans and climate change. In this regard, the General Assembly has, *inter alia*, encouraged States, organizations and institutions to urgently pursue further research on ocean acidification and to increase efforts to address levels of ocean acidity and the projected negative impact on vulnerable marine ecosystems, particularly coral reefs.

In order to support its policy-making role, the General Assembly has established a number of processes, including the United Nations Open-ended Informal Consultative Process on Oceans and the Law of the Sea, the Ad Hoc Open-ended Informal Working Group to study issues relating to the conservation and sustainable use of marine biological diversity beyond areas of national jurisdiction, and the Ad Hoc Working Group of the Whole to recommend a course of action on the regular process for global reporting and assessment of the state of the marine environment, including socio-economic aspects.

The regular process was established by the General Assembly in 2002, following the recommendation of the United Nations World Summit on Sustainable Development. At its current session, the General Assembly will consider the work of the Ad Hoc Working Group of the Whole, which met in 2009, including in relation to the implementation of the regular process through a succession of cycles. The regular process could serve to highlight, *inter alia*, ramifications of ocean acidification on sustainable development. This issue could also be considered by the other processes established by the General Assembly, as described above.

Other efforts on the issue of ocean acidification have been coordinated by the Intergovernmental

Oceanographic Commission of UNESCO and the United Nations Environment Programme. In addition, UN-Oceans has served as a mechanism to share information and coordinate UN work on oceans. The Conference of the Parties of the Convention on Biological Diversity has also considered the issue with respect to its impacts on marine biodiversity. The Commission on Sustainable Development will consider the issues of oceans and seas and small island developing states in 2014 and 2015 at its 22nd and 23rd sessions, and will provide an opportunity to highlight ocean acidification and take policy decisions aimed at combating it.

Policy options

Many countries are only beginning to grapple with the implications of ocean acidification and address policy needs. It is important to note that measures to combat ocean acidification are best undertaken as part of a broader effort to preserve and maintain marine ecosystems. Relieving pressure on the resource under stress with the adoption of sustainable fishing practices at the regional and national levels would be a critical part of such efforts. Some countries have taken steps in this regard and the international community has adopted a number of instruments aimed at halting illegal fishing and at conservation and management of fish stocks based on the precautionary principle, but linking them with policy measures to combat ocean acidification is critical.

International Action on Mitigating CO₂ Emissions

Clearly the most urgent policy option pertains to the negotiations currently under way on climate change under the aegis of the United Nations Framework Convention on Climate Change. The threat of ocean acidification adds to the range of threats posed by climate change to conditions of life on the planet. More importantly, this threat cannot be mitigated through some of the geo-engineering schemes that seek to reduce radiative forcing without abating the emission of greenhouse gases.

Information Generation and Dissemination

Recent reviews of changing ocean chemistry include the recently submitted Assessment of Assessments by the Group of Experts set up by the General Assembly, the Climate Change Science Compendium by UNEP and the Fourth Assessment of the Intergovernmental Panel on Climate Change (Chapter 5 of Working Group 1). Regular systems for monitoring changing ocean chemistry are urgently needed. Furthermore, scientific study of ocean acidification and impacts on marine ecosystems, biodiversity and marine life is still in its infancy. The full range of possible environmental and socio-economic impacts of ocean acidification is also not well understood, and research on these topics, scant at best, is just as important.

While there are some initiatives underway to enhance scientific monitoring, such as the European Project on Ocean Acidification, further support is needed for long-term monitoring programmes and targeted research addressing specific questions related to the impacts of ocean acidification on sustainable development. The international community could take further concrete steps to enhance monitoring as the United Nations proceeds with the regular process for global reporting and assessment of the state of the marine environment, including socio-economic aspects, building on established and ongoing efforts such as UNEP's work on marine and coastal ecosystems and UNESCO's Intergovernmental Oceanographic Institute.

Improving Capacities in Developing Countries

Improving capacities in developing countries to undertake further research is urgently needed. This would include not only training future scientists but also strengthening capacities of research, scientific, oceanographic and socio-economic institutions in developing countries. Technical cooperation with and assistance to regional and international institutions with relevant experience would be a good step forward.

Raising Awareness

While the existence of ocean acidification is now known among scientists, including oceanographers, the general public and even many policy makers are still largely unaware of it. Raising awareness of the important role of oceans in general to addressing climate change and other environmental issues is crucial and could be undertaken immediately by the international community. Awareness raising efforts should build on support of scientific efforts such as the UNESCO-sponsored Monaco Symposium on the Ocean in a High-CO₂ World and could include preparation of easy-to-understand technical reports written for the lay person, documentaries and publicity in related events and fora including highlighting options to avoid adverse impacts of ocean acidification on marine life and ecosystems.

The United Nations holds a unique place for raising awareness and facilitating discussions among delegates and the international community during ocean- and sustainable development-related events. The IPCC has a special responsibility in this regard. In addition to the processes on oceans, including the Convention on the Law of the Sea, under the General Assembly, relevant fora to raise awareness and highlight options on ocean acidification include the United Nations Framework Convention for Climate Change, the Convention on Biological Diversity, Intergovernmental Oceanographic Commission, the UNEP Governing Council and the UN Commission on Sustainable Development. ■

Prepared by the United Nations Division for Sustainable Development, DESA, with input from the United Nations Division for Ocean Affairs and the Law of the Sea, the secretariat of the Convention on Biological Diversity and members of UN-Oceans.

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<http://www.un.org/esa/dsd/index.shtml>