

Protecting the Oceans

The world's scientific community is calling for urgent actions to halt rising levels of acidity in the oceans.



We scientists who met in Monaco* to review what is known about ocean acidification declare that we are deeply concerned by recent, rapid changes in ocean chemistry and their potential, within decades, to severely affect marine organisms, food webs, biodiversity, and fisheries.

To avoid severe and widespread damages, all of which are ultimately driven by increasing concentrations of atmospheric carbon dioxide (CO₂), we call for policy makers to act quickly to incorporate these concerns into plans to stabilize atmospheric CO₂ at a safe level to avoid not only dangerous climate change but also dangerous ocean acidification.

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Ocean Acidification

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Since industrialization began in the 18th century, surface-ocean acidity has increased by 30%. This ongoing ocean acidification is decreasing the ability of many marine organisms to build their shells and skeletal structure. Increasing acidity and related changes in seawater chemistry also affect reproduction, behaviour, and general physiological functions of some marine organisms, such as oysters, sea urchins, and squid.

Damage is Detectable

Observations collected over the last 25 years show consistent trends of increasing acidity in surface waters that follow increasing atmospheric CO₂.

These trends match precisely what is expected based on basic marine chemistry and continuous measurements of atmospheric CO₂. A range of field studies suggest that impacts of acidification on some major marine calcifiers may already be detectable.

Also, naturally high-CO₂ marine environments exhibit major shifts in marine ecosystems following trends expected from laboratory experiments. Ocean acidification has altered some coastal waters to the extent that recently during spring they have become corrosive to the shells of some bottom dwelling organisms. Within decades these shell-dissolving conditions are projected to be reached and to persist throughout most of the year in the polar oceans.

Imminent Danger

Currently the average concentration of atmospheric CO₂ is 385 parts per million (ppm), which is 38% more than the preindustrial level of 280 ppm. Half of that increase has occurred in the last 30 years. Current CO₂ emissions are greater than projected for the worst-case scenario formulated a decade ago. And along with increasing emissions, the increase in atmospheric CO₂ is accelerating.

By mid-century, the average atmospheric CO₂ concentration could easily reach double the preindustrial concentration. At that 560- ppm level, it is expected that coral calcification rates would decline by about one-third. Yet even before that happens, formation of many coral reefs is expected to slow to the point that reef erosion will dominate. Reefs would no longer be sustainable. By the time that atmospheric CO₂ reaches 450 ppm, it is projected that large areas of the polar oceans will have become corrosive to shells of key marine calcifiers.

Socioeconomic Impacts

Ocean acidification could affect marine food webs and lead to substantial changes in commercial fish stocks, threatening protein supply and food security for millions of people as well as the multi-billion dollar fishing industry. Coral reefs provide fish habitat, generate billions of dollars annually in tourism, protect shorelines from erosion and flooding, and provide the foundation for tremendous biodiversity, equivalent to that found in tropical rain forests. Yet by mid-century, ocean acidification may render most regions chemically inhospitable to coral reefs.

These and other acidification-related changes could affect a wealth of marine goods and services, such as our ability to use the ocean to manage waste, to provide chemicals to make new medicines, and to benefit from its natural capacity to regulate climate. For instance, ocean acidification will reduce the ocean's capacity to absorb anthropogenic CO₂, which will exacerbate climate change.

Rapid Acidification, Slow Recovery

The current increase in ocean acidity is a hundred times faster than any previous natural change that has occurred over the last many millions of years. By the end of this century, if atmospheric CO₂ is not stabilized, the level of ocean acidity could increase to three times the preindustrial level. Recovery from this large, rapid, human-induced perturbation will require thousands of years for the Earth system to re-establish ocean chemical conditions that even partially resemble those found today; hundreds of thousands to millions of years will be required for coral reefs to return, based on the past record of natural coral-reef extinction events.

Limiting Future CO₂ Levels can Help

So-called geo-engineering strategies that would not aim to restrict future atmospheric CO₂ concentrations would not reduce ocean acidification. Mitigation strategies that aim to transfer CO₂ to the ocean, for example by direct deep sea disposal of CO₂ or by fertilising the ocean to stimulate biological productivity, would enhance ocean acidification in some areas while reducing it in others. Climate-change negotiations focused on stabilizing greenhouse gases must consider not only the total radiation balance; they must also consider atmospheric CO₂ as a pollutant, an acid gas whose release to the atmosphere must be curtailed in order to limit ocean acidification. Hence, limits (stabilization targets) for atmospheric CO₂ defined based on ocean acidification may differ from those based on surface temperature increases and climate change.

Despite a seemingly bleak outlook, there remains hope. We have a choice, and there is still time to act if serious and sustained actions are initiated without further delay. First and foremost, policy makers need to realize that ocean acidification is not a peripheral issue. It is the other CO₂ problem that must be grappled with alongside climate change. Reining in this

The Intense Effort Needed

To stay below an atmospheric CO₂ level of about 550 ppm, the current increase in total CO₂ emissions of 3% per year must be reversed by 2020. Even steeper reductions will be needed to keep most polar waters from becoming corrosive to the shells of key marine species and to maintain favourable conditions for coral growth.

If negotiations at the UN Climate Change Conference — Conference of the Parties in its fifteenth session (COP15)— in Copenhagen in December 2009, fall short of these objectives, still higher atmospheric CO₂ levels will be inevitable.

double threat, caused by our dependence on fossil fuels, is the challenge of the century.

Solving this problem will require a monumental worldwide effort. All countries must contribute, and developed countries must lead by example and by engineering new technologies to help solve the problem. Promoting these technologies will be rewarded economically, and prevention of severe environmental degradation will be far less costly for all nations than would be trying to live with the consequences of the present approach where CO₂

The Monaco Environment and Economics Group

In the spirit of the Monaco Declaration, the IAEA Marine Environment Laboratories and the Scientific Centre of Monaco have established an expert group to assess the economic impact of ocean acidification. Bridging the gap between environmental science and economics, the Monaco Environment and Economics Group brings together the leading scientific experts of ocean acidification and natural resource economics. They investigate both what is known about ocean acidification, its biological effects and predicted global impacts, as well as ways to evaluate its potential economic costs to fisheries, aquaculture and tourism.

emissions and atmospheric CO₂ concentrations continue to increase, year after year.

Fortunately, partial remedies already on the table, if implemented together, could solve most of the problem. We must start to act now because it will take years to change the energy infrastructure and to overcome the atmosphere's accumulation of excess CO₂, which takes time to invade the ocean.

Conclusions

Therefore, we urge policy makers to launch four types of initiatives:

- ◆ to help improve understanding of impacts of ocean acidification by promoting research in this field, which is still in its infancy;
- ◆ to help build links between economists and scientists that are needed to evaluate the socio-economic extent of impacts and costs for action versus inaction;
- ◆ to help improve communication between policy makers and scientists so that i) new policies are

based on current findings and ii) scientific studies can be widened to include the most policy-relevant questions; and

- ◆ to prevent severe damages from ocean acidification by developing ambitious, urgent plans to cut emissions drastically. ☞

**The statement, known as the Monaco Declaration, was approved by 155 scientists from 26 countries, leaders of research into ocean acidification and its impacts, who met in Monaco in October 2008 for the Second International Symposium on the Ocean in a High-CO₂ World.*

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This document is based on the report Research Priorities for Ocean Acidification, available online at: <http://ioc3.unesco.org/oanet/HighCO2World.html>.

The photo is a reprint of 'The Great Wave off Kanagawa' by the Japanese artist Katsushika Hokusai.

