Ocean acidification: implications for coral reefs

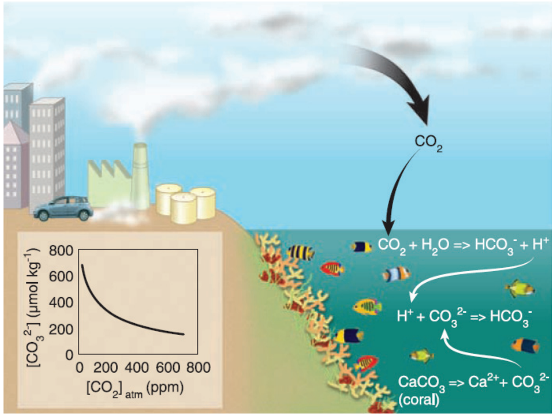
Ocean acidification is happening now

Acidification due to ocean uptake of carbon dioxide will have serious consequences for coral reefs worldwide over the course of this century. The surface ocean now absorbs up to 30 percent of the yearly emissions of carbon dioxide. The absorbed carbon dioxide dissolves in water through a well-understood chemical process, forming a weak acid that is decreasing the pH of the oceans.

Ocean acidification is reducing the concentration of dissolved carbonate ions, the chemical component used by corals and many other marine organisms to make calcium carbonate shells and skeletons.

The uptake of atmospheric carbon dioxide is occurring at a rate exceeding the natural buffering capacity of the ocean. If unabated, the current trajectory of carbon dioxide emissions will cause oceans to acidify to an extent not seen for millions of years.

The long time-lags inherent in the marine carbon cycle put a penalty on delaying limits on carbon dioxide emissions, and a premium on early action if the loss of coral-dominated ecosystems is to be avoided.



Linkages between the buildup of atmospheric carbon dioxide and the slowing of coral calcification due to ocean acidification. Carbon dioxide emitted to the atmosphere is absorbed by the ocean where it combines with water to produce carbonic acid. Resulting changes to ocean carbonate chemistry reduce the ability of corals to build calcium carbonate skeletons

(figure from Hoegh-Guldberg et al.)[4]

If current carbon dioxide emission trends continue, the ocean will continue to undergo acidification, to an extent and at rates that have not occurred for tens of millions of years[1].

Coral reefs are at risk

Coral reef organisms and the structures they build will be increasingly exposed in the coming decades to the impacts of ocean acidification. The changes in seawater chemistry brought about by acidification have been correlated with decreased production of calcium carbonate by marine organisms along with increased calcium carbonate dissolution.

Impacts on coral reefs and reef organisms include:

REDUCED CALCIFICATION RATES

Calcification rates of corals will decrease by around 30% over the next 30-50 years. Calcification rates of calcifying algae are also expected to decrease.

REDUCED REEF ACCRETION

The growth of reefs as geological structures will be affected by both reduced accretion and increased erosion rates. In some cases reef-building may reverse by the latter half of this century.

REDUCED SKELETAL GROWTH

Reduced calcification will have varying impacts on different coral species. Reduced skeletal growth may be manifested as slower growth rates, or weaker coral skeletons that are more susceptible to storm damage.

IMPACTS ON OTHER REEF ORGANISMS

Ocean acidification will affect numerous calcifying organisms such as molluscs and certain plankton, with impacts cascading through marine ecosystems.

An urgent response is required

Changes to ocean chemistry and the marine environment resulting from ocean acidification compromise the long-term viability of coral reef ecosystems.

Coral reef systems provide economic and environmental services to millions of people as coastal protection from waves and storms, and as sources of food, pharmaceuticals, livelihoods and revenues. Reefs are threatened by the combined impacts of human stresses, such as coastal development, pollution, overexploitation, and destructive fishing, in addition to climate change impacts.

Recognising the potential irreversibility of acidification impacts, it has never been more imperative to improve the management of coral reef ecosystems. The growing threat of climate change combined with escalating anthropogenic stressors on coral reefs requires a response that is both proactive and adaptive.

Ocean acidification is unique among human impacts on the marine environment in its pervasiveness and persistence[2].

Reef managers can take action

In response to this urgent challenge, The Nature Conservancy convened an ocean experts workshop in Honolulu, Hawaii from August 12-14, 2008. The group introduced key findings and recommendations to tackle ocean acidification through the 'Honolulu Declaration on Ocean Acidification and Reef Management.'[1]

The Declaration stresses that two major strategies must be implemented urgently and concurrently to mitigate the impacts of climate change and to safeguard the value of coral reef systems: 1) limit fossil fuel emissions; and 2) build the resilience of tropical marine ecosystems and communities to maximise their ability to resist and recover from climate change impacts. Despite the dire predictions, there is hope for coral reefs if action is swift.

The only remedial action for ocean acidification is a reduction in carbon dioxide emissions, which will not reverse processes already underway, but will prevent even greater effects over the long term. The challenge for reef managers will be to reduce all stresses on coral reefs as much as possible to enhance their health and resilience. The Honolulu Declaration outlines a suite of policy and management practices that will guide the initial and urgent steps required to give coral reefs the best chance of coping with ocean acidification.

The first, and ultimately only effective, step is to stop polluting our earth with greenhouse gases. The second is to minimise other stresses affecting reef biota in order to maximise the reef's resilience to the adversities of the future. ~JEN Veron 'A Reef in Time'[8]

Find out more

The following documents have been used to produce this pamphlet or are recommended for further reading on ocean acidification and coral reefs:

1. McLeod, E, RV Salm, K Anthony, B Causey, E Conklin, A Cros, R Feely, J Guinotte, G Hofmann, J Hoffman, P Jokiel, J Kleypas, P Marshall, and J Veron. 2008. *The Honolulu declaration on ocean acidification and reef management*. The Nature Conservancy <www.nature.org/wherewework/northamerica/states/hawaii/press/press3661.html>
2. Antarctic Climate and Ecosystems CRC. 2008. *Ocean acidification: Australian impacts in the global context* <staff.acecrc.org.au/ace-notes/OAcommunique.pdf>
3. Feely, RA, et al. 2004. Impact of anthropogenic CO_2 on the $CaCO_3$ system in the oceans. *Science* 305: 362–366 <www.sciencemag.org>
4. Hoegh-Guldberg, O, et al. 2007. Coral reefs under rapid climate change and ocean acidification. *Science* 318: 1737-1742 <www.sciencemag.org>
5. ISRS. 2008. *Coral reefs and ocean acidification*. Briefing Paper 5. International Society for Reef Studies, 9pp. <www.fit.edu/isrs/documents/ISRS_BP_ocean_acid_final28jan2008.pdf>
6. Kleypas, JA, et al. 2006. *Impacts of ocean acidification on coral reefs and other marine calcifiers: A guide to future research*. Workshop report, sponsored by NSF, NOAA, and the USGS, 88 pp. <www.ucar.edu/communications/Final_acidification.pdf>
7. Royal Society. 2005. *Ocean acidification due to increasing atmospheric carbon dioxide*. The Royal Society, London <royalsociety.org/document.asp?id=3249>
8. Veron, JEN. 2008. *A Reef in Time: The Great Barrier Reef from beginning to end*. Belknap Press / Harvard University Press

Produced by the Climate Change Group,
Great Barrier Reef Marine Park Authority, Australia
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