AdvisoryPaper
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Climate change: It's now or never to save coral reefs

Coral reefs are increasingly coming under pressure from human activities, arising from over-exploitation, destructive fishing, pollution, eutrophication and the extensive modification of coastlines adjacent to coral reefs. Recent evidence suggests that climate change, by increasing sea temperatures and ocean acidity, may interact with and worsen the plight of coral reefs. This has serious consequences for tens of millions of people and billion-dollar fishing and tourist industries.

A recent report in the international journal, Science Magazine, from the Coral Reef Targeted Research & Capacity Building for Management (CRTR) Program has analyzed the evidence and has concluded that climate change is now the biggest threat to coral reefs.

Global projects such as the CRTR Program are essential to our ability to understand and respond to the problems posed by the increasing stress on coral reefs for many nations.

Key Points

- Coral reefs may not survive the rapid increases in global temperatures and atmospheric CO_2 that are forecast this century if we do not reduce our CO_2 emissions
- The livelihoods of 100 million people living along the coasts of tropical developing countries and those businesses earning billions of dollars from reef-related tourism may be the first casualties
- There needs to be drastic action from world leaders to urgently reduce CO_2 emissions
- Policy-makers and reef managers need to immediately address over-fishing, pollution and unsustainable coastal development - many coastal management tools already exist - they require broader application in earnest

Three scenarios

The CRTR Program has forecast future scenarios for coral reefs with increased CO_2 (measured in parts per million, ppm) in the Earth's atmosphere and mean temperature above today's associated with climate change.

Scenario A - 380 ppm

Today's situation; 10-60% coral cover, a diversity of marine life; mass bleaching impacts continue and coral dominated reefs struggle to survive. The formation of calcium carbonate is slower than 100 years ago but can still keep up with reef erosion. (This image shows a rich coral community on the southern Great Barrier Reef)

Scenario B - 450-500 ppm

Reef structures reach a tipping point and reef erosion in most parts of the world exceeds reef calcification. The structure of coral reefs begins to crumble. Coral bleaching events occur almost annually and coral cover declines as a result to less than 10% of what it was previously. Coral dominated reefs are rare but still exist in a few places. (This image was taken from the inshore Great Barrier Reef)

Scenario C - >500 ppm

The concentration of carbonate ions decreases well below the carbonate threshold; coral-dominated reef ecosystems are rare or non-existent. Those few corals that exist grow very slowly and do not produce the amount of carbon required to maintain reef structures. Coral reefs collapse into rubble. (This image shows a reef that once grew on the inshore region of the Great Barrier Reef)

The Coral Reef Targeted Research & Capacity Building for Management Program (CRTR) is a leading international coral reef research initiative that provides a coordinated approach to credible, factual and scientifically-proven knowledge for improved coral reef management.

The CRTR Program is a proactive research and capacity building partnership that aims to lay the foundation in filling crucial knowledge gaps in the core research areas of Coral Bleaching, Connectivity, Coral Diseases, Coral Restoration and Remediation, Remote Sensing and Modeling and Decision Support.

Each of these research areas are facilitated by Working Groups underpinned by the skills of many of the world's leading coral reef researchers. The CRTR also supports four Centers of Excellence in priority regions, serving as important regional centers for building confidence and skills in research, training and capacity building.

The CRTR Program is a partnership between the Global Environment Facility, the World Bank, The University of Queensland (Australia), the United States National Oceanic and Atmospheric Administration (NOAA) and approximately 50 research institutes & other third parties around the world.

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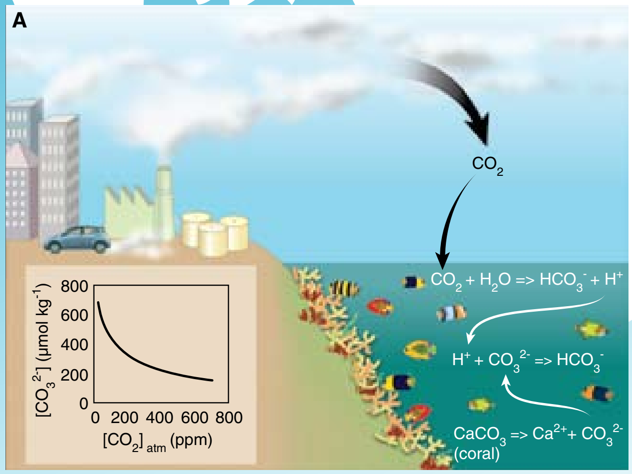

Figure 1. Approximately 25% of the CO_2 emitted by humans in the period 2000 to 2006 was taken up by the ocean where it combined with water to form carbonic acid.

(Fig 1 and 2 reprinted with permission of Science Magazine)

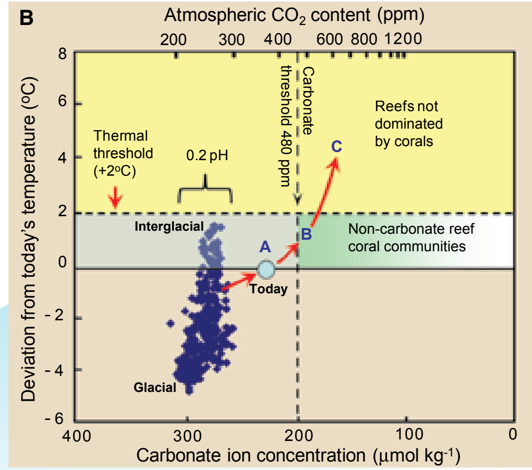

Figure 2. Temperature and carbonate ion concentrations related to calcification rates reconstructed for the past 420,000 years. A, B, and C refer to scenarios depicted in page 1.

The facts and conclusions collected by the CRTR Program are as follows:

- Sea temperatures and ocean acidity are now outside the values experienced by coral reefs during the past 420,000 years, at least.
- Conditions surrounding coral reefs are changing at rates which exceed even the most rapid changes over the past 420,000 years. Rates of change in conditions are now 100 to 1000 times higher than those experienced during the ice age transitions, in which the planet underwent great physical and biological change.
- Our current understanding of coral reefs is that they have specific limits with respect to sea temperature and acidity. There is little evidence that these thresholds will change rapidly enough to keep pace with climate change.
- Increases in atmospheric carbon dioxide above 450 ppm will largely eliminate carbonate coral reefs.
- Corals are central to coral reef ecosystems. If corals are unable to build reef structures, 50% of the estimated million species that live in and around coral reefs will disappear.
- Analysis of the potential impact of increased sea temperature and acidity indicate a series of potential negative feedback loops to date which increase the level of risk. It is essential that we reduce the risk of these occurring by helping and buffering the ability of coral reefs to rapidly return from climate shocks.
- Best case scenarios arise if we can keep carbon dioxide below 450 ppm and increase our efforts to build the ecological resilience of coral reefs by reducing the impact of other stresses, such as pollution, sedimentation, over exploitation and destructive fishing practices.
- Worst-case scenarios arise if we do not take stern action on emissions today. In these scenarios (greater than 450 ppm), extensive coral reef ecosystems will not be present in the rapidly warming and acidifying seas.
- Given the trend of increasing global stress, it has become increasingly important to reduce the impact of other stresses on coral reefs. This alone, will not be enough to save coral reefs if we do not reduce our carbon dioxide emissions.
- The current scientific consensus is that the highly-biodiverse coral reefs of today will be relics of the past if we do not act globally to rapidly reduce global emissions of carbon dioxide and other greenhouse gases.

When corals get too warm

Bleached corals on southern Great Barier Reef in January 2002. Photo: Ove Hoegh-Guldberg, Centre for Marine Studies, The University of Queensland

When corals get too warm, The symbiosis with brown plant-like organisms known as zooxanthellae breaks down. The result is coral bleaching as shown here. The beautiful blue colors are due to animal pigments while the pale brown color remaining at the base of the branches is due to remaining zooxanthellae. Unfortunately, these beautiful corals are in trouble as their energy source (zooxanthellae) has been removed.

This material has been reproduced from the Science Magazine, where it first appeared in the paper, *The Carbon Crisis: Coral Reefs under Rapid Climate Change and Ocean Acidification*, on December 14, 2007.