

The Great Barrier Reef in 2050

The earth is undergoing accelerating climate change that is being driven by rapidly increasing greenhouse gas concentrations. This is changing the conditions under which the earth's fauna and flora have flourished over the past several million years. There is now extensive evidence of changes to the distribution, abundance and health of earth's terrestrial and aquatic ecosystems. Species are migrating towards the poles, ecosystems like coral reefs are experiencing increasing stressful conditions and populations of organisms are in decline as a result of a combination of climate change and other anthropogenic impacts.

Reproductive seasons have lengthened for animals and plants over the entire planet. Similar changes are occurring in the sea. Many regions of the world are experiencing the invasion of warm water benthic fish and invertebrate species into reefs at higher latitudes. Shifts in the structure of planktonic and intertidal communities show similar patterns with major changes being documented over the past 100 years. The melting of the earth's polar ice caps is rapidly changing the habits and distributions of both Arctic and Antarctic biota.

Coral Reefs

Coral reefs have shown some of the most dramatic impacts of climate change, with the advent of worldwide coral bleaching events from 1979 as the thermal threshold of corals have been exceeded. Reports of global cycles of coral bleaching and mortality have increased dramatically. The global episode of mass coral bleaching in 1998 was the largest in recorded history, and coincided with the warmest year and decade on record. It removed an estimated 16% of the world's living coral, with estimates for the Indian Ocean rising as high as 46% of living coral dying over a few months.

Coral reefs across the world are also deteriorating due to a combination of coastal land practices, overfishing and marine based pollution. These influences alone have been estimated to potentially remove over 50% of coral reefs over the next 30-50 years. Reduced carbonate alkalinity of seawater (the source of ions for calcification) is inflicting additional pressure on coral reefs.

This will have dramatic impacts on the world's coral reefs over the next 50 years. It will reduce coral abundance to less than 5%, will cause major changes to fish populations and will change the natural values of coral reefs to millions of reef users and associated industries. These changes will add to the problems of global fishing industries which are already in crisis as fish stocks plummet.

Australia's Great Barrier Reef is arguably the best-managed reef ecosystem in the world; yet this does not prevent it from being under great threat from continued warming of sea temperatures. It also faces growing threats from coastal land practices and exploitation of fisheries resources. The facts supporting these conclusions are indisputable.

Half of Coral Cover by 2050

Change to the health of our ecosystems as a result of climate change is inevitable. Even under the best case scenario, losses of at least 50% of the Reef's living coral cover are likely to occur by 2050. It is estimated that corals on the Great Barrier Reef will experience between 2 degrees Celsius and 6 degrees Celsius increases in sea temperature by 2100. Torres Strait temperatures will be found at

the southern Great Barrier Reef as early as 2030. As with coral reefs elsewhere, thermal stress is likely to increase to levels that are several times higher than in 1998. By the middle of this century, these levels will be exceeded every year at all sites along the Great Barrier Reef. Corals will either have to adapt or move. If they don't do either, then corals will become rare over most of the Great Barrier Reef.

There is little to no evidence that corals can adapt fast enough to match even the lower projected temperature rise. Most evidence points to rates of adaptation that involve centuries and millennia. There is no evidence that coral can take on completely new varieties of symbiotic dinoflagellates with the result that they are hardened to the projected increases in sea temperature. Reefs do not exchange masses of larvae over hundreds of kilometres even though they are connected genetically. These factors plus the observation that mass mortalities of corals are increasing in response to sea temperature increases suggest that the rate of adaptation cannot match the high rate of climate change currently occurring.

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The flora and fauna of the Great Barrier Reef is going to change dramatically if current estimates of climate change are correct. The past behaviour of coral reefs to warming has revealed that thermal stresses of 5 degree heating months remove the majority of reef-building corals and other related organisms. There is no evidence to the contrary. The Great Barrier Reef will see thermal stresses of 5 or more degree heating months on an annual basis by 2050. They are projected to rise to as high as 15-20 degree heating months by 2100. Coral cover will decrease to less than 5% on most reefs by the middle of the century under even the most favourable assumptions. This is the only plausible conclusion if sea temperatures continue to rise. Reefs will not disappear but they will be devoid of coral and dominated by other less appealing species such as macroalgae and cyanobacteria.

The Circle of Life

The rapid reduction in coral cover will have major consequences for other organisms and reef functions. Many organisms that are coral dependent will become rare and may become locally or globally extinct. Other organisms, such as herbivores, may actually increase as reefs change from coral domination to algal/cyanobacterial domination. Fish and other organisms that form the basis of fisheries will change, although the direction of this change has yet to be determined and will depend on how reefs are treated with respect to other anthropogenic stresses. Increases in the abundance of cyanobacteria may have implications for the incidence of ciguatera poisoning, a major problem in some areas of the world already.

Coral reefs have deteriorated due to a combination of anthropogenic misuse and climate change induced bleaching events such as those in 1998 and 2002. This will have implications for the tourist industry through changing environmental qualities, commercial fisheries through changing fish community structure and abundance, and other activities such as recreational fishing, subsistence gathering and coastal protection. Understanding and planning for this change should be an imperative of governments everywhere. The Great Barrier Reef is no exception.

(Excerpt from "Likely ecological impacts of global warming and climate change on the Great Barrier Reef by 2050 and beyond")

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