CLIMATE SCIENTISTS AUSTRALIA

Climate Change Science Fact Sheet

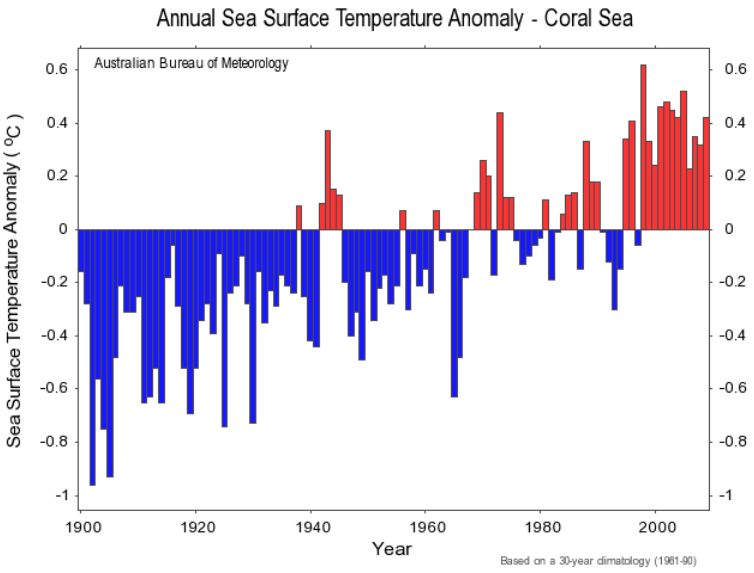
May 2010

Climate Change and the Great Barrier Reef

- The Great Barrier Reef (GBR) brings in over $5 billion each year in tourist and fishing revenue. It is the world's largest continuous coral reef in the world and was World Heritage listed in 1981.
- The GBR is currently in good condition relative to other coral reef systems. However, it faces serious threats from local factors, such as declining water quality along the Queensland coastline, shipping, and over-fishing of some areas. Recent evidence suggests that coral cover (a measure of reef health) is now around half of what it was in the early 1980s. Increasing atmospheric carbon dioxide (CO_2) has placed additional threats on the GBR through its impact on water temperature and acidity.

Water temperature

- Elevated water temperatures cause corals to 'bleach'. Bleaching occurs when the all-important symbiosis between corals and tiny brown plant-like symbionts called zooxanthellae breaks down. This results in the brown symbionts leaving the coral and causing it to look bleached.
- Small increases in water temperature (1°C above the long-term average) trigger mass coral bleaching. At low levels of bleaching, coral may recover. When conditions are warmer for longer, increasing numbers of corals become starved or diseased and die.
- In the warm conditions of 1998, for example, around 16% of the world's corals died. The GBR has been relatively lucky so far, with 7 moderate to severe bleaching events since 1979. So far, we have not experienced extreme thermal stress seen in 1998 in places like the Western Indian ocean. There, an estimated 46% of coral died as a result



This graph from the Australian Bureau of Meteorology (see www.bom.gov.au/cgi-bin/climate/change/timeseries.cgi) shows sea surface temperatures in the Coral Sea as a difference from a long-term average ('anomaly'). It shows that 2009 was the eighth warmest year on record for the Coral Sea. Experts at the Bureau also suggest that the temperature in 2010 is likely to be near-record, based on the development of the current El Niño event.

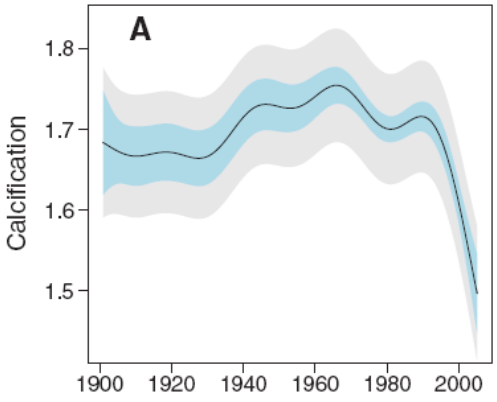
- There is no evidence that mass bleaching occurred on coral reefs such as the GBR prior to 1979.
- However, sea temperatures in the Coral Sea have been increasing steadily over the past century (see right). They are pushing coral reefs closer to or above their thermal limit.

Ocean acidification

- An increased amount of atmospheric CO_2 causes a greater amount of CO_2 to enter the ocean, where it reacts with ocean water to form carbonic acid. Since industrialization, about 40% of human-produced CO_2 has entered the world's oceans, increasing the acidity of ocean water by 0.1 pH units and decreasing the concentration of carbonate ions by around 15-20%.
- Carbonate ions are crucial to reef calcification. Experiments with corals have shown that calcification and reef building decrease as the concentration of carbonate ion decreases.

Prognosis for the Great Barrier Reef?

- A recent study by the Australian Institute of Marine Science found that long-lived corals in the GBR are now calcifying 15% less than they were before 1990 (see right). They also found that this was unprecedented in the 400 years of record they inspected. Similar results have been found by several other studies for other regions.
- The decrease in coral calcification is likely to have resulted from a combination of increasing water temperatures and acidities – it is not yet possible to say which factor is more important.
- Further decreases in coral calcification as observed in the GBR are likely to cause coral reefs to stop growing or even to start disintegrating. This is because there is a fine balance between calcification (reef growth) and physical or biological erosion. Currently around 90% of what is laid down during calcification is removed by erosion.
- Under current trajectories of human-related greenhouse gas emissions, atmospheric concentrations of CO_2 will reach 450 ppm within 35 years. Most studies indicate that under these conditions, ocean temperatures and acidities will reach such levels that carbonate coral reefs (like the GBR) will be severely degraded, and are likely to eventually disappear.
- As a result, the GBR will be a vastly changed place. Given corals create the habitat for approximately 1 million species, the deterioration of the coral structure of the GBR will lead to major reductions in its biodiversity and productivity – as well as the ecosystem services that it currently provides (tourism, fishing, coastal protection).



This panel from Figure 2 in De`ath et al. (2009) shows the decline in calcification (in grams per square centimetre per year) since 1990, based on 1900–2005 coral data in the Great Barrier Reef.

References and further information

Bruno JF, Selig ER (2007) Regional decline of coral cover in the Indo-Pacific: Timing, extent, and subregional comparisons. *PLoS ONE* 2(8): e711

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Where the GBR might be heading: On the left is a healthy coral reef at Heron island, on the right is Kelso Reef off Townsville (which was largely destroyed by a combination of Crown of Thorns starfish and thermal stress related bleaching).

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Climate Scientists Australia is an independent group of senior working scientists with a mission to advance the use in Australia of balanced, scientifically-based information in decisions on climate-related issues.

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