A changing climate for the Great Barrier Reef: physical observations and biological responses

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Abstract

The Great Barrier Reef (GBR) extends for ~2,000 km along the Queensland coast (9º-24ºS) and up to 200 km from shore, encompassing ~ 35 million hectares. This vast area includes nearly 3,000 coral reefs, home to 360 species of hard coral, 1,500 species of fish, 4,000 species of molluscs, 400 species of sponges and the list goes on. Internationally-endangered dugongs inhabit extensive sea grass beds. Six of the world's seven marine turtles live, and hump-backed whales from Antarctica breed in GBR waters. The unique values of this complex and highly diverse marine ecosystem are recognized through its World Heritage status and are of economic significance to the Queensland and Australian economy. Coral reefs occupy only ~10% of the GBR area and the rich biodiversity of the inter-reefal areas is only just being explored. The GBR is probably the world's best managed and protected (~30% no-take zones) coral reef ecosystem; protected from the local, direct exploitation that has significantly degraded many of the world's coral reefs. The GBR is not, however, immune from the regional consequences of a changing climate due to increasing greenhouse gases.

The symbiotic relationship between coral animals and single-celled algae (zooxanthellae), at the heart of tropical coral reefs, is particularly sensitive to unusually warm water temperatures and we have already observed mass coral bleaching events on the GBR associated with increased thermal stress. Warmer water has also been linked to more observations of coral diseases. More intense tropical cyclones will lead to increased frequency of localized reef destruction and changes in oceanic circulation patterns will affect the critical connectivity between reefs. A more insidious affect of increased atmospheric CO_2 is progressive ocean acidification (the oceans have already absorbed ~30% of the extra CO_2). This will make it harder for marine calcifying organisms, such as corals, to form their skeletons and shells.

Significant warming of the GBR has already occurred and many components of this complex ecosystem are known to be both sensitive and vulnerable to a changing climate. Assessing biological responses of the GBR requires high-quality, on-going observations of the physical environment over a range of spatial and temporal scales. AIMS' capabilities through automatic weather stations, satellite observations, ocean moorings and an intensive water temperature logger program have already provided critical measurements that link biological responses with the physical environment (for example, spatial variations in coral bleaching thresholds). This monitoring program is now being enhanced and expanded through the GBR Ocean Observing System (GBROOS). A commitment to such long-term and detailed climate change monitoring programs is essential to identifying how GBR climate is changing and which parts of this unique

ecosystem maybe more or less susceptible to the evolving consequences of a rapidly warming world.