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Coral Reef Cooling

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The Problem:



There have been five mass extinctions on the planet earth. Each extinction has been preceded by the death of the coral reef. In the last 15 years, 30% of the world's coral reefs have perished and another 6% are expected to die in the next two years. Scientists are predicting that the Great Barrier Reef will become a geological relic in 27 years. In 1998 there was a massive global coral bleaching event. In 2010 there was another one. Because of global warming, massive global coral bleaching events will happen with increasing frequency and with far-reaching results. Bleaching of this magnitude has not occurred for hundreds, if not thousands, of years. We will continue to lose thousands of square kilometers of coral reef; Unless, of course, we do something about it.

Coral reefs comprise some of the most biologically diverse and valuable ecosystems on the planet. although reefs occupy only 0.2 percent of the ocean's area worldwide, they are home to one-third of all sea life. and support more species per unit area than any other marine environment, including about 4,000 species of fish, 800 species of hard corals. It is estimated that there are 8 million (8,000,000) undiscovered plants and animals that may live in or near coral reefs.

The annual global economic value of coral reefs is estimated between US \$30 to \$375 billion in goods and services, including; fisheries, tourism, coastal protection, as a source of medical advances, and environmental wealth.

Every day 30 million TONS of carbon dioxide is poured into the ocean - EVERY. DAY. The ocean is becoming too warm and acidic for the organisms that live there and the acid is killing coral and many thousands of species.

The warming planet has slowed down the underwater jet stream which provides both the nutrients and the cooler water to the surface of the ocean. As a result, the coral are getting too hot and are becoming nutrient deprived. And if the coral reefs go extinct, which they are, life as we know it is permanently going away.



Humans are naïve to believe that life will continue as usual without healthy coral reefs, or, for that matter, a planet. A quarter of all marine species spend some part of their life cycle in the coral reef ecosystem. It is estimated that 100 million humans will die by 2030 because of climate change. That is 100 million people in the next 14 years. 660,000 humans have already died due to climate change. We must protect the biggest, most diverse environment on the planet or pay the price.

What We Did:

There are very few tools available for Coral Reef managers for counteracting mass coral bleaching, primarily caused by elevated seawater temperatures. Climate Foundation developed a field-based cooling system for reef water to give Coral Reef managers the possibility to act on bleaching warnings to preserve high-value reefs in the face of climate threats.

We asked ourselves, can we reverse coral bleaching in the field on a small scale? Can we scale it? Can we provide reef managers with new tools to protect high-value reefs against climate change?

Project funding:

In 2008, Brian von Herzen participated in testing thermal exchange of deep water from the bottom of the ocean thanks to a floating pump device in the middle of the ocean. You can see this [here](#).

In 2009, a grant from the US Fish and Wildlife Service made it possible to conduct experiments on the staghorn corals on Tutuila Island, American Samoa to demonstrate methods for reversing (and preventing) coral bleaching.

In 2011- 2012, in partnership with Univ. Hawaii, Hawaiian Institute of Marine Biology (HIMB), Climate Foundation explored how to cool off the reef on a bigger scale with solar arrays, a generator, a marine pump and a thermo-electric cooling system.

Experimental setup:

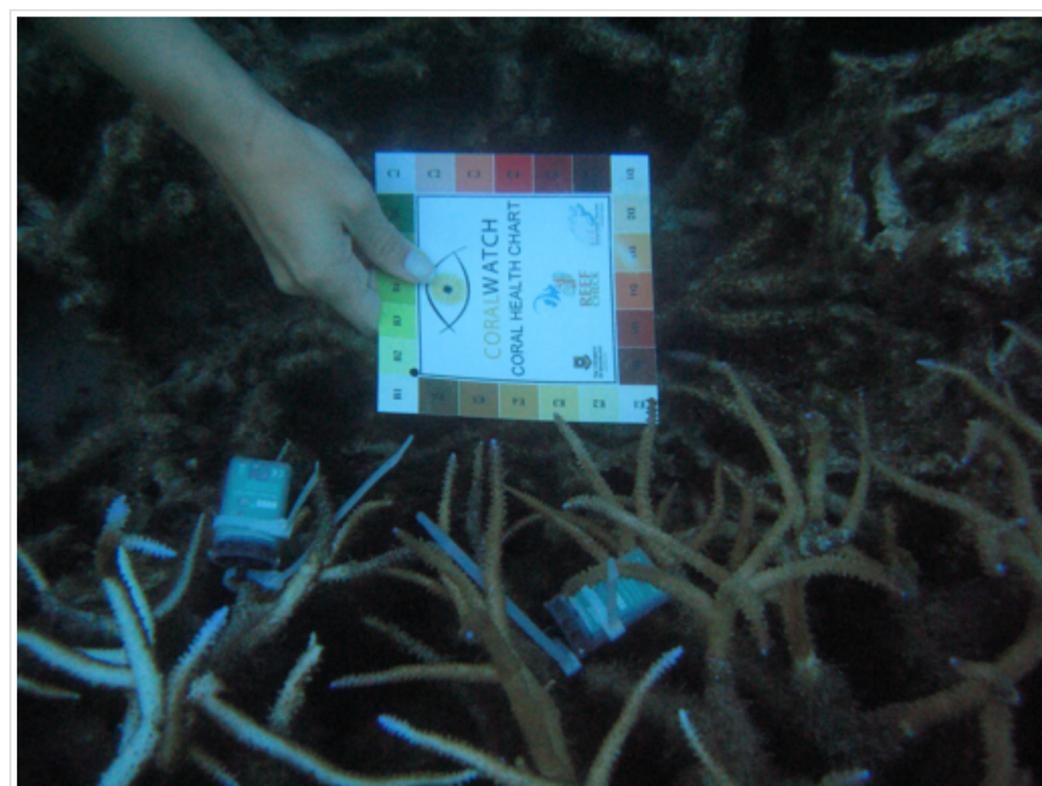
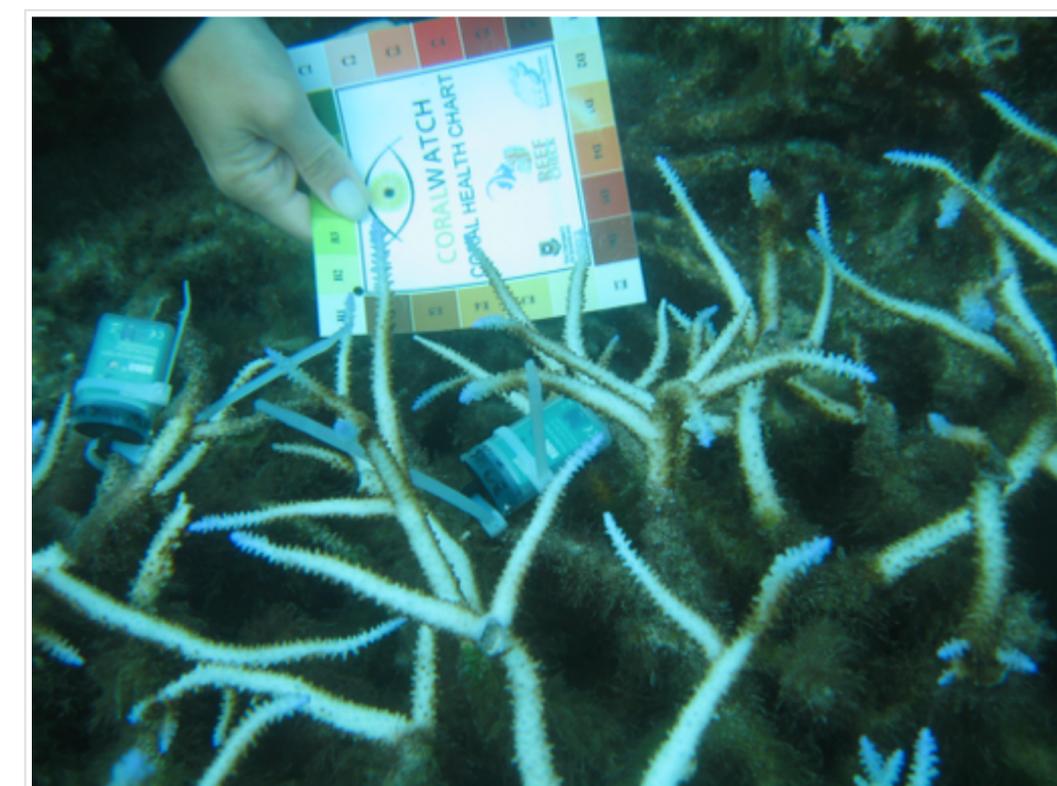
In order to test methods of reversing coral bleaching Climate Foundation selected an area where it is possible to estimate precisely the beginning and the end of an annual coral bleaching process. The Tutuila airport reef was chosen as a perfect exploration ground since it offers all relevant site selection criteria. It was near to shore, it was near a power source, the coral bleached annually and Doug Finner had systematically logged the temperature and bleaching for years.

Methodology:

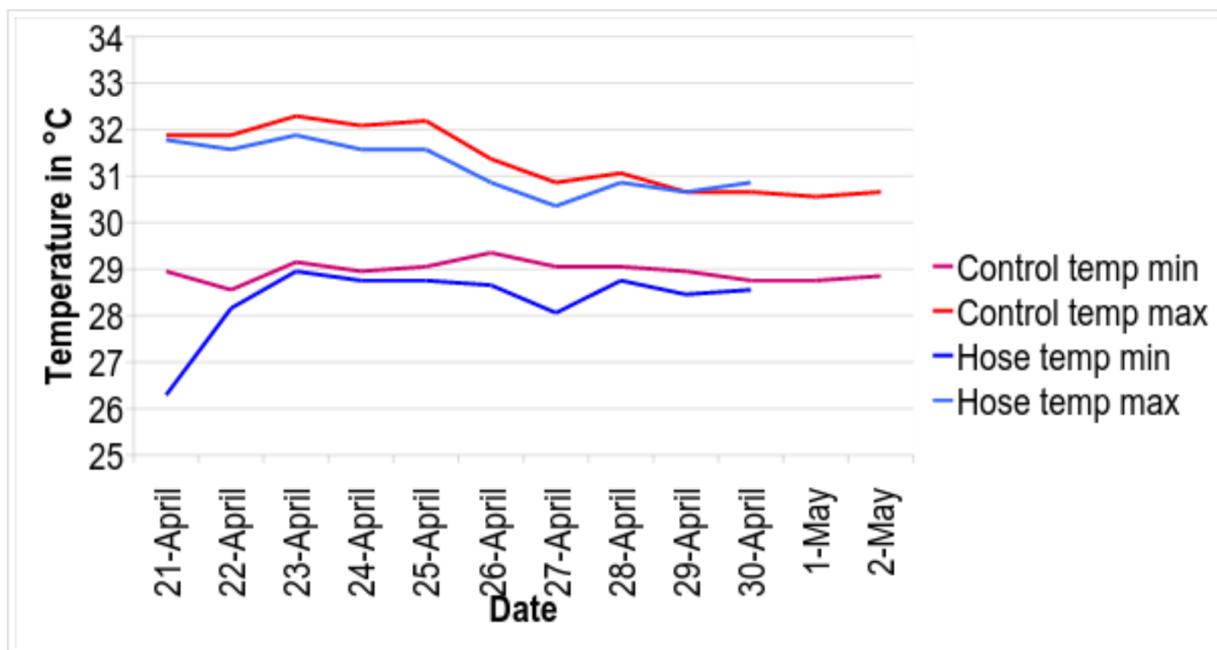
Photos of coral were calibrated using a CoralWatch coral-health chart to measure color intensity. On this scale, low values of 1-2 correspond to pale, bleached color, while higher values of 3-5 correspond to more intense color (less bleached). Temperature loggers and illumination data loggers recorded temperature to 0.1°C. Recordings were made for up to two weeks after treatment to observe the prolonged biological response to treatment.

Experiment results:

Color intensity increased 3 to 4 units at test sites in one day on the CoralWatch scale with no increase at reference sites. Color intensity held for over a week before declining by 1 unit a week after cooling stopped. Other reference sites remained bleached. In under 12 hours, the color returned to the coral! The bleaching had stopped.



Experiments with solar arrays, a generator, a marine pump and a thermo-electric cooling system showed similar results.



PAM Fluorometer measurements confirming the correlation between color difference and photosynthetic efficiency

Outcome:

Based on these results, effective strategies to reverse coral bleaching can be developed. Besides using the NOAA bleaching forecasts to provide warning to reef managers, reef managers can deploy portable thermal management systems to ensure reef survival through major thermal bleaching events. Therefore regional scaled cooling infrastructure anticipating future bleaching can be designed and procured after testing biological response with a portable cooling system.

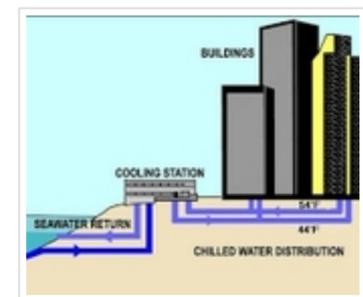


Reef managers can deploy thermal management systems to ensure reef survival through major thermal bleaching events

So the next question is: how do we scale up and cool down big reefs?

The Solution:

Seawater Air Conditioning uses cold deep water from seas or lakes to cool buildings, military bases and entire cities. On a multi-megawatt scale, it takes comparatively little energy to bring such cold water to the shoreline, where it passes through a titanium heat exchanger to cool a closed-loop chilled fresh water cooling system. That system runs under the streets to district buildings to provide chilled-water air conditioning that is standard in many commercial buildings, especially high-rise buildings.



Water enters the system at just a few degrees Celcius, providing chilled water at a typical temperature for 44 degrees F. After the air chilling, the temperature of the return water is typically on the order of 54 degrees F. The seawater return temperature is on the order of 54 degrees F, providing plenty of surplus capacity to seasonally cool nearby coral reefs. This cooling has been demonstrated to reverse coral bleaching in some locations, potentially protecting square kilometers of reef from seasonal bleaching due to excess heat in the local summer. This combination of renewable energy practice and coral reef conservation provides strong benefits to the economy and local ecosystems. The Climate Foundation is dedicated to developing these kinds of synergies in combined commercial practice and conservation efforts.

In The News:

New York Times

[Large Sections of Australia's Great Reef Are Now Dead, Scientists Find](#)

March 15, 2017

US Fish and Wildlife Service

Hawaii: Developing Options for Coral Reef Management in a Changing Climate

June 8, 2011

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