# Climate Change Threatens the Survival of Coral Reefs
# Only 12 years to Avoid the Worst Damage

**Bleaching coral reef in American Samoa, 2015 (photo: XL Catlin Seaview Survey)**

Coral reefs are structures created by coral animals and are among the most biologically diverse ecosystems on the planet. They provide goods and services worth at least US$11.9 trillion per year and support (through such activities as fisheries and tourism) at least 500 million people worldwide. Potent anti-cancer drugs have been derived from coral reef organisms, and others are in testing; healthy coral reefs could save millions of lives.

Coral reefs, however, are being eliminated from the planet rapidly by climate change. In particular, increasing sea temperatures have already caused widespread coral bleaching and mortality. In addition, elevated carbon dioxide levels are causing ocean acidification that may further accelerate coral reef loss.

Over recent decades, worldwide, over 50% of living coral has been lost on coral reefs due to a combination of local factors and global climate change. In 2016-17 bleaching alone caused the loss of half the shallow water corals on the northern 700 km of the Great Barrier Reef and substantial damage elsewhere. Recovery from such events is a decades-long process. With bleaching now frequent, reefs have little time to rebuild.

As a result of reef ecosystem destruction, a quarter of all marine species are at risk, while the associated economic losses will expose hundreds of millions of people to decreasing food security and increased poverty.

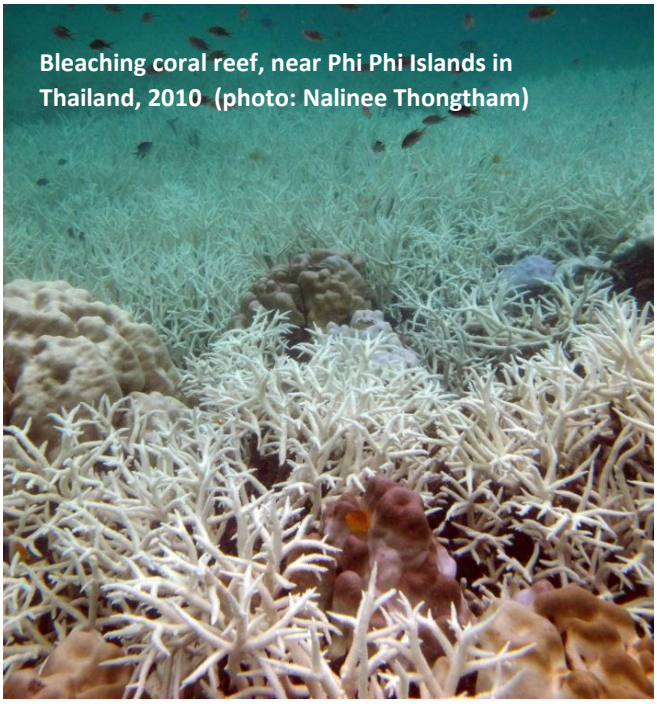
**The International Society for Reef Studies, in the International Year of the Reef 2018, calls on nations to implement the Paris Agreement and take the necessary action, by 2030, to keep global warming to a maximum of 1.5°C above the pre-industrial period.**

If carbon dioxide increase is capped to warm the climate by no more than 1.5°C above the pre-industrial period, warming and acidification will still cause widespread destruction of coral reef ecosystems, but some should persist. Warming of over 2°C or more will largely eliminate them. The current emission reduction pledges submitted by the international community fall short of what is required to avoid this catastrophe.

***The International Society for Reef Studies (ISRS) is the leading international association for coral reef scientists and managers. Its members carry out and publish work that promotes scientific knowledge and understanding of coral reef ecosystems.*** *www.coralreefs.org*

***Revised ISRS Consensus Statement on Climate Change and Coral Bleaching, November 2018.*** *Prepared for COP14 of the Convention on Biological Diversity, Egypt, November 2018 and COP24 of the UN Framework Convention on Climate Change, Poland, December 2018.*

## Warming oceans and bleaching reefs

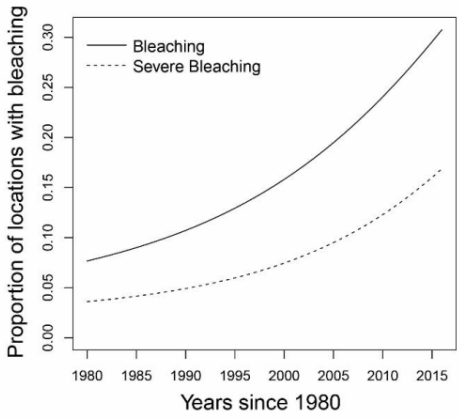


Bleaching coral reef, near Phi Phi Islands in Thailand, 2010 (photo: Nalinee Thongtham)

There is overwhelming consensus within the scientific community, and robust evidence, that the surface layers of the world's oceans have warmed since the beginning of the 20th century. This warming has taken place at a faster rate than at any previous time for which we have evidence, including the fossil record for those ocean regions where coral reef ecosystems have grown for millions of years [1].

This is due to changes in the composition of the atmosphere, in particular the large increase in concentration of atmospheric carbon dioxide ($CO_2$) from a mean of about 280ppm during pre-industrial times, to near 410ppm at the present time [2]. Burning of fossil fuels by humans has accelerated over the past 50 years and is the primary cause of this increase. Projected rates of change indicate that, under existing patterns of human activity, tropical waters will be 3-4°C (5.4-7.2° F) warmer by 2100.

Coral reefs grow in warm shallow seas and have experienced relatively stable temperatures over thousands of years. Since the early 1980s, however, as sea surface temperatures have rapidly increased, corals have experienced large-scale bleaching and subsequent mortality [3]. Bleaching events occur in response to periods during which surface waters become so warm that there is a breakdown of the symbiosis between corals and the microalgae that live in great numbers within their cells. The loss of these symbiotic algae causes whitening (bleaching) of the coral animals and leads to their starvation, sickness and, in many cases, death.




Proportion of locations with bleaching each year since 1980 (16)

In 1998, when extremely high mean sea temperatures were recorded, an estimated 16% of the world's coral communities bleached and died [4,5]. Since then many more coral bleaching events have affected reefs worldwide, in response to raised sea surface temperatures; the extent of these impacts has significantly increased over time [1,6]. Over 50% of coral reefs have been largely or completely degraded by a combination of local factors and global climate change [5], with reefs in many regions already having lost well over half of their living coral cover [6-8]. The three-year global coral bleaching event that hit most of the world's reefs in 2014-17 shows the extent to which impacts are growing. During this period, over half of the shallow water corals were killed across an area of the Great Barrier Reef Marine Park that is the size of Italy (6).

Experimental, field, and remote sensing studies have led to a scientific consensus that projected changes in atmospheric $CO_2$ concentration will soon push average global land and sea surface temperature increases to 2°C or more above pre-industrial levels. These changes are already leading to ocean temperatures which are beyond the temperature tolerance of reef building corals and of many other reef organisms [9,10]. NOAA satellites and climate models are able to predict reasonably accurately when and where mass coral bleaching is likely to occur by tracking positive thermal anomalies. Satellite data show the heat stress causing global coral bleaching during 2014-2017 was more widespread and prolonged that any past bleaching event [11].

## Ocean acidification

An additional threat to coral reefs is ocean acidification. This arises from increasing amounts of $CO_2$ entering the ocean, where it reacts with water to produce a mild acid, which decreases pH and causes a cascade of

changes to seawater chemistry. Experimental studies show that acidification has negative effects on calcification, metabolism, sensory systems, survivorship, reproductive stages, and many other fundamental processes to corals and other reef dwellers [1,2], and also accelerates destructive processes including erosion and dissolution of the reef structure.

Ocean acidification is taking place at a rate faster than anything seen over the past 65 million years, if not the past 300 million years [12]. Given the long generation times of corals and some other reef organisms, there is concern that they will be unable to adapt rapidly enough to persist in this rapidly changing environment. Acidification has the potential to lead to slower reef ecosystem recovery from other impacts including not only coral bleaching, but also disease, predation, cyclones and destructive fishing. It will promote reef loss and, in many cases, as a result lead to coastline erosion.

## Functioning coral reefs will disappear without urgent action to reduce $CO_2$

Dead reef on Lizard Island, Australia (photo: XL Catlin Seaview Survey)

Ocean warming and acidification, because of their effects on corals, are jointly driving fundamental shifts in the structure and function of coral reef ecosystems, turning reefs into low diversity and low productivity systems, as well as eroding their structure. While coral populations can recover from brief exposure to warm water, the combination of increasing ocean temperatures, acidification and more local pressures such as pollution and overfishing is causing cumulative damage [2]. As coral reefs disappear, so will the habitat of a quarter of all marine species, many of which require the three-dimensional structure and high productivity of these unique and diverse environments to survive.

Coral reefs provide food and income for hundreds of millions of people spread across dozens of countries, and the loss of these ecosystems will have an unimaginable impact, with serious damage already visible. The potential net benefit streams per year from the world's coral reefs were estimated over ten years ago at close to US$30 billion per year [13], through benefits such as fisheries, tourism and coastal protection, and may now be much more [14].

Mass coral bleaching and mortality of coral reef ecosystems is one of the most visible impacts of climate change, and warns us of the dangerous world that we are entering as our climate warms. The loss of most if not all functioning coral reef ecosystems from the world's oceans would be an unthinkable tragedy. Unfortunately, that tragedy is on our doorstep today, but is avoidable given the required international leadership.

# ISRS calls on all nations to take the action necessary, within the next 12 years, to keep global warming to a maximum of 1.5°C

The 2018 Special Report of the UN Intergovernmental Panel on Climate Change (IPCC) (16) is clear that human activities have already caused about 1.0°C of global warming above pre-industrial levels. The consequences of this is already being seen through more extreme weather (hurricanes, typhoons, forest fires), rising sea levels, underwater heat waves and diminishing Arctic sea ice, among other changes.

The IPCC Special Report warns that global warming is likely to reach 1.5°C between 2030 and 2052 if business as usual continues. There are therefore only 12 years within which to take the necessary action to keep global warming to a maximum of 1.5°C. Allowing warming of 2.0°C will significantly worsen the risks of drought, floods, extreme heat, poverty for hundreds of millions of people and the loss of almost all coral reefs.

Reduction of $CO_2$ concentrations to the levels necessary to save coral reef ecosystems will require major initiatives to reduce both $CO_2$ emissions and our carbon footprint. Global net human-caused emissions of $CO_2$ would need to fall by about 45% from 2010 levels by 2030, reaching 'net zero' around 2050. Such global scale measures will be critical, not only for the survival of coral reefs and many other types of marine life, but also for the stability of human communities.

The IPCC Special Report maps out four pathways to achieve 1.5°C, with different combinations of land use and technological change. Reforestation is essential, as are shifts to electric transport systems and greater adoption of carbon capture technology. There would need to be rapid, far-reaching and unprecedented changes in all aspects of society, including land, energy, industry, buildings, transport, and cities. The costs of doing nothing would be far higher – coral reefs show us how vitally urgent it is to take action NOW.

**Authors:** Hoegh-Guldberg, O., Eakin, C.M., Hodgson, G. Sale, P.F., Veron, J.E.N.
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**Contacts:** Ove Hoegh-Guldberg, University of Queensland, Brisbane, Australia (oveh@uq.edu.au); Rupert Ormond, Heriot-Watt University, Edinburgh, UK (rupert.ormond.mci@gmail.com)

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**As well as government action, we all have a role to play. Individuals must play their part. See the ISRS pledge for what you can do: Ten Things YOU CAN DO to Help Save CORAL REEFS**