IMPACT ASSESSMENT OF CLIMATE CHANGE ON GLOBAL CORAL REEFS (GREAT BARRIER REEF)- A CASE STUDY

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Abstract
*Coral reefs, the home of the **most diverse marine habitat**, are the direct receptors of anthropogenic disaster **–(climate change).** The drastic increase in temperature causes the degradation of the presently declining status of the coral reefs.**Summer temperatures** in **February-April 2016** have caused severe and widespread coral bleaching in Australia**.** Compared to earlier **mass bleaching** in **1998 and 2002**, **2016 is much more severe**, with **50-80% coral mortality** recorded on **northern reefs**. **.** On the **east coast**, this is the **third mass bleaching event**.In this paper, **we reviewcoral reef responses to climate variability** and discuss the **possible mechanisms** by which **climate impacts the coral reef ecosystem**. Most **bleaching events** are reported from the **Great Barrier Reef,** Moorea, and the Caribbean .**Organisms** tend to be **limited** to **specific thermal ranges** with **experimental findings** showing that **sufficient oxygen supply** by **ventilation** and **circulation** only occurs within these ranges. **Effects** of **oceanographic variables** such as **sea temperature**, turbulence, salinity, and nutrients on the coral reef are discussed in terms of their **influence** on **coral growth**, reproduction, **mortality**, acclimation and **adaptation** .The **main objective** of the study is to **assess the impacts** of this **long-term climate variability** on the **biophysical condition** of these coral reefs.*

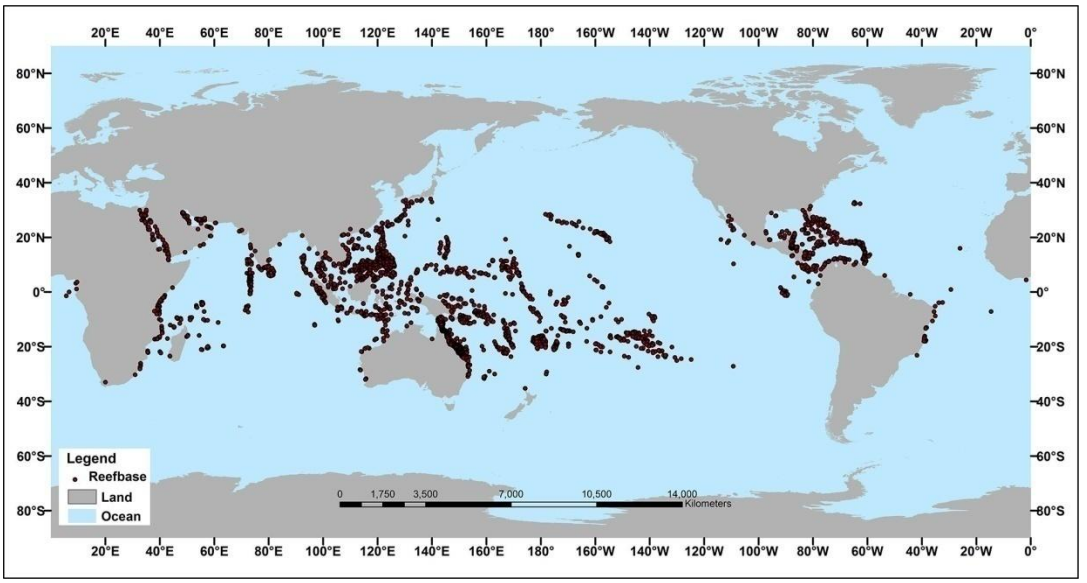
***Keywords: C**limate change(variability), coral bleaching, biophysical condition ,coral morality, specific thermal ranges.*

Introduction

Coral reefs are diverse underwater ecosystems held together by calcium carbonate structures secreted by corals. Coral reefs are built by colonies of tiny animals found in marine waters that contain few nutrients. Most coral reefs are built from stony corals, which in turn consist of polyps that cluster in groups. The polyps belong to a group of animals known as **Cnidarians,** which also includes sea anemones and jellyfish.This diverse invertebrate (invertebrates are animals without spinal columns) group includes corals, sea anemones, hydras, jellyfishes, and their relatives. All cnidarians are radiallysymmetrical (the body is symmetrical around a central axis), lack a head, usually have a crown of tentacles around the mouth, and possess nematocysts. About 9,000 living species are known.Unlike sea anemones, corals secrete hard carbonate **exoskeletons** which support and protect the coral polyps. Most reefs grow best in warm, shallow, clear, sunny and agitated waters.

Global coral reef location

Coral reefs are found in more than 100 countries around the world. Most reefs are located between the Tropics of Cancer and Capricorn, in the Pacific Ocean, the Indian Ocean, the Caribbean Sea, the Red Sea, and the Persian Gulf. Corals are also found farther from the equator in places where warm currents flow out of the tropics, such as in Florida and southern Japan. Worldwide, coral reefs cover an estimated 110,000 square miles (284,300 square kilometres).



Great Barrier Reef
Length: 1,553 miles (2,500 km)
Location: Coral Sea near Australia

Red Sea Coral Reef
Length: 1,180 miles (1,900 km)
Location: Red Sea near Israel, Egypt and Djibouti

New Caledonia Barrier Reef
Length: 932 miles (1,500 km)
Location: Pacific Ocean near New Caledonia

The Mesoamerican Barrier Reef
Length: 585 miles (943 km)
Location: Atlantic Ocean near Mexico, Belize, Guatemala and Honduras

Great Chagos Bank
Area: 4,633 square miles (12,000 sq km)
Location: The Maldives

Florida Reef
Length: 200 miles (322 km)
Location: Atlantic Ocean and Gulf of Mexico near Florida

Andros Coral Reef
Length: 124 miles (200 km)
Location: Bahamas between the islands of Andros and Nassau

Zhongsha Islands
Length: 50 miles (81 km)
Location: South China Sea

Saya Del Malha
Area: 15,444 square miles (40,000 sq km)
Location: Indian Ocean

Reed Bank
Area: 3,423 square miles (8,866 sq km)
Location: South China Sea, claimed by the Philippines

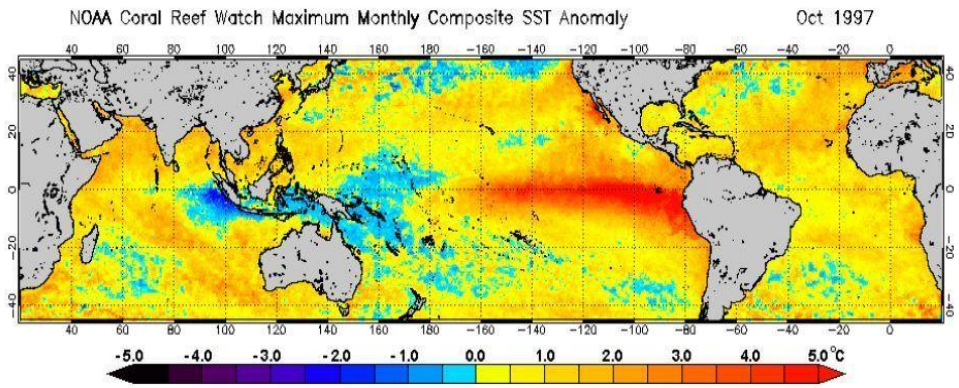
Effect of elnino and global warming on global coral bleaching

The El Nino Southern Oscillation (ENSO) is a periodic shift of the ocean-atmosphere system in the tropical Pacific that impacts weather around the world. It happens every 3-7 years (5 years on average) and typically lasts nine months to two years. It is associated with floods, droughts, and other global disturbances. During an ENSO event, there is a rise in air pressure over the Indian Ocean, Indonesia, and Australia, and a fall in air pressure over Tahiti and the rest of the central and eastern Pacific Ocean.

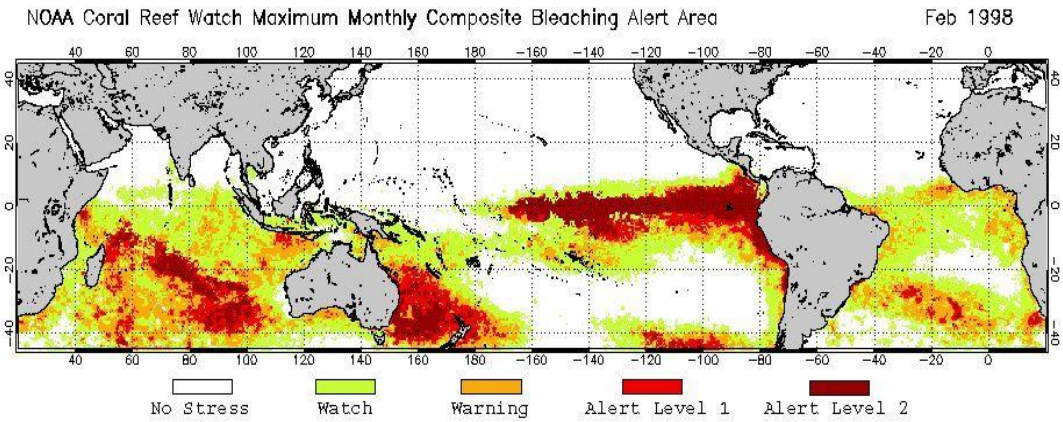
The following is a brief overview of the pattern and timing of thermal stress that resulted in widespread severe coral bleaching during 1997-1999. Past reports have estimated that over 15% of the world's coral reefs were effectively lost during the 1997-1999 period At that time, Watch observed widespread, prolonged high temperatures that caused coral bleaching. This was associated with what has been argued to be the largest El Nino on record (1997-1998) followed immediately by a strong La Niña (1998-1999). In general, many areas that are untouched by warming during an El Nino are influenced by warming during a La Niña

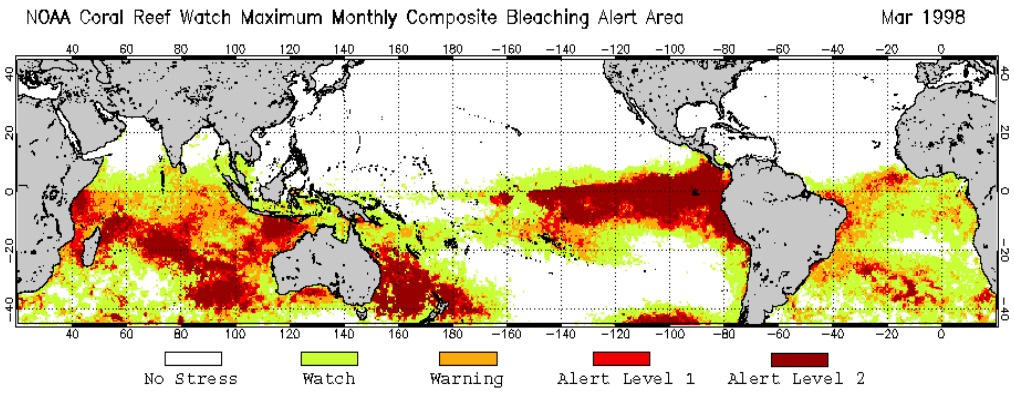
In short, several areas of the tropical oceans experienced thermal stress sufficient for coral bleaching with impacts covering a 14-month period (May 1997-June 1998). Reefs in the central Pacific and eastern tropical Pacific were exposed to thermal stress early after the onset of the El Nino. Thermal stress moved to the Great Barrier Reef and across the islands of the south Pacific during February-April 1998 and the Indian Ocean during March-June 1998. In the Gulf of Mexico and the Caribbean, the worst of the El Nino impacts with the highest thermal exposure culminated in July-October 1998. The mid-1998 onset of La Nina conditions resulted in thermal stress in the north-western Pacific Ocean from July-October 1998.

1997: The classical El Nino warming pattern formed by May 1997, with initiation of SST warming from the central tropical Pacific eastward to the South American coastline. Prolonged thermal stress with the potential to cause bleaching was seen along the equator, from Howland and Baker Islands east to the Galapagos and the Ecuadorian coastline, during the remainder of 1997. During this time, warming also proceeded northward along the South American coast to Panama. Additionally, warming was seen reaching northeast to Mexico, and some warming was seen along the Central American Coastline. Limited warming was seen in the Caribbean.



1998: By early 1998, the classic El Nino pattern was fully developed, with broader areas of high temperature in the eastern Tropical Pacific and extending up the Central American coast past Costa Rica, including all of the eastern Tropical Pacific islands; high temperatures in these regions began to dissipate in June. Bleaching levels of warming were seen along the Great Barrier Reef in February-March. Warming also began in the eastern to central Indian Ocean south of the equator, spreading to the eastern Indian Ocean by March, and dissipating after May.





2014-15 El Nino While that El Nino never fully formed, it helped set off the ongoing multi-year global coral bleaching event

Present effect of elnino on global coral bleaching and future further bleaching probability

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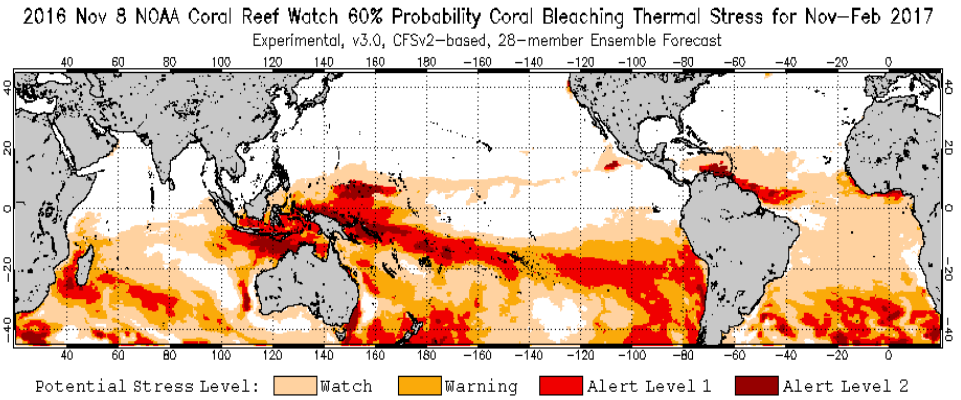

subsequent 2015-16 strong El Nino formed, spreading and worsening the bleaching, and has already caused bleaching in some areas two years in a row. As of April 2016, the current global coral bleaching event is the longest ever recorded. It has affected more reefs than any previous global bleaching event and has been worse in some locales (e.g., Great Barrier Reef, Kiribati). Thermal stress during this event also has caused mass bleaching in several reefs that never bleached before (e.g., northernmost Great Barrier Reef).

Threats from Global Warming

Higher sea temperatures from global warming have already caused major coral bleaching events. Bleaching occurs when corals respond to the stress of warmer temperatures by expelling the colourful algae that live within them. Some coral are able to recover, but too often the coral dies, and the entire ecosystem for which it forms the base, virtually disappears .Longer-lasting and more extensive bleaching events are already on the rise, with further increases expected in the decades ahead as ocean temperatures continue to rise. Warmer waters are also expected to increase the incidence of other coral diseases such as black band disease, white band disease, white plague, and white pox, all of which can lead to mass mortality of coral, and subsequently the entire ecosystem it supports.

Ocean acidification--which occurs when oceans absorb carbon dioxide from the atmosphere--is also a threat to coral. As the oceans become more acidic, the corals' ability to form skeletons through calcification is inhibited, causing their growth to slow. A doubling of atmospheric carbon dioxide will reduce calcification in some corals by as much as 50 percent. Sea level rise caused by melting sea ice and thermal expansion of the oceans could also cause problems for some reefs by making them too deep to receive adequate sunlight, another factor important for survival.

Great barrier reef: a case study on

The Australian Great Barrier Reef (GBR) is one of Earth's most extraordinary natural wonders, but it is vulnerable to climate change. Ainsworth et al. have tracked the effects of three decades of increasing heat stress on coral organisms. In the past, pulses of elevated temperatures that presaged hot seasons stimulated the acclimation of coral organisms and resilience to thermal stress. More recently, temperature hikes have been severe and precluded acclimation. The result has been increasing bleaching and death; notably extreme during 2016 in the wake of El Niño.

Location, extension of great barrier reef

The **Great Barrier Reef** is the world's largest coral **reef** system composed of over 2,900 individual **reefs** and 900 islands stretching for over 2,300 kilometres (1,400 mi) over an area of approximately 344,400 square kilometres (133,000 sq mi). 18.2871° S, 147.6992° E (lat long)The **reef** is **located** in the Coral Sea, off the coast of Queensland, Australia. In the past three decades, bleaching events have caused reef- wide declines in coral across the Great Barrier Reef (GBR).Coral bleaching is a stress response that results in the loss of intracellular symbiotic dinoflagellates (Symbiodinium) and/or their photosynthetic pigments; on a broad spatial scale, bleaching results from extended warm periods. The frequency and intensity of such bleaching events are expected to increase as sea surface temperature (SST) continues to rise under climate change. Acclimatization and adaptation to future temperature conditions have been suggested as mechanisms by which corals may withstand increasing SST, reducing the severity of coral bleaching and ameliorating mortality. Although the extent of adaptation remains uncertain, processes of acclimatization have been studied

empirically. An important driver of thermal acclimatization in any organism is the variance of temperature to which it is exposed. Sub-lethal pre- stress events reset physiological and molecular mechanisms that underpin the innate stress response, and provide a means to survive subsequent stress events Summer is always a period of heightened risk for the Great Barrier Reef. Warmer conditions bring the threat of high sea temperatures that can cause coral bleaching and wet seasons with strong monsoonal conditions can result in large flood plumes and damaging cyclones. While regional climate processes such as El Nino Southern Oscillation (ENSO) cause seasonal weather patterns to swing between clear/dry (El Nino) and cloudy/wet (La Nina), global climate change is altering the underlying conditions.

Effects on Marine ecosystem

Seagrass meadows are vitally important to the Great Barrier Reef ecosystem. They are also vulnerable to the effects of extreme weather. Survey results indicate the extensive and prolonged floods have caused significant damage to important seagrass meadows in the southern Great Barrier Reef.

Dugong and green turtles are almost entirely reliant on seagrasses for their nutrition. This strong dependency has meant dugong and green turtles have also suffered from the 2010-11 summer's extreme weather. It is likely the impacts of the extreme weather of 2010-11 on dugong and green turtles are being exacerbated by the longer-term decline in seagrass abundance.

Conclusion

Coral reef are dying around the world. In particular ,coral mining , agricultural and urban runoff, pollution (organic and inorganic) overfishing , blast fishing, diseases, island and bays access are localized threats to coral ecosystem. Some experts predict if coral are dead, the reef will also die and erode, destroying important marine life spawing and feeding grounds .Animals that rely on coral for protection and cover ,such as grouper , snapper, oysters and clams would also be negatively impacted .The disruption to the food chain and biodiversity of ocean could lead to additional problems that we can't begin to fathom. There are actions we can take to help maintain coral reefs. Such as alternative means of transportations like walking or biking, which decreases the use of pollution like oil and gas, volunteering with beach and reef clean up organisation and reducing the use of pesticides and fertilizers runoff .So with a little awareness and commitment to positive choices , we can help corals – and maintaining the biodiversity to enjoy for next generation.

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