

IMPACT OF CLIMATE CHANGE ON CORAL REEFS

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Abstract- This paper provides an account of what coral reefs are, how they are formed, coral reef management and reports. Today, coral reefs fascinating are under threat from over-exploitation and climate change; some are dead and other are dying. They could face extinction, unless our conservation efforts are stepped up in order to save them. Coral reefs are found all around the world, from the Indo-Pacific coral reef region to the Australia and Carribean, and they support both human and marine life.

Keywords- Coral reef, Climate change, Ocean acidification, Barrier reef, Coral reef management

I. 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 water 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 Cnidaria, which also includes sea anemones and jellyfish. 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 water.

Most of the coral reefs we can see today were formed after the last glacial period when melting ice caused the sea level to rise and flood the continental shelves. This means that most modern coral reefs are less than 10,000 years old. As communities established themselves on the shelves, the reefs grew upwards, pacing rising sea levels. Reefs that rose too slowly could become drowned reefs. They are covered by so much water that there was insufficient light. Coral reefs are found in the deep sea away from continentalshelves, around oceanic islands and as atolls. The vast majority of these islands are volcanic in origin. The few exceptions have tectonic origins where plate movements have lifted the deep ocean floor on the surface. The Great Barrier Reef—largest, comprising over 2,900 individual reefs and 900 islands stretching for over 2,600 kilometers (1,600 mi) off Queensland, Australia[1].

It is not that coral is found only in Australia. In India too, this wall is seen in many places. So let us know which places in India there is coral reef. Lakshadweep's name comes first in India when Coral Reef is named. Apart from Andaman Nicobar, Gulf of Kutch, Gulf of Mannar, Natrena and Malwa are places where we get to see the Coral Reef.

The share of coral reefs in the marine environment is less than one percent. 25 percent of marine life flourishes in this or through them. These are the sources of their food. These reefs are home to 1,500 species of fish, 411 hard corals and 134 species of sharks and rays (specialty fish). One-third of the world's soft coral is also present here. It is also home to seven such species of sea turtle and 30 types of marine mammals, which are on the verge of extinction. Along with this, there are 630 species of sperms like Starfish and Sea Urchin. There are 215 species of birds, thousands of species of sponges, insects and crustaceans as well as Sea-birds.

II. CLIMATE CHANGE EFFECTS

The warmer air and ocean surface temperatures brought on by climate change impact corals and alter coral reef communities by prompting coral bleaching events and altering ocean chemistry. These impacts affect corals and the many organisms that use coral reefs as habitat. Warmer water temperatures brought on by climate change stress corals because they are very sensitive to changes in temperature. If water temperatures stay higher than usual for many weeks, the zooxanthellae they depend on for some of their food leave their tissue. Without zooxanthellae, corals turn white because zooxanthellae give corals their color. White, unhealthy corals are called bleached. Bleached corals are weak and less able to combat disease.

Climate change alters ocean chemistry leading to ocean acidification

Much of the carbon dioxide that enters the atmosphere dissolves into the ocean. In fact, the oceans have absorbed about 1/3 of the carbon dioxide produced from human activities since 1800 and about 1/2 of the carbon dioxide produced by burning fossil fuels (Sabine et al. 2004)[2]. As carbon dioxide in the ocean increases, ocean pH decreases or becomes more acidic. This is called ocean acidification.

With ocean acidification, corals cannot absorb the calcium carbonate they need to maintain their skeletons and the stony skeletons that support corals and reefs will dissolve. Ocean acidification affects more than just corals. Snails, clams, and urchins also make calcium carbonate shells and ocean acidification negatively impacts these organisms as well. Just like corals, ocean acidification makes it harder for these organisms to absorb the calcium carbonate they need to build their shells[3].



Fig 1: Coral bleaching Source: NOAA



Fig 2: More carbon dioxide in the water makes the ocean more acidic. This coral's skeleton has been damaged by ocean acidification.
Source: NOAA

III. CORAL REEF MANAGEMENT

Coral reefs are facing unprecedented threats from a combination of local and global stressors. At the same time, coral reefs are increasingly recognized as a vital foundation for economic development, community wellbeing and social resilience.

Effective management of coral reefs has become an important focus for coastal communities, and a range of strategies are available to help protect reef biodiversity and facilitate sustainable use. This section introduces some key

strategies for coral reef managers to address local stressors and build resilience of coral reefs in the face of global change. These strategies are important complements to marine protected area (MPA) management and are best implemented as part of an integrated management approach.

Managing local stressors is an important strategy to help maintain the condition of coral reef ecosystems and facilitate the recovery of damaged reefs. MPAs have been identified as a critical management tool to support reef resilience by addressing local stressors. Fisheries management is an essential component of coral reef management in many locations. Reducing land-based impacts is an important strategy aimed at ensuring activities in the watershed are managed to reduce downstream impacts on coral reefs. Managing for disturbance helps coral reef managers to prepare for unpredictable events, such as vessel groundings, disease outbreaks and coral bleaching events. Ecological restoration can be a viable strategy for assisting or accelerating recovery of damaged reefs. Understanding social resilience can be important to the effectiveness and equity of coral reef management. Ocean acidification is a particularly serious result of increasing concentrations of atmospheric CO₂ and an important consideration for coral reef managers. Integrated approaches to management can help managers deal with the complex interdependencies in coral reef systems [4].

IV. RESULTS AND DISCUSSION

Terry Hughes, director of ARC Center of Excellence for Coral Reef Studies located in Australia, said that in the 1980s, when the color of the coral was taken once in the period of 25 to 30 years, it has now increased fivefold in the last three four decades. Have been seen. Since the year 2010, on average, every six years is happening this once. He said that the main reason for this change is the continuous increase in temperature.

Terry Hughes, says white corals can return to their old state, provided the temperature drops. Otherwise Coral may die. Hughes said that the good thing is that despite the devastating effects of summer, nearly one billion moats are still alive and they are more rigid than those who have died. Now we should concentrate on saving that glass, which is still half full. This study underscores that if we do not take global action to limit temperature-rise from 1.5 to 2 degrees, then the reef's habitat system can be widespread. There is a need to immediately assess this danger. The largest coral reef i.e. the Great Barrier Reef is located in the marine area of Queensland. Its total area is 23 hundred km. Due to climate change, sea water is getting damaged due to warming above average. Algae are separated from the edges by the global warming coral bleaching. Algae provide 90% of the energy to the patients. With the

destruction of them, the existence of many marine organisms is also threatening.

One study has shown that the summer of 2016 has had disastrous effects on Australia's famous Great Barrier Reef coriander. Astronomers from Australia's ARC Center for Coral Reef Studies (Coral COE) used to ignore the geographical effect of the heat through satellites. It is worth mentioning that the 2300-km-long Great Barrier Reef is World Heritage Site. In 2016, the sea temperature increased significantly and due to the long lasting summer, many reef rocks were destroyed. Australian scientists have made extensive studies of the impact of heat on this world's largest reef system. According to a study published in Nature Magazine, 29 of the 3863 coral-rocks of this system have lost their corals. Keep in mind that due to the increase in the temperature of the sea, the coral reefs have to face the highest bleaching. During coral bleaching, the coriander expands micro algae. Due to damage to colorful algae, coriander gets white Australia has taken initiative to protect the Great Barrier Reef, an area protected by the UNESCO-based region in its maritime area, from the threat of climate change. He has allocated 16 million US dollars of funds. To save these coral or coral reefs, effective measures have been sought from scientists and entrepreneurs globally. The person concerned will be able to do research on this suggested solution under this fund. The Great Barrier Reef extends over 2,300 kilometers on the Queensland coast of Australia[5]. Bleaching events on coral reefs around the globe were observed in 1998 (West and Salm 2003)[6]. In some Pacific islands, a little bit of bleaching is common in the summer; however, there have been times when bleaching is particularly bad in this region (Craig 2009)[7]. For example, larger than normal bleaching events in the National Park of American Samoa occurred in 1994, 2002, and 2003 (Craig 2009). As climate change continues, bleaching will become more common, and the overall health of coral reefs will decline.

Ocean acidification has lowered the pH of the ocean by about 0.11 units (SCOR 2009)[8]. Moving the ocean's pH from 8.179 to a current pH of 8.069, which means the ocean is about 30% more acidic now than it was in 1751 (SCOR 2009). If nothing is done to reduce carbon dioxide emissions into the atmosphere, ocean acidification will increase and more and more corals will be damaged or destroyed.

If we continue to produce carbon dioxide at the current rate, future atmospheric carbon dioxide will be high enough to lower ocean surface pH to 7.8 by the year 2100 (Royal Society 2008)[9]. Scientists have done laboratory studies that suggest a pH about this low could dissolve coral skeletons and may cause reefs to fall apart (Fine and Tchernov 2006)[10].

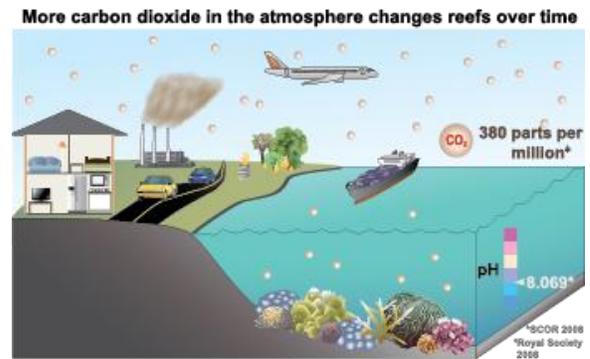


Fig 3: Present-People are releasing unprecedented amounts of carbon dioxide into the atmosphere. This increase in carbon dioxide has lowered ocean surface pH and made it more acidic (SCOR 2009). Source: NOAA

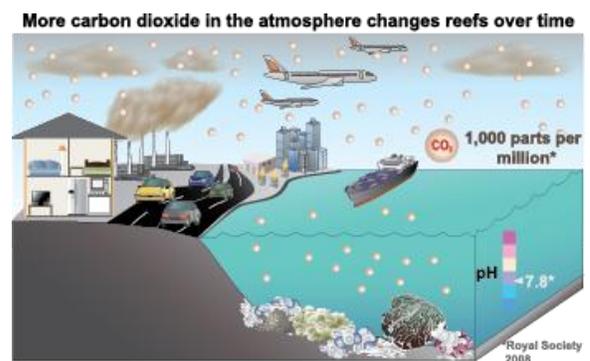


Fig 4: Future (2100): If we continue to produce carbon dioxide at the current rate, the ocean pH will lower to 7.8 (Royal Society 2008). Studies suggest a pH this low could cause coral reefs to fall apart (Fine and Tchernov 2006). Source: NOAA

If coral reefs are lost, vital habitat will be lost too. The future health of coral reefs and many marine organisms depends on our ability to reduce our carbon dioxide emissions on a global scale.

Future emissions depend on how many people there are on the planet, what energy sources we use, how much energy we use, what new technologies we create—just to name a few factors. So, how do scientists investigate what the world will look like in the future if it is not known what future greenhouse gas emissions will be?

They try to make predictions about what the world will look like in the future by using different scenarios. For example, scientists from all over the world work together on the Intergovernmental Panel on Climate Change (IPCC) to generate models that reflect different rates of population growth, economic growth, technology application, and social change. These models help us understand what climate change means for our future and have predicted how the ocean pH may decrease as carbon dioxide emissions increase.

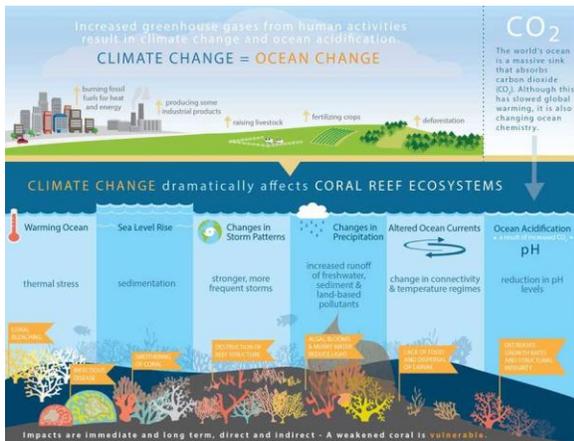


Fig 5: Threats to coral reef, climate change
Source: NOAA

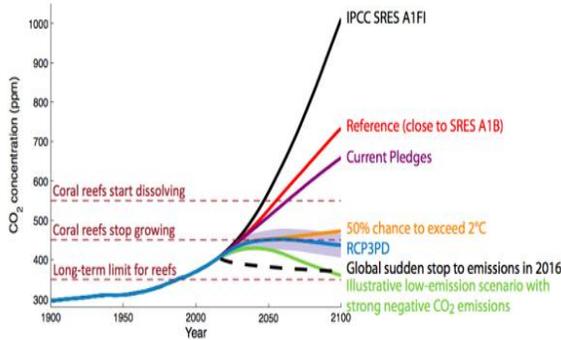


Fig 6: Acidification on corals
Source: Internet

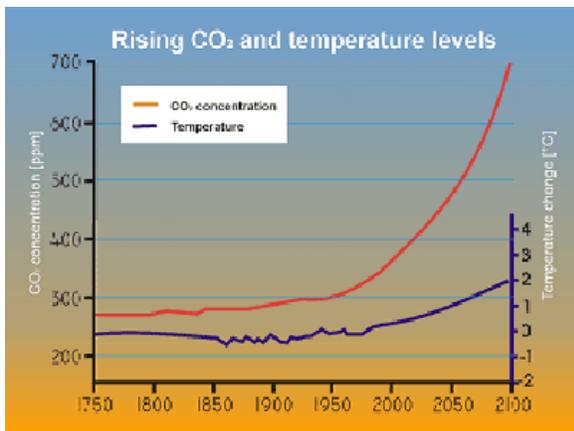


Fig 7: Rising CO₂ and Temperature levels with respect to Year
Source: Internet

- Establishment of Indian Coral Reefs Monitoring Network (ICRMN) for effective implementation of Management Action Plans on identified coral reef areas, training and capacity building in taxonomy, bio-physical methods and scuba diving so as to monitor health of coral reefs and promotion of research on identified thrust areas.

- Establishment of Database Network and Website on Coral Reefs.

- Establishment of National Coral Reef Research Centre at Port Blair. Inclusion of Corals in Schedule I of the Wild Life Protection Act, 1972.

- Establishment of National Focal Points of Global Coral Reef Monitoring Network (GCRMN), International Coral Reef Initiative (ICRI) and Coral Reef Degradation in Indian Ocean (CORDIO) in the Ministry.

- Implementation of UNDP-PDF-B Project on Management of Coral Reefs in Andamans.

- Implementation of India-Australia Training and Capacity Building (IATCB) Project on Coral Reefs. Two scientists from Zoological Survey of India, Marine Biological Station have been trained in Coral Reef Taxonomy at Queensland Museum of Natural History in Australia. A delegation of policy makers, managers and scientists visited various research institutes including Great Barrier Reef Management Authority (GBRMA). A training programme for middle level managers was also organized in Australia.

- On the recommendations of the National Committee on Mangroves and Coral Reefs following coral reef areas in the country have been identified for intensive conservation and management since 1987:

- Andaman & Nicobar Islands, Lakshdeep Islands, Gulf of Kutch (Gujarat), Gulf of Mannar (Tamil Nadu)



Fig 5: Reef flats with dead corals - Rutland Island
Source: MoEF

The Ministry of Environment, Forest and Climate Change (MoEF) is an Indian government ministry report on coral reefs:

- Progress of implementation of Management Action Plans on all the identified Coral Reef areas was reviewed by the

National Committee and financial assistance was extended to the respective States/UTs for implementation of Management of Action Plans during the year.

- Progress of implementation of activities of the National Coral Reef Research Centre in Port Blair was reviewed and grants received for strengthening infrastructure of this Centre leading to biophysical monitoring of health of Coral Reefs.

- Database Network and Website of Indian Coral Reef Monitoring Network (ICRMN) were updated and protocols for sharing of data have been finalized. Database CDs on all the identified Coral Reef areas as per the protocols of GCRMN have been prepared and are being launched on the Website of ICRMN for wider dissemination.

- Planning and Coordination Meeting and Review Workshop of Global Coral Reef Monitoring Network (GCRMN) was organized at National Institute of Oceanography (NIO), Goa and area specific Strategies and Monitoring Action Plans for all the identified Coral reef areas in the country have been discussed. Draft document on National Action Plan on Conservation and Management of Coral Reefs and Strategy for its implementation has been prepared.

- Project on Regeneration of Coral Reefs in Gulf of Mannar was launched with financial assistance from Coral Reef Degradation in Indian Ocean (CORDIO). DFID-RLA completed Pilot studies on Reef Livelihood Alternatives in Andamans, Lakshdweep and Gulf of Mannar (Tamil Nadu).

- Gulf of Mannar Coral Reef area in Tamil Nadu was included in the World List of Biosphere Reserves by UNESCO.

- Final Workshop of UNDP/GEF PDFB Project on Management of Coral Reefs in Andamans was organized in Port Blair to discuss the Project Brief for next phase of this project.

- Under India-Australia Training and Capacity Building project on Coral Reefs a delegation of Scientists, policymakers and senior level managers visited various institutes including Great Barrier Reef area in Australia. Similarly a team of middle level managers and scientists from relevant academic institutions in India underwent a Training on Marine Protected Area Management in Australia. Two scientists from Zoological Survey of India, Marine Biological Station completed a Training in Taxonomy of Coral Reefs in Queensland Museum in Australia.

- Training Programmes on Biophysical and Socio-economic Monitoring of Coral Reefs for middle level Managers in India were organized at GEER Foundation, Ahmedabad and Port Blair.

- Research sub Committee on Mangroves and Coral Reefs reviewed progress of ongoing research projects on Coral reefs and recommended four new research projects during the current financial year as given in Annexure V[11].

V. CONCLUSION

Coral reefs form some of the world's most productive ecosystems, providing complex and varied marine habitats that support a wide range of other organisms. Coral reefs deliver ecosystem services to tourism, fisheries and coastline protection. Coral reefs protect shorelines by absorbing wave energy, and many small islands would not exist without their reefs to protect them. So in this time the protection of coral reefs is highly importance.

Steps to protect coral reefs:

1. Conserve water: The less water you use, the less runoff and wastewater will pollute our oceans.
2. Help reduce pollution: Walk, bike or ride the bus. Fossil fuel emissions from cars and industry raise lead to ocean warming which causes mass-bleaching of corals and can lead to widespread destruction of reefs.
3. Research what you put on your lawn: Although you may live thousands of miles from a coral reef ecosystem, these products flow into the water system, pollute the ocean, and can harm coral reefs and marine life.
4. Dispose of your trash properly: Don't leave unwanted fishing lines or nets in the water or on the beach. Any kind of litter pollutes the water and can harm the reef and the fish.
5. Support reef-friendly businesses: Ask the fishing, boating, hotel, aquarium, dive or snorkeling operators how they protect the reef. Be sure they care for the living reef ecosystem and ask if the organization responsible is part of a coral reef ecosystem management effort.
6. Plant a tree: Trees reduce runoff into the oceans. You will also contribute to reversing the warming of our planet and the rising temperatures of our oceans. Help us Plant a Billion.
7. Practice safe and responsible diving and snorkeling: Do not touch the reef or anchor your boat on the reef. Contact with the coral will damage the delicate coral animals, and anchoring on the reef can kill it, so look for sandy bottom or use moorings if available.
8. Volunteer for a coral reef cleanup: You don't live near a coral reef? Then do what many people do with their vacation: visit a coral reef. Spend an afternoon enjoying the beauty of one of the most diverse ecosystems on the Earth.
9. Contact your government representatives: Demand they take action to protect coral reefs, stop sewage

pollution of our oceans, expand marine protected areas and take steps to reverse global warming.

10. Spread the word: Remember your own excitement at learning how important the planet's coral reefs are to us and the intricate global ecosystem. Share this excitement and encourage others to get involved[12].

VI. REFERENCES

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