

A Review to Coral Reef Ecosystem: A Critical Habitat to Look after for Conservation of Marine Biodiversity

Suman Nama

Fisheries Resource Harvest and Post-Harvest Management Division
ICAR-Central Institute of Fisheries Education, Pinch Marg, Off Yari Road, Versova, Mumbai 400061, India

Abstract: Corals are found in tropical and sub-tropical world's oceans. Corals are the most diversified, economically, and ecologically valuable ecosystems. Reef ecosystem covers 0.1% area of the world and supports 25% of ocean life, including fish, crustaceans, mammals, sponges, and echinoderms. Corals are also known as 'Rainforests of the Sea' because of the native biodiversity. Coral reefs provide economic, social, cultural, and ecosystem services. Despite providing immense ecosystem services, corals are degraded to a great extent due to climate change, anthropogenic threats, Coastal development, overfishing, and destructive fishing practices. This magnificent creature of nature needs to be protected by adopting management and conservation strategies recommended by national and international authorities. Some advanced management methods like satellite-based study (mapping, monitoring) and coral gardening adaptation are essential for obtaining maximum benefits out of the reefs ecosystem without harming it.

Keywords: Coral reef, Rainforest, echinoderms, mapping, overfishing.

1. Introduction

Coral reef ecosystem is the most diverse, ancient, and highly productive underwater ecosystem, but they are sensitive and fragile to environmental changes. Coral belongs to the phylum Cnidaria, and class Anthozoa in the animal. Generally, corals are available throughout the world oceans, but reef-building coral (hermatypiccorals) is found in the ocean's tropical and subtropical region (300N and 300S latitudes). Coral mostly grows in shallow, bright, warm, and agitated water. Coral reefs are essential marine resources in the tropical and subtropical regions of the world ocean (Spalding et al., 2001). Reefs occur in less than 0.1 percent of the ocean area, yet they provide shelter for 25% of all marine species (Spalding et al., 2001). Apart from the biodiversity, coral also plays a crucial role in shoreline protection, revenue generation, and employment generation. Different species of corals found in different ocean basins of the world. The reefs in the tropical western Atlantic Ocean look different from the reefs in the Indo-Pacific region. The structure and Reef type are differing from area to area. The types of reefs included are

- 1) Fringing reefs: They reefs are directly attached to the shore and grow towards the sea. Also known as shore reefs. These are found in Andaman and Nicobar Islands, Gulf of Mannar and Palk Bay.
- 2) Barrier reefs: These are separated from a mainland or island shore by a lagoon and are present in Andaman and Nicobar Islands. Barrier reefs are found in Australia (The great barrier reef).
- 3) Platform Reefs: Platform reefs are almost flat reefs without any lagoon. They may associate with the coast and a barrier reef. These reefs are found in the Gulf of Kutch of India.
- 4) Atolls: Atolls are circular or continuous barrier reefs and extend around a lagoon without a central island. Lakshadweep is the only atoll union territory of India.

Although coral provides various ecological, regulatory, provisional, and cultural services, their habitat is degraded and destroyed due to the several natural and anthropogenic activities such as climate change, storms, hurricanes, pollution, coral mining, anchoring.

Zones of the coral reef: There are three distinct zones of coral reef contained in a coral reef, i.e., the fore reef, reef crest, and the back reef (frequently referred to as the reef lagoon) which support different types of life forms. The reefs generally occur less than 50m water depth, and the reefs are ecologically and physically interlinked. The reef lagoon is an entirely enclosed area, and it is less affected by wave action and often contains small reef patches (Moyle et al., 2004).

Locations of corals: Coral reefs cover an area of about 284,300 km² (109,800 sq mi), which is just under 0.1% of the oceans' surface area (UNEP 2001). The Indo-Pacific region (including the Indian Ocean, Southeast Asia Red Sea, and the Pacific) accounts for 91.9% of this area. Southeast Asia contributes 32.3% of that area, while the Caribbean and Atlantic coral reefs account for 7.6% and Pacific, including Australia, which accounts for 40.8% of that figure (Spalding et al., 2001). The optimum temperature for growth of the most coral reefs is 26–27 °C, and few reef exist in waters below 18 °C (Achtuvand Dubinsky, 1990). However, the reefs in the Persian Gulf have adapted to temperatures of 38 °C (100 °F) in summer and 13 °C (55 °F) in winter (Wells and Nick, 1992). Coral reefs are scarce along the west coasts of Africa and America primarily due to intense cold coastal currents and upwelling (the Benguela, Canary Currents, and Peru respectively) that makes water temperatures below the optimum level for coral growth in these areas (Nybakken and James, 1997). Corals are scarcely found along the coastline of South Asia Myanmar borders and from the eastern tip of India (Chennai) to the Kolkata and as well as Bangladesh and along the north-eastern South American

coasts of due to heavy freshwater discharge from the Ganges and Amazon Rivers respectively (Spadling *et al.*, 2001).

Coral reef biodiversity: These ancient reef structures provide various and complex marine habitats that support the number of a million of aquatic flora and fauna including fish, sponges, seabirds, worms, crustaceans (shrimp, crabs, and lobsters), cnidarians (jellyfish and corals), mollusks (cephalopods), echinoderms (sea cucumbers, starfish and sea urchins), sea snakes, sea turtles, seagrasses, marine algae. (Costanza *et al.*, 2014). That exceptional richness in biodiversity has given them the nickname "rainforests of the sea" (NOAA 2020). Higher the species diversity, the higher the biomass.

Importance of coral reef ecosystem:

Economic importance: Healthy coral reefs support subsistence and commercial fisheries, jobs, and businesses through tourism and recreational fishing trip. The global economic value of coral reefs ecosystem is in between US\$29.8 billion, i.e., Tourism activities represent \$9.6 billion, fisheries \$5.7 billion, biodiversity \$ 5.5 billion and coastal protection \$9 billion (Cesar *et al.*, 2003) and \$375 billion per year (Costanza *et al.*, 1997). Due to their immense recreational and economic value, the coral reefs are severely destroyed by habitat destruction, pollution, disease, and overfishing activities. Millions of people worldwide depended on coral reefs for employment, food, and protection.

Tourism Benefits of Reefs: Coral reef ecosystem attract visitors from across the globe to enjoy recreational purposes. More than hundreds of countries & territories benefited from coral reef-associated tourism. Recreational activities provide livelihood opportunities for local tour operators. Every year tourism and recreational activities account for \$9.6 billion (Cesar *et al.*, 2003).

Sustainable Fisheries: Approximately one billion people, many of whom are in developing countries, rely on fish as their primary source of animal protein (MSC 2014). Coral reef fisheries are worth \$6.8 billion a year globally (Burke *et al.*, 2011) and over \$100 million per year in the United States (NOAA 2008). Every year about 6 million tons of fish are captured from the coral reefs ecosystem. Well-managed coral reefs can produce 15 tons of seafood per square kilometer per year. The annual value of \$2.4 billion is gained every year from Southeast Asia's coral reef fisheries (WWF 2011).

Employment: Coral reef provides employment opportunities for millions of people worldwide, including hotel rooms, dive trips, clothing, and gear to sport fishing. Southeast Florida's coral reefs generate \$324 million per year in local sales and provide more than 70,000 jobs. Hawaii's coral reefs attribute \$304 million directly from reef tourism and recreation.

Shoreline protection: Beyond the ecological and biological value, the coral reefs structures protect about 150,000 km of shoreline in about 100 countries and territories (The World Fish Center and WRI 2011). Coral reefs absorbed wave

energy, reduce routine soil erosion, lessening inundation, and wave damage. Moreover, many small islands would not exist without reefs. The coral reefs protect infrastructure, human settlements, and valuable coastal ecosystems such as mangrove and seagrass meadows (Fernando *et al.*, 2008).

Medical Discoveries: There are several bioactive compounds extracted from the coral reef ecosystem. Many such compounds have massive potential for discovering life-saving drugs and pharmaceuticals. Explorations into the medical application of reef-related compounds to date include treatments for cancer, HIV, malaria, and other diseases. For example, scientists have synthesized an anti-cancer agent discovered in the Caribbean Sea squirts into a treatment for ovarian and other cancers (Glaser and Mayer, 2009).

Threats to the coral reef ecosystem:

• Environmental threats:

• **Coral bleaching:** Due to climate change (increases SST, Salinity), mass coral bleaching events occurred in the summers of 1998, 2002, and 2006. With this increasing SST and bleaching events, corals will not be able to keep up lead to increased disease susceptibility. The symbiotic algae 'zooxanthellae' inhabit in coral and have got vibrant color. When the water temperature rises, the algae expel from the coral, which leads to the coral discoloration and the coral die. The reef can recover if the water temperature back to normal quickly.

• **Ocean Acidification:** The atmospheric CO₂ sink into the ocean bottom and make the seawater more acidic, which dissolves the shells of corals. The reef becomes more fragile and less able to protect its residents.

• **Diseases outbreaks:** Coral reefs are vulnerable to certain diseases due to environmental and physical threats, and a vast reefs area is damaged every year. Some common diseases are occurring in corals such as pink diseases, Black and white band diseases.

• **Biological threats:** Crown of thorns (Starfish) prey upon the coral polyps and release neurotoxins to absorb the coral (Bradbury *et al.*, 1985). As a result, the coral deprived of nutrients and die.

• **Invasive Species:** A well balanced, healthy habitat, and the interdependent system is toppled by invasive or alien species (Hutchings, P.A. 1986). When new species introduced into a new reef ecosystem, they can alter the reef habitats by consuming food, oxygen, light, and other resources. As a result, the reef is weakened, or corals die, and the native species will disappear and decline.

• Anthropogenic threats:

• **Pollution:** Farming practices damage the reef due to overgrazing, nutrients (fertilizers), and chemicals including herbicides and pesticides and sediments of agricultural, posing a significant threat for the coral and coral reef biodiversity.

• **Eutrophication:** The overuse of fertilizer releases some vital nutrients (nitrogen, phosphorus, and potassium) into the ocean ecosystem. These limiting nutrients cause massive algal bloom, leading to depletion in oxygen available for marine organisms, altering the species composition, and decreasing the biodiversity of coral reefs. Fertilizers enhanced the phytoplankton production

and made available for the crown-of-thorns starfish larvae to consume.

- **Pollution from mining:** Mining caused disturbance of sea bed by increasing Turbidity. Limiting nutrients like Nitrates are releasing into water bodies and causing eutrophication.
- **Overfishing:** Unsustainable overfishing on the vast area of the world's coral reefs affects the ecological balance by the extinction of certain fish species, altering the food chain, closures, and collapses of fisheries of coral reef ecosystem (Sweatman and Robertson, 1994).
- **Destructive fishing practices:** Destructive fishing methods, including bottom trawling, dynamite fishing, cyanide fishing, and Muroami fishing, are causing significant damage to coral reefs (Sweatman and Robertson, 1994). Bottom-trawling is one of the greatest threats to the coral reef ecosystem (Clark and Tittensor, 2010).
- **Unsustainable coastal development:** Coastal infrastructure and tourist resorts built close enough to coral reefs, causing significant damage to them. The impacts of coastal development vary widely and can put considerable additional pressure on coral reef systems. Some resorts and coastal households dumped their wastes or sewage directly into coastal.
- **Careless tourism:** Careless tourism like boating, fishing, diving, and snorkeling happens worldwide, and tourists are touching reefs, collecting coral, stirring up sediment, and dropping anchors on reefs. Tourism activities via offshore platforms are responsible for the spread of coral disease (Lamb and Bette, 2011).
- **Shipping (Oil spills):** Shipping accidents occur mostly due to commercial shipping routes pass through the world ocean. In 2010, the *Shen Neng* (bulk coal carrier) ran aground on Douglas Shoals, spilling four tons of oil into the water and causing severe damage to the reef ecosystem.

What we can do for reef conservation:

- The best possible way to conserve the coral reefs ecosystem and reduce future habitat loss is to know everything about coral reefs and share our knowledge. We can conserve corals by surveying, locating, and monitoring coral reefs around the world.
- The conservation strategies adopted by several international organization (NOAA) includes surveying, Reef mapping, Monitoring, Assessment of reefs, modeling, Biological and socio-economic research work, education, Management.
- Designating coral reef as a marine national park, biosphere reserve, and world heritage site can offer better protection (UNESCO 2016). Example, Great Barrier Reef.
- For conservation and management of the degraded coral habitat restoration program can be adopted. Coral gardening or coral farming is a potentially useful tool for restoring coral reefs (Hatcher and Gordon, 1988).
- We can be involved in community-based coral reef restoration, surveying and monitoring programs, beach clean-ups, marine aquariums, and clean-up the river or lakes waterways that end up in the ocean.

- We can Purchase wisely to legally collected and ethically raised and aquarium fish and corals ornaments.
- Can Join local environmental or aquarium clubs and Support coastal communities.
- We can Practice good coral reef civility by Avoiding touching, sitting on coral, and anchoring on reefs.
- We can follow the RRRs policy (Reduce, Reuse, Recycle). It can make understand people not to trash the ocean and Reporting dumping or other illegal activities.

Conclusion

Coral reef, the magnificent creature of nature, is providing various enormous economic, environmental, and ecosystem services. Despite their immunes commercial and recreational value, coral reefs are critically threatened by habitat destruction, pollution, and disease outbreak. Once coral reefs are damaged, it may take several decades to restore the reefs and may also lose many creatures inhabited in them. Once the coral biodiversity is degraded, it supports fewer species of flora and fauna (fish, plants, animals, and mammals). As a result, the coral loses its value as a tourist destination. Threats to coral reefs may bring severe hardship to coastal communities and nations for whom economy, livelihoods, and food are closely associated with reef ecosystem services. Many management measures (coral gardening, creating a substrate for coral, community-based management) need to be adopted globally to conserve the beautiful creatures on nature. The issues like ocean acidification and climate change need to be addressed globally, and international authorities' involvement with local communities is essential for safeguards of corals around the world. Research about coral reef habitat status and the outreach and education of coastal communities is necessary for sustaining the coral resources.

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