
WORKING PAPER 175/2018

**Current Status of Coral Reefs in India:
Importance, Rising Threats and Policies for its
Conservation and Management**

**Srihitha Baswapoor
Zareena Begum Irfan**



**MADRAS SCHOOL OF ECONOMICS
Gandhi Mandapam Road
Chennai 600 025
India**

July 2018

*Current Status of Coral Reefs in India: Importance,
Rising Threats and Policies for its Conservation and
Management*

Srihitha Baswapoor

MA Environmental Economics, Madras School of Economics

Zareena Begum Irfan

Associate Professor, Madras School of Economics

Corresponding Author

zareena@mse.ac.in

WORKING PAPER 175/2018

**MADRAS SCHOOL OF ECONOMICS
Gandhi Mandapam Road
Chennai 600 025
India**

July 2018

Phone: 2230 0304/2230 0307/2235 2157

Fax : 2235 4847/2235 2155

Email : info@mse.ac.in

Price : Rs. 35

Website: www.mse.ac.in

Current Status of Coral Reefs in India: Importance, Rising Threats and Policies for its Conservation and Management

Srihitha Baswapoor and Zareena Begum Irfan

Abstract

Coral reefs are the most ancient and diverse eco-systems on earth, occupying less than 1 percent of the ocean floor and host more than 25 percent of all known marine species of the world. Reefs provide wide range of economic and environmental services to millions of people. Despite their immense importance, coral reefs are being damaged and destroyed due to natural and anthropogenic activities. If the same situation continues, by 2030, 90 percent of the reefs will be in danger and are likely to cause hunger, poverty and political instability around the world as the livelihoods of millions of people would disappear. In this context, studying the status of coral reefs and increasing threats to them becomes extremely important. The objective of this study is to focus on the exploitation of corals, understand their importance and analyse government policies intended for its conservation and management. The reef formation in India is restricted to four major centres Gulf of Kutch, Gulf of Mannar, Lakshadweep Islands and Andaman and Nicobar Islands. Reefs provide ecosystem services such as provisional, regulatory, cultural and supporting services. Climate change impacts of coral reefs are coral bleaching, sea level rise, stronger storms, ocean acidification and ozone layer depletion. The current law and policy framework for coral reefs in India is virtually non-existent except its protection through five Marine Protected Areas. Brief insights into international policy framework on coral reefs indicates that Australia has done a lot towards private sector involvement and local community participation in conservation of coral reefs, both of which India lacks. Similarly, Indonesia has good public awareness campaigns and capacity building programmes which could be implemented in India to improve reefs. Major policy suggestion made for improving the coral reef ecosystems in India is to have a separate legal status for them so as to regulate and prevent harmful activities.

Key words: *Coral reefs, Conservation, Ecosystem services, Climate change and Policy*

JEL Codes : *Q220, Q250, Q260, Q570, Q580*

ABBREVIATIONS

- (1) CBD - Convention on Biological Diversity
- (2) CITES - Convention on International Trade in Endangered Species
- (3) **CRZ1** – (I) Areas that are ecologically sensitive and important such as national parks, sanctuaries, reserve forests, wildlife habitats, mangroves, coral reefs, areas close to breeding and spawning grounds of fish and other marine life, areas of outstanding beauty/areas rich in genetic diversity, areas likely to be inundated due to rising sea level; consequent upon global warming and such other areas, as may be declared by the Central and State Government at the State or Union territory level from time to time (II) Area between low Tide Line and the High Tide Line
- (4) **CRZ4 (Andaman and Nicobar Islands)** - (I) No new construction of buildings shall be permitted within 200 metres of the HTL (II) Corals and sand from the beaches and coastal waters - shall not be used for construction and other purposes (III) Dredging and under water blasting in and around coral formations shall not be permitted (IV) Further, in some islands, coastal stretches may also be classified into categories CRZ (I) or (II) or (III) with the prior approval of the Ministry of Environment and Forests and in designated stretches, the appropriate regulations given for respective categories will apply.
- (5) GCRMN- Global Coral Reef Monitoring Network
- (6) NIO – National Institute of Oceanography
- (7) NOAA- National Oceanic and Atmospheric Administration
- (8) UNCLOS - United Nations Convention on the Law of Sea
- (9) UNDP- United Nations Development Programme

Acknowledgement

The authors are grateful to their parent institute which provided them the infrastructural benefit of conducting the research work.

**Srihitha Baswapoor
Zareena Begum Irfan**

INTRODUCTION

World's richest biodiversity areas are found on the coastal zones and the coral reefs are the prominent ones among them. Coral reefs are the most ancient and diverse eco-systems on earth. Occupying less than 1 percent of the ocean floor, they are home to more than 25 percent of all known marine species of the world (WWF). They support more species per unit area than any other marine environment. This includes more than 4000 species of fish, 700 species of coral and thousands of other species of plants and animals, all which play a unique and vital role in the reef-ecosystem. In addition to providing valuable habitat for marine creatures, they are incredibly beautiful, with seemingly infinite structures and growth forms. Coral Reefs are often called the "Tropical Rainforests of the Sea", for their astounding richness of life and extraordinary uniqueness. Being storehouses of immense biological wealth, reefs also provide wide range of economic and environmental services to millions of people around the globe. Globally, half a billion people are estimated to live within 100 kilometres of a coral reef and benefit from its production and protection (NOAA). Despite their immense importance, coral reefs are being damaged and destroyed at an increasing rate underwater due to both natural and anthropogenic activities. According to World Resources Institute Report (2011), 75 percent of the world's coral reefs are endangered, of which a quarter of them have already been damaged beyond repair. If present rates of destruction are allowed to continue, 90 percent of the reefs will be in danger by 2030, and nearly all of them by 2050. If coral reefs vanish completely experts predict hunger, poverty and political instability around the world as the livelihoods of millions of people would disappear. Against this backdrop, studying the present status of coral reefs and increasing threats to them becomes extremely important. The objective of this paper is to throw light on the increasing exploitation of corals, understand their importance and analyse government policies intended for its conservation and management. The present paper also provides brief insights into international policy framework on coral reefs with a comparative analysis of these policies vis-a-vis India.

REVIEW OF LITERATURE

Coral reef ecosystems are under increasing natural and anthropogenic pressures, despite their ecological significance and economic importance to mankind. In this context, Magnus Ngoile (1998), analysed the global area loss of coral reef systems and the interactions of coral reefs ecological linkages to other coastal and marine habitats. It was found out that the global area of the coral reefs was 6,00,000 km² (almost equal to the size of France or Somalia) out of which 60,000 km² have already been degraded and 1,80,000 km² are threatened. The researcher argued that the coastal waters are biologically richer than the open oceans and deep sea. Mangroves and coral reef ecosystems were found to be interdependent in his study. Coral Reefs protect mangroves from violent storms whereas mangroves prevent silting on reefs, provide nursery areas to fish whose adult age is in the reef area and they also absorb nutrients from the terrestrial area therefore cushioning the effects on reefs which require less nutrients. The study suggested that management measures for the preservation of reef systems must link coastal and marine systems, pay attention to socio-economic factors as well as institutional and legal ones, employ a cooperative approach, and be based on scientific advice.

A Study done by Venkataraman (2011) throws light on the diversity of species in the coral reefs both at the global and the Indian level. As many as 100,000 species may have been named and described worldwide from reefs, but the total number inhabiting the world's reefs may be anything between half and 2 million. Large portions of the world's reefs occur within the Indian ocean. According to him, Indian reefs have a total of 199 species, recorded from 37 genera. Among the four major reef areas of India, Andaman and Nicobar Islands are found to be very rich and Gulf of Kutch is poor in species diversity. Lakshadweep Islands have more number of species than the Gulf of Mannar. There are 18 families reported from the world, of which 15 are represented in India. This diversity is almost the same when compared

biogeographically to all reefs in the world. However, of the 111 genera reported from the world, India has only 60, which is slightly less when compared to Indo-Pacific centre of diversity (82 genera).

In an important study done by Stephanie and Wear (2016) based on the responses from 170 managers representing organisations from 50 countries, overfishing and coastal development were found out to be the two major threats for coral reef degradation. While overfishing receives much attention, coastal development and its attendant pollution are largely neglected and underfunded. The study results call for a re-examination of how resources are allocated in coral reef conservation, with more attention given to aligning how money is spent with what are perceived to be the primary threats.

CORAL REEFS IN INDIA

India has a coast line of nearly 8129 km. However, the reef formation is restricted to four major centres (1) Gulf of Kutch (2) Gulf of Mannar (3) Lakshadweep Islands and (4) Andaman and Nicobar Islands (Saroj, Gautam and Joshi, 2016) The total area of coral reefs in India is estimated to be 2,375 Sq. Km (DOD and SAC 1997). Not all these regions have the same types of coral reefs. Reef type and the structure differs from area to area. The types of reefs include (1) Fringing reefs: They are directly attached to the shore and grow towards the sea. These are found in Andaman and Nicobar Islands and Gulf of Mannar. (2) Barrier reefs: are separated from a mainland or island shore by a lagoon and are present in Andaman and Nicobar islands. (3) Atolls: are circular or continuous barrier reefs and extends all the way around a lagoon without a central island. Lakshadweep is the only atoll union territory of India.

ECOSYSTEM SERVICES OF CORAL REEFS

Coral reefs are very productive ecosystems. Not only do they support enormous bio-diversity but are also of immense value to human kind. Ecosystem goods and services represent the benefits human populations derive, directly or indirectly from ecosystem functions (Costanza *et. al.*, 1997). The following section briefly discusses the provisional, regulating, cultural and supporting services of coral reefs.

Provisional Services

Food and Fisheries

Coral reefs are vital to the world's fisheries. They form nurseries for about a quarter of the ocean's fish, and thus provide primary source of protein. They also generate revenue for local communities, national and international fishing fleets. If properly managed, each year for every square kilometer, reefs can yield around 15 tonnes of fish and other seafood.

Medicinal Advances

Coral reefs are often referred as the 'medicine chests of the sea'. Coral reefs have the potential to provide cures for life-threatening diseases such as cardio-vascular, ulcers, leukemia, lymphoma and skin cancer. In addition coral's unique skeletal structure has been used to make most advanced forms of bone-grafting materials.

Rich Minerals

Coral Reefs are rich in limestone which is often used as a cement substitute in the construction industry. At an industrial level, the coral sand rich in calcium is also a potential raw material for the cement industry.

Regulating Services

Coastline Protection

Healthy reefs act as natural barriers, protecting coastal cities, communities, harbours and beaches from pounding ocean waves and thus prevent erosion, property damage and loss of life. In the Indian Ocean Tsunami of December 2004, some coastlines were spared further damage as a result of healthy reefs. The reefs thus save billions of dollars each year in terms of reduced insurance and reconstruction costs and reduced need to build costly coastal defences-not to mention the reduced human cost of destruction and displacement. Also barrier reefs help stabilize mangroves and seagrass beds which can be easily uprooted by large waves and h6 currents.

Water Filtration

Most corals and sponges are filter feeders, which means that they consume particulate matter suspended in the water column. This contributes to enhanced quality and clarity of our near shore waters.

Air Quality Maintenance

Corals use the dissolved carbon dioxide in the ocean water to form new reefs. This gas conversion to limestone shell controls the carbon dioxide levels in the ocean. Without coral's activity, that gas could saturate the ocean and air mass above it. All wildlife, including humans, would be negatively affected with a higher carbon dioxide level. (The above mentioned provisional services of the coral reefs have a marketable value while the regulating services are non-marketable)

Cultural Services

Tourism, Recreation and Aesthetic Services

Coral reefs are often a backbone to the costal economies through extensive tourism. Diving tours, fishing trips, hotels, restaurants, and other businesses based near reef systems provide millions of jobs and contribute billions of dollars all over the world. Studies show that on average, countries with coral reef industries derive more than half of

their Gross national product (GNP) from them. Also the reef itself is a tourist attraction, creating water sport economies based on snorkelling and Scuba fees. The recreation, aesthetics and adventure provided by coral reefs may not match any other ecosystem. Thus, sustainably managed coral reef-based tourism can also provide additional sources of income to poorer coastal communities in developing countries.

Intrinsic Cultural Heritage Value

For many coastal societies around the world, coral reefs and their inhabitants are intricately woven into cultural traditions also.

Supporting Services

Coral reefs are the source of nitrogen and other essential nutrients for marine food chains. They also assist in carbon and nitrogen fixing along with assisting in nutrient recycling. The fishing industry depends on coral reefs as many fish spawn there and juvenile fish spend time there before making their way to the open sea. The high species diversity in the coral reefs also help in maintaining a balance in the ocean's food web.

STATUS OF CORAL REEFS IN INDIA

It can be seen from Table 1 that the Andaman and Nicobar islands have the largest stretch of coral cover in India. They are not only the largest in terms of area but also rich in diversity. 89 percent of India's Coral diversity is seen in these reefs. The major coral reef bleaching event of 1998 caused widespread damage to the Indian Coral Reefs especially to the reefs of Gulf of Kutch and Lakshadweep. Fortunately, the later showed a good potential for recovery due to slow tourism development and lesser population pressures. Impact of coral mining, and sewage and oil pollution were not found in these reefs. Whereas corals in the Gulf of Kutch region survive through extreme conditions such as high temperature, salinity charges, high suspended particulate loads and tides as high as 12mts caused due to industrial development, ports, harbours and oil extraction. This causes stress to the corals and as a result coral

fauna/diversity in Gulf of Kutch is comparatively less diverse than other parts of India. This also makes its potential for recovery low after the bleaching event of 1998. Incidents of aquaculture, destructive fishing and industrial pollution are severe in the Gulf of Mannar Reefs which again makes its potential low for recovery and hence deserves special attention.

Table 1: Status of Coral Reefs in India

Particulars	Geographical location	Area of the reef (in Sq.Km)	Destruction during Bleaching - 1998	Potential for Recovery
Gulf of Mannar	21 islands, South East Coast of India 140 km, between Tuticorin and Rameswaram	94.3	60-80 percent loss of live cover. Only 25 percent live corals remaining	Medium-Low
Gulf of Kutch	40 islands, Northern side of Saurashtra peninsula	325.5	50-70 percent	Medium-Low
Andaman and Nicobar Islands	530 islands	1021.46	15-20 percent	Good
Lakshadweep Islands	Uninterrupted chain of coral atolls- stretch of 2000 km	933.7	70-90 percent loss of live cover	Good

Source: Saroj (2016), Jayaprakas and Radhakrishnan (2014), SAC (2010), Rajasuriya, (2000), D.O. D. and S. A. C. (1997)

THREATS TO CORAL REEFS

Being sensitive, Coral Reefs are prone to various natural and anthropogenic threats. While the natural threats are humanly uncontrollable, the manmade catastrophes leave them in a vulnerable state. Natural threats include (1) Predation by the crown; (2) Periodic exposure (3) Continuous pounding by waves on the fore reef and (4) Bio-erosion. Whereas anthropogenic threats are (1) Coral mining and Construction; (2) Destructive fishing methods; (3) Unsustainable tourism; (4) Boat anchors (5) Mangrove destruction; (6) Coral collecting and (7) Pollution. An in-depth analysis of these threats is given below.

Natural Threats

Predation by the Crown

The triton snail living on the ocean bed feeds on the young ones of the crown of thorns starfish and keeps their number in check. Once, commercial harvesting of these triton shells has started, there were not enough snails to feed on the starfish. This has led to build-up of star fish population which in turn fed on coral reefs. This problem is more serious in the Gulf of Mannar and Lakshadweep islands in India.

Exposure

Corals living in the inter-tidal zones periodically get exposed to atmosphere. This generally lasts for 1-2 hours and corals can withstand this. But in regions of high tidal amplitude, as in Gulf of Kutch, this exposure lasts for several hours and if coincided with sunny weather it can kill corals (NIO).

Natural Breakdown

Coral Reefs are home to hundreds of species of marine creatures but not all are grateful to them. Many fishes graze corals, either dead or alive and change their morphology, making them more susceptible to other physical and chemical threats.

Continuous Pounding by Waves

Corals living in shallow waters are most affected by violent waves and storms. Particularly during hurricanes, corals, several metres below can be killed. This incidence is very high in the Pacific reefs but very rare in the Indian ones.

Anthropogenic Threats

Coral Mining

Very often, corals are removed and used to build houses and produce lime. Unfortunately distinction is not made between live and dead corals. Large patches of low lying reefs are thus lost (see box 1). This impact is profound in Gulf of Mannar region where 250 m³ of corals are quarried every day (Rajasuriya *et. al.*, 2000). On an industrial scale, this is catastrophic.

Box 1: Coral Mining in Gulf of Kutch

The extraction of coral sands in Gulf of Kutch was leased out to a cement company in the 1980's. Every year, about a million of tonnes of coralline material, including live corals were dredged out, killing a large portion of the reefs. Fortunately, better sense prevailed and the lease was not renewed. But the damage was already done and the loss of coral cover was in excess of 50 percent at most of the reefs in the leased out areas.

Source: National Institute of Oceanography, India - www.nio.org

Destructive Fishing Methods

Fishermen generally use dynamite under water as an effect of which fishes get narcotized and stunned, hence float to the surface where they are collected. But this causes intensive damage to the corals by smashing them into bits and pieces. However this is not practiced in India because of non-accessibility to dynamite. What is more prevalent in India is the practice of collection of live baits and ornamental fish. The live bait fish are used in Tuna fishing and ornamental fish are collected for sale. Both these fishes live in between the coral branches or around coral colonies. Fishermen encircle the corals with large patches of net and hit on the corals for the fish to come out. In the process of collecting these fish which are worth just a hundreds of rupees, coral species growing over

several years are killed. This activity impacted the diversity of coral species in Lakshadweep islands where Tuna fishing is a major economic activity.

Boat Anchors

Most of the fishermen anchor their boats into the shallow parts of the water when they go for reef fishing. When the anchor falls on the corals or sometimes if the boat drifts, the chain gets dragged over the corals. This can break the branches of the corals and uproots them. The damage is enormous when a large ships anchor (weighing 20-30 tons) sweeps over the reefs (see box 2). If moored buoys, which float on water could replace the boat anchors large damage could be controlled.

Box 2: Incidents of Boat Anchor Damages

Several incidents in the past, involving both cruise and cargo vessels have caused great threat to the coral reefs by hitting and grounding. In August 2010, within a span of eight days, two container vessels and a cargo ship caused serious damage to the coral reef near Mumbai and off the Kavaratti Island in Lakshadweep, which seconds the Andaman and Nicobar Islands for the largest collection of reefs in Indian waters. In another incident, in April 2010, a Chinese cargo ship, ShenNeng-1 ran aground on the Douglas shoal at the Great Barrier Reef, and caused immense damage. Prior to this, the world's largest marine conservation park had suffered three major ship groundings, in the past decade. The most frightening fact is that an anchor-damaged reef may never recover, and even if it does, it may take about 50 years.

Source: Lyn Baum, 2017.

Coral Collection

Beautiful white and black corals are harvested for jewellery making and branching corals are most often collected for souvenir purposes. Gulf of Kutch and Andaman and Nicobar islands are largely damaged because of coral collecting. Though these areas have laws to regulate the ban on gathering of corals, they are very vague and difficult to implement (Saxena, 2015). When we purchase these souvenirs, we are unknowingly contributing towards the damage of the reef.

Mangrove Destruction

The mud-binding capacity of the mangroves help them filter the amount of sediment reaching the ocean bed and thus settling on corals. When mangroves are devastated on a large scale it indirectly affects the corals which lie under the shade of them. Gulf of Kutch in India witnesses huge destructions of mangrove forests, thus affecting the life of coral reefs there.

Unsustainable Tourism

Snorkelers, divers who dive into the water sometimes unknowingly stamp the corals which destroy them. An interesting fact observed is, the sunscreen applied by human beings, when comes in contact with water, leaves chemicals which is also harmful to reefs. In Andaman and Nicobar islands in India where tourism is a major economic activity - plastic, oil, sewage solid waste are also major issues of concern.

Pollution: Corals are very sensitive to oil and metal pollution. Reefs in Gulf of Kutch area which are located near the harbours are innately doomed. Andaman and Nicobar Islands, known for its logging industry witnesses huge loads of sedimentation. As a result of this mud and silt settling, corals under water are killed by smothering. Reefs are also severely affected by thermal pollution.

CLIMATE CHANGE: IMPACT ON CORAL REEFS

Coral Bleaching

Warmer water temperatures can result in coral bleaching. When water is too warm, corals will expel the algae (zooxanthellae) living in their tissues causing the coral to turn completely white. This is called coral bleaching. Major coral bleaching event occurred in 1998 around the world. According to NIO, more than 40 countries reported impacts varying from moderate to severe. Globally 16 percent of the reefs were destroyed (Goldberg and Wilkinson, 2004).

Sea Level Rise

As the planet gets warmer, glaciers melt, causing sea level to rise. As a result, corals are predicted to end up deeper underwater, receive less sunlight and grow more slowly. The Intergovernmental Panel on Climate Change (IPCC) has found that sea level is rising at a rate of 0.12 inches per year- 60 percent faster than the 0.08 inches per year that were predicted in 2007.

Stronger Storms

Another predicted climate change impact is an increase in the frequency and intensity of tropical storms. These storms cause larger and more powerful waves than normal and can break coral branches and overturn coral colonies.

Ocean Acidification

As the oceans absorb CO₂, their chemistry changes and they become more acidic. This makes it difficult for corals and other marine organisms to grow their skeletons and shells. The calcification rates of corals and other reef organisms have already begun to decrease. With increased CO₂ in the water, coral may form weaker skeletons, making them more vulnerable to disease and destruction by storms.

Ozone Layer Depletion

When the protective ozone is depleted, the intensity and nature of ultraviolet (UV) radiation that reaches the earth's surface increases. Although corals have a natural sunscreen to protect themselves from UV radiation, at increased levels, this radiation can damage corals in shallow waters.

LEGAL POLICY FRAMEWORK OF CORAL REEFS AND STATUS OF MARINE PROTECTED AREAS

The coral reefs of India come under the jurisdiction of the Department of Forests and Wildlife and it is their responsibility to monitor, manage and conserve these fragile eco-systems (Saxena, 2015). The Ministry of environment and forests is authoritative to develop a constructive action plan to manage the reef resources and issue guidelines for the sustainable utilization of coral reefs. The management of coral reef ecosystems has also been affirmed in India's National Conservation Strategy and Environment Action Plan (UNDP, 1997).

The current law and policy framework for coral reefs in India is virtually non-existent (Panini, 1997). There are a few laws in the country that can be activated for the protection of coral reef areas such as the Environment (Protection) Act, 1986 and the Wildlife Protection Act (WPA), 1972. However, even under the WPA coral reef areas have no separate legal status (Saroj, 2016). Only reefs in the protected areas are prohibited from exploitation. The other laws that would have a bearing on coral reef areas are the Indian Forest Act (1927), the Forest Conservation Act (1980) and the Indian Fisheries Act which is of vintage origin. The Coastal Regulation Zone (CRZ) Notification (1991) offers the only legal protection to all the coral reefs in India and under this coral reef areas come under the CRZ1 category (Panini, 1997). A special category CRZ 4 has been prepared for the Islands of Andaman, Nicobar and Lakshadweep (see appendix).

Marine Protected Areas in India (MPA's)

Marine Protected Areas are an important tool for marine conservation and management. In India, MPA is an umbrella term that includes, national parks and sanctuaries, eco-sensitive zones, protected areas, state conservation areas, national marine sanctuaries etc. MPA refers to an existing patchwork of local, state and national efforts to protect corals.

The **IUCN (International Union for Conservation of Nature)** defines a Marine Protected Area as: "Any area of the intertidal or sub-tidal terrain, together with its overlying water and associated flora, fauna, historical and cultural features, which has been reserved by law or other effective means to protect part or all of the enclosed environment." There are 36 MPA's in India, of which 5 are for the conservation of coral reefs. These include Gulf of Mannar Biosphere Reserve (GoMBR-10,500 km²); Gulf of Kutch Marine National Park (GoKMNP-400 km²); Mahatma Gandhi Marine National Park (MGMNP) also known as the Wandoor Marine National Park in the Andamans (282km²); Great Nicobar Biosphere Reserve (GNBR- 885 km²) and Rani Jansi Marine National Park (RJMNP) in Ritchie's archipelago in the Andamans (Rajasuriya *et. al.*, 2000). Another marine protected area (Perumal Marine Park) was proposed for Lakshadweep in 1996, but there is no evidence of its declaration(see box 3). No management or legal protection exists for the reefs of Palk Bay. In both the Andaman and Nicobar Islands and Gulf of Kutch regions, a ban has been laid on the gathering of corals and endangered marine species. However the laws are very vague and difficult to implement. The corals outside the purview of MPA's are not included in the WPA. It is therefore difficult to take action against offenders outside the national park. They cannot be convicted and only the material gathered is confiscated by the police department. The Gulf of Mannar National Park is one the better managed parks in the country (see box 4).

Box 3: Monitoring the Degradation of Coral Reefs

The Lakshadweep islands do not boast of a protected area, however this is India's only atoll Union Territory. The Department of Science, Technology and Environment conducts periodic awareness programs and has proposed establishment of a Marine National Park and development of an appropriate sewage system in association with competent institutions. They propose to monitor the degradation of corals both inside and outside the reef by regular diving and to employ protective measures to prepare a master plan for the conservation of corals.

Source: Rajasuriya *et. al.*, 2000.

Although reserves provide no refuge from climate change, they can provide potential for corals to adapt to the stress caused by climate change. The management of these protected areas is generally weak, particularly those near the subcontinent where human impacts from resource use, urban and industrial development are high. Reefs in the Gulf of Kutch Marine.

Box 4: Status of Gulf of Mannar MPA in India

The Gulf of Mannar has the status of first marine biosphere reserve not only in India, but also in south and south east asia. It has been recognized as an area of particular concern by IUCN and WWF given its diversity and multipurpose use. This area has been zoned for tourism development and also dugong hunting has been banned. GoMBR is now included in the world list of Biosphere reserves by the UNESCO. The M.S. Swaminathan Research Foundation and the Tamilnadu department of forests are currently in the process of developing a management plan for operationalizing the management activities of the Gulf of Mannar Biosphere Reserve.

Source: Saxena, 2015.

Park have been neglected, with monitoring activities limited to occasional EIA (Environmental Impact Assessment) studies associated with development activities. There is a growing concern that parts of the park may be rescinded for industrial development. Due to less human interference, the protected areas of Andaman and Nicobar Islands and Lakshadweep are in better condition. These MPA areas are still vulnerable to impacts from the crown-of-thorns starfish and bleaching, which are largely beyond local management. While the formation of protected areas and the CRZ notifications and Acts are laudable, one finds that there seem to be problems in trying to implement them.

On the recommendations of National Committee on Mangroves and Coral Reefs, the Ministry of Environment and Forests, Government of India has set up the Indian Coral Reef Monitoring Network (ICMRN). Coral Reef Monitoring Action Plans (CRMAs) were prepared during the

first phase of the GCRMN (1997-98) and have been launched by the ICRMN for all reef areas except the Gulf of Kutch. Government support has been extended to implement the CRMAPs and train people to monitor the reefs, however, activities are still at an early stage and the capacity for monitoring and management is still very poor.

Non Legislative Framework

Includes significant international initiatives on Indian coral reefs - UNDP-GEF Projects on the Gulf of Mannar and Andaman and Nicobar Islands; the Coral Reef Degradation in the Indian Ocean project (CORDIO); an Integrated Coastal Zone Management Training Project (ICZOMAT) funded by the UK Department for International Development (DFID); and an India-Australia Training and Capacity Building (IATCB) programme (Rajasuriya *et. al.*, 2000)

INTERNATIONAL ASSESSMENT OF POLICIES

The relative effectiveness of various policies and strategies is discussed below in relation to management of coral reefs in Australia and Indonesia which host world's major coral reefs.

Australia

The Great barrier reef of Australia contributes as much as Aus \$6 billion to the countrys' economy generating 49,000 jobs. The Australian and the Queensland governments are jointly investing approx \$200 million annually in the reefs health (www.environment.gov.au). The following initiatives are taken towards the conservation and development of coral reefs.

(1) The Reef 2050 Long Term Sustainability Plan

This plan is the world's first document that outlines concrete management measures for the next 35 years to ensure that outstanding value of the reef is protected over generations to come.

(2) Reef Trust

Under the reef trust, both the Australian government and private funds are used to focus on improving coastal habitat and water quality throughout the GBR.

(3) GBR Gully and Stream Bank Program

Sediment runoff is one of the biggest pressures on the GBR with gully and stream bank erosion contributing significantly to sediment entering the reef. Australian government in partnership with the private sector and conservation groups tackles sediment runoff by fixing gullies and stream banks in high erosion areas.

(4) Runoff Reduction and Water Quality Improvement Plan

Through reef trust, funding is provided to farmers to increasingly adopt land management practices improving the quality of water reaching the lagoon.

Analysis indicates that Australia has done a lot towards private sector involvement and local community participation in conservation of coral reefs, both of which India lacks. Policies specific to certain reef issues should also be formulated in India, for enhancement of their current quality. Due to effective water management plans, the regulatory services provided by the Australian reefs rank topmost in the world.

Indonesia

The coral initiative in Indonesia include Ecosystem Based Approach (EBA) to fisheries management, adopting climate change adaption measures and effective management of MPA's(World Bank, 2014). Indonesia has put much effort into achieving sustainability of marine resources management, including capacity building, public awareness campaigns and development of national strategies for managing marine eco-systems. If such public awareness campaigns and capacity building programmes could be implemented in India, Indian reefs would be in a much better condition than they are today.

CONCLUSION

Conservation and management of coral reefs is of immense importance for the mankind. They are playing phenomenal role by way of providing various ecosystem services. This is high time that we create awareness among various stakeholders about the need to protect these rich and diverse ecosystems on earth. The following policy suggestions are made for improving the coral reef ecosystems in India.

- A separate legal status should be given to the coral reefs in India in order to regulate and prevent harmful activities.
- India is a part of international treaties like UNCLOS, CITES and CBD. According to these treaties, coastal states can exercise sovereign rights to living resources within 200 nautical miles of their shore (Panini, 1997). Hence, the coastal states are responsible for preventing them from urgent exploitation. In this context, there is an immediate need to revise the WPA act.
- There is a urgency on the part of national committee on wetlands, mangroves and coral reefs, to formulate a sound and coherent national policy for coral reef areas.
- Strengthening infrastructure and capacity building for coral reef resource management, primarily targeting MPA's.
- The capacity for bio-physical monitoring of reefs has improved over recent years with training activities undertaken by the GCRMN node for India (Rajasuriya 2000). Similarly, strengthening of socio-economic monitoring of coral reef resources is needed to provide information appropriate for coral reef management.
- Awareness activities have to be conducted for government ministries and departments, primary resource users and schools, colleges and local groups highlighting the reef eco-system and its interdependence with the surrounding coastal ecosystems.

- Strengthen the role and powers of ICRMN to act as the central co-ordinating body for policy and programmes relating to coral reef resources, to provide better integration between government departments, institutions and local groups to support the implementation of management action plan.
- There is a high need for private sector involvement in the management practices focusing the development of reef resources around the stakeholder.
- National and State governments of India should devolve sufficient responsibility for management of coastal resources to local authorities at the village level and local communities should be a part of the management program.
- Other suggestions include sustainable fishing, controlled harvesting of fish, emphasize treatment of sewage/ diverting them away from the ocean.

REFERENCES

- Alfred, J.R.B., P. Shekhsaria, H. Andrews and V. Selvam (2006), "Coral Reefs", *Report of the Task force on Islands, Coral Reefs, Mangroves and Wetlands in Environment and Forests for the eleventh five year plan (2007-2012)*, 25-50.
- Costanza, R., *et. al.* (1997) "The Value of the World's Ecosystem Services and Natural Capital", *Nature* 387, 6630, 253.
- D. O. D. and S. A. C. (1997), "Coral Reef Maps of India", *Department of Ocean Development and Space Application Centre*, Ahmedabad, India.
- Goldberg, J., and C. Wilkinson (2004), "Global Threats to Coral Reefs: Coral Bleaching, Global Climate Change, Disease, Predator Plagues and Invasive Species", *Status of Coral Reefs of the World*, 67-92.
- Hoon, V. (1997), "Coral Reefs of India: Review of their Extent, Condition Research and Management Status", *Proceedings of Regional Workshop on Conservation and Sustainable Management of Coral Reefs*, Section B, 1-27.
- Jayaprakash, V., and R.A.N.J.U. Radhakrishnan (2014), "Indian Coral Reefs: Diversity, Anthropogenic Influences and Conservation Measures", *International J. Humanities, Arts, Medicine Science*, 2(4), 25-36.
- Lawyers Initiative for Forests and Environment (2013), "Coastal and Marine Conservation in Indian Legal Instruments", *Legal Framework for Conservation of Coastal and Marine Environment of India*, 10-26.
- Lyn Baum (2017), "Coral Reef Destruction from Boat Anchors", Reef Life Restoration. <http://www.reefliferestoration.com/single-post/2017/08/02/Coral-Reef-Destruction-from-Boat-Anchors>
- Ngoile, M. (1998), "Coral Reef Biodiversity Loss".

- Panini, D. (1997), "Law and Policy for Conservation and Management of Coral Reefs In India", Proceedings of *Regional Workshop on Conservation and Sustainable Management of Coral Reefs*, Section C, 16.
- Rajasuriya, A., *et. al.* (2000), "Status of Coral Reefs in South East Asia: Bangladesh, India, Maldives and Srilanka". *Status of Coral Reefs of the world*, (95-114).
- S.A.C. (2010), "Coral Reef Atlas of the World, Central Indian Ocean", *Space Application Centre, Indian Space Research Organization*, Ahmedabad, India, (1) 281.
- Saroj, J., R.K. Gautam, A.M. Joshi (2016), "Review of Coral Reefs of India: Distribution, Status, Research and Management", *International Journal of Science, Environment and Technology*, Vol. 5, 3088 – 3098.
- Saxena, A. (2015), "Coral Reefs and their Conservation - A Review", *Biological and Chemical Research*, 2015, 187-206.
- Sehgal, R. (2006), "Legal Regime Towards Protecting Coral Reefs", An International Perspective of the Indian Scenario, *Law, Environment and Development Journal*, 183-195.
- UNDP, (1997), "Project document IND/95/G41/A/I G/Management of Coral reef Ecosystem of Andaman and Nicobar Islands", *UNDP*, New Delhi.
- Venkataraman, K. (2011), "Coral Reefs in India by National Biodiversity Authority", In eds. "*Encyclopaedia of Modern Coral Reefs: Structure, Form and Process*".
- Wear, S. L. (2016), "Missing the Boat: Critical Threats to Coral Reefs are Neglected at Global Scale", *Marine Policy*, 74, 153-157.
- World Bank Group (2014), "It takes Villages to Conserve Indonesia's Precious Coral Reefs", *The World Bank*, June 5.

World Resource Institute Report (2011), "Reefs at Risk Revisited", World Resources Institute, Washington D.C.

http://pdf.wri.org/reefs_at_risk_revisited.pdf

http://wwf.panda.org/about_our_earth/blue_planet/coasts/coral_reefs/

https://oceanservice.noaa.gov/education/kits/corals/coral07_importance.html

<http://www.environment.gov.au/marine/gbr/protecting-the-reef>

http://www.nio.org/index/option/com_nomenu/task/show/tid/85/sid/92/id/196

MSE Monographs

- * Monograph 30/2014
Counting The Poor: Measurement And Other Issues
C. Rangarajan and S. Mahendra Dev
- * Monograph 31/2015
Technology and Economy for National Development: Technology Leads to Nonlinear Growth
Dr. A. P. J. Abdul Kalam, Former President of India
- * Monograph 32/2015
India and the International Financial System
Raghuram Rajan
- * Monograph 33/2015
Fourteenth Finance Commission: Continuity, Change and Way Forward
Y.V. Reddy
- * Monograph 34/2015
Farm Production Diversity, Household Dietary Diversity and Women's BMI: A Study of Rural Indian Farm Households
Brinda Viswanathan
- * Monograph 35/2016
Valuation of Coastal and Marine Ecosystem Services in India: Macro Assessment
K. S. Kavi Kumar, Lavanya Ravikanth Anneboina, Ramachandra Bhatta, P. Naren, Megha Nath, Abhijit Sharan, Pranab Mukhopadhyay, Santadas Ghosh, Vanessa da Costa and Sulochana Pednekar
- * Monograph 36/2017
Underlying Drivers of India's Potential Growth
C.Rangarajan and D.K. Srivastava
- * Monograph 37/2018
India: The Need for Good Macro Policies (*4th Dr. Raja J. Chelliah Memorial Lecture*)
Ashok K. Lahiri
- * Monograph 38/2018
Finances of Tamil Nadu Government
K R Shanmugam
- * Monograph 39/2018
Growth Dynamics of Tamil Nadu Economy
K R Shanmugam

MSE Working Papers

Recent Issues

- * Working Paper 166/2017
Task Force on Improving Employment Data - A Critique
T.N. Srinivasan
- * Working Paper 167/2017
Predictors of Age-Specific Childhood Mortality in India
G. Naline, Brinda Viswanathan
- * Working Paper 168/2017
Calendar Anomaly and the Degree of Market Inefficiency of Bitcoin
S. Raja Sethu Durai, Sunil Paul
- * Working Paper 169/2018
Modelling the Characteristics of Residential Energy Consumption: Empirical Evidence of Indian Scenario
Zareena Begum Irfan, Divya Jain, Satarupa Rakshit, Ashwin Ram
- * Working Paper 170/2018
Catalyst Role of Indian Railways in Empowering Economy: Freight or Passenger Segment is on the Fast Track of Expansion or Exploitation?
Zareena Begum Irfan, Shivani Gupta, Ashwin Ram, Satarupa Rakshit
- * Working Paper 171/2018
Sustainable Debt Policies of Indian State Governments
P.S. Renjith, K. R. Shanmugam
- * Working Paper 172/2018
Sustainability and Efficiency of Microfinance Institutions in South Asia
Brijesh C. Purohit, S. Saravanan
- * Working Paper 173/2018
Corporate Governance Practices in India
Ekta Selarka
- * Working Paper 174/2018
Current Status of Mangroves in India: Benefits, Rising Threats Policy and Suggestions for the Way Forward
Samyuktha Ashokkumar, Zareena Begum Irfan

* Working papers are downloadable from MSE website <http://www.mse.ac.in>
\$ Restricted circulation