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VULNERABLE / THREATENED MARINE ECOSYSTEMS

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Coastal environment is constantly stressed from anthropogenic activities and other developmental programmes. Improper and excessive use of natural resources and short term economic objectives has resulted in long term environmental degradations. Oil-related activities and urbanization have caused tremendous stress to the Arabian Sea. For example, large scale coastal habitat modification by dredging and construction of causeways and artificial islands and converting shallow, productive marine areas into land for homes, recreation and industrial facilities are some of the major threats for ecosystem sustainability. Because of the unregulated anthropogenic interventions our beaches, estuaries, mangrove flats, seagrass meadows and the continental shelf are fast becoming vulnerable.

Estuaries

Major threats to estuaries are sand mining and dumping pollutants. On an average 192 dugout canoes, ranging from 185-210 numbers are being engaged in sand mining everyday from Kadalundi, Murad, Korapuzha and Azhikal estuaries causing considerable destruction of eggs and larvae of fishery resources (Table 1) besides huge number of benthic organisms which might result in drastic reduction in the fish catch. The destruction of macro benthos due to large scale sand mining along the Malabar coast was estimated to 2760 numbers $m^2 day^{-1}$ equivalent to 7.09 g wet weight $m^2 day^{-1}$ registering maximum during the post monsoon season. This was probably the firsthand quantitative information on the destruction of benthic biodiversity due to large scale sand mining being carried out from estuaries.

Sandmining from Payyoli Estuary

Pollutants and contaminants dumped to estuaries lead to find its way to the soft tissues of marine species through food web. Annual average of Mercury in soft tissues of crab *Portunus sanguinolentus* was found in very high levels from Veraval (2.902 ppm) followed by Tuticorin (2.39 ppm) ,Visakhaaptnam (1.83 ppm) and Cochin (1.76 ppm) with levels exceeding the permissible levels. Mercury in finfish, crustacean, bivalve and gastropod tissue samples registered safe levels from Chennai, Mandapam, Mangalore, Mumbai and Cochin excepting the crab from Cochin. However, Arsenic levels were very high in all the tissue samples collected from the Centres along the east coast viz., Tuticorin, Mandapam, Chennai and Visakhapatnam. It could be inferred from earlier investigations conducted from Port Blair that due to various anthropogenic activities in and around Cochin, the fish tissues sampled from off Cochin were found accumulated very high levels of Pb (0.9 – 83.3 ppm) than in the same species and size of fish (nil in all the sp studied) collected from Andaman Sea.

Table: Levels of Mercury and Arsenic (ppm) in fish tissues and sediment

Tissue type	Tuticorin		Kochi		Calicut		Mangalore	
	Hg	As	Hg	As	Hg	As	Hg	As
Crab	3.3	11.846	ND	ND	1.062	16.563	0.00	5.29
Shrimp	ND	ND	ND	ND	0.248	13.510	0.144	2.486
Clam	2.21	39.52	1.167	13.796	0.384	16.45	16.45	ND
Oyster	0.887	56.887	ND	ND	0.851	14.423	ND	ND
Finfishes	2.6	4.64	0.409	10.88	0.351	11.15	1.22	4.21
Sediment	0.653	5.396	4.651	14.75	0.391	4.586	0.00	1.382

Beaches

Beaches have become vulnerable to tar, oilspill, dumping litter, non biodegradable wastes and sewage. Plastic objects strewn around beaches vary from 0.145 g m^{-2} from Calicut, 2.5 g m^{-2} from Cochin, 9.8 g m^{-2} from Tuticorin, 8.7 g m^{-2} from Visakhapatnam and 7.3 g m^{-2} from Mandapam (Table 2). These plastic objects comprised largely of plastic ropes, pet bottles, sachets, milk covers and thin carry bags.


NBD wastes dumped at Dharmadam Beach


Plastic and pet bottle at Calicut Beach

Ship salvaging in the yard produces huge quantities of Asbestos and deadly carcinogenic chemical poly chlorinated biphenyles. Steel Industries Kerala Ltd (SILK) has aship salvaging and ship building yard situated near Azhikal beach (Valappatnam, Kerala). This yard has salvaged 9 ships so far. Preliminary investigation to the salvage yard revealed no visible impacts to the water or sediment quality except for ceramic and iron debris scattered near the shore. The asbestos content in the salvaged ships was estimated to 1-1.5% per ship's weight.

Nearly 44000 m^3 of domestic sewage and 440 m^3 of industrial effluents are discharged every year in the seas of India. Sewage contamination induces proliferation of toxic algal blooms. The sewage disposal site registered appreciable density of toxic algal species such as *Gonyalux fragilis, Peridnium depressum and Porocentrum gracile* than the comparatively cleaner sites less conspicuously and at numbers astray.

Table: Quantity of plastics (g/m^2) in beaches and fishing ground

Centres	Beaches	Fishing ground
Calicut	6.8 (5-15.4)	41 (30- 62.5)
Tuticorin	238 (72.5- 329)	-
Mangalore	334 (183-545	-

Mangroves

The mangrove ecosystems offer breeding and feeding habitats to many of the marine resources of commercially importance. Successful fishery is linked to mangroves. Their leaf litter provide ideal conditions for higher productivity of gastropods which in turn, serve as food, particularly the veliger larvae for numerous other animals.

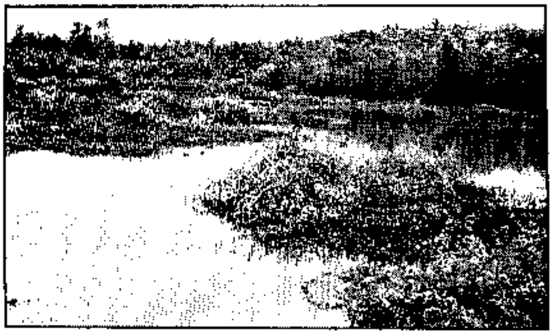
Kerala lost 94% of its mangroves in just 22 years. The State had 70,000 hectares of mangroves in 1975 and this reduced to 4200 hectares in 1997. Going by the statistics of the Forest survey on India 2003, there would be around 800 hectares of mangroves left in kerala. The loss is neary 99% which is higher than the loss reported globally by the millenium ecosystem assessment. Anthropogenic activities like heavy sand mining from the rivers, pose problems for the natural regeneration of mangroves. Formation of sand bars in estuaries due to altered river flow caused by sand mining also result in degradation of mangroves.

Mangroves are denuded mainly for house construction, agriculture and aquaculture. It was estimated that 3.5 acres of mangroves mainly *Avicenia officinalis* was destructed recently near Kadalundi. However, 50 ha of mangroves are now protected at the Kadalundi Community Reserve under the Kerala Forest Department and afforestation with *Rhizophora* saplings have been carried out at 15 ha area. Branches of mangrove trees especially *Avicenia officinalis* and *Rhizophora mucronata* are cut for the purposes of fire wood and timber in Kerala. Approximately 3-5 crore post larvae of *Penaeus indicus* and *Metapenaeus dobsoni* were collected annually from Kerala mangroves in addition to fry and fingerlings of *Chanos, Etroplus, Lates* and *Mugil* sp for aquaculture alone.

It is estimated that one hectare of mangrove forest would give ecosystem service worth around 12 lakhs per annum. Hence a wide awareness among the public is very essential to resist mangroves destruction in our coastal area.

Mangrove destruction at Payangadi

Death of Avicennia due to sand bar formation at Kadalundi



Mangrove destruction for aquaculture

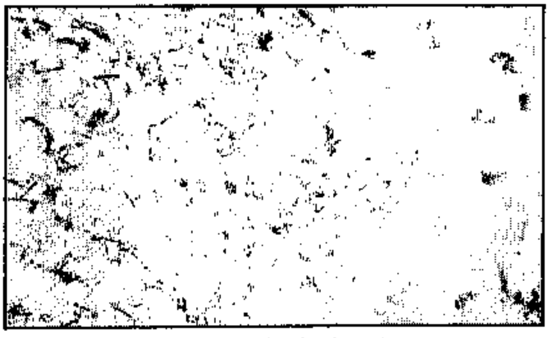
Seagrass meadows

Herbivory, boat services and other construction activities pose threat to seagrass meadows. Herbivory by turtles has caused considerable damage to seagrass meadows in Laccadive atolls. Since these turtles are protected and their exploitation is banned since 1980s by law, their population increased exponentially as the turtles here have very few chances of predation or fishing mortality. Lack of predators or fishing mortality can cause imbalance in the food web and tropic level. Octopus is one of the benthic predators and a sought after resource in Lakshadweep. Due to the demand and innovative fishing skills, Octopus exploitation in the entire Lakshadweep atolls, once confined to lagoons and reefs exposed during low tide has been expanded to outside the reef flat to the reef slope using long rods and snorkels. As a result, availability of Octopus has reduced a lot within the reef area and a huge population of crabs have infested the reefs due to the reduction of their predators. Crabs feed on *Modeolus* and hence *Modeolus* (locally known as *kallumekai* in Lakshadweep) population is also now threatened (Personal communication) which was rightly cautioned by Appukuttan (1996) that any over exploitation of Octopus in Lakshadweep might cause imbalance in reef ecosystem. Pufferfish menace in Kerala coast is also attributed to the decline in their predatory control (Mohamed *et al.*, MS in press).

Table: Wet harvestable biomass of seagrass from three atolls of Lakshadweep

Year of observation	Agati atoll	Kavarathi atoll	Kalpeni atoll
2011	112	116	420
1991 (Ansari *et al*)	895	720	770

Large extensive seagrass bed of *Halophila beccarii* (Ashers) was observed and reported for the first time from Kadalundi community reserve area close to the bird sanctuary covering an area of more than 2 hectares. The substratum is predominantly clay. During the low tide the seagrass bed is exposed. *Halophila beccarii* grows along with seaweed *Entromorpha linza*. This seagrass bed harbours subadults of gastropods , shrimps, crab and fin fishes such as *Liza, Ambasis* etc



Seagrass bed in Agatti atoll denuded due to severe grazing by turtles

Halophila beccarii growing in Kadalundi estuary

Continental shelf

Major threats are Ghost net, over fishing, trawling and other destructive gears

According to the UNEP (2009), worldwide plastic is killing a million seabirds a year and one lakh marine mammals and turtles. From the trawl ground, 20 to 79 g haul^{-1} of one hour duration was collected from off Mandapam, 27-94 g haul^{-1} from off Cochin, and 60- 150 ghaul^{-1} from off Mangalore. India generates over 10000 tonnes of plastic waste materials daily which is almost 10% of the entire solid waste generated and when they decompose Bisphenol-A, a well known hormone disrupter which is used as a plasticizer is liberated.

It is known that nearly 46000 pieces of plastic inhabit per square km of the world's oceans. Bottle caps, nylon rope pieces, pocket combs, cigarette lighters, cotton bud shafts, toys, syringes and thin carry bags are routinely found in the stomachs of dead seabirds and turtles. In 1987, a law was passed in the US restricting the dumping of plastics into the ocean. The Marine Plastic Pollution Research and Control Act (MARPOL) went into effect on December 31, 1988, making it illegal for any vessel or land-based operation to dispose of plastics or any non biodegradable objects at sea. 150 countries are party to the agreement as of December 31, 2010. Although the use of thin polythene bags (less than 40μ) in India is banned legally, its use is going on rampantly unchecked.

Destructive fishing gears made of coconut spikes suspended on long ropes employed to aggregate squid and cuttlefish by traditional fishers along the Malabar coast pose serious problems to the fishery as they exploit the brooders who visit and select the area for laying eggs. They also damage the trawlers during the off season as the huge sand bags and rocks used to anchor the long ropes bearing these spikes called *kolachil* in local parlance are abandoned without leaving any buoys or indicators.

The trawl net, being an efficient but unselective fishing gear with a small cod end mesh size, captures numerous small-sized species as well as juveniles of larger species, compared to any other fishing gear. Trawl fishing has both direct and indirect impacts on the marine ecosystem as well as on biodiversity, as this method of fishing collects and kills huge amount of non-targeted species and juveniles of commercially valuable species, mechanically disturbs the sea bed habitat and injures a wide variety of marine benthic creatures. As trawling removes colossal amounts of high biomass organisms in the sea bed, represented mainly by emergent organisms, productivity of the sea bed will be affected considerably. Most of the disturbances in the sea bottom remain unrecorded as they are hidden from direct human observation. Though most of the studies on the impacts of mobile fishing gears on marine biodiversity are currently focused around ecosystems with hard bottoms, such as coral reefs and rocky shores, major part of the seafloor is composed of soft sediments. This warrants further studies on the effect of trawling on coastal waters with soft sediments.

Ecosystem indicators

Ecological indicators are used to communicate information about ecosystems and the impact human activity has on ecosystems to groups such as the public or government policy makers. Ecosystems are complex and ecological indicators can help describe them in simpler terms that can be understood and used by non-scientists to make management decisions. For example, based on the structure of the molluscan assemblages, the pollution damage in mangrove forests can be assessed.

Many different types of indicators have been developed. They can be used to reflect a variety of aspects of ecosystems, including biological, chemical and physical. Due to this variety, the development and selection of ecological indicators is a complex process.

Using ecological indicators is a pragmatic approach since direct documentation of changes in ecosystems as related to management measures, is cost and time intensive. For example, it would be expensive and time consuming to count every bird, plant and animal in a newly restored wetland to see if the restoration was a success. Instead a few indicator species can be monitored to determine success of the restoration

Thus, an indicator species is an organism whose characteristics (e.g., presence or absence, population density, dispersion, reproductive success) are used as an index of attributes too difficult, inconvenient, or expensive to measure for other species or environmental conditions of interest

Further Reading

P. Kaladharan, K. Vijayakumaran, V.V.Singh, P.S.Asha, Bindu sulochanan, P.K. Asokan, K.K.Valsala, S.Veena, L. Jayasankaran and H.M. Bhint, 2012. Assessment of certain anthropogenic interventions and their impacts along the Indian coast line. *Fishery Technology*, 49: 32-37.

P. Kaladharan, K.P. Saidkoya, V.A. Kunhikoya and A. Anasukoya. Conservation in the Atolls of Lakshadweep: Turtles versus Turtlegrass (in press).