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Review

CRZ notification 2018 - disastrous to ecosystem functioning

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ABSTRACT

The Ministry of Environment, Forests and Climate Change (MoEFCC), Government of India, New Delhi, came up with number of amendments to CRZ notification 2018. These amendments will not only threaten costal ecosystems but will also degrade the environment to the point of no return. Of the entire coastal ecosystems mangrove, a multiuse ecosystem will be under tremendous pressure from reclamation, development, pollution, habitat destruction etc. Economic growth is often associated with ecosystem destruction and degradation if no due care is taken to the safety of the environment. Goa, a small state along the west coast of India, being tourist destination will have tremendous negative impact on coastal ecosystem, environment and biodiversity as a whole. In this review article, probable impacts of the amendments of CRZ 2018 notification on mangrove ecosystem and coastal environment have been assessed.

Keywords: Environment, biodiversity, mangroves.

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INTRODUCTION

The coastal zone of Indian subcontinent is comprised of wetlands, lagoons, shallow bays, creeks, estuaries, mangroves, sea-grass beds, coral reefs etc. and harbors varied and rich biodiversity. Ecologically and socio-economically these coastal and marine ecosystems are great importance in that they provide wide range of ecosystem services, goods, food, feed and energy to the coastal inhabitants.

Mangroves occupy the intertidal zone between land and sea and are able to tolerate partial submersion in high salinity water and in anoxic soil. These trees have undergone different morphological, anatomical and physiological adaptations to deal with two most limiting factors to survive in this extreme environment. Mangroves are considered to be a natural barrier against ocean dynamics along the coastline by breaking the force of waves and help to prevent coastal erosion (Yoshihiro et al., 1997; Primavera, 1998; Kathiresan and Rajendran, 2005).

The mangrove ecosystems support aquatic food chains and form habitats for marine fauna, such as juvenile crabs, shrimps, offshore fish, reef fish, and larvae (Woodroffe et al., 2013). It is a roosting and resting site for hundreds of shore and migratory bird species. Apart from these, ecological services such as water quality improvement, nursery grounds for variety of animals, supports numerous ecosystem services, nutrient and organic matter processing etc. are being offered by mangroves (Field et al., 1998; Walters et al., 2008). Mangrove sequesters around 25.5 million tons of carbon per year and provides more than 10% of essential organic carbon to the world oceans (Ong, 1993; Dittmar et al., 2006).

CRZ notifications

The Ministry of Environment, Forests and Climate Change (MoEFCC), New Delhi issued first CRZ notification in 1991 under the Environment Protection Act, 1986 which had restricted setting of any industrial activities along the fragile coastline. Over the years

notification underwent amendments several times and replaced it with the CRZ notification 2011.

In June 2014, MoEFCC constituted a committee under the then secretary of the Union Ministry of Earth Sciences, New Delhi to examine the CRZ notification 2011 in light of the issues specified by the various coastal states and union territories. The committee submitted its report in January 2015 and based on the report, ministry proposed several amendments in the CRZ 2011 notification.

These amendments are to accommodate government programs such as “coastal and port connectivity roads” of about 2,000 km under the Bharatmala Pariyojana (BMP) Phase-I and Sagarmala program - the massive port development along the Indian coastline. Tourism being one of the greatest creators of livelihood and jobs, the new Notification will boost tourism in terms of more activities, more infrastructure and will create employment opportunities in various aspects of tourism. In view of this, the amendments also included temporary tourism facilities such as “shacks, toilet blocks, change rooms, drinking water facilities etc. to be permissible in the No Development Zone (NDZ) of the CRZ-III areas.

For the purpose of conserving and protecting the coastal areas and marine waters, the CRZ areas have been classified as follows: 1) CRZ-I constitute areas that are environmentally most critical and it is further classified in to categorize CRZ-I A and CRZ-I B. 2) CRZ-II constitutes the developed land areas up to or close to the shoreline, within the existing municipal limits or in other existing legally designated urban areas. 3) CRZ-III land areas that are relatively undisturbed (viz rural areas etc.) and those do not fall under CRZ-II, shall constitute CRZ –III. It is further classified in to categories CRZ-III A and CRZ-III B. 4) CRZ -IV constitutes the water area and shall be further classified in to following categories CRZ-IV A and CRZ-IV B. Further some coastal areas accorded special consideration for the purpose of protecting Critically Vulnerable Coastal Areas (CVCA). The ministry has simplified the procedure further for CRZ clearances and delegations have been made at various levels for recommending CRZ clearances to the projects/activities.

With this CRZ Notification 2018 costal area will be heavily stressed, indiscriminately reclaimed for numerous activities that will lead to disaster and imbalance in the ecological system if no due care is taken. The impact of development activities need to be assessed on long term basis taking in to account the envisaged changes that may hamper ecological functioning and socio-ecological implications.

MANGROVES OF GOA – A CASE STUDY

About 108 km long coastline of Goa (15°30′N, 73°50′E and 15.50°N, 73.83°E) is segmented as a result of estuaries, beaches, rocky shores, cliffs, bays, heads and creeks. There are seven estuaries with their numerous creeks fringed with 16 mangrove species. A luxuriant growth of mangroves and associated species can be seen along most of the water bodies within the estuaries (Dhargalkar et al., 2014).

Mondovi-Zuari estuarine complex of Goa harbours variety of mangrove species. As per earlier estimates, the total area covered by the estuaries in Goa including the major Mandovi - Zuari estuarine complex was approximately 12,000 ha of which the mangrove forest occupy 2000 ha. Out of this, about 900 ha of mangroves were found along the Zuari estuary, 700 ha along the Mandovi estuary and 200 ha along the Cumbharjua Canal that connects these two estuaries. The recent report of Forest Survey of India, the mangrove cover of Goa has increased by 28 sq. km (FSI, 2017).

Threats to Goa mangroves

The Goa coast, in particular, will be more prone and subjected to the degradation as it is tourist destination. For last two decade or so, large mangrove areas along the Goa coast were being reclaimed for developmental purposes such as housing, industrial development, construction of roads, bridges, harbours and jetties, dredging and discharge of sediments, dumping of garbage, pollution etc. This has resulted in extensive damage to the fragile mangrove ecosystem that supports high biodiversity and various other adjoining ecosystems. Presently, construction of two bridges, each on Mandovi and Zuari estuaries and adjoining roads along with the widening of the road for four lane national high ways have resulted in clearing of around lakhs of mangroves trees (Untawale et al., 2017). Apart from this indiscriminate and illegal cutting of mangroves continues in some parts of Goa.

Number of direct and indirect threats on coastal ecosystems in the form of degradation and destruction of natural resources such as mangroves, seaweeds, sea grasses, corals etc. and the Climate Change is likely to further exasperate more pressure on these resources and the loss of biodiversity (Upadhyay et al., 2002). With increase in extreme weather events like sea-level rise, warming of the sea surface temperatures and ocean acidification, socio-economic and environmental problems will be added and in due course of time coastal populace will face hardship and food scarcity.

PROBABLE SCENARIO OF CRZ AMENDMENTS

With these CRZ amendments, number of unplanned developmental activities may result in the loss of natural resources. Apart from this many vital roles played by natural resources for ecosystem functioning and sustaining of coastal biodiversity may cease. Some of the most crucial factors that may lead to the degradation of ecosystem are identified below:

Unstable coastline

Mangrove species are considered “foundation species” that control population and ecosystem dynamics, including fluxes of energy and nutrients, hydrology, food webs and rich biodiversity hence have high conservation value (Ellison et al., 2005). Dense mangrove roots trap silt and sediment that tides carry in and out towards the sea. By holding the soil in place, the trees stabilize shorelines against erosion (Spalding et al., 2014).

It has been established that the physical ability of mangroves prevents shore line erosion, shielding inland areas from severe damages which is further supported by other factors such as the slope, elevation, tidal range, salinity, substrate and hydrology (Clark, 1995; French, 2001). The theoretical models have shown that mangroves attenuate shorter wave more than longer waves and field experiments have confirmed that relatively narrow strip of mangrove can substantially reduce the energy of wind driven waves (Massel et al., 1999; Mazda et al., 2006).

Mangrove degradation will accelerate erosion, alter sediment characteristic, benthic faunal composition, quality food availability and habitat loss such as mangrove tree (bark), pneumatophores, roots etc. this will lead to ecological changes. Many benthic organisms and plants prefer specific sediment particle size; slight change in the sediment particle size will affect the benthic community structure leading to flourishing of opportunistic species (Mayoral, 2011).

Goa’s fringing coral reef present at St. Georges Island (tourist attraction) will suffer from heavy siltation which will affect filtering mechanism of *Zooxanthellae*, algae responsible for providing food and energy to coral polyps and this in turn will accelerate coral bleaching. The symbiotic relationship between coral polyp and algae is very delicate and is subjected to slight changes in water quality.

Enhance sedimentation rate shallows estuaries, increase load particles bound toxicant and nutrients mainly phosphorous and ammonia leading to eutrophication. It will also add to the change in the size, structure and fragmentation of habitats, increase organic matter, degradation by anoxic processes (sulfate reduction) etc. (Caitcheon et al., 1995). Goa’s pristine beaches on which tourism depends will get covered with silt and mud along with other debris coming from the eroded coast and upstream region making beaches un suitable for recreational purpose.

Hydrodynamic alterations

The interaction between mangrove vegetation and hydrodynamic and water quality fluxes play an important role in coastal protection, in mangrove restoration, forest conservation and water pollution control in coastal waters. Mangrove vegetation reduces the tidal velocities by inducing higher frictional resistance. This effect prevents erosion and stabilizes the coast and within the hydrodynamic range it allows mangrove trees to grow and establish.

Hydrodynamics alteration of estuaries and coastal water is caused by modification to the entrance or shore line which can influence the volume, frequency and duration of flow of water that enters. The fringing mangroves influence hydrodynamics such as current velocities, wave length and morphodynamics such as the magnitude of sediment transport and sediment deposition (Siemerink, 2011). The proven sediment accretion abilities of mangroves will have protective function for the coastal zone to counter act of sea level rise.

Mangrove loss along the Goa coast may modify the salinity, water temperature, pH and structure of the water column and can lower dissolved oxygen concentration at depth. The natural and anthropogenic changes to the structure of mangrove stands have a direct impact on the physical processes operating within the habitat and their associated fauna (Wolanski, 1992). These physical modifications will lead to structural changes and functioning of the existing benthic communities. These communities may be replaced as a result of physiological stress or by competition or predation by species that are better suited and adapted to the favourable modified conditions.

Degraded water quality

The nutrients to coastal waters are from land runoff, coastal discharge including outfall from industries, wastes from aquaculture and sewage discharged from boats and ships. Apart from these there are number of small units of ship repair yards along the Goa estuaries. Ship repair activities generate waste engine fluids such as oil, hydraulic fluids, lubricants, anti-freeze, solvents, paints containing biocides and other hazardous substances, particulate matter, fine dust etc.

Mangroves trees with their complex root systems regulate water quality by filtering nitrate and phosphate that rivers and streams carry to the sea. They also perform an effective service in bio-filtration of contaminants, waste processing by filtering pollutants and biodegradable oil by microbes present in mangrove soil (Snedaker and Brown, 1981; Satheesh and Khan, 2012). Higher nutrient levels may result in ‘eutrophication’ (triggering algae blooms) in the water that covers the water surface blocking the sunlight and oxygen from reaching other marine organisms.

This ecological service provided by mangroves is particularly important to associated ecosystems such as sea grass, seaweed beds and coral reefs as these ecosystems are vulnerable to deteriorating water quality. Mangrove degradation exemplifies how environmental change not only causes over all destruction and loss of biodiversity, but also perpetuates and intensifies the

damage to the level of no return.

Loss of habitats

Habitats do not exist in isolation and are integrally linked to each other through biological, chemical and physical processes to form a complex ecosystem. It has been widely acknowledged that the size, vitality and spatial distribution of populations of many marine organisms depend on the quality and quantity of the habitats (Karr, 1991). However, the ecological relationships which constitute this dependence have not been quantified in most cases.

Any disturbance that changes critical habitat areas or species numbers has the potential to change and alter the composition and reduction in biodiversity. The disturbance may be associated with habitat conversion, modification, destruction and fragmentation; waste water disposal, oxygen depletion and accumulation of human waste and compounds.

Invertebrates play an important role in structure, health, functioning and processes of intertidal habitats. Mangroves integrated root system provides shelter, refugees and food for juvenile and adult fishes and other organisms. As mangroves are found in sheltered places, there remains long residence time and calm water that helps to reduce energy spent for searching food. High organic matter in the mangrove promote high primary and secondary production resulting into the abundance of benthic organisms on which fishes feed (Krishnamurthy et al., 1984).

Presently, habitat loss and its effect on biodiversity is a growing global concern. The health of coastal water depends on the conservation of a diversity of coastal habitats that provide multiuse of services. Mangrove loss or degradation limits the quality of habitat that can support healthy population of marine organisms and other wild life. There will also be change in the size and distribution of habitats such as inter-tidal areas, rocky coast, sandy beaches, seaweed and sea grass beds, coral reef etc.

Impact on fisheries

Mangrove provides detritus rich environment for fish and shell fish, especially their juvenile stages. Detritus from mangroves provide a major energy source in coastal waters to support high productivity in food change involving large numbers of detritus feeding species. Many high value commercially exploited fishes and shell fishes utilize mangrove during part of their life cycle. It has been estimated that 75 percent of commercially caught fish spend some time or their entire life in the mangroves or relies on food resource that can be traced back to these coastal forests (Yulianto et al., 2016).

Fishery activities are a traditional source of livelihood and income for the local fishing communities along the Goa coast. It is a vital employment opportunity for thousands of families along the Goa coast. Fishery products provide cheap protein in the diet of Goa populace. As these favourable and sustainable growth conditions will no longer exists, the fisheries of Goa will dwindle many fold. This will cause decline in the rate of production as fish will divert their energy away from reproduction to competition for a smaller reserve or scanty food. At the same time limited food availability and smaller habitat size will result in weaker and expose fish population to increased predation.

Oyster beds are a dominant structural and ecological component of estuaries around the globe. The oyster densities may be high in some parts of estuary which is the result of the adaptation of these organisms to specific habitat. Oysters provide food and habitat to many animals (fish, carbs, birds etc.) and costal populace, stabilizes the shoreline, provide coastal defense and fisheries. This fishery will suffer from loss of suitable substrate such as mangrove trunks, roots and pneumatophores.

The gastropods will be affected by change in surface sediment composition and microhabitat complexity. Some climbing gastropods will lose grazing (mangrove leaves and roots) grounds while some bottom dwelling gastropods that ingest organic carbon through mud will not get desired quality food.

Prawn fisheries are especially reliant on estuarine habitat areas, particularly tidal creeks and mud flats, for spawning and for the development of juvenile and on substantial freshwater flows to flush adult prawns into marine areas for commercial harvesting (Peters, 2013). A number crab species such as mud crabs, blue swimmer crabs (sand crabs) and wild life such as otters, flying foxes, monitor lizards, crocodiles (*Crocodylus palustris*) etc. are estuarine dependent.

Birds are bio-indicators of habitat quality and are sensitive to any changes in habitats. Mangrove plays an important role for migratory water fowls mainly as roosting sites during high tides but also as places of shelter and foraging. Vegetation richness is crucial determinate of water birds richness and diversity, because vegetation provide birds unique micro habitats for nesting and roosting (Begon et al., 1996).

Birds forage during low tides in intertidal mudflats and also use other habitats such as sandy beaches, rocky areas, oyster beds, saltmarsh and muddy edges of mangroves. Each bird species forages, depending on their bill size and lengths, tidal exposure, spatial distribution etc (Norazlimi and Ramli, 2015). In absence of mangroves, these resident, migratory, visiting terrestrial and marine birds will be deprived of roosting, breeding and feeding grounds.

Change in biodiversity structures

Biodiversity reflects both the variety of species as well as

their interactions between various components of the ecosystems. Therefore, any effect on some of the key species will have detrimental effect on the remaining species of the ecosystem. A ton of mangrove leaves that fall, decay and form detritus is the base of a productive food web. Microorganisms engineers these decayed leaves into rich nutrients for variety of invertebrates species. These in turn feed many small organisms, such as worms, anemones, sponges, jellyfish, shrimp, fishes etc. Tides circulate nutrients among mudflats, estuaries, and coral reefs, thus feeding species like oysters that rest on the seabed. It has been estimated that mangrove plants produce detritus on average 1 kg m^{-2} y^{-1} (Wafar et al., 1997).

With degraded mangroves the ecosystem will be devoid of rich and nutritious detrital food that supports variety of organisms. However, detritus and nutrients coming from land runoff will no doubt provide food for organism but it will be contaminated and will not be a quality food which is provided by mangrove detritus. This will result in deterioration and change in structure and functioning of benthic communities in particular and biodiversity in general. There is possibility that more tolerant and uneconomical invasive species may invade and flourish in the changing environmental conditions resulting in the loss of biodiversity.

The number of unplanned infrastructure development along the coastal zone area will result into the increase in direct discharged of waste water laden with pollutants that will increase organic matter. This in turn will increase nutrient concentration within the ecosystem resulting into accumulation of organic sediments and a hypoxia condition.

No studies are available to estimate what the collective value of Goa's coastal biodiversity. It is apparent that the value of biodiversity in estuarine ecosystems has the potential to be enormous and decline in biodiversity will result in economic losses and will impact sections of the coastal communities. These changes in biodiversity will alter ecosystem processes and the resilience of ecosystems to environmental change.

Impact on benefits and services

Mangrove forests provide habitat for thousands of species at all levels from bacteria to barnacles to fishes to mammals. The mangrove trees shelter insect species attracting birds which also take cover in the dense branches. Other species may depend on mangroves for more complex life cycle including several aquatic animals which depend on mangrove areas for spawning and juvenile development. For some species, mangrove may provide critical elements (that may not be easily available elsewhere) required to complete their lifecycle.

Mangrove contributes to water quality maintenance by nutrient transformation, retention of toxins and particle suspension which may be caused by saltwater intrusion to aquifers and leaching of heavy metals present in fertilizers. Ground water recharge by mangroves is an aquifer refill supplier which supports domestic and industrial purposes in the surrounding regions which is an additional value of mangroves. The nutrient and energy that flows through mangroves are believed to stabilize local climatic condition particularly humidity and temperature which has valuable influence on agricultural or resource based activities (Chow, 2018). When mangroves get degraded in an estuarine environment, many of these ecosystem services that aid the survival and production of fisheries can be either lost or diminished in value.

Goa population which depends largely on fish catch will be deprived of quality and quantity of fish. Apart from this, Goa fisheries provide livelihood to people and more than 5% of total population of Goa is engaged in fishing and allied activities will suffer badly.

Goa is known for tourism, the coastal tourism often raise number of environmental concern. Tourist activities can affect marine ecosystem many fold. Beaches are frequented by the large number of tourists for recreational activities. Invariably and unknowingly they interfere and damage benthic flora and fauna of the area. Developmental activities like infra structures, construction of tourist resorts, harbours, jetties, boating facilities etc. required reclaiming of coastal and mangrove areas changing the topography of the area.

The degradation of mangroves leads to modified social and economic livelihood of the local communities. The impact of mangrove degradation is useful means of assessment in evaluating social, economic, cultural and environmental degradation. It suggests that the development related activities bring both positive as well as negative effects; however, negative effects appear to be more numerous by the arising of problems which are irreversible.

Studies have recognized the ability of mangroves to sequester carbon dioxide from the atmosphere and store it in leaves, woody parts and soil. When mangroves are degraded this stored carbon gets release in to the atmosphere in the form of carbon dioxide thus aiding global warming (Alongi, 2012; Mitra et al., 2018). Goa's fringing mangroves would release many thousands of tons of carbon in to the atmosphere when degraded mangrove areas are put to use.

CONCLUSION

The question is not "Where would Goa be without mangroves?" but "Can we restore this degraded ecosystem to the level of sustainability"? Do we have scientific technology, methodology and will power at various levels and most importantly support from general public who are connected and day to day utilizing the products and services of this ecosystem? With this scenario are we assured with continuous ecological

service, fisheries, other products as well as all other environmental and socio economic benefits by amended CRZ notifications 2018?

Loss of biodiversity is one of the most serious environmental problems affecting the world today. The decline in biodiversity due to degraded mangroves will have devastating effect on food security and livelihood of the coastal communities. Economic growth is often associated with ecosystem destruction and degradation and unlimited economic growth will lead to an increase and unsustainable over consumption of energy, fresh water, mangrove forest, marine habitats, clean air and rich soil.

The changing scenario that is suggested above are for small state like Goa and this can be extrapolated to other larger maritime states of India. There will be many more alteration that will take place over the years at species, genus and ecosystem level that will be very difficult to restore and conserve to the level of sustainability. It will be a dismal scenario of the coast with unproductive shore, collapsed fisheries, turbid and polluted water, little protection for the costal people from severe weather events and sea level rise resulting in to loss of many plants and animals.

Infrastructure and developmental activities are must for providing better life and food security for populace of any country but it should never be at the cost of environment. The scenario of environmental degradation and economic losses that will occur in the long run by implementing proposed amendments should be very seriously and critically viewed and meaningful and realistic actions should be strictly implemented in the interest of ecosystem integrity.

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