

India's coastal zone management with an emphasis on rapidly developing Gujarat State

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Abstract India's Gujarat state has a long coastline with rich maritime history. The entrepreneurial nature of its citizens enabled Gujarat to emerge as the most aggressive industrial development state in the country. Due to the availability of vast land resource for industrial expansion along the coast, affordable labor cost, sparse human density and liberal state government policies have significantly contributed towards the outburst of the industrial sector's growth across Gujarat. Ecologically fragile ecosystems such as mangroves, coral reefs, mudflats, salt marshes, sea grass beds and nesting sites of winter migratory birds are increasingly threatened due to direct and indirect pressure induced by the industrial and allied development projects. This article reviews the status of coastal environment in Gujarat state with an emphasis on integrated coastal management associated laws and regulations.

Keywords Coastal zone management · Coastal policy · Industrial development · Ecology · Gujarat · India

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Introduction

India is known for its vast coastline stretching over 7,517 km and it also covers several offshore islands that harbor immense diversity of fauna and flora (Venkatraman and Wafar 2005). India has 2.02 million km² area of exclusive economic zone to boost development, comprising 0.86 million km² on the East coast, 0.56 million km² in the West coast, and 0.60 million km² around Andaman and Nicobar islands, respectively (Kannaiyan 2011). The coast line supports 13 major and 200 minor sea ports enhancing economic development while raising environmental distress. India's coastal zone continues to face human population growth leading to rapid environmental degradation over the past three decades (Agoramoorthy 2012a). One fifth of India's over 1 billion inhabitants live along the coast and three metropolises like Mumbai, Chennai and Kolkata are located along the coast.

The 19th century industrialization has certainly contributed to the reduction in coastal and marine biodiversity resources throughout the world. Therefore many countries around the world started to establish policies to protect coastal and marine resources—at least in theory (Jones 2014). The coastal ecosystems are known to be ecologically fragile since they include sensitive habitats such as mudflats, mangroves, marshes, coral reefs, salt pans and wetlands. Nevertheless, the coastal ecosystems are under immense threat from anthropogenic pressures (Salomons et al. 1999). Therefore integrated coastal management has been given a priority worldwide. But the question is—do countries seriously protect the fragile coastal zones in reality from further deterioration? This paper reviews the problems and prospects associated with the coastal zone management policies of India's Gujarat state in perspective of current industrial and allied developmental activities.

Gujarat has an area of 196,024 km² and it harbors 1,650 km long coast line comprising nearly 21 % of the country's total

coastline. The coast extends from Valsad in Western Ghats forest to all the way up the Kori creek in the Kachchh region (Fig. 1) accommodating 41 active sea ports of all sizes (Ahmed and Fajber 2009). Besides, it is also home to two of India’s three major gulf systems namely the Gulf of Kachchh and the Gulf of Khambhat (Nayak and Shetye 2003). The inter-and-high tidal mudflats of these gulf regions combined with the Great Rann of Kachchh are not only enormous in size but also extremely sensitive and fragile. The Rann is an extensive salt marsh that lies along the northwestern frontier bordering Pakistan (Agoramoorthy 2012b). The weather patterns of Gujarat’s coastal areas are also intriguing since the annual average rainfall reaches up to 2,500 mm in the south to a mere 300 mm in the north. Similarly, the tides also fluctuate widely between <3 m to a maximum of >10 m exposing even the coral reefs.

Gujarat being an industrial state harbors many small, medium and large scale industries along the vast coastal plains. The rapid industrial and urban development along the sea coast has put the fragile coastal and marine resources under constant intimidation (Armitage and Johnson 2006). Various government agencies have been involved in the protection and management of India’s coastal regions (Upadhyay et al.

2002). But an ecologist argued that the government efforts are not strong enough to preserve the dwindling biodiversity resources along the coastal zone and the reckless development has sadly created a kind of ‘ecological nightmare’ in Gujarat (Faizi 2009).

Gujarat’s fragile coastline and industrial development

Over one million people live along the coastal areas of Gujarat. The land area leading up to 20 km from shoreline alone comes to 30,022.25 km². This portion covers parts of 11 major districts with 59 townships and 2,802 villages. The Gujarat state government promotes special economic zones along coastal areas to expand sea ports, industries and oil and natural gas exploration operations (Palit and Bhattacharjee 2008). Gujarat has been in the forefront of industrial development since the 1990s (Kashyap and Shah 1995). The state has shown an astounding economic growth of 12 % in recent years, which is one of the highest development records for the country. It produces 98 % of India’s required soda ash and 78 % of salt while maintaining per-capita gross domestic product above the national average (Government of Gujarat

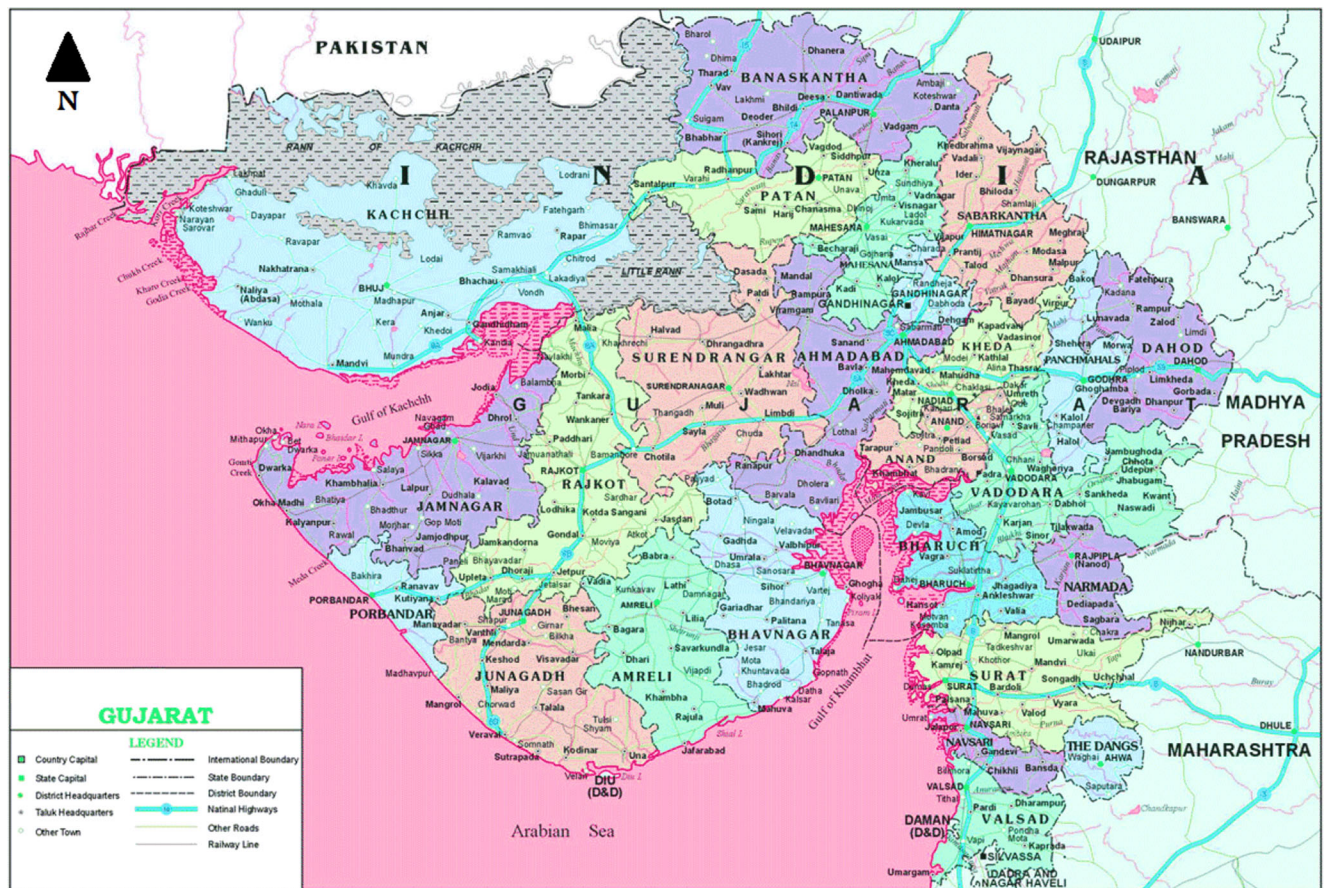


Fig. 1 Map of Gujarat state’s coastal zone (photo courtesy Gujarat government)

2014). Gujarat's contribution to fisheries is considerably high and it constitutes nearly 25 % of India's fish production (Mohanraj et al. 2009). Major industries along the Gujarat coast include oil refineries, petrochemicals, salt, marine chemicals, cement, glass, ceramics, fish processing, dye textile, pharmaceuticals, pesticide, steel, metallurgy and thermal plants (Table 1).

Gujarat state is also a leader in toxic pollution and its one among the seven states accounting for ~80 % of the total hazardous waste of the country (DNA 2010). Some of the industrial sites are known to have toxic pollutants like oxides of sulphur and nitrogen while others have wastewater and solid waste toxic contamination (TOI 2004). Furthermore, oil spills near Mumbai (Maharashtra), Kodinar and Navsari (Gujarat) coastlines have raised questions about the legitimacy of law enforcement in ecologically sensitive coastal areas (DNA 2011). Report indicates that the 'Golden Corridor' of the Ankleshwar-Vapi industrial estate of Gujarat has long been

polluting the land and sea, and continues to be in the list of critically polluted industrial clusters of India (DNA 2009).

India's major concentration of mangroves occurs in West Bengal state (46.21 %), which is followed by Gujarat (22.69 %) and Andaman-Nicobar islands (13.23 %) (Kathiresan and Rajendran 2005). Majority of the mangrove forests in Gujarat (73 %) has been distributed in Kachchh district along the frontier region adjoining Pakistan (FSI 2011). But these mangroves are heavily disturbed in recent years due to industrial development that include expanding factories, salt pans, sea ports and docks. As a result, mortality of mangroves increased and natural mangrove regeneration decreased significantly (Saravanakumar et al. 2009). Besides, the influx of fresh water into the mangrove habitat has been diminishing due to the construction of large number of small and medium-size dams in the upstream areas of seasonal rivers. The Kachchh district received a tax break for industries for a period of 15 years after the devastating 26th January 2001 earthquake that lead to the outburst of industrial development along the Gulf of Kachchh. Although the overall mangrove cover of Gujarat has increased from 1,046 to 1,058 km² within 2 years (2009–2011), some reduction in mangrove cover was reported in Bharuch, Surat and Valsad districts (FSI 2011). The increase has been due to planting of mangroves forcefully along the coast line mostly on mudflats. But, the question is—can the massive planting of mangroves complement or compromise the ecologically-sensitive coastal zone? The mangrove restoration history cautions one to avoid making two blunder mistakes—planting the wrong species in inappropriate place, and failure to understand the biological concept of restoration (Quarto 2010; Agoramoorthy 2012b).

Mangrove forests are known to provide livelihood opportunities for people who live along the coastal villages (Upadhyay et al. 2002). Thus, alternative sources of fodder and fuel need to be introduced by the government, non-government and corporate sectors that have an active presence in the area. The best option is to promote the environment friendly biogas for cooking (Agoramoorthy and Hsu 2008). Also, specific areas for cattle grazing and fodder production have to be designated and promoted to reduce pressure on the mangrove zone while restricting development projects. The health of mangrove ecosystem needs to be regularly monitored. Active involvement and participation of local communities in the preservation of mangroves is absolutely necessary for achieving major success in mangrove forest conservation (Macintosh and Ashton 2002).

Gujarat harbors natural coral reefs along the Jamnagar coast in Gulf of Kachchh, which is one of India's four major coral reef ecosystems. The Kachchh coral reefs are located in the northern most part of Indian Ocean. Many small and large islands in the gulf support fringing coral reefs that spread across 460 km². These reefs have gained prominence in recent years due to their uniqueness and as a major carbon sink.

Table 1 Major industrial clusters in the coastal districts of Gujarat state of India (source: WAPCOS 2009)

Industrial cluster No.	District	Name of industrial area
1	Valsad	Vapi Industrial Area
2		Sarigam Industrial Area
3		Atul Products
4	Surat	Sachin Industrial Area
5		Surat Industrial Area
6		Hazira Industrial Area
7		Olpad-Kosamba Kim Industrial Area
8	Bharuch	Ankleshwar-Panoli-Jhagadia Industrial Area
9		Dahej-Vilayat Industrial Area
10		Gandhar-Vagra Industrial Area
11		Umraiya-Dabhasa Industrial Area
12	Vadodara	Petrochemical Area-Vadodara
13	Anand	Cambay Industrial Area
14	Bhavnagar	Alang-Sosiya Ship Breaking Yard
15		Pipavav-Rajula Area
16	Junagadh	GHCL-Indian Rayon Industrial Set-ups
17		Veraval Fish Processing Units
18	Porbandar	Saurashtra Chemicals-Porbandar
19		Tata Chemicals Industrial Area
20	Jamnagar	Reliance - Essar Refinery Units, IOC Oil Terminals, GSFC, Digvijay Cement and Thermal
21		Sachana Ship Breaking Yard
22	Rajkot	Navlakahi Port Area
23	Kachchh	Kandla-Gandhidham Area
24		Mundra Port Area
25		Lakhpat-Abdasa - Panandhro Area

Besides, they provide natural habitat and food source for numerous species of colorful reef fishes and varieties of invertebrates. The degradation of coral reefs are caused by a multitude of factors involving sedimentation, oil exploitation, oil spill, land development, leakage of oil and grease caused by single-point moorings, movements of ships and dumping of untreated domestic sewage and industrial effluents (Fig. 2). The existing coral reef can only be successfully protected by declaring protected buffer zones. Furthermore, the ecologically-sensitive mangroves, coral reefs, tidal/intertidal organisms, planktons, fisheries, marine mammals and sea turtles are not at all exempted from the impact of unmanaged development along coastal Gujarat. These problems can be kept at minimal if the government and corporations work together with local communities and NGOs in partnership to monitor the coastal and marine areas by using latest science and technology tools as well by implementing the best solutions outlined by scholars (Jones 2014).

Ship recycling trade threatens coast zone

The world's largest ship recycling site located at Alang, Gujarat provides over 50,000 jobs for the impoverished while bringing 2.5 million tons of steel representing 10 % of India's total steel production in the name of 'recycling'. So the economic potential is enormous for this ongoing metal waste processing trade. But ecologists worry about the environmental problems associated with this toxic trade. Until the shipyard came into action in 1983, the sea shore was pristine. In 2010, about 3 million tons of iron was recovered by demolishing 348 large ships at 127 ship dismantling yards located on the shore. Realizing the extent of pollution associated with the site, the Gujarat state government signed an agreement with Japan to upgrade technologies using the beaching method. Whether this would reverse

environmental damage or not is yet to be realized. Alang is known for the highest tidal level of up to 10 m so vast intertidal zone gets exposed exhibiting millions of inter tidal fauna including coral reefs during low tide. It provides the best chance for ship breaking since high the tide makes it possible for big ships to land on shore with ease (Ahmed and Fajber 2009).

The Environmental Protection Agency in the USA does not allow the contaminating ship recycling business on its soil. Therefore most of the condemned American ships reach the shores of Gujarat for final disposal. To make matters worse, the Indian Central Pollution Control Board's policies are not rigorous enough to return poisonous shipments back to the country of origin. So India's weak environmental laws provide safe havens for rich developed nations to dump their condemned ships that are proved to possess toxic substances such as asbestos, lead and polychlorinated biphenyls. Transboundary toxic waste shipment that contains the above materials is officially banned by the Basel Convention. So we wonder why India engages in this toxic venture at the cost of human and ecological health.

Gujarat's ship recycling trade load has been projected to increase during the next decade due to the ban by the European Union on carrying heavy grades of oil in single-hull tankers (Sonak et al. 2008). As a result, over 2,250 tankers (129.5 million DWT) will have to be scrapped in the name of recycling. Between 1994 and 2003, <2 % of the scrapped ships originated from Europe with Turkey accounting for >85 %. Asia leads the world in this ship scrapping trade, and for example, between 1994 and 2003, 4,658 ships were scrapped of which 2,638 in India, followed by 603 in Bangladesh, 523 in China and 125 in Turkey. India by the way continues to hold the top rank in recycling doomed ships since it processes nearly 60 % of the total ship junk worldwide.

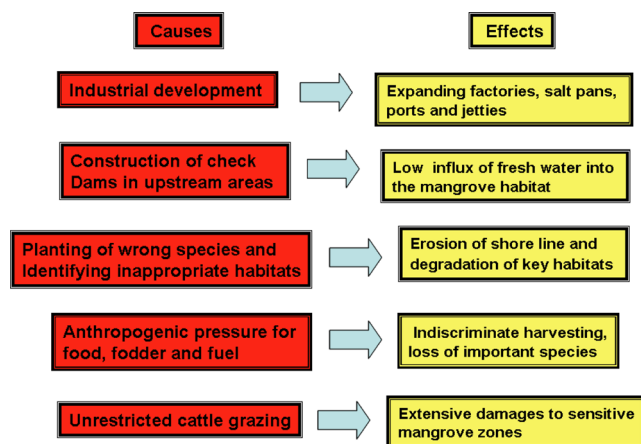


Fig. 2 Causes and corresponding consequences impacting Gujarat's coastal ecosystems

Gujarat's coastal zone policies: prospects, problems and future

India has a long history of marine laws and the first law on merchant shipping act was enacted in 1858. The Indian fisheries act followed suit later in 1897. Between 1980 and 2002, several laws were enacted to safeguard India's coast; they include Forest Conservation Act of 1980, Environmental Protection Act of 1986, Hazardous Waste Management Act of 1989, Coastal Regulation Zone Notification of 1991, Deep Sea Fishing Policy of 1991, Environment Impact Assessment Notification of 1994, National Environment Tribunal Act of 1995, and the Biological Diversity Act of 2002. To meet the objectives of Agenda 21 (1992), continuous monitoring of ongoing industrial projects, acquiring of new technology to minimize

negative impact of development to coastal zone and implementation of policies are being carried out by both the central and state government agencies. Agenda 21 has also identified sustainable management of coastal and marine areas as an essential component in the global life-support system. The coastal and marine area decision-making has been done by various government ministries and departments that include Environment and Forests, Ocean Development, Agriculture, Water Resources, Coast Guard, Surface Transport, Petroleum and Natural Gas, Tourism and Mines.

Gujarat's coastal development has been legally regulated by national legislations such as Environmental Protection Act of 1986, Water (Prevention and Control of Pollution) Act of 1974, Coastal Regulation Zone Notification of 1991, and Biodiversity Act of 2002. The Environment Protection Act is a major eco-legislation that deals with all aspects of environment across the nation. The State Pollution Control Board and the Central Pollution Control Board are the major regulatory authorities to enforce this law. The Water (Prevention and Control of Pollution) Act of 1974 primarily deals with all aspects of pollution and their control measures. This act covers only up to 5 km into the sea and the Central Pollution Control Board is the enforcement authority for this law. Besides, the Coastal Regulation Zone Notification (CRZN 1991) regulates activities along the coast. As per this notification, all states should regulate coastal zones in their territories following the stipulated guidelines. Coastal area is deliberated as the stretch of land from low tide up to 500 m from the high tide mark. The high tide mark is defined in the notification as the land up to which the highest level of spring tide (CRZN 1991). The distance from the high tide mark can apply to both sides in rivers, creeks and back waters and can be modified on a case by case while preparing the coastal zone management plan. The coastal regulation zones are grouped under four categories such as zone 1: ecologically fragile mangroves, coral reef, national parks, marine national parks and sanctuaries, wildlife habitats, and wetlands; zone 2: areas under development close to the shorelines; zone 3: rural coastal areas within municipal limits and legally-designated urban coastal areas; zone 4: smaller islands within each state.

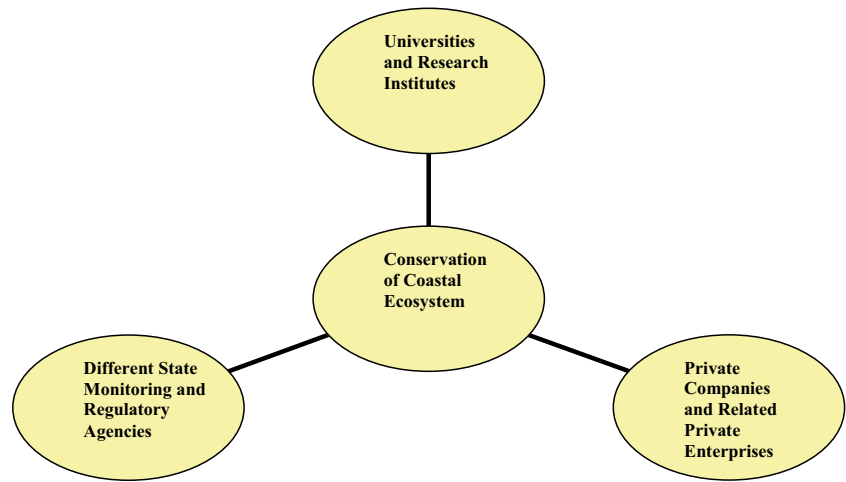
Between 1991 and 2009, 25 amendments were made to the Coastal Regulation Zone Notification (CRZN 2011). They include special provisions to protect the mangroves of Sundarbans (West Bengal), Chilka and Bhitarkanika (Orissa); Gulfs of Khambat and Kachchh (Gujarat), Malwan (Maharashtra), Karwar/Kundapur (Karnataka), Vembanad (Kerala), East Godavari/Krishna Delta (Andhra Pradesh), and Gulf of Mannar (Tamil Nadu). The coastal zone includes the maximum distance of 12 nautical miles into sea and all the inter-tidal areas including creeks, rivers, and estuaries. But there are no restriction imposed on local

communities that rely on fishing. The notification amendments also prohibit the following aspects: new/expansion of existing industries; manufacture, handling, storage and dumping of toxic waste; new/expansion of fish processing units including warehouses (excluding hatchery, natural fish drying, existing fish processing modernization); new/expansion of units for disposal of wastes/effluents (except for discharging treated effluents into storm drains); discharge of untreated sewage and industrial toxins; dumping of ash and wastes from thermal power stations; land reclamation, bounding or disturbing natural sea; mining with the exception of rare minerals not available outside of coastal zone; harvesting ground water; and construction activities in ecologically sensitive areas. Also exceptions are given to the Department of Atomic Energy's non-conventional energy projects, desalination plants, and reconstruction/repair of dwelling/fisheries units of local communities already inhabiting coastal zones. Untreated industrial effluents and household sewage dumping into coastal areas need to be phased out within 2 years. Similarly, all new development of beach resorts, hotels and infrastructure facilities along the designated coastal regulation areas for tourism should have preceding government approval, especially from the Ministry of Environment and Forests in Delhi (DNA 2011; Saravanakumar et al. 2009).

The Wildlife Protection Act also safeguards endangered marine species such as whale shark and dugong listed in the Schedule I. They occur in the waters of coastal Gujarat. The Forest Conservation Act extends protection of forest resources including forest alteration for non-forestry purposes. The overall management of coastal zone comes under the Coastal Zone Management Authority of Gujarat (DNA 2009; Upadhyay et al. 2002). The State Biodiversity Board has been formed in Gujarat with a mandate to safeguard biodiversity. The Gujarat Ecology Commission was constituted in 1992 with an objective to restore degraded ecosystems. The Gujarat Pollution Control Board is responsible to monitor pollution levels in atmosphere and effluents levels in rivers and coastal areas. The Gujarat Ecological Education Research Foundation promotes environmental education and field research. Several educational and research institutions such as Kachchh University, MS University, Saurashtra University, South Gujarat University, Gujarat Maritime Board, Biodiversity Board, Mundra Port and Special Economic Zones Limited, Gujarat Pipavav Port Ltd, and various other NGOs based in Gujarat are also involved in the coastal areas research to monitoring.

Integrated management of coastal zones appears to be the most appropriate tool for sustained development of eco-social system (Fig. 3). It reconciles development in terms of ecological health by integrating environmental, social and economic issues. The Gulf of Kachchh has been proposed for demarcation for coastal zone management

Fig. 3 Integrated efforts among different state agencies, academic institutes and private enterprises towards conservation of coastal ecosystem in Gujarat



activities. Agencies such as the Gujarat Ecology Commission, Marine National Park, Bhaskaracharya Institute for Space Applications and Geo-informatics, Gujarat Pollution Control Board and Gujarat Ecological Education Research Foundation are involved under the state government as nodal agencies to implement the integrated coastal zone management plan. The plan include restoration, plantation and conservation of mangroves along the coast, coral transplantation in the Gulf of Kachchh, coastal ecosystem monitoring, socio-economic development, and integration of geo-spatial information. The targeted area includes the Gulf of Kachch that covers 160 villages in three districts. The Gujarat coastline is quite extensive so the government alone in partnership with some corporations cannot manage it efficiently. Therefore it is crucial for the state government to incorporate (Fig. 4) more local NGOs, community institutions, industry members, local governing departments, academic and research institutes integrated together into a common platform

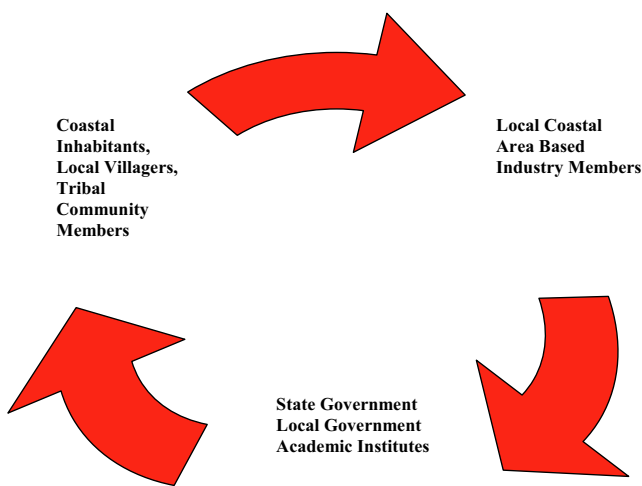


Fig. 4 Important stakeholders in the integrated coastal management model

(Fig. 5). Then only the vast coastal areas can be managed effectively with transparency.

Over the last decade, some basic research concerning coastal zone management of Gujarat has been conducted. Some examples include the Gujarat Ecological Education Research Foundation that has been involved in projects to document marine biodiversity in the Gulf of Kachchh, especially coral reef to know health indicators, coral growth, recruitment, restoration and regeneration. It surveyed dugongs in the Gulf of Kachchh. The government of Gujarat state has included 132,440 ha as protected reserve to contain manmade impacts in the mangrove forest areas of Jamnagar, Rajkot and Kachchh districts. The Bhaskaracharya Institute for Space Applications and Geo-informatics is the nodal agency for the government funded projects. It has done work on the coastal land use information system and prepared mangrove atlas, aquaculture atlas, saltpan atlas, and fishing zone atlas for Gujarat state. The coastal land use maps are being prepared for the entire Gujarat state (Nayak and Bahuguna 2001). Similarly, the Gujarat Ecology Commission has taken up some research to determine the ecological impact on the Gulf of Kachchh and Gulf of Khambhat as well as the health status of coral reefs.

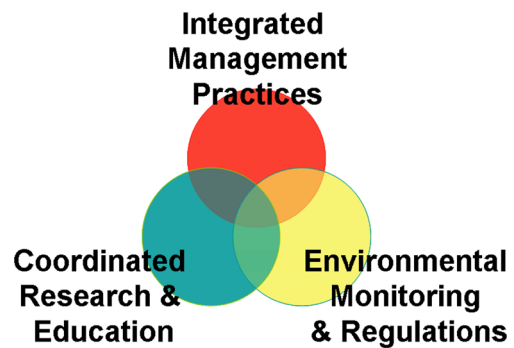


Fig. 5 Three prong approach adopted for successful preservation of coastal ecosystem in Gujarat

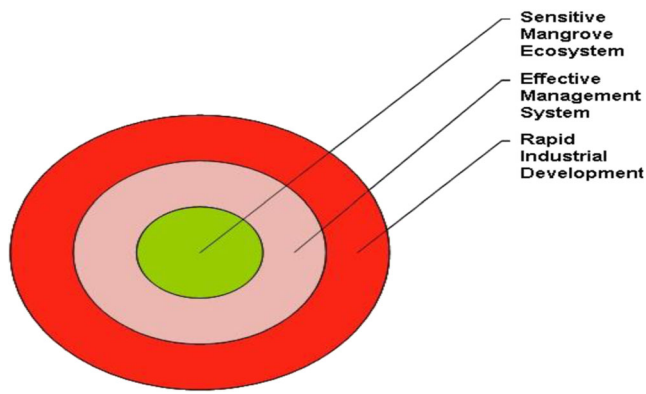


Fig. 6 Diagrammatic representation of the ideal that effective integrated coastal management system involving comprehensive monitoring and conservation can save Gujarat's sensitive coastal zones from rapid industrial expansion

Conclusion

Coastal areas with high population densities that are linked to urban growth and industrialization continue to face serious environmental pressure due to several anthropogenic activities. The uncontrolled development has been known to destabilize natural ecosystems. Sustainable development is therefore a viable option to control excessive reduction in natural resources for instant commercial profits. But the sustainable solution necessitates an integrated scientific information system to coordinate and accommodate varied interests of coastal resource users. Most of the industries that are based along coastlines do conduct periodic environmental impact assessments for name sake to comply legal and regulatory obligations. So competent scientists from government agencies, NGOs and corporations may need to engage in a conglomerate way with local communities, and then only problems can be understood at the grassroots level. Once the exact problems are identified in coastal villages across Gujarat, mitigation measures can be put in place by respective management authorities. Gujarat's coastal municipalities must update sewage treatment technology to avoid releasing of untreated toxic waste to sensitive coastal zone. Besides, new sewage treatment plants must be established at grassroots. It is essential to conduct modeling and computer simulations to predict probable oil spills along coastal Gujarat so that government and corporations involved in oil exploration and refinery joint venture can timely mitigate crisis. An efficient and integrated management approach is therefore essential for successful preservation of the extremely fragile coastal region (Fig. 6). Also, modeling studies need to be done systematically to explore the movement of oil spills, dispersion of discharged oil from ships and single-point moorings, counter measures to neutralize spills, and contingency crisis mitigation plan at local levels. Also, disaster management against storms, cyclones, floods, tsunamis, and earthquakes should be put in place. It is important to create awareness on the benefits of

integrated coastal and marine area management among major stakeholders, mainly politicians, policy makers, industrialists and community members.

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