CHAPTER V

LITERATURE

SURVEY
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5.1 COASTAL ENVIRONMENT

Coastal environment plays a vital role in the nation's economy by virtue of the resources, productive habitats and rich biodiversity. India has a coastline of about 7,500 kms of which the mainland accounts for 5,400 kms, Lakshadweep coast extend to 132 kms and Andaman & Nicobar Islands to about 1900 kms. Nearly 250 million people live within a distance of 50 kms from the coast. The coastal zone is also endowed with a very wide range of coastal ecosystems like mangroves, coral reefs, sea grasses, salt marshes, sand dunes, estuaries, lagoons, etc., which are characterized by distinct biotic and abiotic processes. The coastal areas are assuming greater importance in recent years, owing to increasing human population, urbanization and accelerated developmental activities. These anthropogenic activities have put tremendous pressure on the fragile coastal environment.

The coastal areas are also the place where natural disasters are also experienced. The entire East coast of India, the Gujarat coast along the West coast and the islands of Lakshadweep and Andaman and Nicobar face frequent cyclonic conditions which sometimes cause large scale destruction of life and property. While it is agreed that no human interference is possible to control such an event but precautionary measures such as coastal area planning for locating coastal communities in safer areas, protecting and propagating the natural protecting systems such as mangroves, coral reefs, shelter belt plantations, along with installation of early warning systems, timely evacuation and relief measures can minimize loss of life and property to a large extent.

The Ministry, after gaining experience from implementation of the Coastal Regulation Zone Notification over a decade, suggestions received from stakeholders and NGOs and taking into the lessons learnt for the Coastal Zone Management programme of other countries, the Ministry is of the opinion that there is a need to ensure that the regulations are firmly founded on scientific principles to ensure effective protection to valuable coastal environmental resources and without unnecessarily impeading livelihood or legitimate coastal economic activity or settlements or infrastructure development. For this
purpose, the Ministry is of the opinion that the CRZ Notification should be reviewed to make the approach to coastal environmental regulation more holistic and ensure protection to coastal ecological systems, coastal waters and vulnerability of some coastal areas due to potential sea level rise and other natural hazards. The Coastal Zone Management Plans (CZMPs) need to be reviewed at predetermined intervals to take into account the changes in geomorphological features that take place due to the ocean dynamics and settlement patterns. (MOEF, 2005)

The oceans have a profound influence on the life on earth and thus they are a common heritage of humankind for the future. The ocean space, occupying more than 70 percent of the earth’s surface, plays a significant role, together with the atmosphere and land mass, in shaping our climate. The oceans provide a treasure house for food and energy that needs to be harnessed properly for sustaining life. About 38 percent people in the world live in the coastal zones within 100 km from the coast line at elevations less than 100 metres from the mean sea level.

Understanding the oceanic processes and enhancing our capability to predict the ocean as well as climate thus become a key national agenda. A systematic observation of the ocean and providing reliable and timely information and advisory services to the stakeholders is vital need. (Gupta H.K. 2003)

5.2 MAJOR COASTAL ACTIVITIES / PROJECTS

The programme on Coastal Zone and Islands was started in 1985 with the objective of:

a. Developing and maintaining data bases for assessment and management of coastal areas, islands, exclusive economic zone and its resources including harnessing of wave energy

b. Conducting regular environmental assessment of the state of the environment of coastal and marine areas

c. Developing marine resource potential of islands and

d. Technology demonstration in select fields.
The programme has been structured into the following projects, with a stress on development of relevant technologies:

- Marine Satellite Information Service (MARSIS)
- Coastal Ocean Monitoring and Prediction System (COMAPS)
- Wave Energy – Integrated Breakwater System Island Development
- Sea Level Monitoring and Modeling (SELHAM)
- International Geosphere Biosphere Programmes (IGBP)

The outputs under these projects have direct relevance and provide economic benefits to the people living in the coastal areas.

A major project on Marine Satellite Information Service (MARSIS) to generate and disseminate select value based ocean data products viz. Sea Surface Temperature, Potential Fishing Zone maps, wetland, erosional and depositional maps, mixed layer depth maps, sea level eddy and wind vector maps etc has been taken by the Department during the year 1993-94.

Phase II of the MARSIS programme, i.e. 1993-97 envisages full utilization of ocean remote sensing capabilities by retrieval of additional oceanic parameters and generation of a whole series of value based ocean data products. Under these the following activities got covered.

Data from remote sensing was used for studying various components of coastal environment, viz. wet lands, mangrove vegetation, shoreline changes, brackish water area, coral reefs etc.

Coastal wetland and shoreline change maps for Tamil Nadu (38 maps) and Kerala (27 maps) on 1:50,000 scale, coral reef maps for the Gulf of Kachchh, Gulf of Mannar, Andaman, Nicobar and Lakshadweep islands were completed and given to the State Governments for taking appropriate measures for conservation.

Rotational velocities and elevation at the centre of the eddy were estimated using dynamic topography data, as a part of oceanic eddy studies.
A cyclone model for Bay of Bengal was under development for climatological seasonality studies and critical parameter determination.

Methods were developed to detect sea eddy using ERS (European Remote Sensing Satellite) Altimeter data.

International Geosphere Biosphere Programme (IGBP)
Under the International Geosphere Biosphere Programme (IGBP), the Department is coordinating at the national level activities relating to the Joint Global Ocean Flux Studies (JGOFS) initiated by the Intergovernmental Oceanographic Commission. (DOD, 1994)

Indian Ocean Global Ocean observing system (IOGOOS-2000) key coastal area issues of India were reported as follows:

- **Biodiversity and habitat loss**: There is a need to establish a baseline and a monitoring to screen organisms for bioactive compounds.

- **Coastal erosion**: There is a need to set up monitoring stations and to be able to map natural changes; there is also a need to estimate the economic impacts of development.

- **Harmful algal blooms**: An increased frequency of such blooms is observed; there the factors that trigger blooms and the bloom species.

The erosion of land, whether by the sea in coastal areas or by river waters inland, should be minimized by suitable cost-effective measures. The States and Union Territories should also undertake all requisite steps to ensure that indiscriminate occupation and exploitation of coastal strips of land are discouraged and that the location of economic activities in areas adjacent to the sea is regulated.

Each coastal State should prepare a comprehensive coastal land management plan, keeping in view the environmental and ecological impacts, and regulate the developmental activities accordingly. (National Water Policy, Ministry of Water Resources, 2002)
An ocean (from Okeanos (Oceanus) in Greek) is a principal component of the hydrosphere: a major body of saline water that, in totality, covers about 71% of the Earth's surface (or an area of some 361 million square kilometers). Nearly half of the world’s marine (oceanic) waters are over 3,000 meters (9,800 ft) deep. Average oceanic salinity is around 35 parts per thousand (ppt) (3.5%), and nearly all seawater has a salinity in the range of 31 to 38 ppt.

The major oceanic divisions are defined in part by the continents, various archipelagos, and a number of other criteria; these divisions are (in descending order of size) the Pacific Ocean, the Atlantic Ocean, the Indian Ocean, the Southern Ocean (which is sometimes subsumed as the southern portions of the Pacific, Atlantic, and Indian Oceans), and the Arctic Ocean (which is sometimes considered a sea of the Atlantic). Smaller regions of the oceans are called seas, gulfs, bays and other names.

The total mass of the hydrosphere is about $1.4 \times 10^{21}$ kilograms, which is about 0.023% of the Earth’s total mass. Less than 2% is freshwater, the rest is saltwater, mostly in the oceans.

Oceans are divided into numerous regions depending on the physical and biological conditions of these areas. The pelagic zone includes all open ocean regions, and can be subdivided into further regions categorized by depth and light abundance. The photic zone covers the oceans from surface level to 200 metres down. This is the region where the photosynthesis most commonly occurs and therefore contains the largest biodiversity in the ocean.

### 5.3 OCEAN RELATED ACTS / RULES

The oceans are home to the majority of plant and animal life on Earth. These lifeforms include:

- Algae
- Radiata
- Fish
- Cetacea such as whales, dolphins, and porpoises
- Cephalopods such as the octopus
- Crustaceans such as lobsters and shrimps
• Marine worms
• Planktons
• Krill (Wikipedia, 2007)

Wetlands conservation in India is indirectly influenced by an array of policy and legislative measures (Parikh and Parikh, 1999). Some of the key legislation is given below:

• The Indian Fisheries Act – 1857
• The Indian Forest Act – 1927
• Wildlife (Protection) Act – 1972
• Water (Prevention and Control of Pollution) Act – 1974
• Territorial Water, Continental Shelf, Exclusive Economic Zone and other Marine Zones Act – 1976
• Water (Prevention and Control of Pollution) Act – 1977
• Maritime Zone of India (Regulation and fishing by foreign vessels) Act 1980
• Forest (Conservation Act) – 1980
• Environmental (Protection) Act – 1986
• Coastal Zone Regulation Notification – 1991
• Wildlife (Protection) Amendment Act – 1991
• National Policy and Macro Level Action Strategy on Biodiversity – 1999 (Prasad S N. et.al 2001)

With respect to marine pollution, when you go through the literature, you repeatedly find two conflicting viewpoints. One viewpoint is that man has to discharge and dump wastage somewhere, as all of it cannot remain in the land and the ocean is an ideal place for this. One well known article exposing this has appeared in the Scientific American two decades ago; by William Boscom (1980). The opposite viewpoint states that humans have been polluting the ocean both by dumping and discharging effluents and dumping even drenched matter to such an extent that it is having a very serious effect on the marine environment. And this debate continues; the moral of the story is that we need yet to do more research to understand all the implications of what is relevant and what is not relevant, what is important and what is not important with respect to marine pollution.

Much before space or outer space becomes a new frontier, ocean will become the next frontier for humans. The ocean holds such vast resources, that some time not long into the next century, when we find that our mineral resources, our water resources etc are very much depleted and there is a limit to extracting these from the earth, we will resort
to extracting all these from the ocean. Our technology will then concentrate on how to extract the metals from the ocean. In fact the ocean is a large mine and it contains the largest ore body on this planet. Every cubic mile of sea water contains about 165 million tonnes of chemical elements other than hydrogen and oxygen. Many of them are metals.

The problem is not that humans pollute. But too many humans pollute. Our country cannot definitely go to a population of 1.5 billion by the year 2050. We have to keep it at 1.2 billion and if that is not managed, all efforts on environmental remediation are going to be wasted because too many humans will be there to pollute the environment.

“Poverty is the most toxic substance in the world” according to Dr K. Toepfer (1985), the Executive Director of UN Environmental Programme. This almost echoes Indira Gandhi’s statement at the 1972 Stockholm Conference that “Poverty is the worst form of pollution.” (Dr. Placid Rodriguez, 1999, Indira Gandhi Centre for Atomic Research)

The Department of Ocean Development initiated Marine Satellite Information Services (MARSIS) programme in June 1990. One of the major accomplishments of MARSIS programme was successful demonstration of generation and experimental dissemination of potential fishing zone (PFZ) information to the end users.

The Department of Ocean Development (DOD) established, an autonomous institution, Indian National Centre for Ocean Information Services (INCOIS) at Hyderabad during February 1999. The mandate of INCOIS is to synthesis, generate and disseminate user oriented data product to promote and coordinate the various endeavours in the field of Ocean observation, Information and Services particularly with respect to seas around India, towards sustainable development of ocean resources, improving weather forecasting and planning of coastal developmental activities. (DOD, AR, 2000 – 01)

5.4 REMOTE SENSING
Oceans play an important role in the social and economic life of people in the region and hence there is growing interest to study about them. Much about the oceans still remains to be understood, largely due to lack of detailed and accurate observations. Satellite platforms have recently been demonstrating reliable and long-term observations. Data
from such observations can be used together with point-based in situ data for sustainable exploration and exploitation of ocean resources and for improving the accuracy of forecast of weather conditions, ocean state and longer-term climate changes. Significant progress has been achieved in India during the past few years in demonstrating the utility of satellite-based remote sensing data for oceanographic research and applications. As part of these efforts, techniques have been developed to retrieve and measure various oceans parameters and processes such as ocean surface waves, wind, sea surface temperature, chlorophyll pigments, oceanic eddies, heat budget, mixed layer depth and latent heat studies. In order to meet the specific and increasing data demands in ocean research, concerted efforts are being made for developing and launching state-of-the-art satellites for ocean applications. The first in the series of the ocean satellites, IRS-P4 (Oceansat-1), was launched successfully on 26 May 1999 using the indigenous Polar Satellite Launch Vehicle (PSLV) from Sriharikota. A well-knit plan has been initiated for the proper utilization of data from Oceansat-1 mission. (Ocean Research in India, Desai P S – Current Science Vol 78, No.3, February 2000)

Images captured by Cartosat-2, the 12th satellite of the Indian Remote Sensing (IRS) satellite series, were released by the Indian Space Organization (ISRO). ISRO released panchromatic images captured by the satellite at an altitude of 630 km in sun-synchronous orbit with a spatial resolution of one metre. The satellite has a lifespan of approximately five years.

The one-metre spatial resolution has its uses in cartography, disaster management, urban and rural infrastructure planning and monitoring, watershed management and coastal land use monitoring. These satellite images will be far more affordable for domestic users than those bought from the United States. (K Radhakrishnan, April 2007, NRSA, Geospatial)

Over 900 scientists from around the world will attend the Envisat Symposium in May, 2007 to be held at Montreux in Switzerland from April 23 to 27 to review and present results of the European Space Agency’s Earth observation satellites in particular Envisat.

Almost all fields of Earth science will be highlighted such as greenhouse gas concentrations, Ozone hole monitoring, sea-level rise, sea surface temperature, ice sheets
Remote Sensing Data could be used to provide inputs for coastal land use, shoreline changes, etc. Remote sensing data is being used for an operational purpose. The different physical (SST, Currents, etc) and biological products (Ocean Colour) could be derived from satellite data. Derived parameters such as currents (from sequential data) and productivity are important parameters. Shallow water bathymetry and benthic cover can also be derived from satellite data.

Satellite missions that are valuable sources of remote sensing data for IOGOOS are:

- INSAT
- MTSAT
- IRS P5/6
- Oceansat1
- Feng Yung
- NOAA AVHRR
- SeaStar
- Hyperion
- Meteosat
- Envisat
- Quicksat
- Topex / Poseidon
- ERS – 2
- Jason

New satellite systems to be launched in the near future include:

- Mega Tropiques Oceansat2
- MTSAT
- NPP / NPOESS
- METOP

These platforms variously include visible, infrared, microwave sensing instruments.

Parameters and products of interest to IOGOOS are listed below

- Sea surface temperature  - Wave parameters
- Thermal Front  - Surface Currents
- Eddies  - Vessel movement
- Sea Surface Height  - Oil spill
- Wind Vector  - Harmful algal blooms
The coastal zone is dynamic, both natural and anthropogenic processes continue to modify it. The loss of habitats, coastal erosion and appropriate site selection are some of the issues faced by the coastal managers. One of the major requirements for the coastal zone management is availability of up-to-date and accurate information on coastal habitats, shoreline processes and water quality. Remote sensing data, especially from IRS series, have been found to be very useful in providing vital inputs on condition of wetlands, mangroves, coral reefs, coastal land use, coastal erosion and deposition, delineation of high and low tide and construction setback lines, etc. Satellite based coastal maps have an accuracy of 85 to 90 percent at 90 percent confidence level. Satellite-based maps provided information on status of wetlands, mangroves and coral reefs for the entire country on 1:250,000 and 1:50,000 scale. This information has been useful as a baseline or reference data for planning conservation measures. Thematic maps showing high and low tide line as well as wetland and land use categories in regulation zone on 1:25,000-scale are extensively used for implementing guidelines for coastal zone into four regulatory zones having various restrictions and regulations. The central and state governments extensively used these maps for preparing coastal zone management plans. The use of IRS LISS III and PAN data improved the control accuracy to about 20 m. It is now almost mandatory for all industries, governmental as well as non-governmental agencies to use satellite-derived information for the coastal regulation zone activities. Coastal land use maps on 1:50,000-scale were used to assess potential of the brackish water aquaculture in the country. Shoreline-change maps on 1:50,000 show changes occurred during the period 1960-1990 period for the entire country. The changes due to developmental activities as well as natural processes have clearly been brought out. Today in India, satellite data is widely used to study many aspects of coastal zone.
The likely availability of high-resolution data from RESOURCESAT-I and CARTOSAT-I and II will facilitate preparation of local level maps at large scale. (Nayak S R, 2002, Indian Cartographer)

5.5 SEA LEVEL CHANGES

Sea level changes can be of two types:

i) changes in the mean sea level and

ii) changes in the extreme sea level

The former is a global phenomenon while the latter is a regional phenomenon. Estimates of mean sea level rise made from past tide gauge data at selected stations along the coast of India indicate a rise of slightly less than 1 mm/year; however these estimates need to be corrected by including the rates of vertical land movements, whose measurements are not available at present. Simulation results of a regional climate model, HadRM2, were analyzed for the northern Indian Ocean to provide the future scenarios of the occurrence of tropical cyclones in the Bay of Bengal for the period 2041-60. These model simulations consist of a control run with concentration of CO2 (GHG) according to the IS92a scenario for the period 2041-2060. Simulation results show increase in frequencies of tropical cyclones in the Bay, particularly intense events during the post-monsoon period, for the increased GHG run. A storm surge model was used to compute the surges associated with the cyclones generated by the climate model. The storm surge model was forced by the wind field from HadRM2 over the model domain and tides prescribed along the open boundary from a global tidal model. The frequency of high surges is found to be higher in the model run forced by winds from increased GHG run than in the model run forced by winds from the control run. (Unnikrishnan A S, 2000, Current Science Vol 90, No. 3)

Information on winds, waves, tides, currents, geomorphology and rate of sediment transport along a coast is required for planning and design of coastal facilities. Beach erosion is a universal problem and it has been estimated that 70% of all the beaches in the world are eroding. Any attempt to handle the coastal problems either to arrest erosion or
prevent deposition requires a thorough understanding of the factors and processes involved in the coastal geomorphological system.

Based on the data collected, stretches of the Indian coastline affected by erosion, wave and current characteristics and sediment transport rate at a few locations are presented. (Sanil Kumar V, 2006, Current Science, Vol 91. No. 4)

Change detection is the measure of the district data framework and thematic change information that can guide to more tangible insights into underlying process involving land cover and land use changes than the information obtained from continuous change. Digital change detection is the process that helps in determining the changes associated with landuse and land cover properties with reference to geo-registered multi-temporal remote sensing data. It helps in identifying change between two (or more) dates that is uncharacterized of normal variation. Change detection is useful in many applications such as landuse changes, habitat fragmentation, rate of deforestation, coastal change, urban sprawl, and other cumulative changes through spatial and temporal analysis techniques such as GIS (Geographic Information System) and Remote Sensing along with digital image processing techniques.

Coastal environment changes were analyzed through qualitative evaluation techniques (Debashis Mitra, 1999). The techniques included change map derived from vegetation index differencing, image ratioing, image differencing and image regression. The basic principle of all change detection techniques was that the digital number of one digit is different from the digital number of another date. (T V Ramachandran and Uttam Kumar, FOSS / GRASS Users conference, Bangkok, Thailand, 12-14 Sept 2004)

Digital remote sensing data of SPOT-1 (Nov 1990), IRS-1C (Jan 2001) and IRS-1D (Jan 2003) have been subject to maximum likelihood classifier (MLC) to carry out change detection studies in the coastal zone of Goa. The classified images were evaluated on both homogeneous and heterogeneous regions in terms of confusion matrix as well as by field validation. The classification results of these multi-temporal data reveal that MLC gives an average accuracy of 85.69, 77.66, and 88.43% for 1990, 2001 and 2003 images.
respectively, and the corresponding kappa coefficients are 0.89, 0.84 and 0.86 respectively. Results of MLC indicate that there is an increase in urban land, vegetation and water body reduction in barren land and sandy beach along the coastal zone of Goa. The urbanization is attributed to tourism boom-related activities. (Mani Murali R, 2006 Current Science Vol 91, No. 6)

Coastal zones are constantly undergoing wide ranging changes in shape and environment due to natural as well as human development activities. Natural processes such as waves, erosion, changes in river courses etc., cause long time effect at slower rate; but man made activities, such as settlement, industrial activities, recreational activities, waste disposal etc., affect the coastal environment at comparatively much faster rate.

The present work deals with the study of a part of the eastern coastal zone of India, occurring between Subernarekha river mouth in the north and Rishikulya river mouth in the south using remote sensing sensor data.

The study shows that IRS – P3 WiFS and IRS – 1B LISS II data can be successfully used in studying the coastal landuse / land cover and landform of the eastern coast of India. These themes were integrated in GIS and change detection analysis has been carried out using algorithms developed in GIS environment. (Bhattacharya A K and Srivastava P K, 1998)

Tsoo-nah-mee, the Japanese word meaning harbour wave is basically a wave train, generated in the ocean due to sudden disturbance that vertically displaces the water column. The causative factor of such an impulse can be ocean-floor tectonics (earthquakes and volcanic eruptions) or mass movements in the continental slope. All these processes result in elevating (potential energy) the water column up above the mean sea level, which then horizontally propagates (kinetic energy) as tsunami. Thus the tsunami differs from the tidal wave in that the latter has very low-order energy, since it originates due to gravitational forces.
The tsunami once generated, is split into distant (propagating towards nearby coast) tsunamis which travel in opposite directions with an amplitude about half of the original. Both tsunamis have a wavelength more than 100 km and period of the order of about 1 h. Since the speed of the tsunami varies as the square root of water depth, it travels faster in the open ocean than near the coast. As the tsunami moves from the deep ocean to the shore, its amplitude increases and wavelength decreases. This results in the steepening of the tsunami run-up, a measure of the height of the water on shore. After hitting the shore, a part of the tsunami energy is reflected back to the open ocean and also results in generation of edge waves that travel back and forth parallel to the shore. The generation of run-up and edge waves is complex depending upon the slope, smoothness, wave type, depth of water and coastal topography.

The recent tsunami that paralysed the entire southeast and southern parts of India, owes it origin to a devastative earthquake off the west coast of Sumatra (5.51° N 92.92° E) with a magnitude of 8.9 on the Richter scale and focus at a depth of 33.9 km. Here an attempt has been made to understand the trails of the recent tsunami during its propagation and aftermath using satellite remote sensing and GIS techniques.

Acquisition of MODIS – Terra and Aqua calibrated radiance data sets (level 1B) of 25 December 2004 (07:30 GMT) and 26 December 2004 (5:10, 5:20, 8:15 GMT). MODIS band 1 (0.62 – 0.67 um) and band 2 (0.841-0.876 um) (250 m spatial resolution) are used to map coastal flooding. Band 3 (0.459-0.479 um) and band 4 (0.545 – 0.565 um) have spatial resolutions of 500 m. For sediment load study, band 2 was re-sampled to 500 m. As MODIS –Terra data was acquired less than 3 h after the earthquake, special emphasis is made to understand the trails during the propagation and after its impact on the coast. (Ramkrishnan D, Current Science Vol 88, No. 5, March 2005)

The landward displacement of the shoreline caused by the forces of waves and currents is termed as erosion. Coastal erosion occurs when wind, waves and long shore currents move sand from the shore and deposits it somewhere else. The sand can be moved to another beach, to the deeper ocean bottom, into an ocean trench or onto the landside of a dune. The removal of sand from the sand-sharing system results in permanent changes in
beach shape and structure. The impact of the event is not seen immediately as in the case of tsunami or storm surge. But it is equally important when we consider loss of property. It takes months or years to note the impact. So this is generally classified as a "long term coastal hazard." (NIO – DISR, 2005)

Beaches are the most important geomorphological features of a Coastal state. Coastal erosion is caused by the input of the wave energy to the coastal zone. This wave energy could result in sedimentation or erosion along the coastline. Mathematical model was carried out to investigate and predict the erosion. This model utilized several types of data, including remotely sensed data, ship observations and ground truth data.

The Arabian sea eating into India’s longest coastline has caught the attention of researchers at M S University. They have taken up a project to study the Gujarat coastline stretching across 1,700 kilometre. The researchers are now studying whether the erosion is related to the global sea level rise or some neo-tectonic activity in the area. (NIO – DSIR, 2005)

A tsunami is a very large ocean wave triggered by an underwater earthquake, volcanic activity or a landslide. On rare occasions, the impact of cosmic bodies such as meteorites can generate tsunamis. Tsunamis can savagely attack coastlines, causing devastating property damage and loss of life. These waves have unusually long-wavelength in excess of 100 kms, generated in the open ocean and transformed into a train of catastrophic oscillations on the sea surface close to coastal zones. These normally occur in Pacific Ocean and are highly unexpected surrounding the Indian subcontinent. In fact, the “tsunami” was only a tongue-twister for most Indians till 26 December 2004.

In the open ocean, the tsunamis are harmless because of their small height (typically 30-60 cms). However, as they race onto shallow water regions and pass into continental coasts their speed diminishes which results in increase in the wave height in order to conserve the total energy. Typical speeds in the open ocean are of the order to conserve the total energy. Typical speeds in the open ocean are of the order of 600 to 800 km/hr. The tsunami’s energy flux, which is dependent on both its wave speed and wave height,
remains nearly constant. When it finally reaches the coast, a tsunami may appear as a series of breaking waves.

The genesis of this portal is in the tsunami that struck Indian coastline on 26 December 2004. However, other coastal hazards are more important to the Indian subcontinent and that is why the scope of this portal has been expanded from tsunami to coastal hazards. Information about this hazard has been collected to a large extent to provide links. (NIO – DISR, 2005)

The state of Gujarat has been prone to disasters. Over the years, these disasters have caused extensive damage to life and property and have adversely impacted economic development. The Government of Gujarat (GoG) recognizes the need to have a proactive, comprehensive, and sustained approach to disaster management to reduce the detrimental effects of disasters on overall socio-economic development of the state. With this in view, the GSDMA has formulated the Gujarat State Disaster Management Policy. (NIO – DSIR, 2005)

A tropical cyclone is essentially a rotating storm (an individual low pressure disturbance, complete with winds, clouds and precipitation) in the tropical oceans. The life span of a tropical cyclone is, on average, about six to nine days until it enters land or recurves into cooler latitudes, but this may vary from a few hours to as much as three to four weeks. No two tropical cyclones are identical. The movement of a tropical cyclone is generally 12 knots or less.

Tropical cyclones, storm surges and their associated phenomena (high winds, torrential rains, floods, etc) cause tremendous damage to life and property in the countries bordering the Northern Indian Ocean and particularly the Bay of Bengal leading to disastrous effects on population, economic and social life. (NIO-DSIR, 2005)

Pollution of marine waters was realized sometimes in the 1970s. It was otherwise thought that the world’s oceans have an infinite capacity for absorbing our waste. This hazard is purely of anthropogenic origin. Some major types of pollutants that have been the focus of recent research are oil, sewage, garbage, chemicals, radioactive waste and
thermal pollution. Among these, the oil pollution is always discussed at length because other pollutants affect limited areas. Not enough information is yet available about radioactive waste disposal and its pollution effect.

When oil tankers break close to coastlines or oil is spilled from these tankers. However, only about 10% of oil pollution is because of the oil spills and is a short-term coastal hazard.

Oil pollution is important to the Indian coastline, because, most of the petroleum products (including oil) originate in the West Asian countries and are transported from the Indian Ocean to other parts of the world.

Besides, the effects of these on the environment, this type of pollution also affect the living biota of the seas which is consumed by human being world over. (NIO-DSIR, 2005)

Harmful algae are microscopic, single-celled plants that live in the sea. Most species of algae or phytoplankton, usually are not harmful. Rather they serve as the fundamental source of food for higher forms of life.

Unfortunately, a small number of species produce potent neurotoxins that can be transferred through the food web where they affect and even kill the higher forms of life such as zooplankton, shellfish, fish, birds, marine mammals, and even humans that feed either directly or indirectly on them. Such algae remain on the ocean floor or buried in the sediments in the form of cyst until favourable conditions. They germinate with warmer temperatures and increased light stimulation. Once hatched, they continue to divide and reproduce exponentially until favourable conditions. The hazardous conditions are noticed when these are consumed by the higher forms. During unfavourable conditions, the nutrients in the sea water, etc., get depleted, the growth stops and two gametes join to form one cell to go back on the ocean floor in dormant conditions.

Scientists now prefer the term, Harmful Algal Blooms (HAB), to refer to bloom phenomenon that contain toxins or that cause negative impacts. (NIO-DSIR, 2005)
R P Singh et al (Current Science, 2001, 81, 164-166) have highlighted some interesting and useful information on the physical changes seen around Bhuj as revealed from the IRS-ID LISS-III remote sensing data. According to Wadia, ‘The 1819 earthquake in the Cutch resulted in the subsidence of the western border of the Rann of Cutch under the sea, accompanied with the elevation of a large tract of land. Here some 2000 sq miles of area was suddenly depressed to a depth of 12-15 feet and the whole tract was converted into an inland sea. As an accompaniment of the same movements, another area of 600 sq miles was simultaneously elevated several feet above the plains into a mound, which was appropriately designated by the local people as “Allah Bund” (built by God)’. Wadia further informs that within historic times, the Rann of Cutch was a gulf of the sea, with surrounding coastal towns. The gulf was gradually silted up due to elevation of its floor and eventually converted into a dry saline desert for a part of the year and a shallow swamp for the remaining part.

Similar to the 1819 earthquake, the 2001 earthquake, according to Singh et al. (2001), has also brought out changes in the surface features like appearance of palaeo-channels and water bodies in the Rann of Cutch. Because of the 2001 earthquake, the floor of the Rann of Cutch suffered upliftment, resulting in the exposure of the palaeo-channels and water bodies. Perhaps, if this region suffers one more upliftment, then the Rann of Cutch may be emptied of its saline waters and the area may again become a fertile land. We can then expect some potable water in this region. (Singh R P, 2001, Current Science, Vol 81, No. 8)

Of all the mangroves, the Indian formations have suffered most through human and animal agency. In the deltas, the density of the human populations exceeds 700 inhabitants per km2 and the density of the cattle population is so high that even a rough approximation is very difficult to make. Man has utilized and exploited the products of mangroves in an uncontrolled way for many years. This uncontrolled utilization has resulted in diversified, physiognomically degraded, floristically simple, and impoverished mangrove formations. The diversity of Indian halophytic vegetation today is surprising.
with regard to ecology, floral composition, physiognomy, and structure of each vegetation type, all of which vary from one delta to another. (Blasco F. et.al. 1975)

Gujarat Ecological Education and Research (GEER) Foundation, Gujarat, India has prepared this comprehensive report on “Mangroves in Gujarat.” This report covers detailed information about area, under mangroves, its distribution, international zones, coastal wetlands and other categories as estimated by remote sensing study, species diversity, which can be used to provide insights into the possible response of mangroves to the changes in the marine environment. Report would be helped to ecologists, foresters and to all whosoever is interested in mangrove ecosystems. The information provided in the report will be of immense use for the management of the Marine National Park, Jamnagar, Gujarat and the coastal areas of Gujarat. It would be helped for the long-term conservation of our invaluable heritage viz. mangrove species and marine ecosystems. (Singh H S, 2000, 128; pp)

Indian Ocean is the home of rare flora and fauna that act as the bio-shield to many coastal communities. Indian Ocean experienced the world’s most deadly natural disaster “Tsunami” on 26th December, 2004 which on one hand is unparalleled in the history considering its magnitude and devastation and on the other hand, caused an unprecedented impact on the aqua and aqua terrestrial ecosystems. One of the worst effected flora is the mangrove species that is among the richest in the world. There are places where vast pristine tracts of mangroves have been destroyed and it may pose a long-term threat for the region, not only in terms of forest and biodiversity conservation but also in terms of the ability of the ecosystem to support the livelihoods and the coastal communities. The tragedy of Tsunami invoked the rationale for conserving and sustainably managing natural ecosystems among the researchers and scientific community.

The present research was carried out to make a post Tsunami evaluation of India’s ecologically fragile areas of Gulf of Mannar and South Andaman Island. Indian Remote Sensing Satellite (IRS 1C) and (IRS 1D) LISS ( Linear Imaging Self Scanner)-III and Resourcesat-I LISS IV data have been effectively used to detect, assess and monitor the
changes in the mangroves in the Pre and Post Tsunami period using multi-temporal optical satellite data.

Onscreen visual interpretation was done using FCC of the data to identify the heterogeneous patches for the preliminary classification of fieldwork. A supervised classification was performed using Gaussian Maximum Likelihood (GML) classifier to obtain the pre and post Tsunami land use/land cover maps. Accuracy assessment of the classified maps were performed on pixel level using ground truth.

The changes in the Pre and Post classification maps were performed by comparison of area basis based on different land use classes and using change matrix analysis. The result highlighted the changes in the spatial extent of the mangroves and other land use categories in the study areas as a result of Tsunami. The Damage map showed the degree (intensity) and extent of damage in mangroves on a qualitative basis. (Chaterjee Barnali, 2006, Ph.D Thesis, IIT-IIRS)

This paper describes research to compare two different satellite images for temporal monitoring of mangrove forest in Qeshm Island and its effects on coastal erosion and sedimentation. In this paper following steps were performed: collection of landsat satellite images TM (1988 & 1998) and geomorphologic map for each year was prepared. The final step was preparing a cross map 1988 and 1998. According to cross map, four important areas are distinguished, mangrove forests, coastal erosion area, coastal accretion area and degradation of mangrove forests. To comparison between units of cross map, can be result, that coastal accretion area is more than the coastal erosion area and the coastal accretion area is located in the river outlet to sea and around of mangrove forests with more sediment. (Hossainipour Kooveel, 2005, Map India)

5.6 MANGROVES

The mangroves are fragile complex and dynamic ecosystem, and are dependent on interrelated, environmental both, biotic and abiotic factors. Quite many contributions are available on mangroves and few recent ones are as follows.


