ANNUAL REPORT

2017-2018

NCSCM

NATIONAL CENTRE FOR
SUSTAINABLE COASTAL MANAGEMENT

Ministry of Environment, Forest and Climate Change
Government of India

NATIONAL CENTRE FOR SUSTAINABLE COASTAL MANAGEMENT

ANNUAL REPORT 2017-2018

सत्यमेव जयते

Nature Protects if She is Protected

SOCIETY OF INTEGRATED COASTAL MANAGEMENT
SICOM

THE WORLD BANK
IBRD • IDA

ANNA UNIVERSITY
PROGRESS THROUGH KNOWLEDGE

Published by
National Centre for Sustainable Coastal Management
Ministry of Environment, Forests and Climate Change
Anna University Campus, Chennai

Citation
NCSCM Annual Report 2018. National Centre for Sustainable Coastal Management, Ministry of Environment, Forests and Climate Change. Chennai, p165

CONTENTS


राष्ट्रीय सतत तटीय प्रबंधन केंद्र
पर्यावरण, वन और जलवायु परिवर्तन मंत्रालय, भारत सरकार
NCSCM
NATIONAL CENTRE FOR SUSTAINABLE COASTAL MANAGEMENT
Ministry of Environment, Forest and Climate Change, Government of India
தேசிய கடலோர நிலைத்திட்ட மேலாண்மை மையம்
சுற்றுச்சூழல், வனம் மற்றும் பருவநிலை மாற்ற அமைச்சகம், இந்திய அரசு

ABOUT NCSCM

A. About NCSCM

The National Centre for Sustainable Coastal Management (NCSCM) was established by the Ministry of Environment, Forest and Climate Change (MoEFCC) in 2010 as an autonomous institution with the vision of promoting sustainable coasts through increased partnerships, conservation practices, scientific research and knowledge management for the benefit and wellbeing of current and future generations. NCSCM is designed to support the nationwide adoption of ICZM approaches through the development and provision of cutting-edge science, knowledge and networking with relevant national and international institutes of repute. These will be realized through inter and trans-disciplinary scientific research, advisory capacities and by imparting knowledge into a seamless, holistic decision support system. The necessary research builds upon and integrates expertise within the coupled social-ecological systems.

Picture1: Front-view of NCSCM Building

RESEARCH STUDIES CARRIED OUT BY NCSCM

SHORELINE MANAGEMENT

B. Research Studies Carried out by NCSCM

I SHORELINE MANAGEMENT

1. National assessment of shoreline change

Coastline of India is 7500 km; of which mainland coast extends to 5500 km and island territories form 2000 km. The coast is subjected to multiple coastal processes and anthropogenic pressures, making it vulnerable to erosion. The loss (erosion) and gain (accretion) of coastal land is a visible result of the way shorelines are reshaped in the face of these dynamic conditions. Nearly 45% of India's coast is observed to be under erosion. Accretion has occurred along 35.7% of the shoreline while 18.8% of the shoreline is observed to be more or less stable. Of this, nearly 7% of the Indian coast experiences high erosion (<-5 m yr-1) and 7.6% of the coast has seawalls, embankments etc. as coastal protection measures. A few stretches along the coast of West Bengal, Puducherry and Kerala are highly eroding. Erosion is also a major issue in the islands of Lakshadweep. Recommendations for shoreline management plan was prepared by NCSCM and submitted to the Ministry.

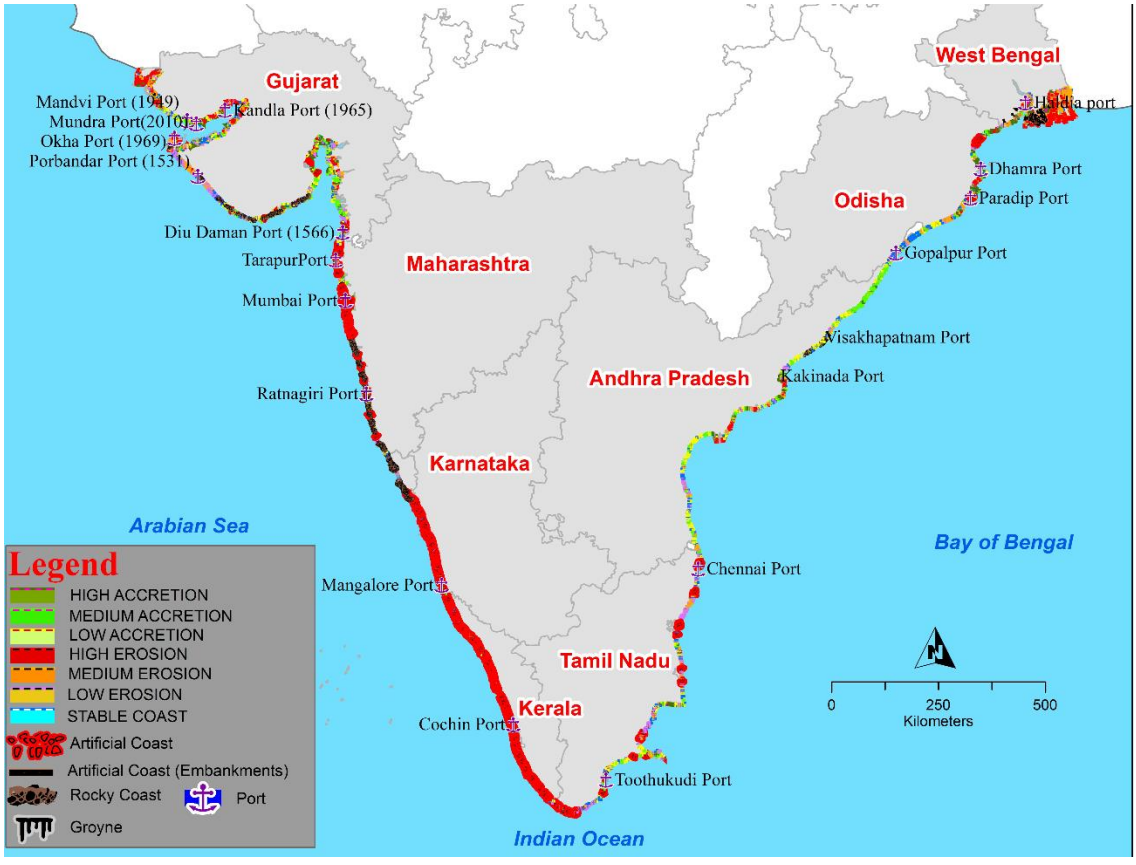


Figure 1: Shoreline change for the coast of India

2. Coastal sediment cells

The coastal zone is important for location of industry, transport links, agriculture, fisheries, tourism and urban development. It is constantly changing due to erosion, accretion, and flooding, all of which threaten human use of the coast. An understanding of the way in which this system functions allows us to identify the impacts of development or management and to take action to mitigate such impacts. It acts as a self-contained unit so that any development within the sediment cell will have a minimal impact on areas outside its boundaries. The findings of the study carried out by NCSCM delineated the West coast of India into 10 and east coast into 16 primary cells of varying coastal lengths. The 10 primary cells of West coast were further divided into 21 sub cells and 16 primary cells of the east coast were divided into 37 sub cells. Most of the cell boundaries along the west coast were bounded by hard coastal headlands while major rivers formed most of the cell boundaries along the east coast. Cell boundaries along the east coast are located at the mouths of major rivers indicating the major sources of sediments and its large scale movement along this coast.

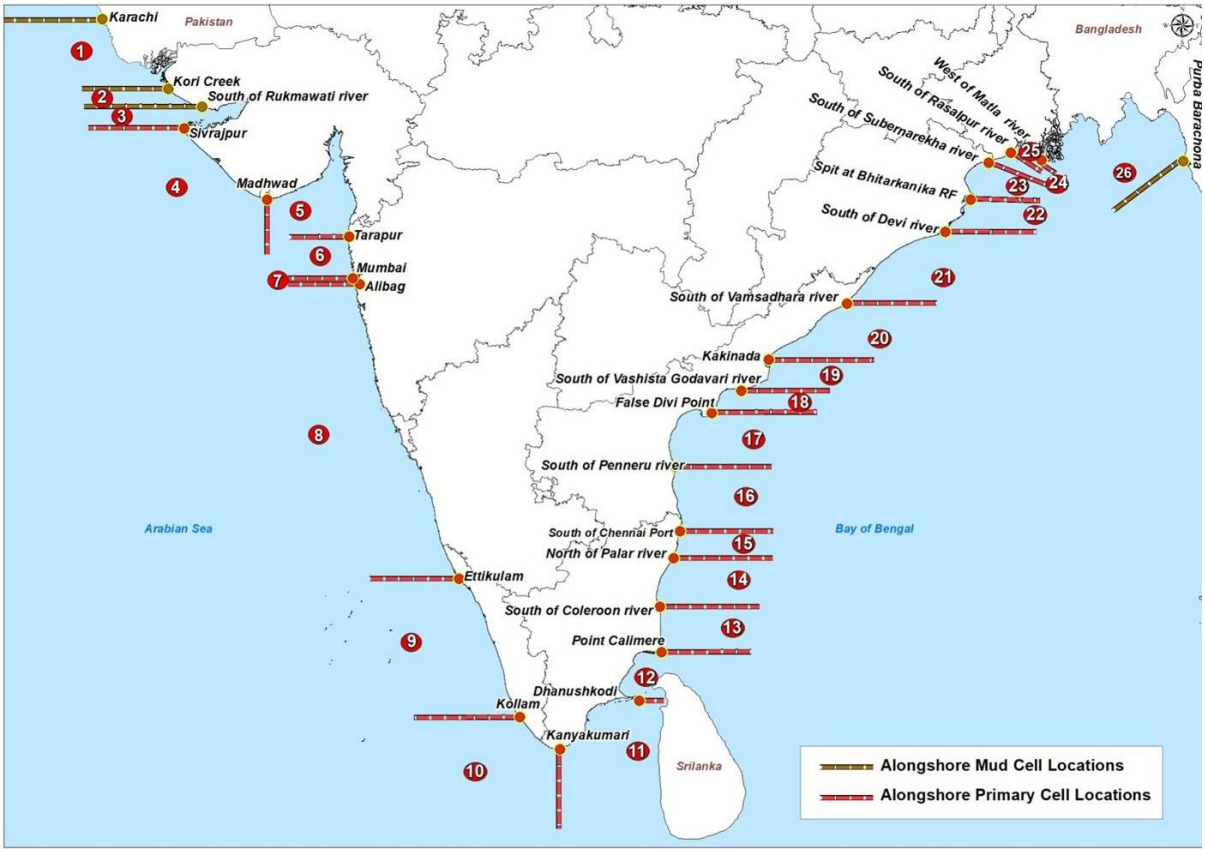


Figure 2: Primary sediment cells along the coast of India

3. High Resolution Erosion/Accretion Mapping of the Indian Coast

Mapping the erosion/accretion status of the Indian coast using high resolution aerial photographs along with historical satellite imagery (1972 – 2009) was undertaken. Aerial photographs of 9cm GSD taken in 2011 – 2012 was taken by Survey of India under the India ICZM Project. Using the Digital Shoreline Analysis System, linear regression line was drawn to derive 8 categories of shoreline change as follows:

1 – 3: High, Medium and Low erosion
4 – 6: High, Medium and Low accretion
7 – Stable coast and 8 – Artificial coast (previously high erosion areas – protected by seawalls/ groynes/ breakwaters etc.

The 40-year historical data (1972 – 2012) was then used to predict the status of shoreline for the next 100 years (up to 2100). This study formed an integral part of delineation of the country's Hazard line. The major outcomes and application of the study included:

a) predicted erosion/accretion extent for the next 100 years of the coast
b) demarcation of the country's hazard line
c) determine hotspots of severe erosion along the country's coastline
d) undertake shoreline management plan with appropriate, site-specific erosion control measures

Figure 3: Erosion protection along Pentha coast, Odisha

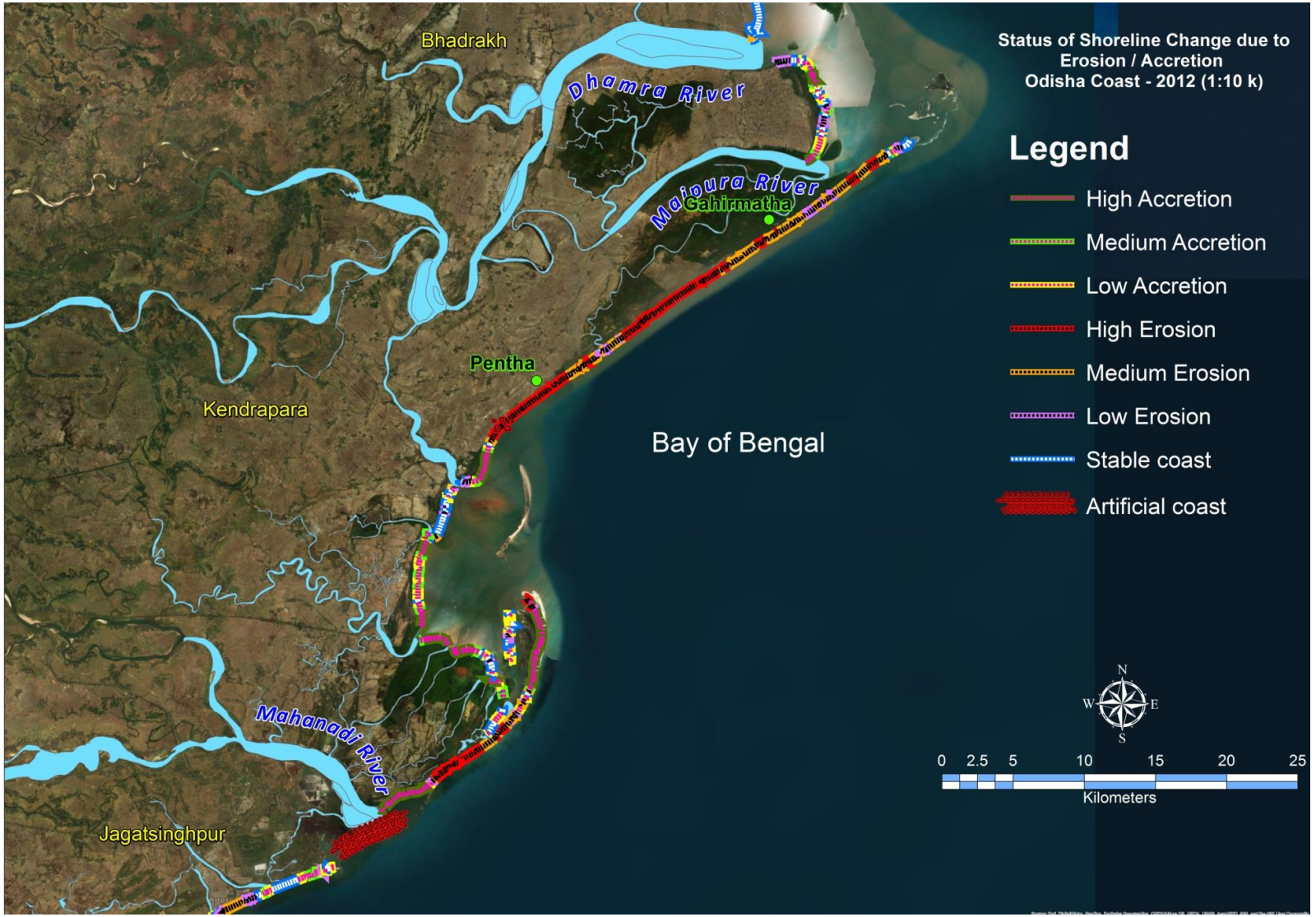


Figure 4: Shoreline change along Kendrapara coast, Odisha

3.1 Hazard Line mapping

The coast is vulnerable to a host of natural and manmade hazards. In order to protect the people and their property mapping of Coastal Hazards which includes flooding and erosion is essential. Coast attracts development and natural hazards put development at risk. Delineation of "hazard Line" along the entire coast of India and demarcation of hazard line has been completed for the West coast of India adopting Digital Stereo Aerial photography all along the coast covering a 7 km stretch from the shore, inter-tidal zones. The Photography was carried out using Fixed-Wing Aircraft and Airborne Differential GNSS/GPS & IMU Control. Digital shoreline Analysis of different time series coastline data was used to arithmetically project shoreline for next 100 years. Higher the erosion and flood line, the higher the hazard line and hence, the hazard line is demarcated on the Digital Elevation Model (DEM) developed from aerial photography.

Demarcation of the Hazard Line involves the following steps:

i. Overlaying the Flood line and the Erosion line in a GIS environment.
ii. Marking the segments of the Flood line /Erosion line which is the most landward, to obtain the Hazard line (Fig. 5)
iii. Transferring the hazard line to topographic maps for public dissemination.

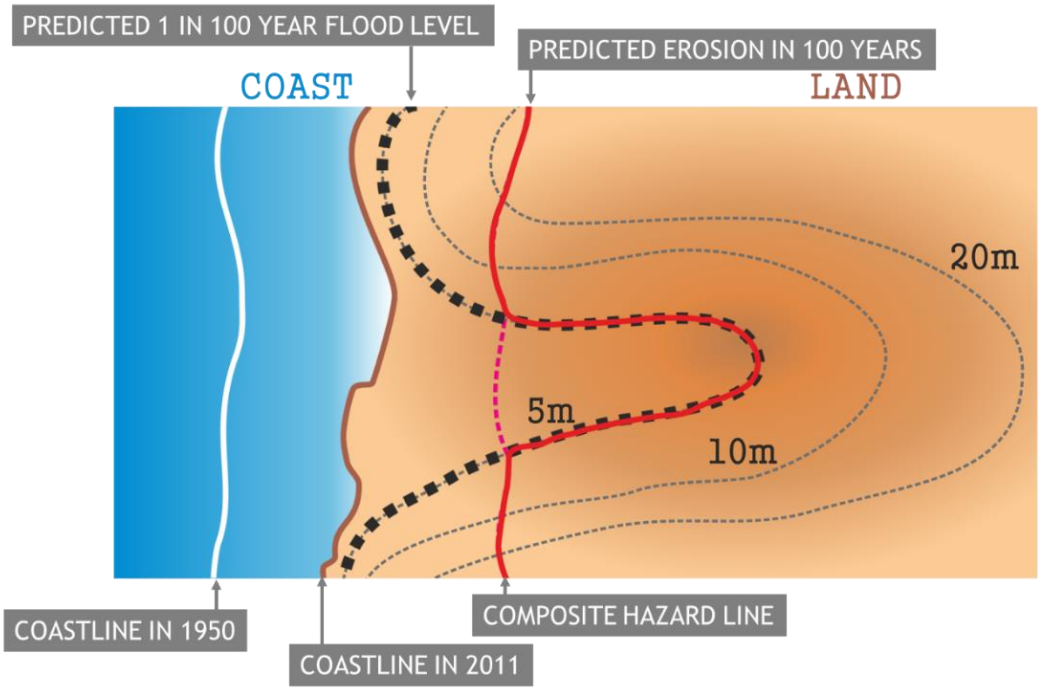


Figure 5: Concept of Composite Hazard Line

Figure 6: Composite Hazard Line for the Coast of India. *Insert: West coast: Near Karwar, Karnataka and East Coast: Near Visakhapatnam, Andhra Pradesh showing 1 in 100-year flood line, 100-year predicted erosion line and composite hazard line*

CONSERVATION AND CLIMATE MITIGATION

II CONSERVATION AND CLIMATE MITIGATION

4. Mapping of coastal Ecologically Sensitive Areas (ESA)

In order to aid in expanding the areas under spatial management measures, a framework for estimation of conservation value of coastal ecologically sensitive areas (ESAs) has been developed by NCSCM with the support of MoEF& CC. This will aid in identification and demarcation of highly stressed zones (HSZ) within these sensitive ecosystems. A total area of 34127.2 sq. km was mapped under ESAs as part of this study, where in 744 contiguous patches representing mangroves (5590.99 sq.km), coral reefs (1439.55), seagrass (518.22), salt marsh (600.36), sand dunes (324.45), mudflats (3557.95) which are biologically active and, turtle nesting grounds (178.72), horse shoe crab habitats (69.87), nesting grounds of birds (5386.46), areas/ structures of archaeological importance and heritage sites (5.78), national parks, marine parks, sanctuaries, reserve forests, wildlife habitats, other protected areas (16454.86) have been demarcated.

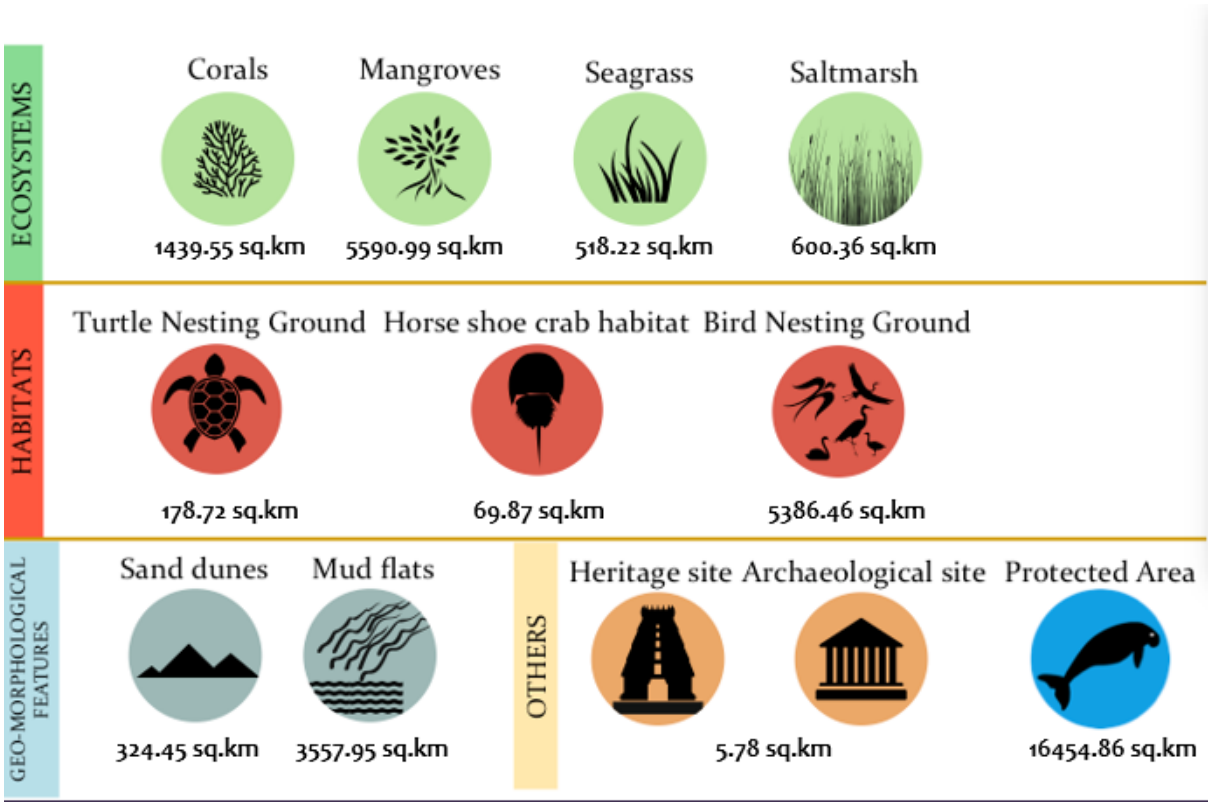


Figure 7: Extent of Ecologically Sensitive Area (ESA) along Indian coast

5. Blue Carbon: Offsetting carbon emissions by coastal vegetative ecosystems: 5.1. PART-A: GHG Emissions and C-Sequestration

Study on greenhouse gas emission indicated that the mangrove and seagrass ecosystems usually act as a net sink of carbon; despite water and sediment acting as source of greenhouse gases. The GHG emission from the sediment-water interface varies with human intervention, altered salinity, reduced tidal flushing and water discharge rates. The impacted system such as alteration of natural mangrove cover, are major emitters of GHG. A 20% increase in mangrove and seagrass cover along the Indian coast, may create an additional sink of ~ 0.7 million tonnes CO_2 per year and sink for ~ 0.1 million tonnes of CO_2 per year.

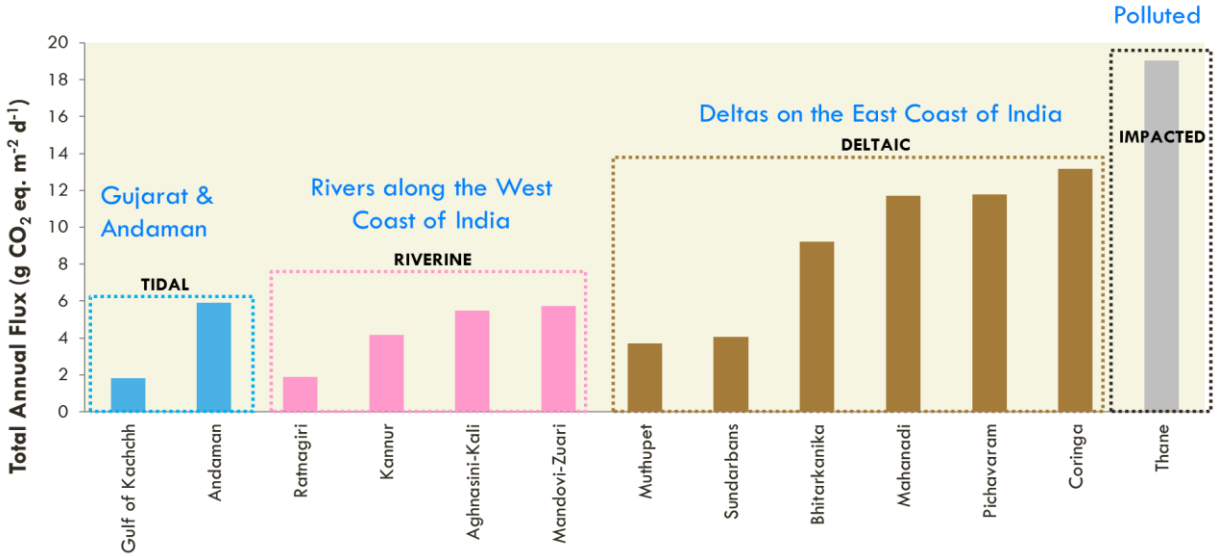


Figure 8: Greenhouse gas emission from mangrove ecosystems

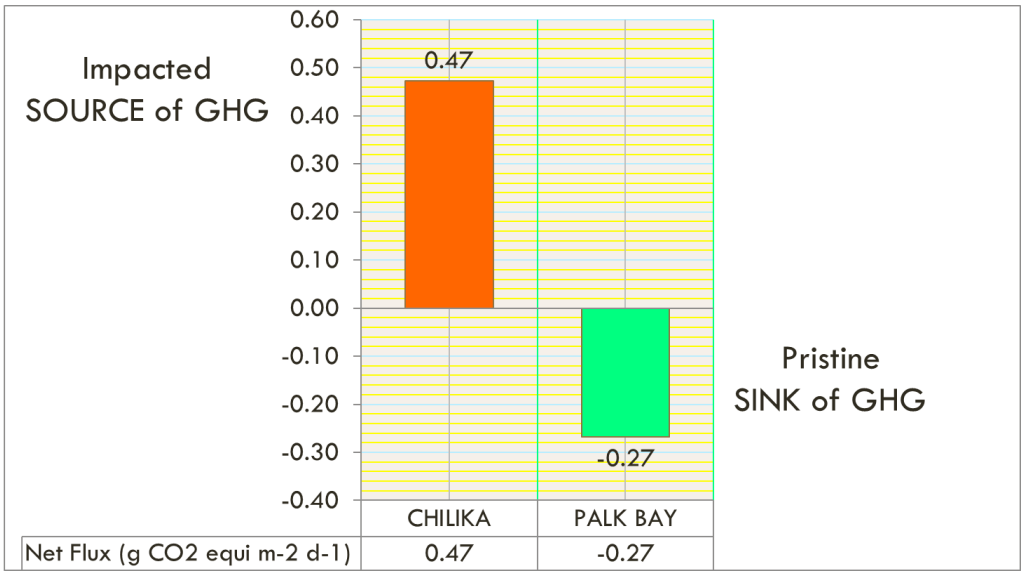


Figure 9: Greenhouse gas emission & sinks from seagrass ecosystems

5.1. Enhancing Blue carbon sequestration

The term "blue carbon" is defined as the carbon captured and stored through biological processes in the coastal and marine ecosystems which includes salt marsh, mangroves, seagrass, phytoplankton etc. Annual growth in global mean CO_2 during 2000-2015 was 2.053±0.43 ppm. At present growth rate of greenhouse gas emissions would reach almost 685 ppm CO_2-equivalent by 2050. The observations from the study carried out by NCSCM include the Net C accrual as mangrove biomass to be 1.69 tonnes C per hectare per year whereas for seagrass the values are 1.67 tonnes C per hectare per year. Net C accrual as mangrove biomass is 1.69 tonnes C per hectare per year. Conservation and restoration of 100 ha of the degraded mangrove forest may reduce ~ 0.15 million tonnes CO_2 emissions per year whereas in case of seagrass, the values are 0.05 million tonnes CO_2 emission per year.

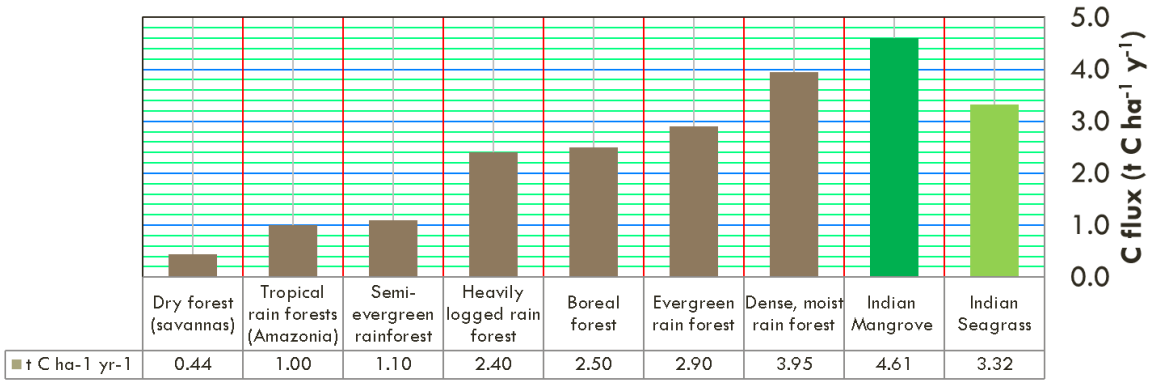


Figure 10: Carbon burial in Indian Forest Ecosystems

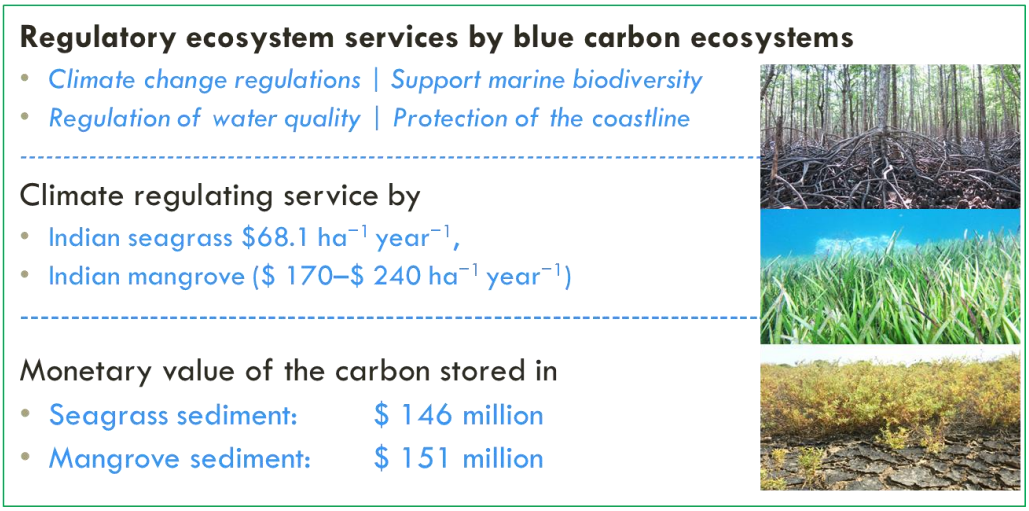


Figure 11: Blue economy from blue carbon ecosystems

5.2 PART-B: Geo-Spatial assessment of Carbon sequestration

Mangrove Zonation mapping and Net photosynthesis production of mangrove ecosystems

Quantification of organic production in terms of photosynthesis production within an established area over a specified period of time provides significant information on the functional status of an ecosystem. The behavior of vegetation to Red and near IR/SWIR wavelengths is utilized to develop the vegetation indices, a measure of the vigor of the plant. A correlation between direct field estimations of LAI and the Vegetation indices is established, which in turn is utilized to develop the LAI map.

Net Photosynthetic Production of the mangrove canopy per m^2 of ground area over a day is obtained based on the LAI, the average rate of net primary productivity obtained through in situ studies and day length. The study is conducted for mangrove patches for the States of Kerala, Tamil Nadu, West Bengal, Gujarat, Goa and Karnataka. The key observations are as follow:

- Dominant mangrove zones of Sundarban are *Avicennia marina, Avicennia alba, Ceriops decandra, Exoecaria agallocha, Heritiera fomes* and *Phoenix paludosa* mixed with other mangrove species of lesser proportion spread in an area of 2111.59 km^2 with an annual photosynthetic rate of 5.8 M T C/ Year.
- Tamil Nadu sustains 42.19 km^2 of which *Rhizophora mucronata - Rhizophora apiculata* and *Avicennia marina* forms the dominant zones.
- Mangroves of Kerala comprises of a mixed population of *Avicennia marina, Avicennia officinalis* and *Rhizophora mucronata* totaling an area of 16.27 km^2.
- Gujarat harbours 1517.41 km^2 of mangrove vegetation, the dominant species being *Avicennia marina, Ceriops tagal, Sonneratia apetala* and *Aegiceras corniculatum*.

5.3 Part C: Prediction and projection of future trends in carbon dynamics

Sediment transport and its load have been predicted using the flow and wave parameters as input to the sediment transport model. The significance of the sediment loads is important to understand the accretion-erosion processes. The sediment load was predicted using the simulations of sediment transport model in the vicinity of Krishna and Godavari delta region The high sediment load is predicted at the Hope Island at Kakinada and at the sand spits of the central and southern domain which are in the vicinity of riverine mouths. The sediment load varied between -3 to >18×10^{-6} $m^3/s/m$ in and around the delta region. The high sediment load greater than 18 ×10^{-6} $m^3/s/m$ is predicted at the Bhairavapalem mouth and less than that is close to the mangrove areas of Coringa and Gaderu regions. The predominant direction of the load is observed along the shore and across the shore.

Following key observations were made:

- Historical shoreline changes by the DSAS model predicted that the southern and northern side of the shore are accreting and mangroves covered areas are eroding along the coast of Godavari Delta.
- Riverine currents are very strong and varied from 0.8 m/s to 1 m/s at the Yanam and Bhairavapalem mouth.
- The predicted maximum wave height is about 2.8 m and the significant wave height of 1.5 m in the offshore region, whereas 0.2 to 0.6 in the near-shore regions.
- The high sediment load greater than 18 ×10^{-6} $m^3/s/m$ is predicted at the Bhairavapalem mouth and less at the mangrove areas of Coringa and Gaderu regions.
- Riverine currents are carrying the large portion of high turbidity and sediment rich water to the offshore regions.

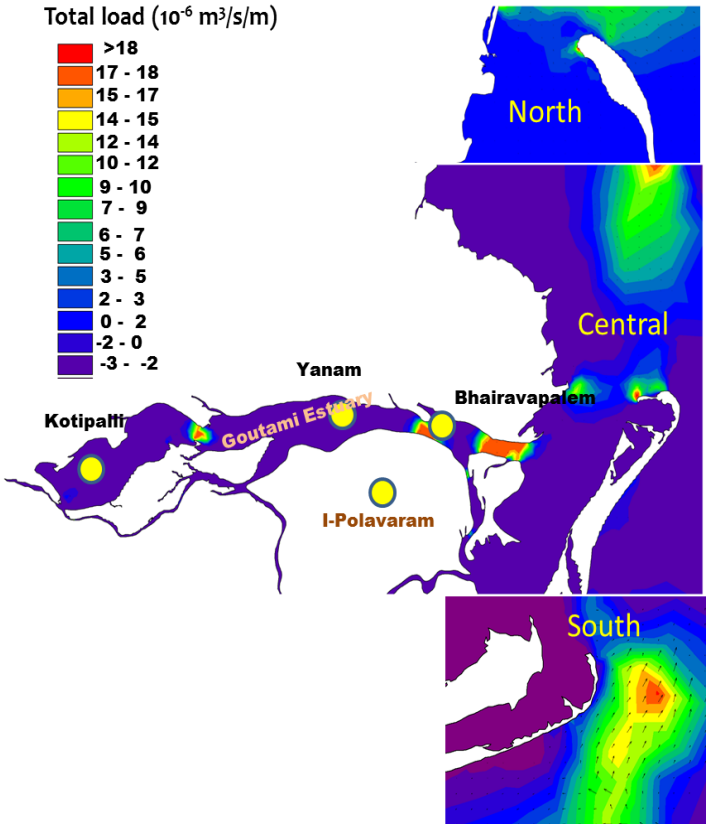


Figure 12: Predicted sediment load in the Godavari estuary and along the coastal regions of Godavari delta

POLLUTION MANAGEMENT

III POLLUTION MANAGEMENT

6. Cumulative Environmental Impact Assessment (CEIA)

One of the serious concerns of the waste water discharge is nutrient enrichment of the coastal waters which leads to algal bloom, eutrophication and hypoxia. These have diverse impacts ranging from change in color of the sea surface to mass fish kills at the worst case due to depletion of oxygen in the coastal waters. Critical effects include mass mortality of fish, emanation of noxious odour and respiratory problems among the coastal population. Assessment of Pollution Status along the coast of India using primary and secondary data, the current status of coastal/ marine pollution has been developed. This includes both point and non-point sources of pollution along the country's coastline, based on two aspects: i) land-based pollution and ii) sea-based pollution. Both forces dynamically have an impact on the vast coastal resources (mangroves/ coral reefs, salt marshes/ seagrass ecosystems/ fishery resources) and directly on the coast (eutrophication, harmful algal blooms etc).

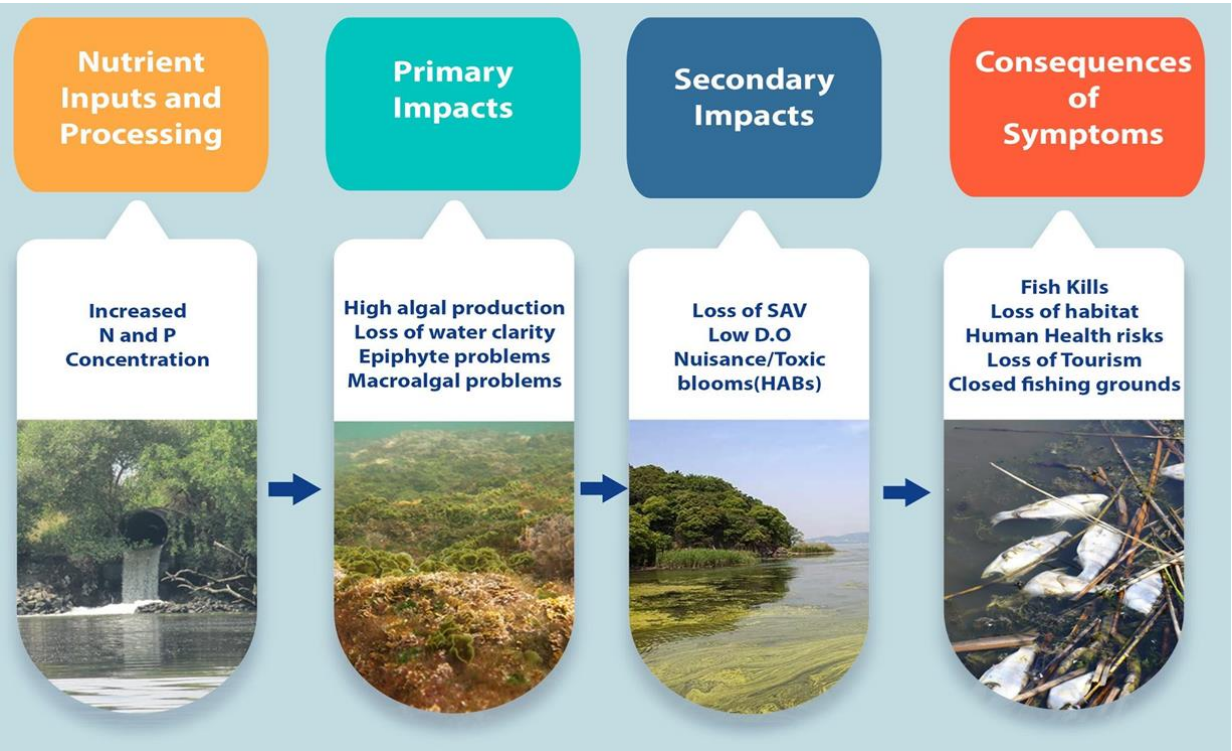


Figure 13: Consequences of Nutrient enrichment on coastal waters

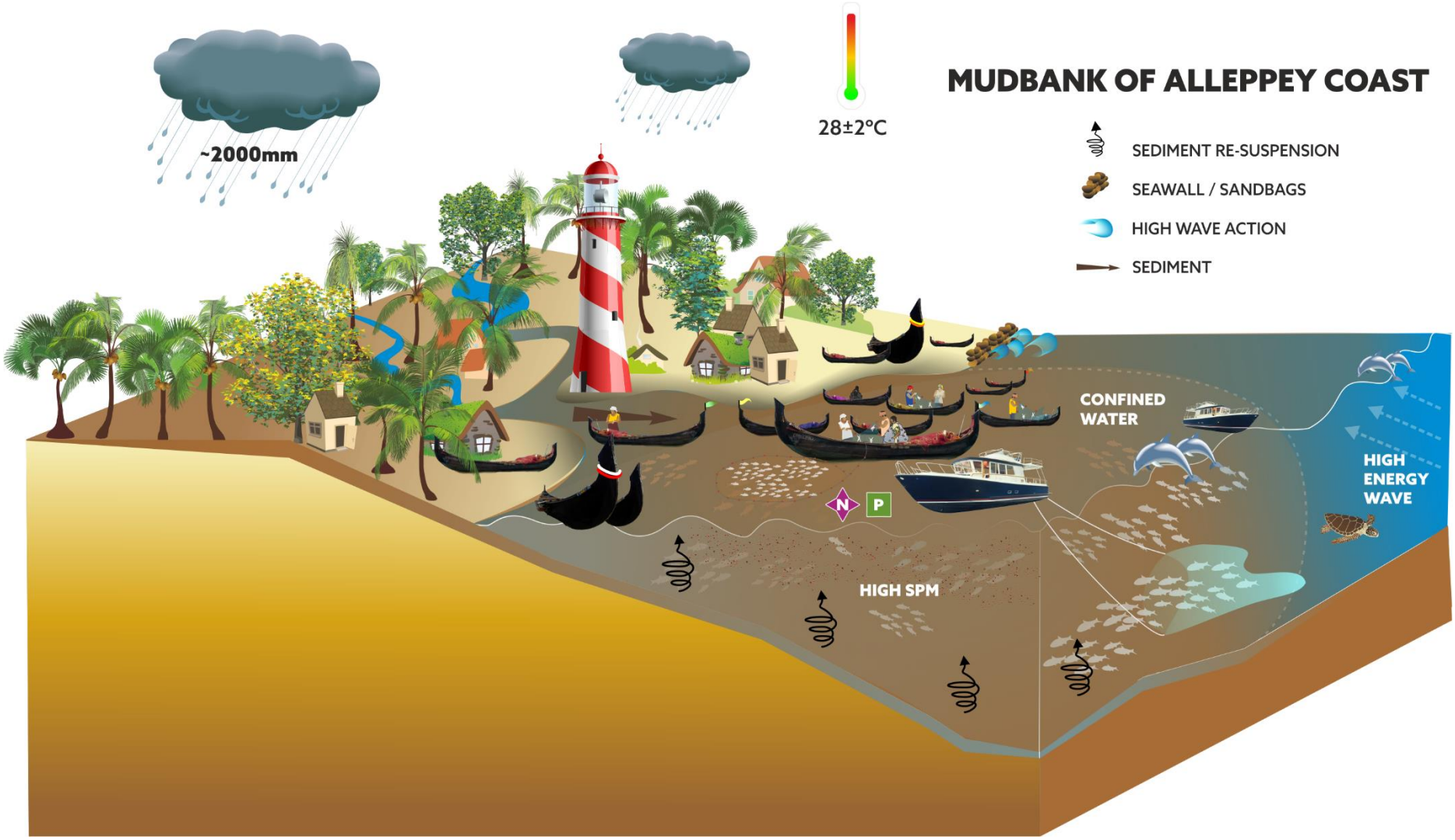


Figure 14: Conceptual representation of mud banks along Alleppey coast Kerala

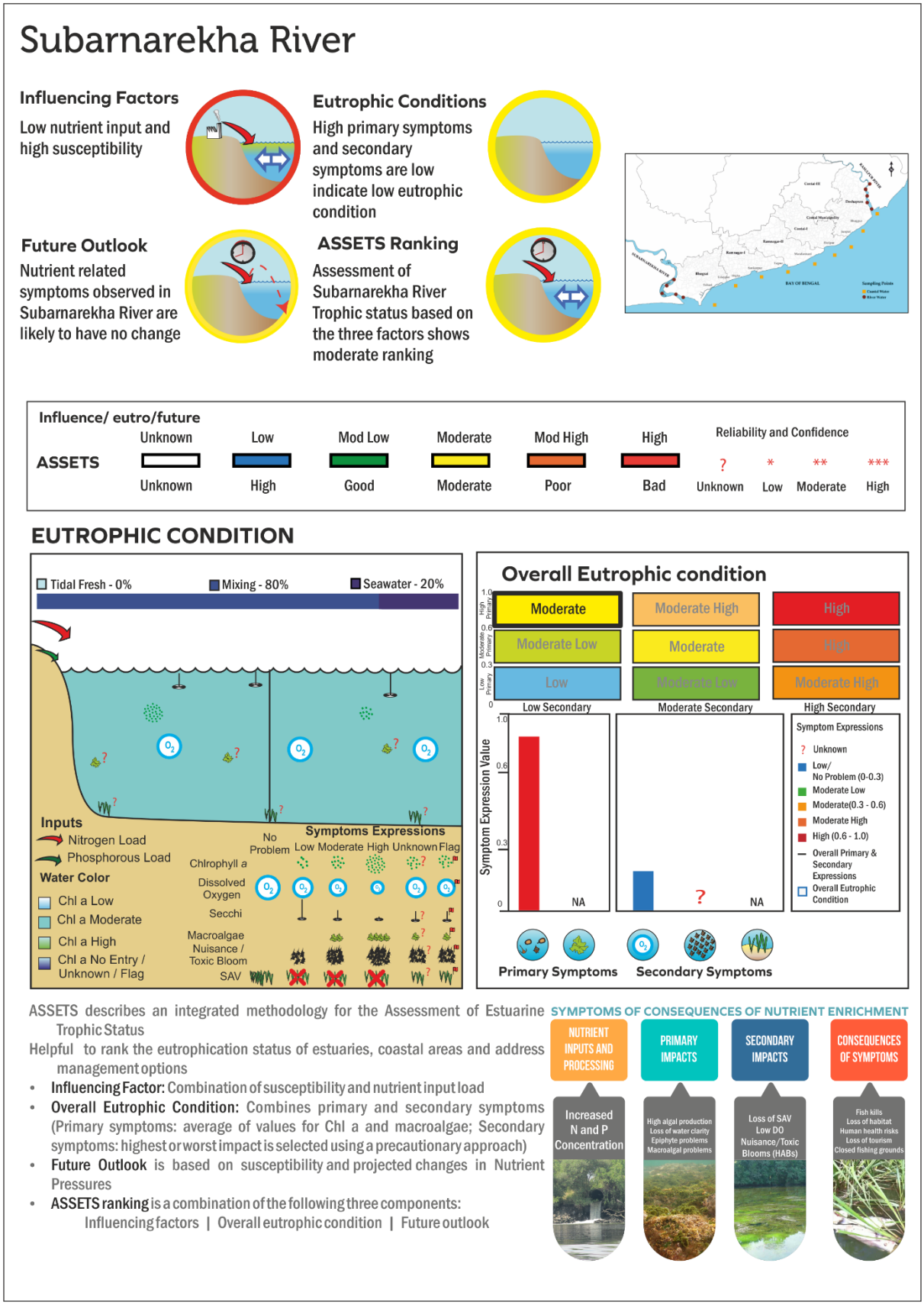


Figure 15: ASSET Eutrophication Index and trophic status of Subarnarekha river and estuary

6.1 Microplastics along beaches of India

Annual global production of plastic products has increased from 1.5 million tons in 1950s to >311 million tons in 2014. An estimated 268,940 tons of floating plastics are thought to be distributed throughout the world's oceans, with additional plastic sequestered in sediments, on beaches, and in biota. As a consequence, plastics are now one of the most common and persistent pollutants, which enter coastal waters and beaches worldwide through numerous pathways. Despite the prevalence of these synthetic materials in aquatic systems, their impacts on both wildlife and human populations are still poorly understood. Microplastic accumulation in the coastal environment is a serious concern, due to its ability to enter in to the food web which demands the necessity of assessing the microplastics from estuarine and coastal waters. Assessment of microplastics abundance, characterization has been completed for the coast of Tamil Nadu, Kerala and West Bengal and work is currently ongoing at Odisha, Gujarat, Karnataka and Maharashtra.

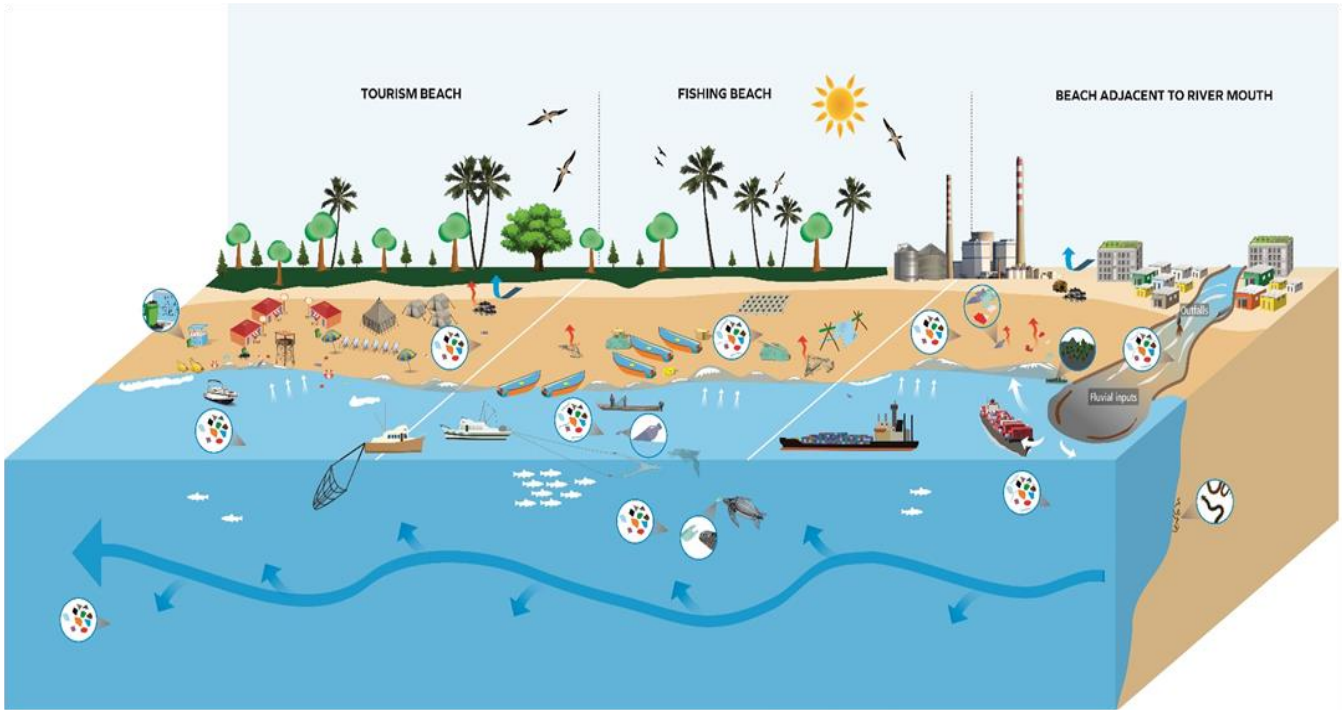


Figure 16: Pathways of microplastic and debris to the beaches and ESA

6.2 Cumulative Environmental Impact Assessment (CEIA)

Cumulative Environmental Impact Assessment (CEIA) is useful to provide information on the combined effects of various developments to aid coastal managers, decision makers and the general public about the broader context and longer-term environmental conditions likely to result from an action, project or projects and the corrective steps that need to be taken. CEIA has been developed for a pilot case study for the Gulf of Kachchh region. The Gulf of Kachchh is situated between Saurashtra and Kachchh Peninsula in the western state of Gujarat, India.

A relatively shallow and well mixed water body, the Gulf covers an area of 7350km^2, is approximately 170km long and upto 70 km wide. CEIA framework is a 5- step process that will lead to improved management planning for the Gulf of Kachchh region. Final outcome of the research would be the drafting of the CEIA Practical Guideline, designed to assist developers, planners, environmental practitioners and regulators in their sustainable management approach to coastal and marine pollution.

Figure 17: Zonation of activities and pressures along Gulf of Kachchh

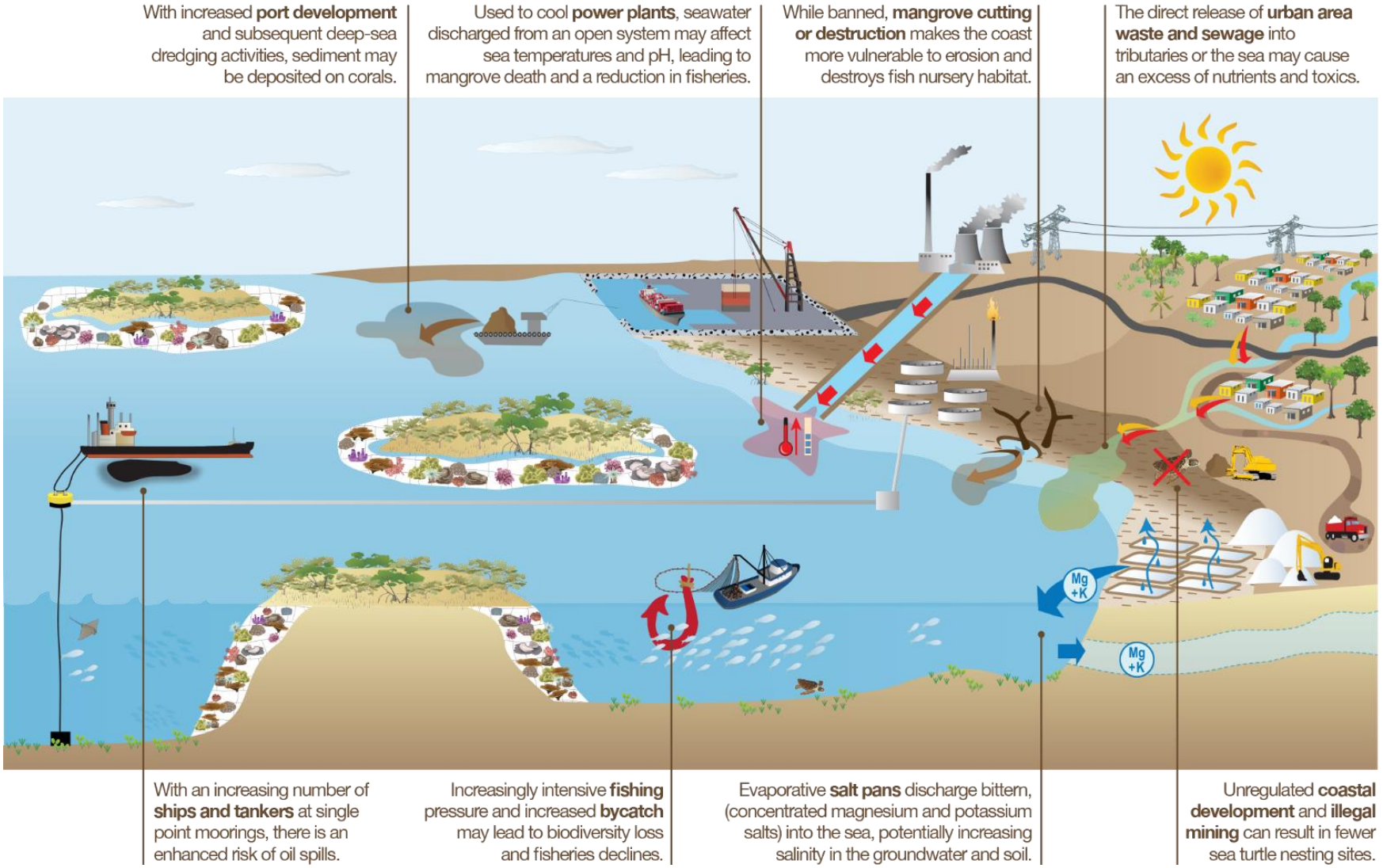


Figure 18: Conceptualization of activities along Gulf of Kachchh

7 Sentinel Sites

The detection and prediction of regional environmental change has become the goal of numerous national and multinational organizations. Sentinel sites are used to better understand regional environmental issues by focusing on resources and the efforts taken at local scale. The discrete locations in coastal and marine environments that have the operational capacity for intensive study and sustained observations to detect and understand changes in the ecosystems they represent.

Nested sets of sentinel sites selected for better understand ecosystem conditions at specific temporal and spatial scales in order to address science and management priorities. These environmental changes, which need assessment, can be broadly classified into the Climate change and Marine Biodiversity. Sentinel sites provide specialized real time coral health monitoring tools along the identified sites. Selection of sites as Sentinel Sites was based on unique coastal signatures in a manner that they would act as sensors of change.

As part of Sentinel site program data buoy and Automated Weather Stations(AWS) has been deployed at three sites (Kurusadai Island at Gulf of Mannar Biosphere Reserve, Tamil Nadu, Kavaratti Island in Lakshadweep and Chester Island at MGMNP, Andaman & Nicobar Island).

Methodology

For determining and understanding the dynamics and coastal process of the marine systems along the Indian coast, it requires a continuous monitoring for various chemical, physical, and biological parameters. Keeping this in mind, few Indian coastal ecosystems were identified for continuous monitoring and the following work packages are designed for the "Sentinel" site programme.

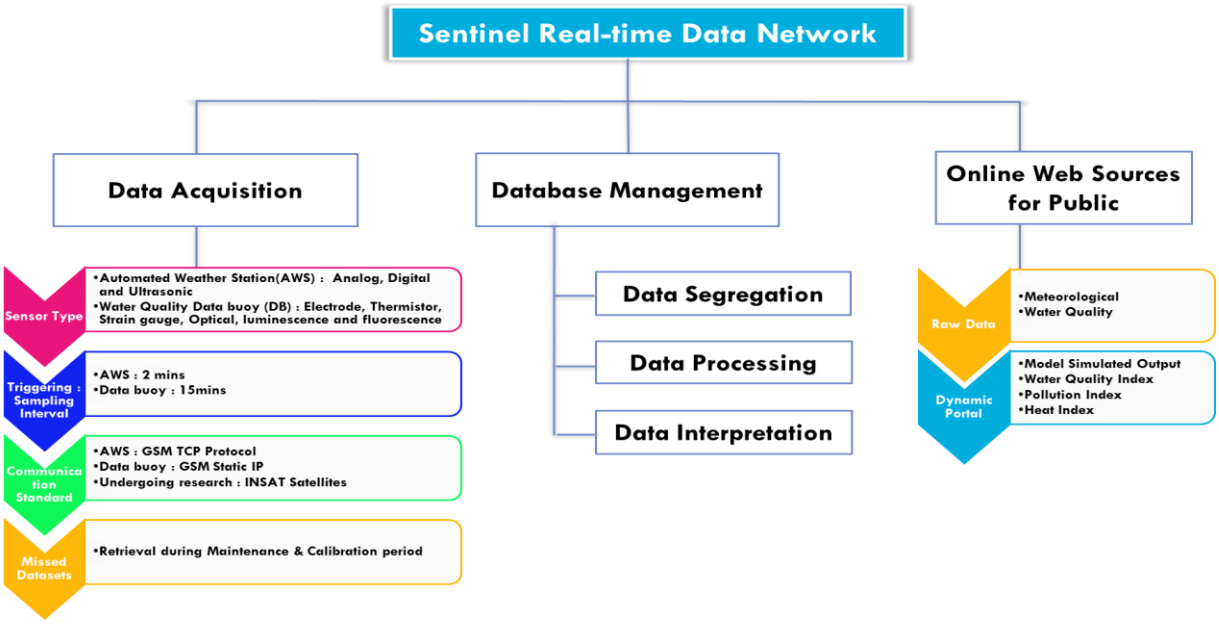


Figure19: Schematic diagram of “Sentinel” site programme, NCSCM

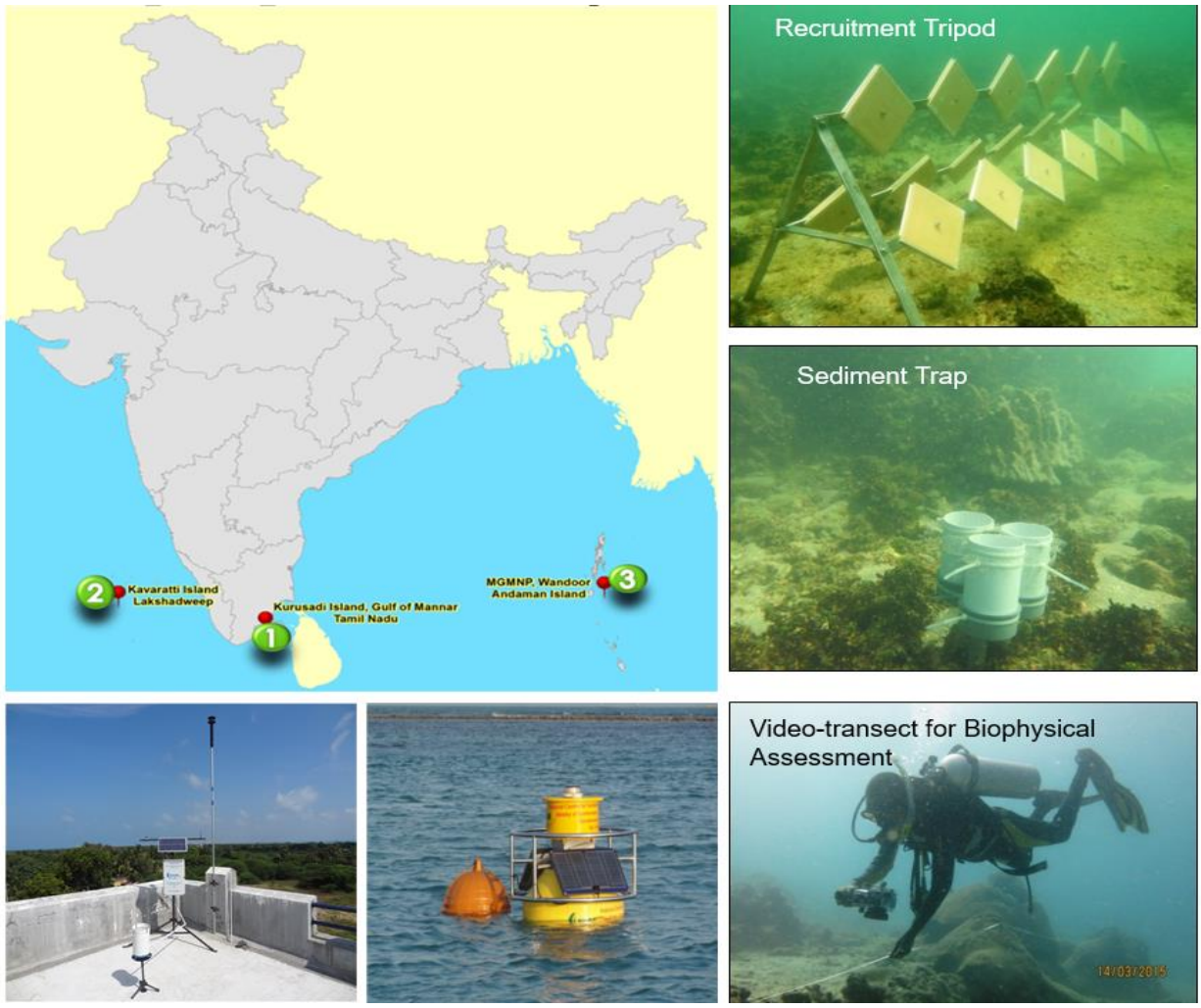


Figure 20: Map of Data buoy deployment sites and key components

8 Coastal Ecosystem Health Report Card (ECOHEALTH)

There have been very few attempts to study different aspects of coastal ecosystem indices, their status along the Indian subcontinents in an integrated manner. A team of scientists from Maryland University as well as National Centre for Sustainable Coastal Management (NCSCM), India are working on the health report card for coastal ecosystems of India. The team is currently finalizing the methodology for the study, based on which information will be generated and devised. The geographic details provided in the report card provide information that can help, guide and focus on restoration efforts. The report card is a developing product, with a more complete assessment of ecosystem health expected in the future. In this study, efforts were made to apply the DPSIR (Driver-Pressure-State-Impact-Response) framework for coastal waters of India.

In view of the growing concerns on progressive environmental deterioration, of vulnerable coastal and marine ecosystem of India, National Centre for Sustainable Coastal Management (NCSCM), Chennai, has identified Coastal and marine areas which are in need of immediate restoration and measures to ensure sustainable development with optimum resource exploitation. This study is expected to explore and formulate an Environmental Health Report Card (EHRC) to rejuvenate coastal and marine environment. Environmental data collected from time-series and monthly measurements will be used to develop an Ecosystem Health Report Card. In this regard NCSCM Has completed two such ecosystem health report card as given below.

1. Coastal Ecosystem Health Report Card for Chilika Lake, Odisha
2. Coastal Ecosystem Health Report Card for the Marine National Park and Sanctuary, Jamnagar, Gujarat

Figure 21: Values & Pressures to Develop Indicators at Chilika Lake, Odisha

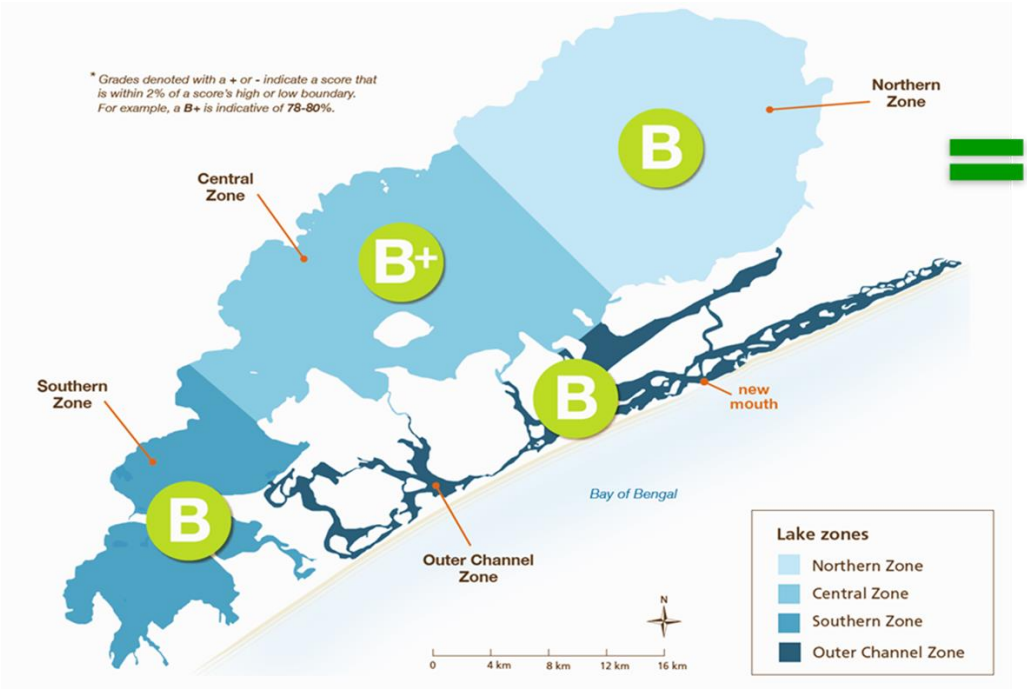


Figure 22: Ecosystems identified for the preparation of Ecosystem Health Report Card

Field survey for the Ecosystem Health Report Card of Gulf of Mannar Biosphere reserve and Vembanad Lake have been completed and data interpretation is under progress.

Incidentally, ecosystem health report card is prepared for the Bhitarkanika mangrove ecosystem, Odisha as part of the Odisha State Forestry Development Project (OSFDP) on *"Long-term monitoring plan for ecosystem based conservation management of Bhitarkanika conservation area"* and is described separately in the latter section of this report.

LIVELIHOOD MANAGEMENT

IV LIVELIHOOD MANAGEMENT

9 Critically Vulnerable Coastal Areas (CVCA)

As per the CRZ 2011 notification, 12 sites have been identified as Critically Vulnerable Coastal Areas (CVCA) namely the entire Sunderbans mangrove area (2) Gulf of Khambat & Gulf of Kutchchh in Gujarat, Malvan & Achra-Ratnagiri in Maharashtra, Karwar & Coondapur in Karnataka, Vembanad in Kerala, Gulf of Mannar in Tamil Nadu, Bhitarkanika in Orissa, Coringa, East Godavari & Krishna in Andhra Pradesh with the objective of promoting conservation and sustainable use of coastal resources and habitats. In order to aid in demarcation of CVCA, a framework has been developed for scientific assessment of the extent of dependence of coastal community on the resources and, their ability to govern them. About 16000 geo-coded household data have been collected using an android application from various coastal villages around the resource areas of all CVCAs notified. The CVCA thresholds have been estimated and detailed CVCA frameworks have been prepared for all the notified locations which will help in preparation of the Integrated Management Plan for aid development activities in these areas.

Figure 23: CVCA demarcated along India's coast

10 Mapping of Fishing Space

This program includes two major activities namely 1) Preparation of a guideline and resource manual for decentralized micro planning exercises in fishing villages and 2) Assess livelihood assets and vulnerability of fishermen communities. The key objectives of the decentralized micro level decentralized planning in fishing villages are to (i) develop plans at the grass root level, (ii) tackle the specific problems at the micro region, (iii) identify and utilize local resources and development of infrastructures, (iv) emphasize and use local culture, traditions, history, values and practices, (v) encourage bottom-up planning, (vi) develop fishing villages as an independent and sustainable habitat for fishers by co-management and decentralized planning to achieve village swaraj. Various schemes introduced by Government departments were applied efficiently for the welfare and infrastructure development of fisher community. These studies also provide details of various assets and livelihoods of coastal fishing communities and villages by to improve / strengthen the livelihood assets and capitals.

Picture 2: Fishing harbour with traditional and mechanized fishing boats

11 Women in ICZM

A Comparative Gender Specific Study on Socio-economic Status of Fishing Communities in India was carried out in five coastal states for identifying the issues relating to the well-being of women in fishing communities and their livelihood challenges and opportunities. The study was aimed to identify opportunities for improving participation of women in the decision-making and management of ICZM projects in general and of livelihood activities by addressing specific and peculiar issues that affect women in coastal communities The sustainable livelihood framework was used to understand the vulnerability context and livelihood strategies of the women. Considerable data and information is available with respect to harvest related activities – such as the type of craft and gear used, the catch per unit effort, and so on. However, there is little information available on a pan-India basis on the profile and activities of women in the fishing communities, *inter alia* their educational levels, roles in decision making, entrepreneurship capacities and occupational hazards they face.

Picture 3: Women fishers with Mudcrab

RESOURCE MANAGEMENT

V RESOURCE MANAGEMENT

12 Coastal and Marine Biodiversity Integration Network (CoMBINe)

The Coastal and Marine Biodiversity Integration Network (CoMBINe) Database is built to function as an online national repository to harbor information pertaining to coastal and marine flora and fauna recorded in the Indian waters. It is the first Indian Biodiversity Portal built as per International codes which envisages of being the National digital repository for coastal and marine biodiversity. It is unique with its Character-based Field Identification of all taxa of coastal biodiversity and for interoperability and data sharing with other renowned international databases.

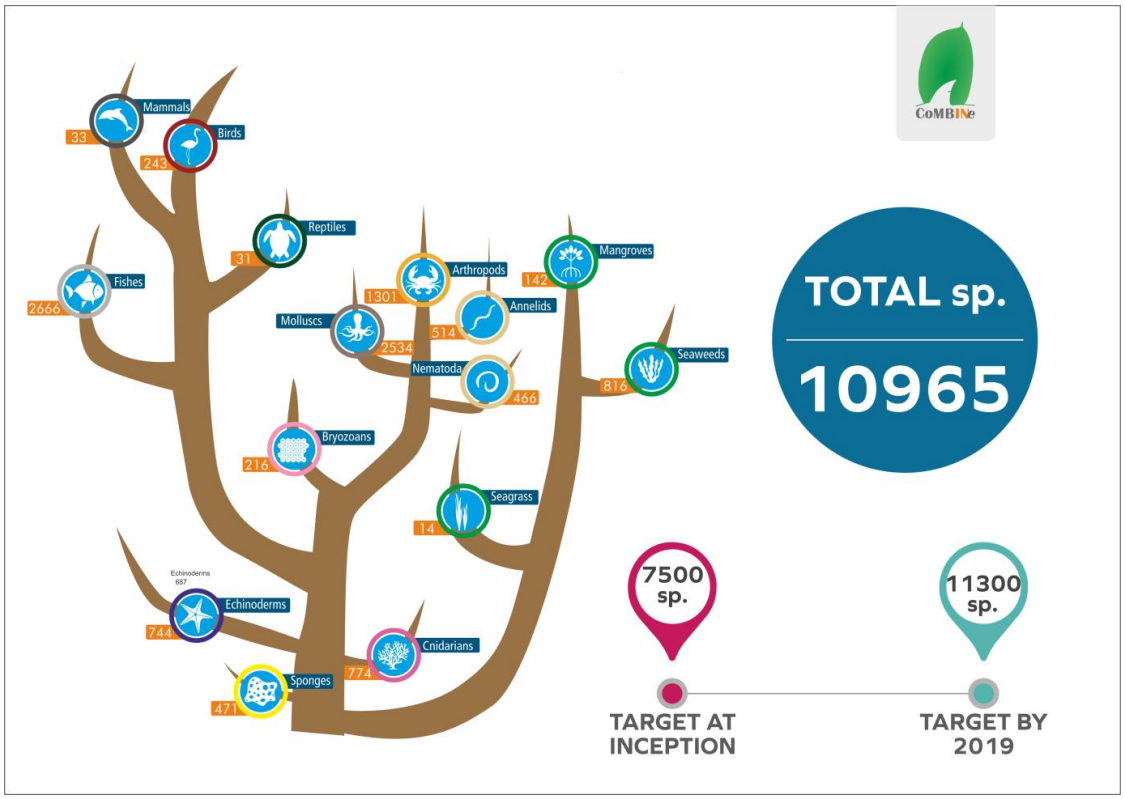


Figure 24: Species number in CoMBINe species database

CoMBINe contains a total of 10965 marine species (at present) comprising of 27 shape-based groups like Seaweeds, Seagrass, Mangroves from the plant kingdom, bryozoans, sponges, cnidarians (except soft corals), arthropods, molluscs, polyclads, polychaetes, Dicyemida, Nemerteans, Echinoderms, fishes, reptiles, mammals and birds. An Android driven CoMBINe mobile application is also available for hand held devices. This is being extended for IOS based hand held devices as well.

13 Mapping seagrass resources of India

Seagrass meadows are firmly anchored marine flowering plants that achieve growth and complete vegetative and reproductive cycles in submerged conditions. The extent of seagrass has not been properly and adequately accounted for in carbon climate policies. An understanding of its spatial distribution is a major prerequisite for its management and conservation. Seagrass aerial extent is determined based on digital image processing of Landsat 8 OLI data (2014-2016), incorporating atmospheric and water column corrections. Total estimated seagrass area amounts to 516.59 km^2 of which Palk Bay and Gulf of Mannar of Tamil Nadu together contribute to 398.81 km2. Overall classification accuracy for the six sites studied, ranged between 64% (Lakshadweep Islands) and 83.5% (Palk Bay).

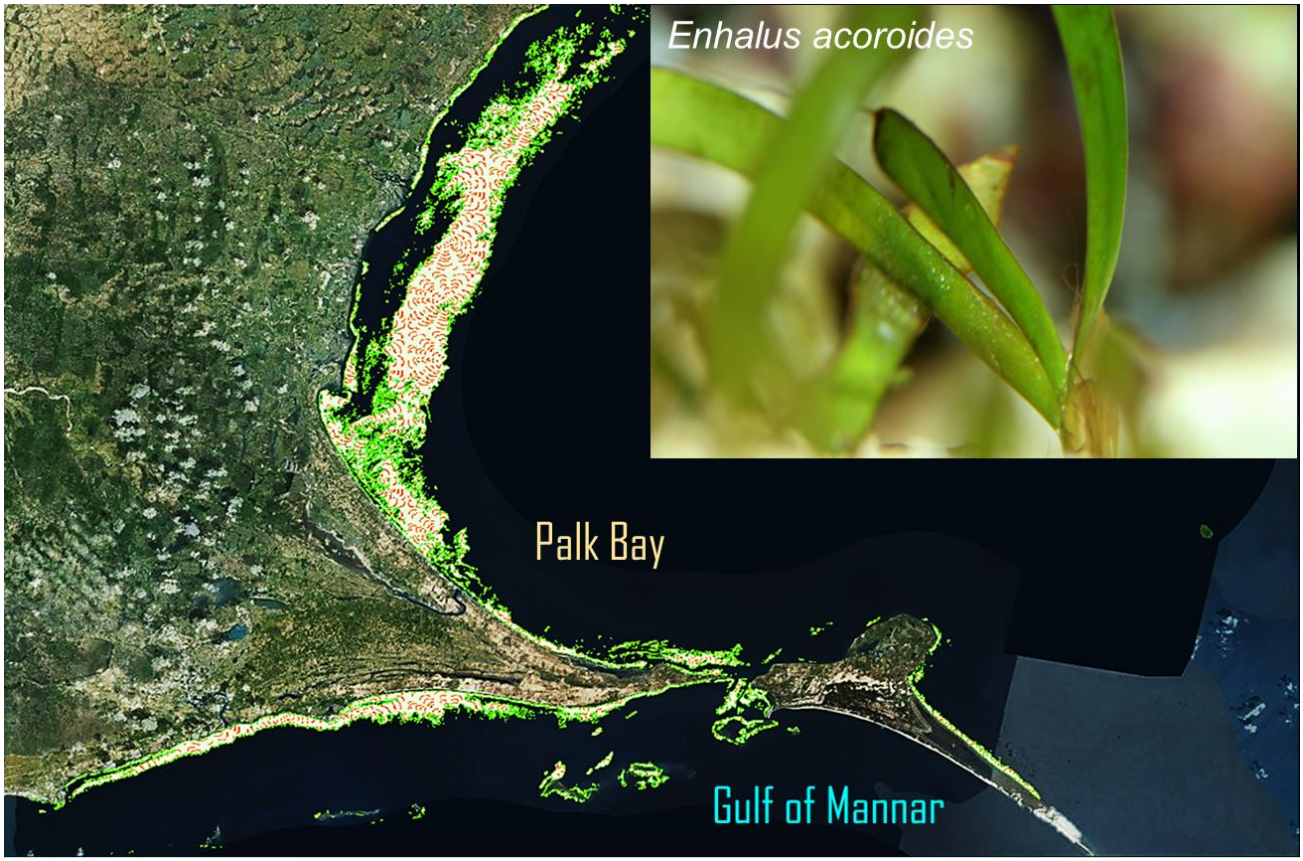


Figure 18: Seagrass distribution along the Palk Bay and Gulf of Mannar, Tamil Nadu

13.1 Development of spectral library of coastal vegetation

Spectral signature, the unique variations of reflected electromagnetic radiations as function of wavelengths helps in identifying terrain features and is the fundamental means of data representation and analysis in all forms of passive (reflected sunlight) remote sensing. The major seagrass meadows in India exist along the southeast coast (Gulf of Mannar and Palk Bay) and in the lagoons of islands of Lakshadweep in the Arabian Sea and Andaman and Nicobar in the Bay of Bengal. 14 species of seagrass belonging to seven genera including *Cymodocea rotundata, Cymodocea serrulata, Enhalus acoroides, Halodule pinifolia, Halodule uninervis, Halodule wrightii, Halophila beccarii, Halophila decipiens, Halophila ovalis, Halophila ovata, Halophila stipulacea, Ruppia maritima, Syringodium isoetifolium* and *Thalassia hemprichii* were reported.

To develop the Spectral Library Theoretically based spectral reflectance of seagrass has been developed by accounting the optical properties of the water and the depth of the water column. In order to account the water optical properties, mean diffuse attenuation coefficients of upwelling radiance (KLu) and downwelling irradiance (Kd) were used for two different water depths namely the height of the water column (H) and measurement water depth (z). The developed formulation is then compared with the measured spectra of seagrass and shows good agreement with each other in terms of spectral and magnitude. For the creation of spectral library, seagrass spectral signatures were obtained for above-water (in air), just below the water surface, near-substratum (bottom) and the water-column corrected spectra.

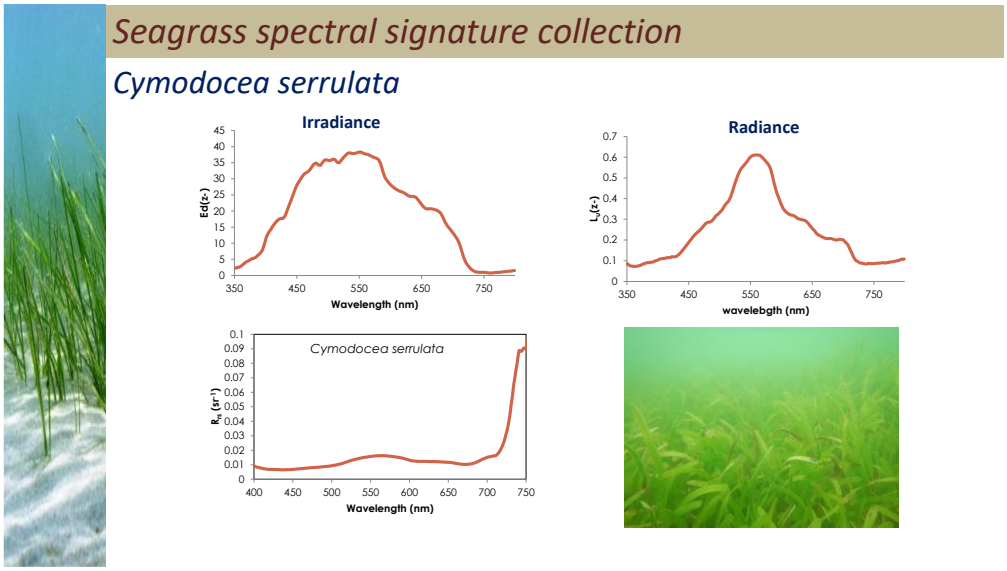


Figure 25: Spectral signature of *Cymodocea serrulata*

14 Coastal and Marine ecosystem goods and services

Coastal ecosystems supply both stock and flow resources that can be used as direct and indirect inputs to production and consumption activities, thereby generating productivity and growth in the overall economic system. Quantifying and valuing ecosystem goods and services shall guide decision making in sustainable coastal management. A three tier approach has been applied to use economical value in decision making process. Monetary values of coastal ecosystems as indicated in CRZ 2011 as Ecologically Sensitive Areas have been estimated. Using meta-analysis and Benefit Transfer (BT) methods, the TEV of mangrove, salt marsh, turtle nesting grounds and horse shoe crab habitats were estimated for Rs. 60,000 crore, 14,000 crore, 7,30,000 crore and 400 crore respectively. Economic valuation of other coastal ecosystems viz., corals and coral reefs, bird nesting grounds, sea grass beds, mudflats and sand dunes are in progress.

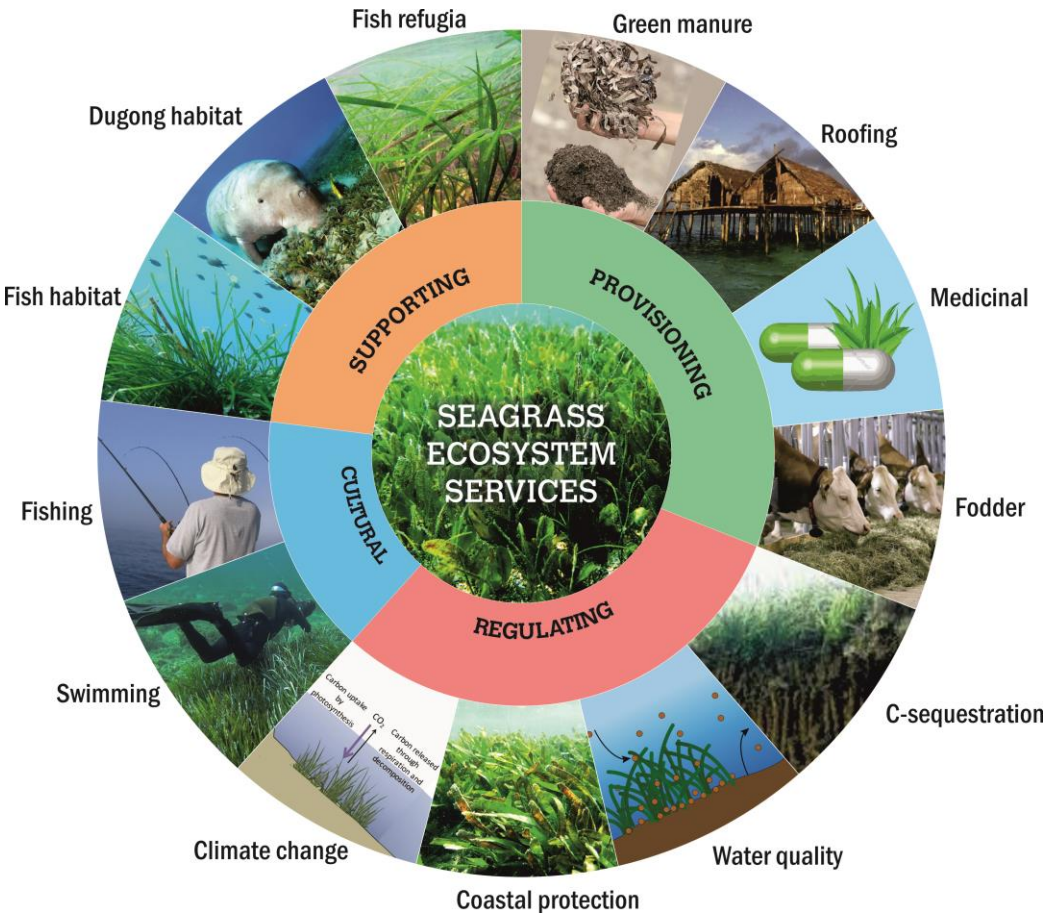


Figure 26: Example of ecosystem goods and services for seagrass ecosystem

15 Offshore wind energy potential Resource for India

NCSCM carried out a study about the offshore wind energy potential over the Indian sub-continent through weather research forecasting models for development of offshore wind energy blocks and potentials in different depths (30-50m, 50-100m, and 100-200m). In this study, Marine Protected Areas (MPAs), bird migratory routes and shipping routes have been excluded from sitting offshore wind platforms although potential may exist, in order to maintain ecological integrity. The potential sites have been identified in different depths in the coastal states of Gujarat, Maharashtra, Kerala, Tamil Nadu and South Andhra Pradesh with estimated offshore electrical power generation potential as ~495 GW from the depth of 30-200m.

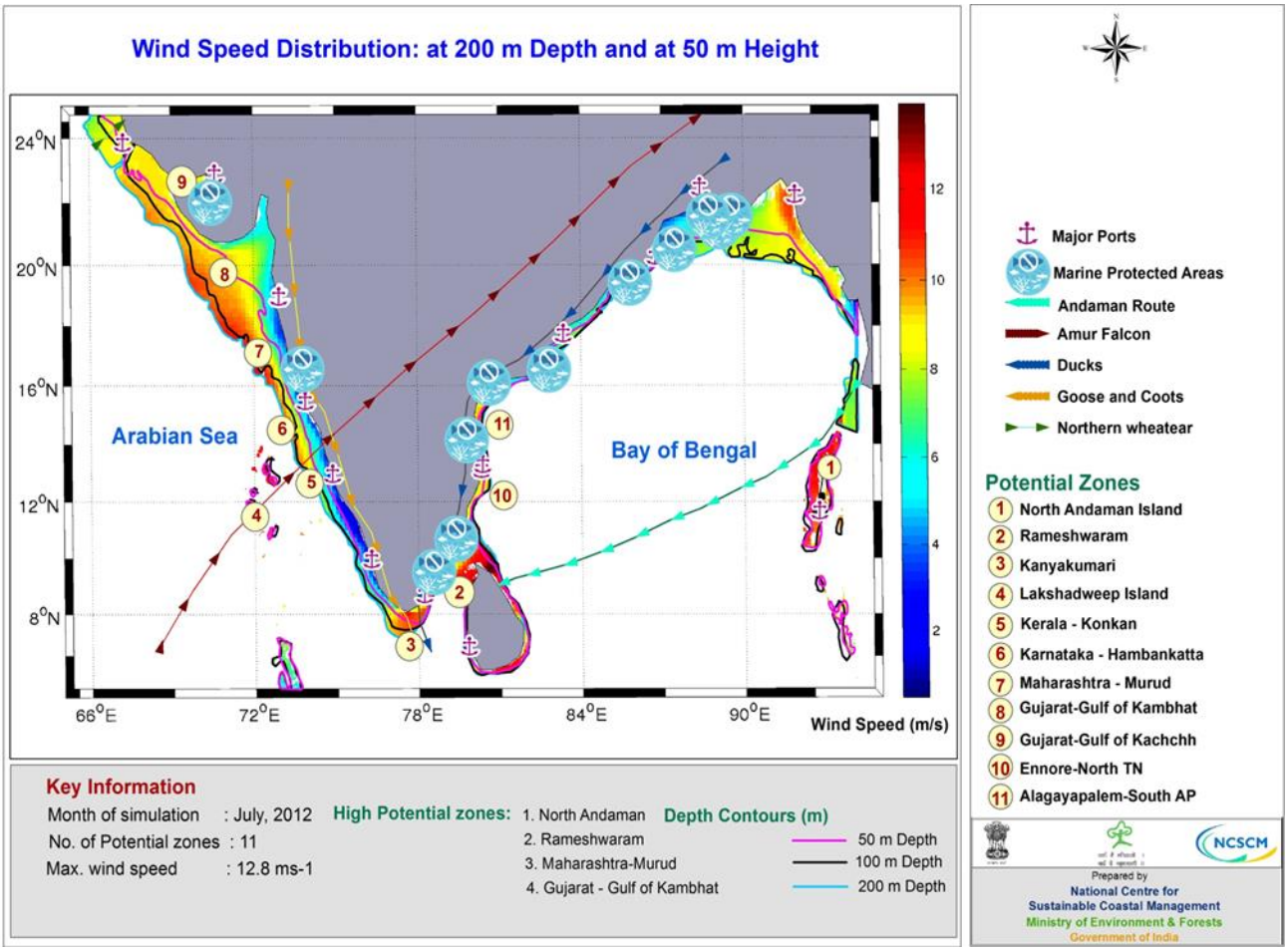


Figure 27: Wind speed along India's coast with Marine Protected Areas

INTEGRATED ISLAND MANAGEMENT

VI INTEGRATED ISLAND MANAGEMENT

16 Integrated Island Management Plan (IIMP)

The Island Protection Zone Notification (2011) of Government of India envisages the management of Indian Islands. While the larger Islands will be managed by Island Coastal Regulation Zone (ICRZ) plan, the smaller Islands will be managed by the Integrated Island Management (IIM) Plan. NCSCM has prepared the IIM for four Islands of Andaman and Nicobar and has also undertaken the task of strengthening the IIM of Lakshadweep by formulating various sub-plans such as Conservation Management, Fisheries Management, Tourism Management, Shoreline management, Water management, Waste management, Pollution management, Energy management, Sustainable Livelihood Development and Disaster Management.

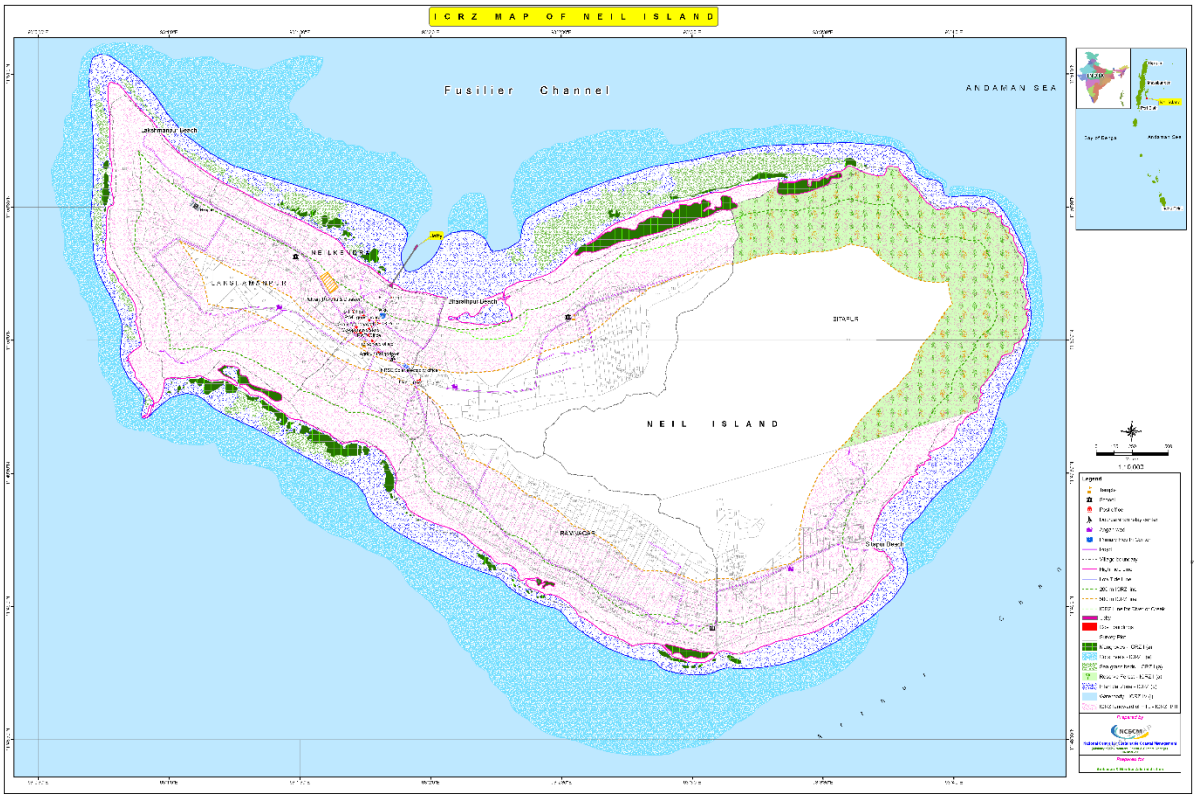


Figure 28: Island Coastal Regulation Zone (ICRZ) of Neil Island

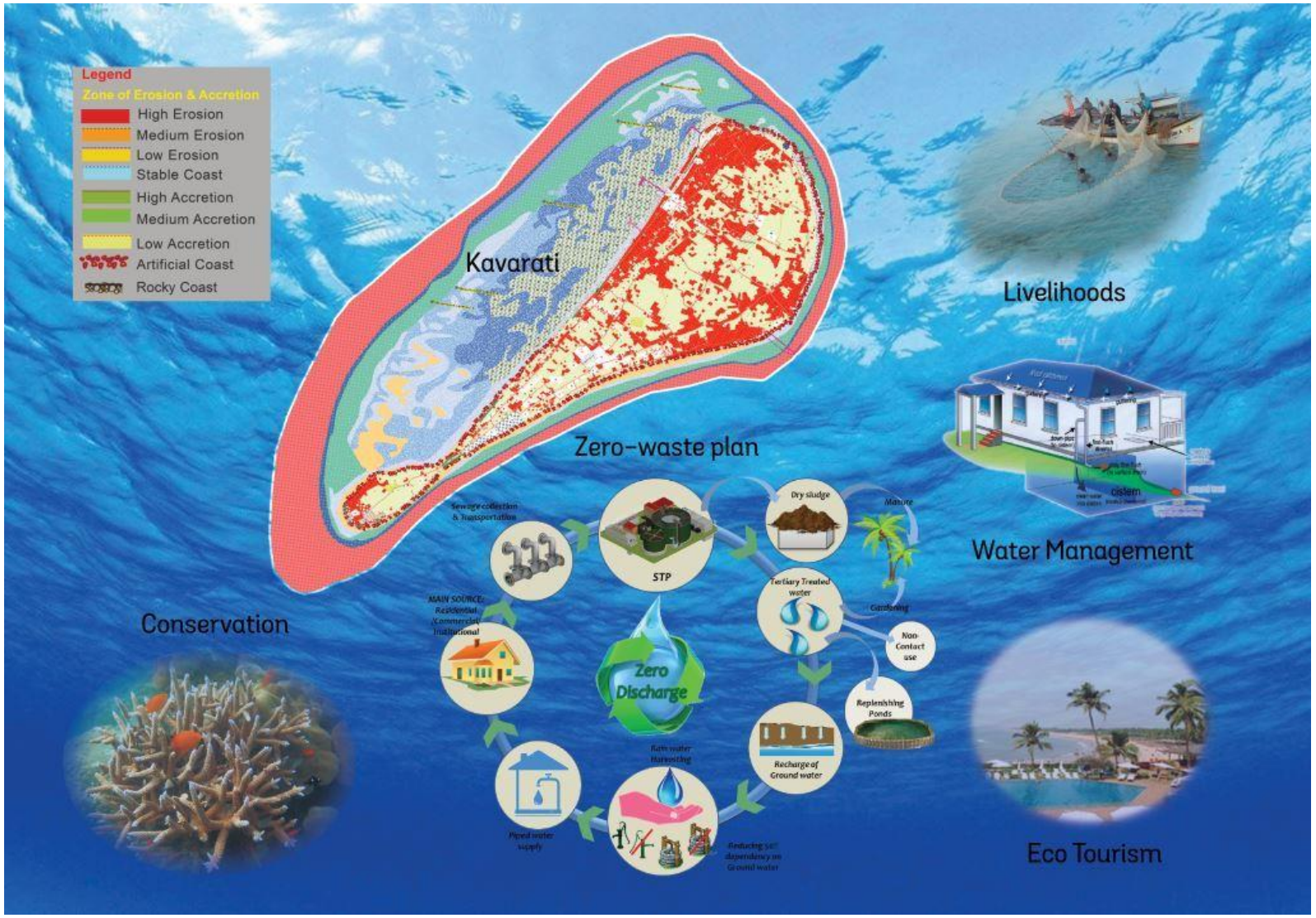


Figure 29: Integrated Island Management Plan (IIMP) of Kavaratti Island, Lakshadweep

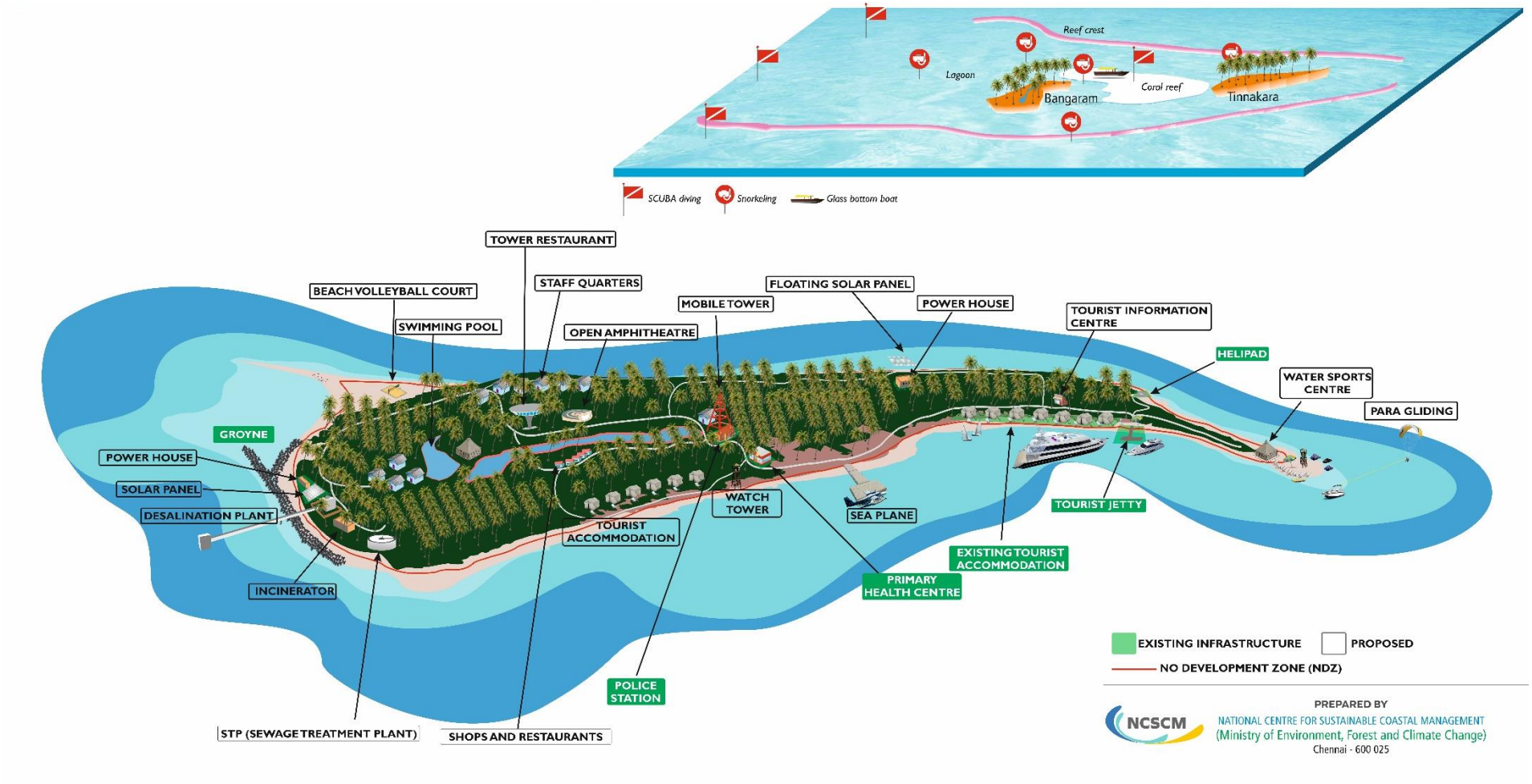


Figure 30: 3-D Spatial planning of Bangaram Island, Lakshadweep

17 Data Web on Island Environment and Protection (DWIEP)

Islands maintain many of the world's most unique and vulnerable plants, animals and ecosystems, while also playing an important role in the health, welfare and cultural diversity of the people living there. India has 1382 off-shore Islands (both habited and un-inhabited), as estimated based on the NRSC's Bhuvan database and in consultation with the respective States/Union Territories by the NITI Aayog through Inter-ministerial group. This estimation comprises of 1093 Islands as shapes and 289 Islands as rocks/rocky islets/rocky outcrops. A database titled "Data Web on Island Environment and Protection (DWIEP)" has been proposed to develop providing information on the 1382 off shore islands that is comprehensive and available in one compendium. DWIEP provides island-wise information of all 1382 islands such as geographical area, geology, climate, socio-economic profile, political profile, ecological profile, conservation status, shoreline change etc.

Figure 31: Web portal of DWIEP

Preliminary information on environmental and socio-economic characteristics of coastal islands Tamil Nadu, Andhra Pradesh, Odisha, West Bengal, Kerala, Goa, Diu & Daman, Maharashtra, Gujarat and UT of Lakshadweep were completed in 2017-18 along with limited ground truth studies. The DWIEP will serve as a useful database for planners, policy makers, academicians and all interested stakeholders familiar. DWIEP provides a complete dataset for coastal islands of India.

INTEGRATED COASTAL ZONE MANAGEMENT

VII INTEGRATED COASTAL ZONE MANAGEMENT

18 Managing the coast through ICZM

The coast is a highly vulnerable zone and is affected by climate change and sea level rise, conflict for space and resources and, development pressure on sensitive coastal ecosystems. The Ministry of Environment, Forest and Climate Change (MoEF&CC), Government of India has developed a vision for sustainable coastal management, as articulated in the National Environment Policy, 2006. One of the major recommendations was to adopt an ICZM approach that would, with people's participation, promote the livelihood security of the coastal communities, and protect the ecosystems while promoting sustainable development. The ICZM plan is currently being prepared for the coastal states of Gujarat, Odisha and West Bengal in five ICZM Demonstration sites, this guideline Up-scaling of ICZM plan for the other coastal states/ UTs is currently underway as Phase II of the project. A case study of the ICZM Plan being prepared for two coastal stretches of West Bengal is given in detail in the subsequent section.

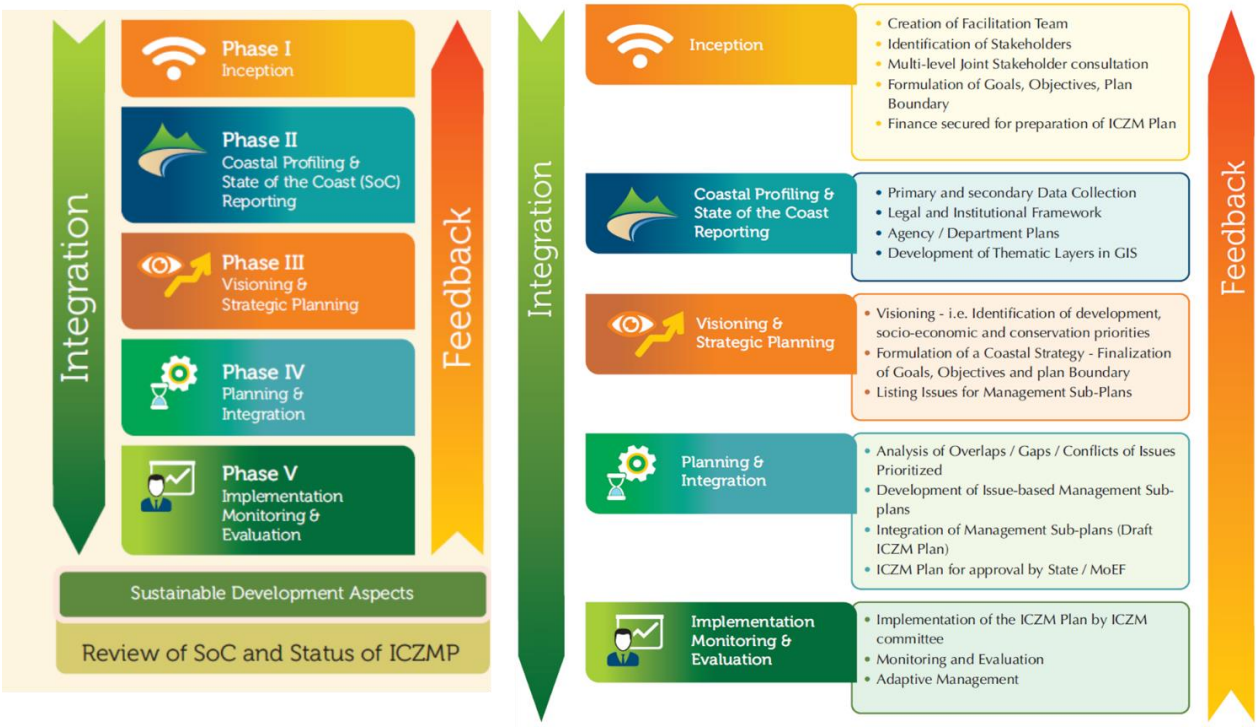


Figure 32: The five-step process in preparation of an Integrated Coastal Zone Management (ICZM) Plan

ICZM PLAN for
Digha to Sankarpur and Sagar Island, West Bengal

This Inception Report is the first integrated basic document to prepare ICZM plan for two pilot areas in West Bengal: 1) Digha-Sankarpur and 2) Sagar Island. The Inception Report aims to harmonize, interrelate and integrate actions to be implemented under the ICZM Project in the two pilot areas in the state of West Bengal. This report comprises of three chapters – Introduction, Plan of Action and Implementation Process.

1. INTRODUCTION

1.1. ICZM PROGRAMME IN INDIA

The coastal zones are diverse and productive ecosystems of great importance to the ecological functions and livelihoods of coastal communities. The coastal systems are areas with multiple use and multiple users. Conventional sectoral planning has been practiced so far, however, a broader management integrating the sectors across disciplines has become necessary. Realizing this, the Government of India (GoI) initiated the Integrated Coastal Zone Management Project (ICZM) with assistance from the World Bank.

I. Objectives of ICZM Programme

The major objectives are to build the national capacity towards implementation of a comprehensive ICZM approach and piloting it in the selected states of India. The project envisages achieving the following:

(i) security of lives and property/ assets in disaster-prone coastal zones;
(ii) conservation, preservation, restoration and development of coastal resources and ecosystems;
(iii) security of livelihood of coastal communities and overall food security;
(iv) security of cultural and heritage sites; and
(v) goals of national development and growth in such ways that the development is sustainable

II. Phase I of ICZM Project

In the first phase of the ICZM Project, three coastal states i) Gujarat, ii) Odisha and iii) West Bengal were chosen based on varying levels of development, industrialization and nature of coastal zone management challenges. Experiences from these state components would be used for preparation of ICZM plans in all other coastal states/ UTs in Phase II. The ICZM plan was to be prepared for small coastal stretches in the areas (pilot sites) as given in Table 1.1 and Figure 1.1 for the three states.

Table 1.1: ICZM Pilot Sites in Phase I

State	ICZM Sites
Gujarat	Gulf of Kachchh
Odisha	Paradeep to Dhamra
	Gopalpur to Chilika
West Bengal	Digha to Sankarpur
	Sagar Island in Sundarban

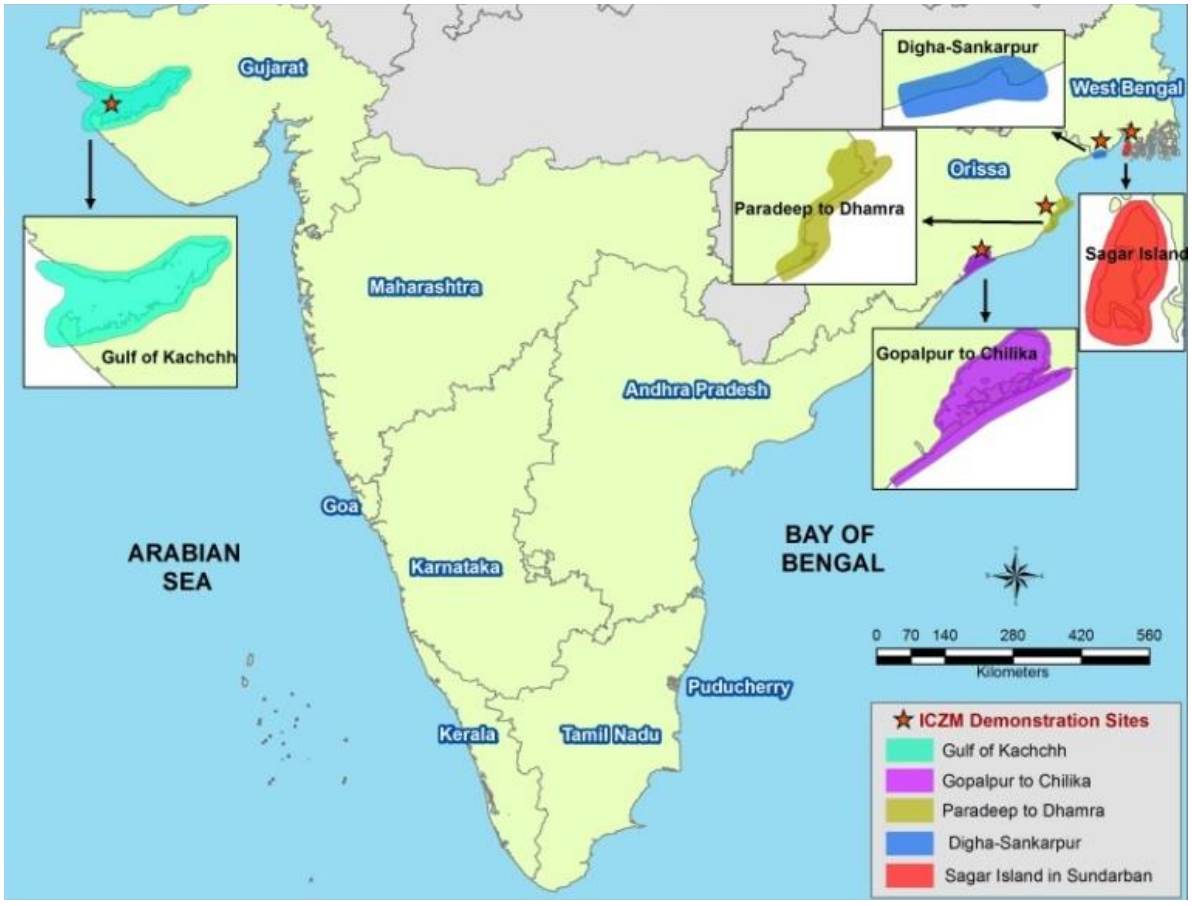


Figure 1.1 Location of ICZM Pilot Sites in Phase I

1.2. ICZM PLAN OBJECTIVES AND METHODOLOGY

While the pilot investments have been initiated and are under various degrees of completion, the ICZM plans for the selected pilot stretches of the three states needs to be prepared. The key objectives as given in the project document for ICZM Plan Preparation are:

1. Developing a suitable methodology for the ICZM plan preparation in consultation with State Project Management Unit (SPMU) and other organisations/ agencies/ stakeholders
2. Creating linkages with stakeholders for the preparation of ICZM Plan and implementation
3. Preparing the ICZM Plan for selected coastal stretches demonstrating the same

Objective 1:

Development of Methodology: The National Centre for Sustainable Coastal Management (NCSCM) has developed a detailed methodology for preparation of the ICZM Plans, based on a five-phased approach as given in the Figure 1.2. As given in the framework the first four phases focuses on development of the management sub-plans and the ICZM plan while Phase V deals with implementation, monitoring and evaluation.

Each of the five phases has specific purpose and tasks to be completed sequentially. Issues/themes identified in the plan area will converge as management sub-plans. Each sub-plan will comprise of various activities with interlinkages to other sub-plans. These sub-plans are integrated so as to harmonise and optimise the use of resources (both financial and human) while minimising potential adverse impacts due to one plan activity on another. For ease of implementation, activities/ projects may be assigned to sectoral (line) departments in consultation with the stakeholders. The outcome of such a series of activities is an integrated coastal zone management plan for the designated plan area

Objective 2:

Stakeholder Linkages: Different line departments and other agencies address coastal issues with different plans and interventions. Based on the issues identified through ICZM project, appropriate interventions need to be integrated with the ongoing development plans of the line departments.

Therefore, linkages with stakeholders during assessment (collection of primary and secondary data), planning and implementation of ICZM has to be ensured for the long term sustainability. Both formal and informal stakeholder consultations will be adopted to establish linkages.

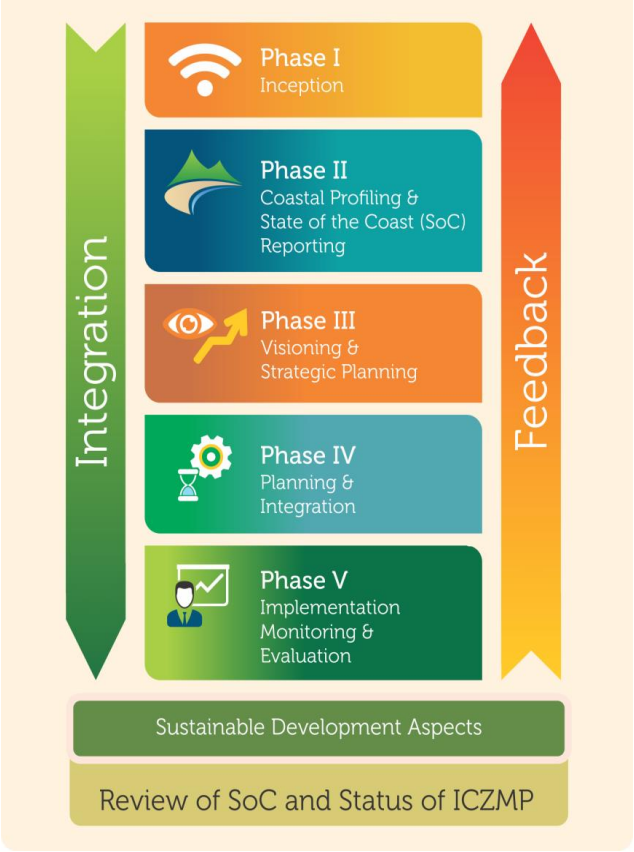


Figure 1.2 Framework for Preparation of ICZM Plan

Objective 3:

Preparation of the ICZM Plan: A detailed plan of action is presented in Chapter 2. Using the methodology developed by the NCSCM and establishing linkages with the relevant stakeholders the ICZM plan for the selected stretches of the state will be prepared. Capacity building needs of different target groups, as given below will be incorporated in the ICZM plan

i) Officials in the State Government Departments
ii) Officials of DSDA/ SDB/ Forest Corporation/ Fisheries Corporation
iii) Academicians/ researchers,
iv) Members of civil society organizations
v) Representatives of coastal communities[1]

[1]http://www.iczmpwb.org/main/Institutional-strengthening-and-capacity-building.php

1.3. ICZM PLAN PREPARATION FOR WEST BENGAL

I. Coastal Environment of West Bengal

West Bengal is located on the eastern, Bay of Bengal coast and is India's fourth most populous state with a population of 91.2 million, as per the 2011 Census. The state borders Odisha in the southwest and Bihar and Jharkhand to the west and shares a long border with Bangladesh on the east and in the north, borders with Assam, Bhutan and Nepal and has Bay of Bengal to the south (Figure 1.3).

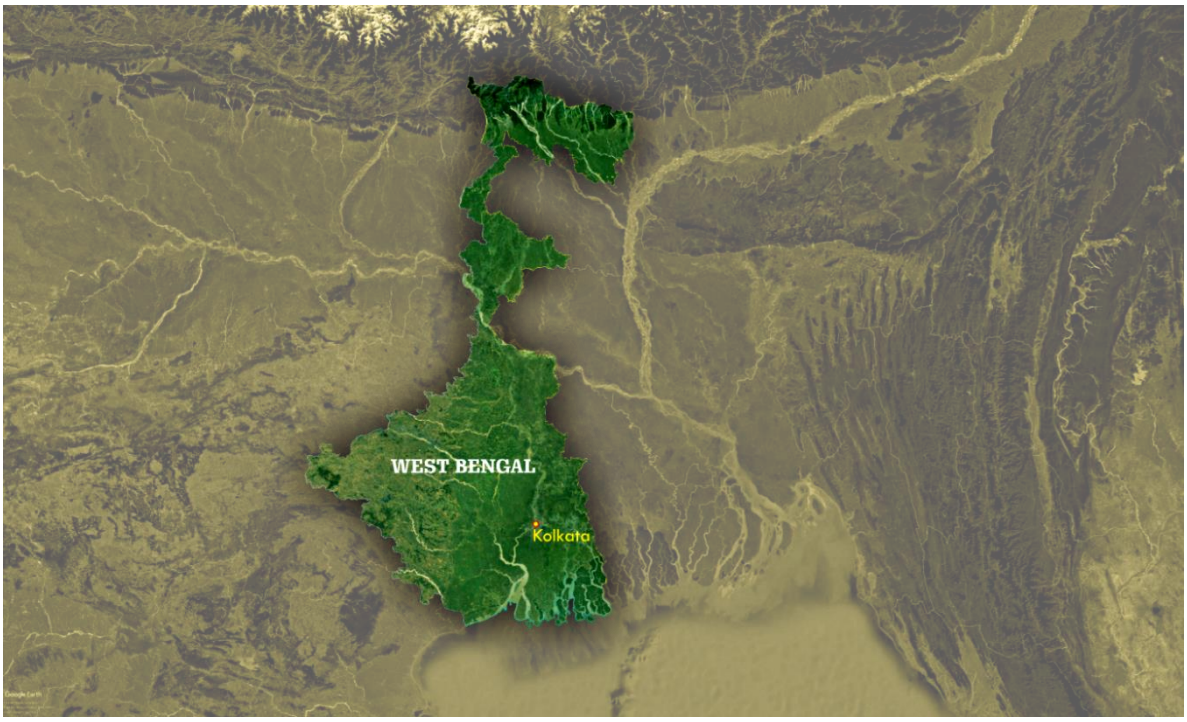


Figure. 1.3: Map of West Bengal

Sundarbans, the world's largest coastal mangrove forests, are spread across the South 24 Parganas and North 24 Parganas districts of West Bengal and the remaining in Bangladesh. They are located in the delta region of Padma, Meghna and Brahmaputra river basins. The Sundarbans is actually a network of marine streams, mud shores and mangrove forests. The Sundarban Tiger Reserve is located in South 24 Parganas. A number of watercourses along with the seven main rivers form a network of channels. All the rivers have a southward course towards the sea. The eco-geography of this area is totally dependent on the tidal effect of two ebb and two flow tides occurring within 24 hours with a tidal range of 3–5 m and up to 8 m. The tidal action deposits silt back on the channels and raising the bed, it forms new islands and creeks

contributing to periodic change in geomorphology. Summary of important indicators regarding West Bengal is given in the Table 1.2.

Table 1.2 Select Indicators for Coastal Districts of West Bengal

S. No.	Indicator	State
1	Total area	88752 sq.km
2	Length of coastline	220 km
3	Number of districts	19
4	Number of coastal districts	3 (Purba Medinipur, North 24-Parganas and South 24 Parganas)
5	Total Population	91276115 (2011 Census)
6	Population of Coastal Districts	
7	Population Density persons per km^2 (India)	1028 (368)
8	Population density of coastal districts	
9	Decadal growth rate (%) (India)	13.84 (17.68)
10	% share of urban population (India)	31.87 (31.15)
11	% share of rural population (India)	68.13 (68.85)
12	Sex Ratio (India)	950 (943)
13	Literacy Rate (%)- 2011 (India)	76.26 (72.99)
14	Per Capita Income at current Price (in Rs.) as on 01.08.2014 (2012-13 Q)	61352.35
15	% of Cultivable area to total area	65.65
16	% of forest area (2011-12)	13.52

Photo 1: View of Hooghly River and estuary at low tide

1. ICZM FOR DIGHA–SANKARPUR & SAGAR ISLAND

According to the World Bank's Project Appraisal Document (PAD)[2],

the pilot investments in West Bengal will complement the ICZM plan and the capacity building sub-components to address the major coastal zone management issues in the two targeted coastal stretches of

(i) Digha-Sankarpur, and

(ii) Sagar Island in the Sundarban, covering about 13 % of West Bengal's coasts

These stretches have experienced high rates of coastal erosion in recent years, and significant coastal resources and community livelihood are threatened. The pilot investments will include

(a) conservation and protection of coastal resources including mangrove and coastal shelterbelt plantation; pilot works in shoreline protection for Digha beach and the southern end of Sagar Island; and rehabilitation of the marine aquarium at Digha;

(b) *environment and pollution management by completing the sewerage system for Digha to prevent flow of sewage onto the sandy beach; cleaning and environmental improvement of the Digha beach, and solid waste management in Digha; improvement of the fish auction centre at Digha; and distribution of grid electricity on Sagar Island to replace diesel generation and prevent soil and water pollution; and*

(c) *livelihood security of coastal communities in Sagar Island including support to CBO coordinated livelihood improvement activities; afforestation-based livelihood improvement; promotion of local small-scale tourism and ecotourism activities; and provision of cyclone shelters in the coastal villages'.*

1.4. PILOT SITES

The two programme sites are Digha-Sankarpur and entire Sagar Island. Brief profile including key features of these plan areas are presented below.

[2] Page 17, Project Appraisal Document (PAD), World Bank ICZM Project

I. Digha-Sankarpur

Digha is West Bengal's most popular sea resort and tourism destination. It is located 187 km southwest of Kolkata and lies in the southwest corner of Purba (East) Medinipur district. Sankarpur is a beach town and fishing harbour located about 14 km east of Digha along the Digha – Contai road. The twin beach resorts of Digha and Sankarpur are being developed for tourism promotion. This is a major objective of the Digha-Sankarpur planning authority apart from developing the adjoining areas for the benefit of local people. The map given in Figure 1.4 indicates the plan area of Digha to Sankarpur (Subarnarekha River to Rasulpur River).

II. Sagar Island

Sagar is an island in the Ganges delta, located about 100 km south of Kolkata. The island covers a large area of 224.3 sq km, lying between 21°36' to 21°56' N and 88°2' to 88° 11' E. This island is in the administrative jurisdiction of South 24 Parganas District. It has 6 Gram Panchayats, comprising 9 *mouzas* with 43 villages altogether (Source: Gangasagar Bakkhali Development Authority). It has 43 villages with a population of 2,12,037 constituting 43,716 households (2011 Census). Though the Sagar Island falls under Sundarban delta it does not have mangrove forests, tiger habitation and river tributaries. The map given in Figure 1.5 indicates the plan area of Sagar Island.

A summary of key information of the two project sites is presented in Table 1.3.

Table 1.3 Summary of Key Features of the two Plan Areas in West Bengal

Details	Digha to Sankarpur	Sagar Island
Latitude & Longitude	From 87° 29'56.81"E -21°36'57.93"N to 87° 34'49.31"E - 21°38'17.03"N	From 88°02'37" E- 21°37'58"N to 88°9'52"E - 21°52'48"N
Length of Coast (km)	60 km (Subarnarekha River mouth to Rasulpur River mouth)	68.5 km (perimeter)
Number/ Name of Districts	1 Purba Medinipur	1 South 24 Parganas
Population	167330 (Ramnagar-I Sub-District)	212037 (Sagar Sub-District)
Key Livelihood	• Marine & Inland Fisheries	• Marine & Inland Fisheries

Details	Digha to Sankarpur	Sagar Island
	• Tourism • Agriculture	• Religious Tourism • Agriculture • Duckery • Betel vine • Rabi crops
Dominant Land use	• Settlements • Forest • Agriculture • Wetlands	• Settlements • Agriculture • Wetlands
Ecologically Sensitive Areas (ESA)	2.3 sq.km	26.9 sq.km
	• Sand Dune	• Sand Dune
	• Mangrove	• Mangrove
	• Mudflat	• Mudflat
	• Turtle Nesting Grounds	• Salt marshes
	• Horseshoe Crab Habitat	• Horseshoe Crab Habitat
Status of Shoreline (km)	• Erosion: 3.5 km (excluding river mouth) • Accretion & Stable Coast: 4.9 km	• Erosion: 25 km • Accretion & Stable Coast: 46.1km
Key coastal infrastructure	• Fishing Jetty • Fish Landing & Processing Centre • Coastal Protection Measures • Tourism Infrastructure • Light house • Road and Rail Networks • Drainage	• Fishing Jetty • Tourism Infrastructure • Cyclone Shelter • Helipad • Light house • Road network • Drainage
Major coastal Issues	• Coastal erosion • Cyclone • Sea level Rise • Coastal flooding • Pollution • Over fishing	• Coastal erosion • Cyclone • Sea level Rise • Coastal flooding • Pollution • Over fishing
Sea Level Rise	-	3.14 mm/year
Areas of Tourist Importance	• Beach Tourism at • Digha • New-Digha • Sankarpur • Mandarmani • Tajpur	• Religious Tourism (Kapil Muni Temple) • Gangasagar Mela
Coastal Protection Structures	• Seawalls • Groynes	• Seawalls

Figure 1.4 Digha to Sankarpur (Subarnarekha River to Rasulpur River), West Bengal

Figure 1.5 Sagar Island, West Bengal

III. ICZM Plan Objectives and Deliverables

The primary objective is to prepare the integrated coastal zone management plan together with capacity building requirements for implementation by the state. Objectives of ICZM plan for the selected sites of West Bengal are the same as for the overall plan. The key expected deliverables are as follows:

- Integrated coastal zone management plan for Digha – Sankarpur and Sagar Island of West Bengal prepared
- Management Sub Plans integrating the ongoing intervention by other stakeholders and additional activities/ projects proposed through ICZM project for execution
- Training and capacity building needs of stakeholders planned
- Periodical reports related to the ICZM planning process (e.g. Inception Report; Coastal Profile and Draft ICZM Plan Document Report) prepared

1.5. PHASES OF NCSCM FRAMEWORK FOR ICZM PLAN PREPARATION

NCSCM prepared a draft framework of action and guidelines for the preparation of an ICZM Plan comprising of five phases. Figure 1.6 provides a detailed description of activities in each phase. This has been marginally modified and updated from the original framework based on better understanding and activities over time.

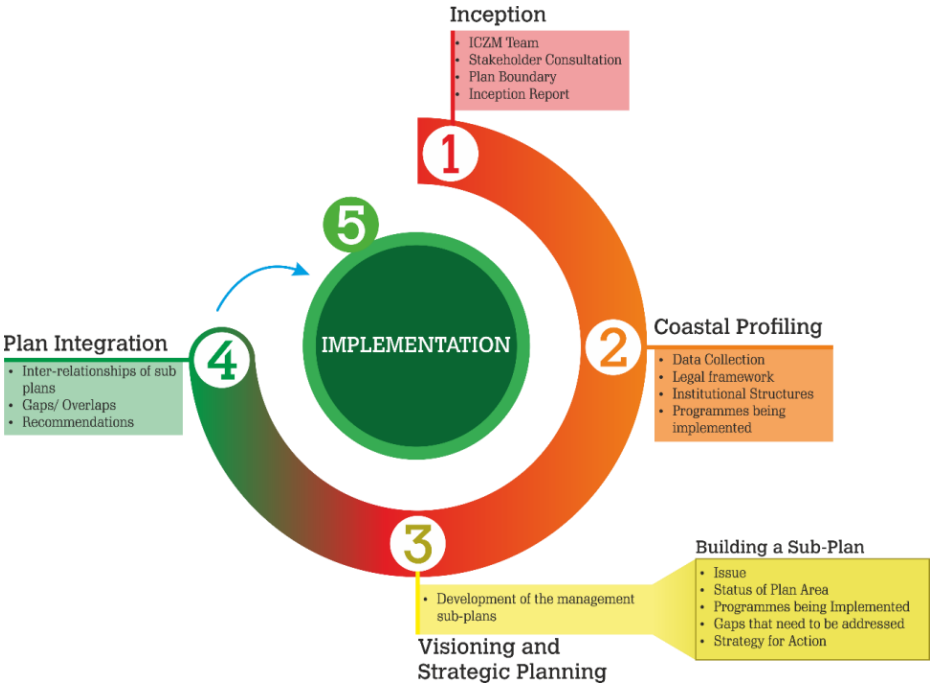


Figure 1.6 Phases of ICZM Plan Preparation Framework

In the **Inception Phase**, the team preparing the ICZM Plan is formulated, stakeholders are identified and series of consultations held to identify major issues which help in formulating goals, objectives and confirmation of plan boundaries. For the two plan sites, the coastal Sediment Cells have been taken as the coastal boundary. In case of Digha to Sankarpur, the entire stretch of coast that falls within the Primary Sediment Cell No 24 covering the coastal area from North of Subarnarekha River to South of Rasulpur River is considered for shoreline management. On the landward side, it is proposed to consider the jurisdiction of the Digha Sankarpur Development Authority (DSDA) as the plan boundary including management sub-plans. In case of Sagar Island, the entire Sagar Island coast that falls within Primary Sediment Cell 25is considered.

Collection of primary and secondary data and information is the major activity in the second phase i.e. "**Coastal Profiling**". Both primary and secondary data will be aggregated in the GIS platform. Information on legal (Central and State legislation and policies of relevance) and institutional (structure of the current institutions dealing with coastal management etc.) framework is also obtained. Details on various programmes that are being implemented or being planned for implementation in the plan areas are collected and collated. This is an activity that would continue until the third phase, and will be consolidated in the final report. The third phase includes **visioning and strategic planning**.

Overall vision of the West Bengal ICZM Programme is…

"to ensure minimum but acceptable planned intervention for development needs in the coastal zone so as to preserve the pristine nature of the prevailing environment making allowances for sustainable exploitation of living and non-living resources for the livelihood of the coastal population"[3]

In addition, where required, vision (specific to the plan area) of the different (sectoral) agencies and the State will be incorporated. In the strategic planning phase, the key issues are transformed into management sub-plans for easier implementation.

[3] http://www.iczmpwb.org/main/vision_strategy.php

Initially, the State Project Management Unit, West Bengal had identified five management sub-plans:

1. Shoreline Management Plan
2. Conservation Management Plan
3. Sustainable Livelihoods Plan
4. Disaster Management Plan
5. Tourism Management Plan

NCSCM has included Pollution Management Plan as an important sub-plan, as it is directly connected to tourism, conservation and livelihood management sub-plans. The six management sub-plans are given in Figure 1.7.

Figure1.7 The Management Sub-Plans

For the two plan areas, six management sub-plans have been identified based on issues. Each of the sub-plans will have a common format for preparation which will comprise of the following details:

(a) Collect secondary and primary data on the plan area to better understand the issue from the perspective of the sub-plan
(b) Analyses the proposed interventions in the plan area under the WB-ICZMP and compare with the ongoing programmes
(c) Identify gaps that need to be addressed and
(d) Provide recommendations on actions to be taken

These six management sub-plans together deal with most issues that are likely to be seen in the plan area. Each sub-plan includes a strategy and action plan to address those issue. These sub-plans may be developed independently by different teams. At the end, however, a list of all the actions under each sub-plan and potential impacts/inter-relationships with other sub-plans are listed in the form of a matrix; any gaps and overlaps are then identified and shall be addressed. These gaps/overlaps may be in terms of resources (human, financial), conflicts, institutional coordination etc. These are addressed through appropriate modifications to provide an integrated plan document with an overall strategy and action plan.

Pilot interventions have already been made in West Bengal at the two ICZM pilot project sites. As part of **Plan Integration** phase, it is necessary to connect these interventions to the ICZM Plan for two purposes: (i) evaluate the success of these interventions in conjunction with the integrated plan and (ii) identify specific gaps that could enhance/compliment the success of such interventions. Possible interlinkages of multiple management sub-plans with interventions currently implemented by other stakeholders in the two pilot sites are given in Figure 1.8.

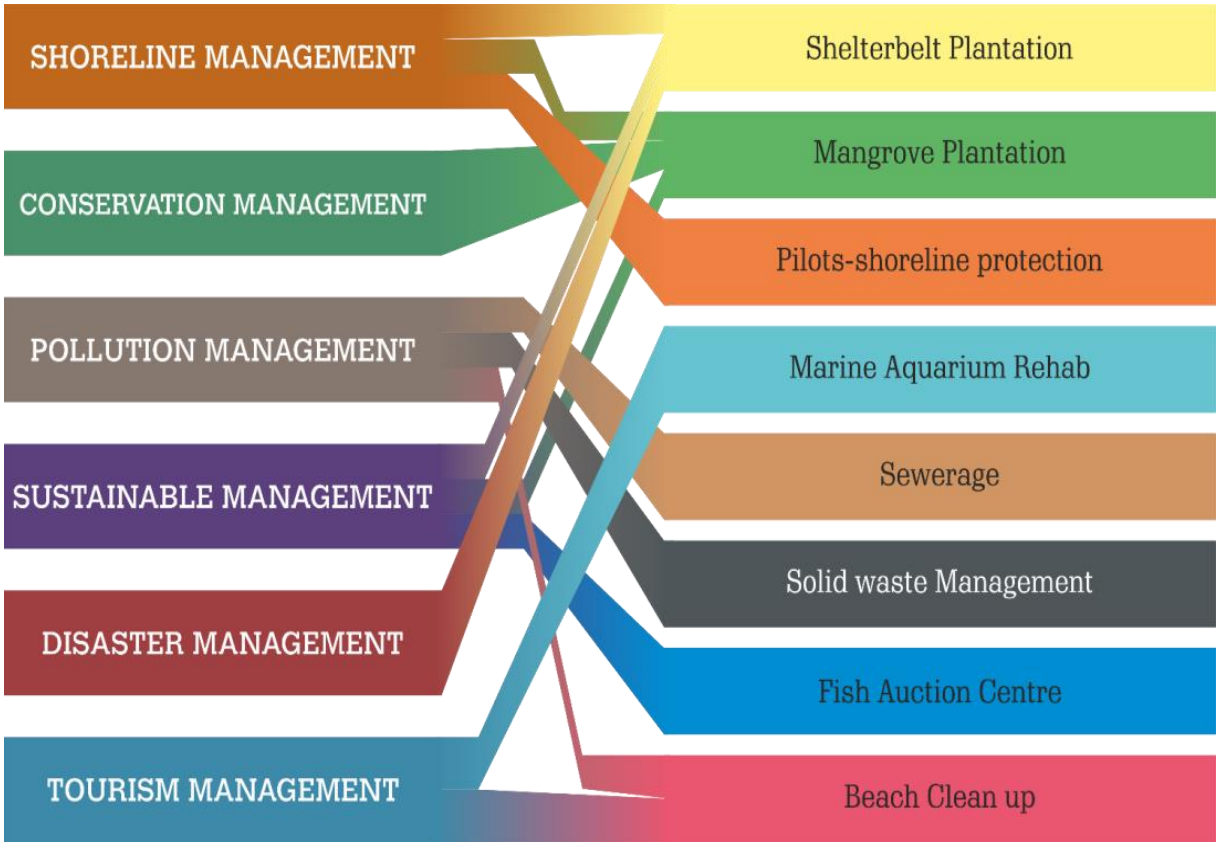


Figure 1.8 Linking Pilot Activities in Digha to ICZM Management Sub-Plans

In addition, the multiple benefits of an individual intervention/ activity (e.g. Shelterbelt plantation) on multiple management sub-plans is indicated in Figure 1.9 as an example.

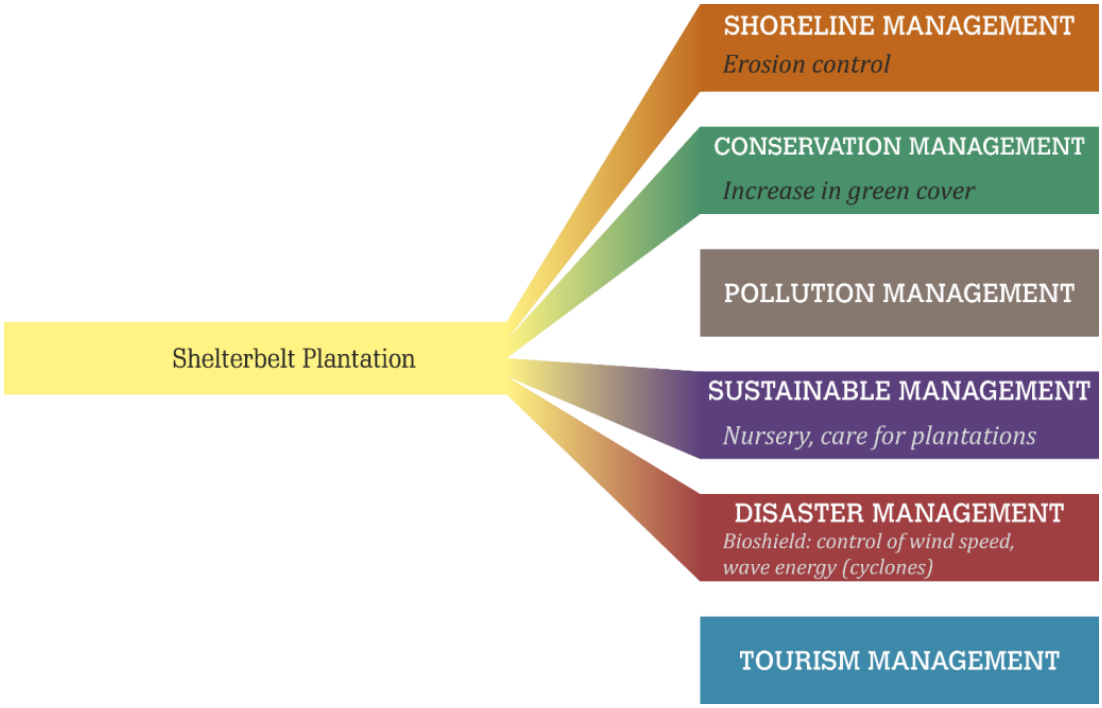


Figure 1.9: Example of interlinks of an intervention with multiple sub-plans

Figure 1.10 indicates the potential gaps identified to provide appropriate solutions, taking the case of shelterbelt plantation as an example.

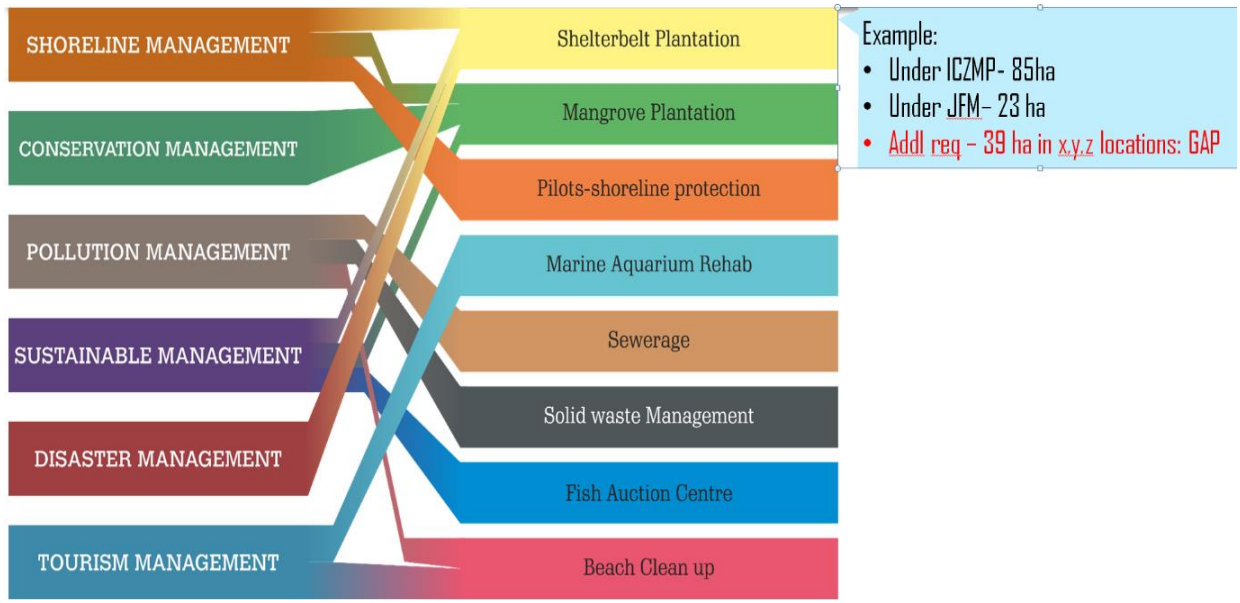


Figure 1.10 Identification Gaps – an example

Once the consolidated ICZM plan incorporating six management sub plans is ready the final phase is to **implement** the same. For this, appropriate

stakeholder will be identified at different levels and built their capacities on the entire process of plan implementation and management.

1.6. Monitoring and Evaluation Framework

A framework will be developed for monitoring and evaluating the ICZM plan preparation and implementation. A Logical Framework Approach will be used to define the larger goal, objectives and activities of the ICZM project along with the expected output, outcome and impact level results to be monitored and evaluated. Both the process and result monitoring will be done by defining appropriate qualitative and quantitative indicators. A clear data collection, compilation and reporting formats will be developed and deployed for periodical documentation purposes. Developing and deploying systematic monitoring and evaluation will facilitate effective and efficient project planning, implementation and management.

According to the WB ICZM Project, the key indicators to measure the success of ICZMP are[4]:

- Minimised or no retreat/advance of coastline along the Digha-Sankarpur sector over a sufficient number of years indicating an equilibrium beach
- Reduced net land loss in the Sundarban areas inclusive of Sagar Island
- Sustained or increased mangrove cover area in Sundarban
- No reduction in the population of keystone species in the Sundarban in the next census
- Ensured near clean environment in and around Haldia and Digha-Sankarpur with water quality meeting the required discharge standards
- Increased or at least no decrease in fish catch (catch per effort) along the coast
- Ensured that no there is no death of olive ridley turtle from Sundarban
- Shifted to multi crop agriculture with the support of grid power in Sagar Island
- Increased GDP of the plan areas of West Bengal
- Increased number of tourists visiting Digha-Sankarpur areas

Positive response in any or all of the above indictors will point towards success and sustainability of the ICZM Plan.

[4] http://www.iczmpwb.org/main/objectives_indicators.php

2. PLAN OF ACTION

Details on development of various management sub-plans in terms of data requirement and methodology for achieving the proposed deliverables is presented in this section. The plan boundary details are given in Table 2.1. A brief description of land use and land cover in both plan areas is described first. This is followed by a description of plan of action for the six management sub-plans.

2.1. PLAN BOUNDARY

Table 2.1 Details of Plan Boundary

S. No	ICZM Sub plans	Plan Boundary		Remarks
		Longitudinal and Sea Side	Land Side	
1	Shoreline Management			
	a. Coastal Process	Sediment Cells 24 & 25	Backshore (Vegetation Boundary)	
	b. Shoreline Change	Sediment Cell 24 & Sagar Island	Hazard lines	
2	Conservation Management	Territorial waters (12 NM) off Sediment Cell 24 & Sagar Island	Ecosystem Boundary	
3	Pollution Management	Territorial waters (at intervals of 0.5, 2 and 5 km in the sea) off Sediment Cell 24 & Sagar Island	Administrative (Mouza) Boundary (upto10 km)	River/ Coast/ TW/ Solid waste/ Air/ GW
4	Tourism Management	Sediment Cell 24 & Sagar Island	Administrative (Mouza) Boundary (upto 10 km)	Cultural & Beach Tourism
5	Livelihood Management	Sediment Cell 24 & Sagar Island	Administrative (Mouza) Boundary (upto 10 km)	
6	Disaster Management	Sediment Cell 24 & Sagar Island	Hazard lines	

2.2. LAND USE

Land use and land cover assessment/mapping is imperative to understand and evolve meticulous management sub-plans. Where ***land use*** *indicates the various uses of the landscape – whether for development, conservation, or mixed uses. Land-use planning seeks to regulate land use in an efficient and ethical way, preventing land-use conflicts. Governments use land-use planning to manage the development of land within their jurisdictions,* needs to be complimented by assessing the ***land cover*** (*land cover data determines the area covered by forests, wetlands, impervious surfaces, agriculture, and other land and water types. Water types include wetlands or open water*). NCSCM adopted quantitative and qualitative methods viz. field survey and discussion with stakeholders to generate the land use and land cover details. Field surveys at Sagar Island and from Subarnarekha River confluence to Rasulpur River mouth was conducted. Discussions were held with the

Executive Officer, Gangasagar Bakkhali Development Authority (GBDA) and the Executive Officer, Digha-Sankarpur Development Authority (DSDA).

Photo 2: Livelihood activities along Hooghly River and estuary at low tide

I. Digha-Sankarpur

Digha Planning Authority was initially constituted in 1990 with 16 (Sixteen) *mouzas* as its Planning Area. Later on its area was extended up to 51Mouzas under Digha Police Station and Ramnagar Police Station with 17220.08 acres of land as its Planning Area. Subsequently the Digha Planning Authority was transformed into Digha Development Authority and from 14/03/1993 with a view to ensuring rapid growth of Digha, Sankarpur and its adjoining areas. The Digha Development Authority has subsequently been re-named as Digha-Sankarpur Development Authority in 2003.

Table 2.2.1: Basic Statistics of Digha-Sankarpur Development Authority – Amenities and infrastructure facilities available in Digha-Sankarpur region

Year of Formation	DDS - 1956 DSDA - 1990
Population as per Census Report	1991 - 25,337 2001 - 27,713
No. of Mouzas under DSDA	51
Total Area	37 sq.km
No. of Hotels	Govt. Sector - 34 (1252 Bed capacity) Pvt. Sector - 440 (10516 Bed capacity)
No. of Tourist Visits	26 Lakhs (approx.)
Parking & sanitation facilities	Parking Spaces - 06 Sanitation - 08
Tourist amenities and Infrastructure	a. Science Centre b. Marine Aquarium c. Amarabati Park d. Toy Train e. Hospitals - 02

	f. Bus Terminus g. Fishing Harbour h. Railway Station
Industry & Institutions	a. Primary Schools - 23 b. Higher Secondary & High Schools - 04 c. Fish Processing units - 03 d. Ice Plants - 12
Transport public	60 (approx.) nos. of routes originate from this town. About 200 buses ply everyday
Market	11 (3 with all facilities/ 08 in street corners).
Important Commodities Imported	Sea shell goods, sandal woods, plastic mats
Important Commodities exported	Sea fish, cashew nut, betel leaves
Commodities Manufactured	Mats and other handicrafts. Variety of goods using sea shell Decorative stationery articles through sandal woods
Revenue Generation Sources	Tourist Accommodations, Amarabati Park, Catering Units, Hoardings, Markets, Development Charges, T.C.A.C, Parking Spaces, Picnic Spot etc.

Photo 3: Digha beach indicating beach beautification program under ICZM Project - Phase I

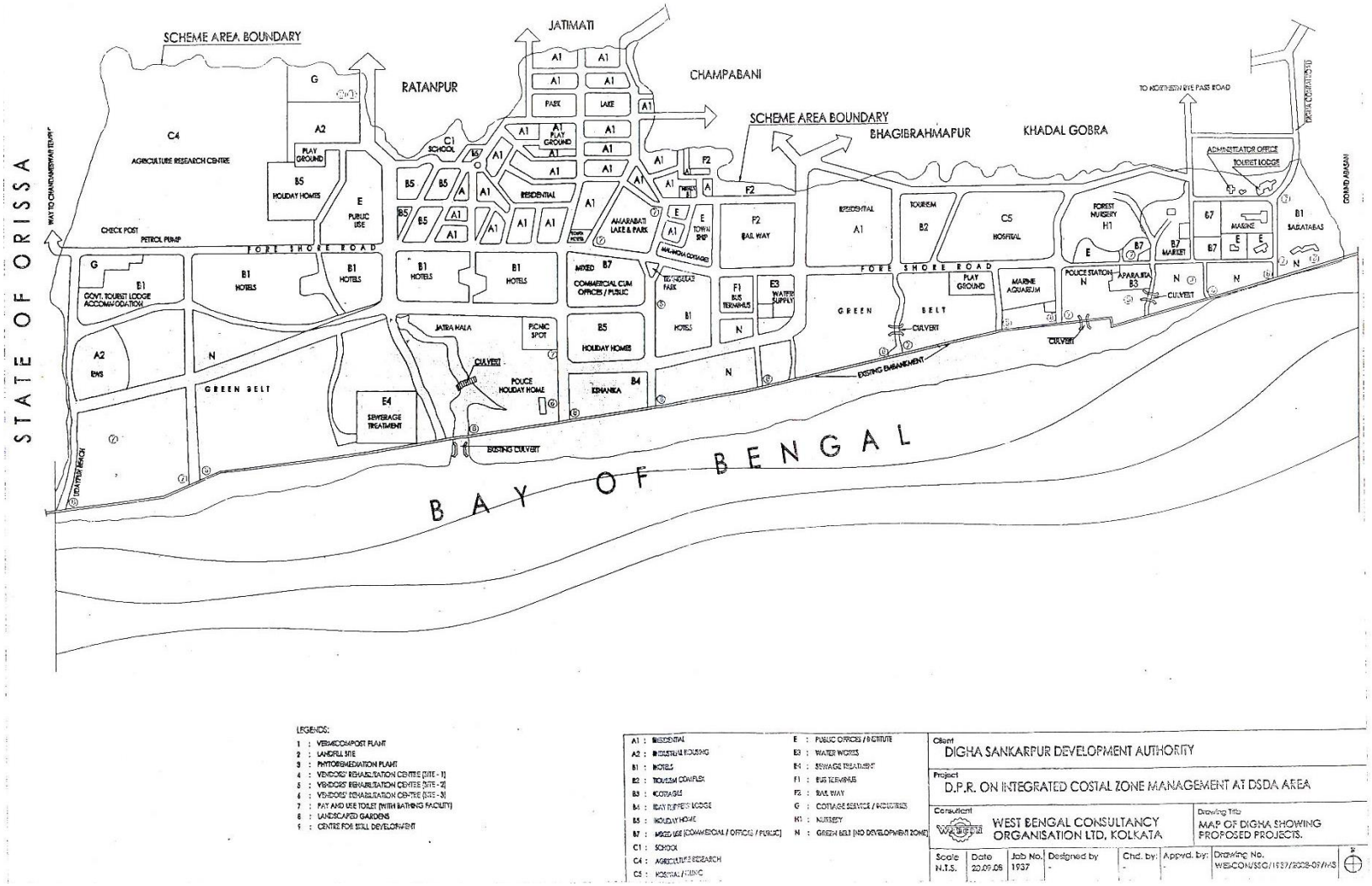


Figure 2.2.1 Digha-Sankarpur Sector Map

II. Sagar Island

Gangasagar Bakkhali Development Authority was constituted on 19June, 2013 and comprises of 9 (nine) *mouzas* of Sagar and Namkhana Development Blocks. Purushottampur of Sagar Development Block was added as the 10th*mouza* in November, 2015.The island has an area of 224.3 km², lying between 21°36' to 21°56' North and 88°2' to 88° 11' East. It has 43 villages and a population of over 160,000. The largest village is Gangasagar, situated on the shores of the Bay of Bengal. The Block map of the Sagar Island was obtained from GBDA and is given in Figure 2.2.2 Land use map has been obtained from DSDA which will be subsequently analysed.

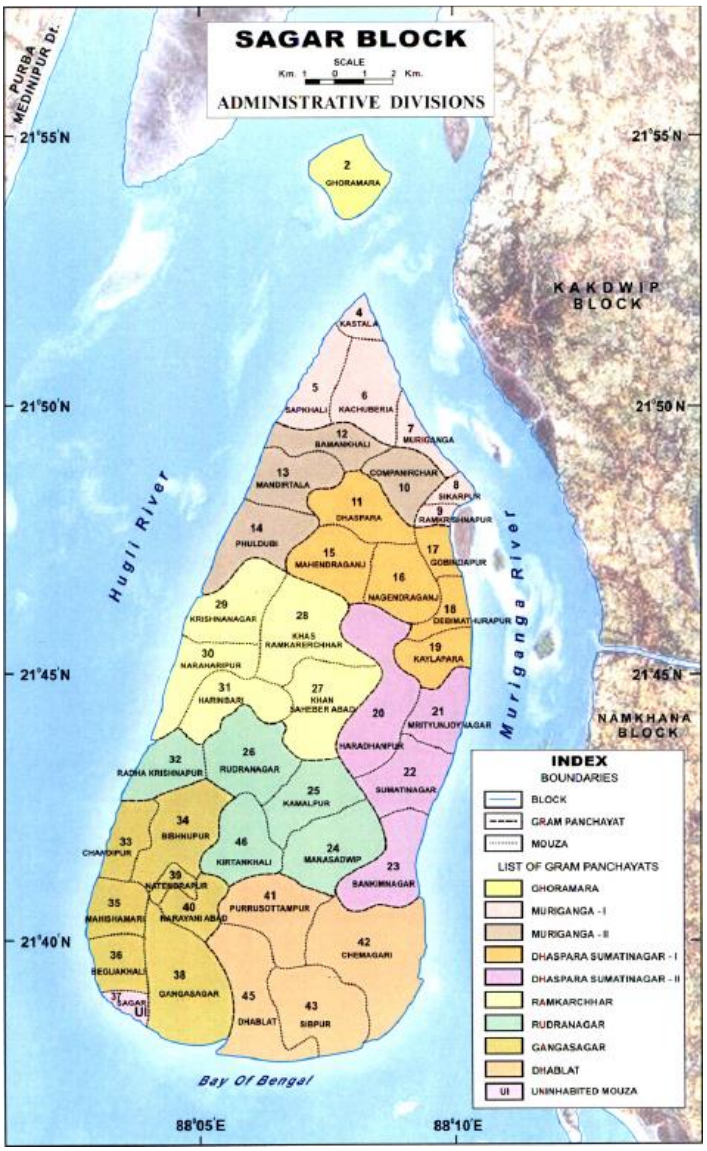


Figure 2.2.2 Block Map of Sagar Island

Photo 4: Ferry transport from Lot 8 to Kachuberia in Sagar Island

2.3. LAND COVER FEATURES

Study on natural coastal terrain features and other land use activities is an essential element for the integrated management of coastal zone. Human usage of land and water invariably results in impacts to the environment. The spatial spread of natural terrain features along the coastal zone enables better understanding of the environment and assesses the impacts due to coastal development. Changes in the land cover features form a basic component of the ICZM Plan. In order to formulate ICZM plan, the physical land spread of the coastal stretch and their dynamics needs to be studied. Remote sensing and GIS will be used to assess the changes in the natural coastal terrain features along the study area between the years 2007 and 2017.

I. Land cover between Subarnarekha River to Rasulpur River

The plan area is located on the east coast extending from 87°13'38.13"E, 21°32'53.84"N in Odisha to 87°57'26.65"E, 21°50'3.83"N in West Bengal. The length of the coast of this stretch is 63 km (Figure2.3.1). A boundary of 10 km from shore landward covering the nearest village boundary has been taken as the plan boundary for this study. The area is dissected by a number of tidal channels such as Ramnagar Khal, Sankarpur Khal, Jalda Khal etc. The stretch also comprises some of the densely populated areas such as Chandrabali, Digha, Sankarpur, Mandarmoni, Biramput, Haripur and Thana Berya. Chandrabali has mudflats and mangrove swamps on the northern bank of Subarnarekha River.

Figure 2.3.1 Plan Area 1: Digha-Sankarpur

II. Land cover at Sagar Island

Sagar Island is located at the extreme south western margin of the Gangetic Delta. It is a flat coastal plain, extending from 21°37'40" N to 21° 55'20" N and from 88° 02'45" E to 88° 10' 30" E (Figure 2.3.2). The island is separated from the district of Purba Medinipur by the Hooghly River in the west and from the Kakdwip and Namkhana on the east. The island is divided into 9 Gram Panchayats, comprising of 46 *mouzas*, of which three *mouzas* were completely destroyed due to coastal erosion and one *mouza* is uninhabited.

Sagar Island is a typical delta island with its apex at the north and the base being at the south. The region belongs to the lower deltaic alluvium tract and is the product of marine-estuarine agencies. The average elevation of the region above mean sea level (MSL) is 3.8 m. The slope of the island is mainly from north-west to south-east. Due to the depositional activities of the rivers, the delta building process is still active in the south-western and south-eastern part of the island. In the southern part of the island, the topography is undulating with the location of dune ridge, dune slack and dune flat.

Figure 2.3.2: Plan Area 2: Sagar Island

Tasks

The tasks for this activity are the following:

- Mapping of natural coastal terrain features along the two plan areas using high resolution satellite images for two different years, i.e., 2007 and 2017
- Assessing changes in land cover features
- Determining conversion of natural coastal terrain features using spatial analysis in GIS

PLAN OF ACTION

The sequential plan of action is presented in Figure 2.3.3. Satellite images for the years 2007 and 2017 are pre-processed for geo-rectification and image enhancement for coastal terrain feature extraction. The spatial information obtained is further field-verified using random selection method. The field-verified spatial data are updated and the features are attributed with the spatial data on the land cover features for two different years.

The two different sets of spatial data are further assessed for their spatial and physical conversions using GIS spatial analysis. The spatial data are integrated with the district, administrative block, village and cadastral boundaries for better understanding of the coastal locations that require specific sub plans for ICZM.

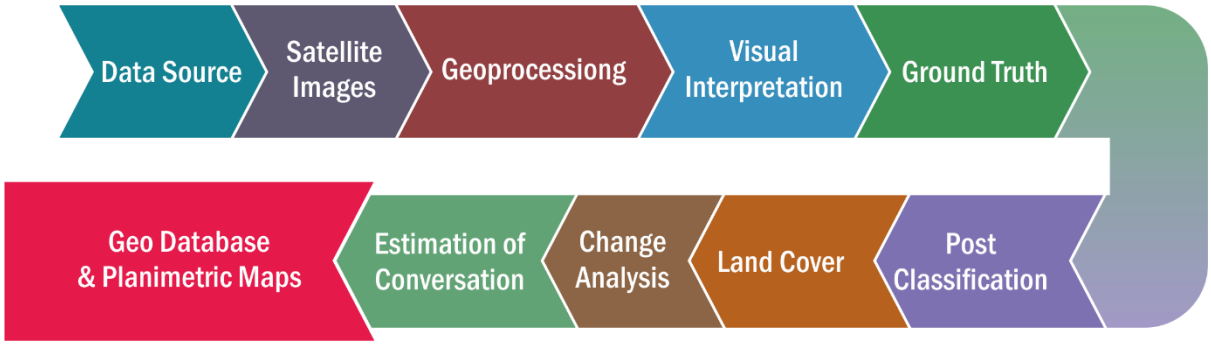


Figure 2.3.3 Approach forLand cover study using GISData products and other data collection

- *Primary Data*: The study would assess changes in natural coastal terrain features between 2007 and 2017 so as to quantify the changes over a decadal time scale. For this purpose, high resolution (ranging from 2.4m – 5.8m ground resolution) satellite images such as Quickbird, Ikonos will be used.

- *Secondary Data*: SpatiallyReferenced Cadastral Maps, Village Boundaries from Survey and Land Records Departments – West Bengal and Odisha (as part of the land area falls in Odisha State)
- *Population* from Census of India
- Nine-fold *classification* details of Odisha and West Bengal from state Statistics and Implementation Department to triangulate and validate the land cover data prepared from satellite images by NCSCM.

Data processing and analysis

Land cover is defined as observed physical features on the Earth's Surface. Classification is a representation of the arrangement of features on the earth surface integrated into groups or sets on the basis of their relationships. A classification table represents the names of classes and criteria used to distinguish or group features which is primarily based on the resolution of the image used. The classification method is on the basis of different levels such as level I, II, III and so on. The different levels of classification include more precise and detailed information of the features. For example, level I classification includes general classes of features while level II indicates sub divisions within each features of level I and so on. Classification method to be used in this study is adopted from NRSC and SAC method.

Deliverables

a) Availability of maps with (Figure. 2.3.1& 2.3.2) land cover features along the two stretches for two temporal periods 2007 and 2017
b) Generated spatial extent of each land cover features for selected temporal periods for both the stretches
c) Prepared planimetric maps of the coastal land features for two stretches in 1:10000 scale
d) Complied spatial database on the changes in land cover features during the comparison period for both the coastal stretches
e) Elicited spatial data on conversion of land cover features into other land use activities over the study period in both the stretches.

2.4. SHORELINE MANAGEMENT PLAN

Coastal area/ beach plays a vital role (productive, protective, biodiversity conservation and recreational) for various activities such as fishery related activities (*e.g. fish landing centre, drying fish, drying fishing nets, storing craft and gear*), recreation (*e.g. beach tourism*) and for coastal developmental activities (*e.g. construction of ports and harbours*) and other activities that require waterfront. Biologically, the coastal area/ beach serves as a habitat and breeding ground for various marine fauna (e.g., nesting of sea turtles; and burrowing crabs use beaches as a habitat). Vegetation in the backshore area support birds, reptiles and small mammals. Besides, beach area provides protection to the hinterland against inundation of seawater during storm surges and tsunamis.

In order to ensure protection of the coast from loss of beaches due to erosion, it is proposed to develop a Shoreline Management Plan for the two plan areas. The objective of the plan is to suggest measures that are required to protect the coast while facilitating its use in a rational manner in order to undertake developmental activities; maintain human use and ensure conservation of marine organisms. The specific objectives of the plan are to:

(i) develop a comprehensive primary and secondary database on oceanographic details (*e.g. bathymetry, tide, current and wave characteristics*) and coastal geomorphology (e.g. sand dune/ mudflats/ beach/ headlands etc.)
(ii) study the coastal processes of West Bengal coast based on the sediment cell delineation
(iii) map the long term shoreline changes and estimate erosion/accretion rates per year
(iv) estimate the sediment budget and transport
(v) prepare Shoreline Management Plan with interventions to solve the problems of coastal erosion

Study Area

Sediment budget and the sediment transport rate are essential in determining the stability of the coast and are chiefly governed by coastal processes prevalent in the region. As the sediment budget and processes vary from one coastal area to the other, there is a need to demarcate coastal areas based on hydrodynamics of the region. For this purpose, the concept of coastal sediment cells developed by the NCSCM has been adopted and is used as the plan boundary.

Coastal Sediment Cell

A coastal sediment cell is the length of the coastline and associated nearshore areas where movement of sediments is largely self-contained, i.e. input and output of sediment into each cell from outside of the cell can be considered to be negligible. The sediment cells are identified and categorized as Primary Cells (PC), within which are sub cells based on key criteria for each type. Key criteria followed by NCSCM for delineation of Primary Cells include the following:

- *Coastal geomorphology*
- *Source of sediments*
- *Stores of sediments and*
- *Interface of sandy – muddy – rocky coasts.*

These cells are numbered serially as PC 1 to PC 25 from Gujarat on the west coast to West Bengal on the east coast of India. The delineated cells would not match with the administrative boundaries of states and UTs.

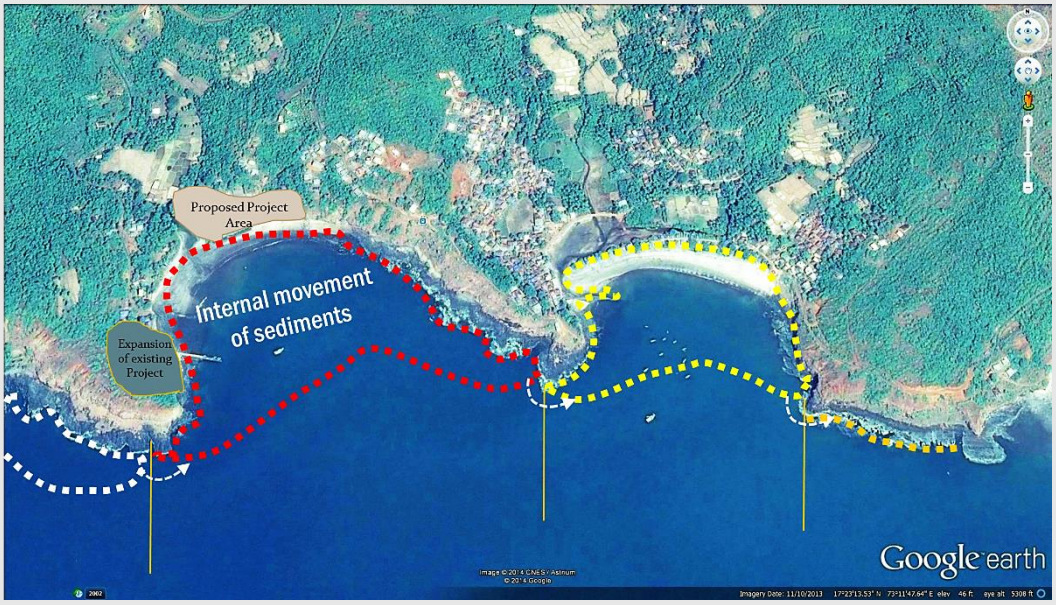


Photo 5: Concept of coastal sediment cells

Based on the criteria given above, the coast of West Bengal consists of two sediment cells PC 24 and PC 25. Primary Cell No 24 extends from North of Subarnarekha River mouth to South of Rasulpur River mouth. The criteria for defining boundary for PC 24 is based on source of sediment from Subarnarekha River and terminates south of Rasulpur River, which is the boundary between sandy and muddy coast. The problem areas identified are Digha and Sankarpur (Figure 2.4.1). Sagar Island falls within PC 25 which extends from North of Rasulpur River mouth to Matla River mouth in the Sundarbans (Figure2.4.2).

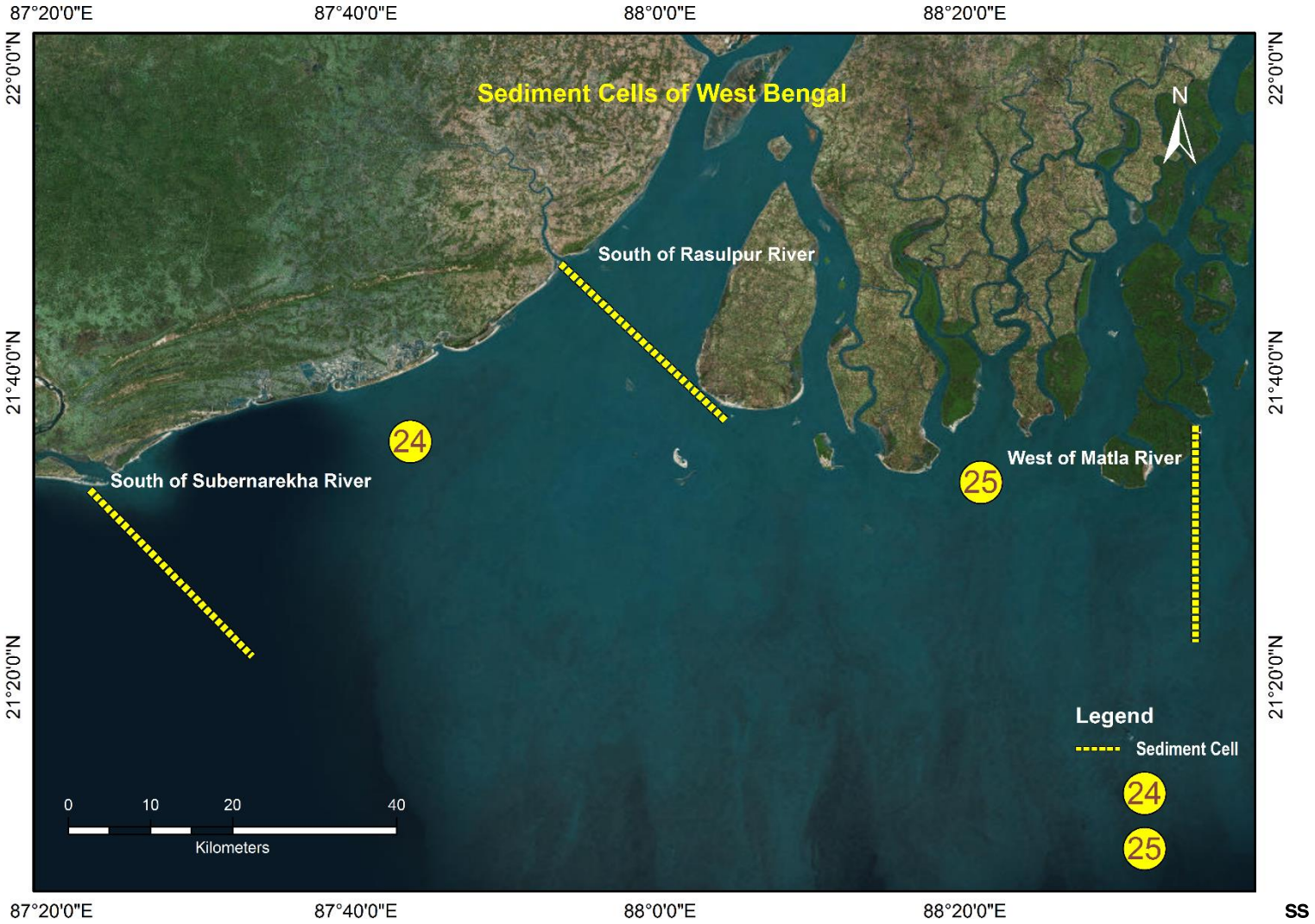


Figure 2.4.1:Boundaries of Primary Cells 24 and 25 along the Digha- Sankarpur coast and Sagar Island

Digha-Sankarpur: The study area is situated between the easternmost parts of the Odisha coast, from Subarnarekha river mouth to the Rasulpur estuary in West Bengal, covering a stretch of 63 km. Digha-Sankarpur is an important tourist location in West Bengal, facing severe erosion due to various coastal developmental activities. The coastal stretch of Digha to Sankarpur measuring 9.5 km has been experiencing severe erosion of 3.2 m annually, leading to a loss of 240 m width of the coast between 1936 and 2011 (Figure 2.4.2).

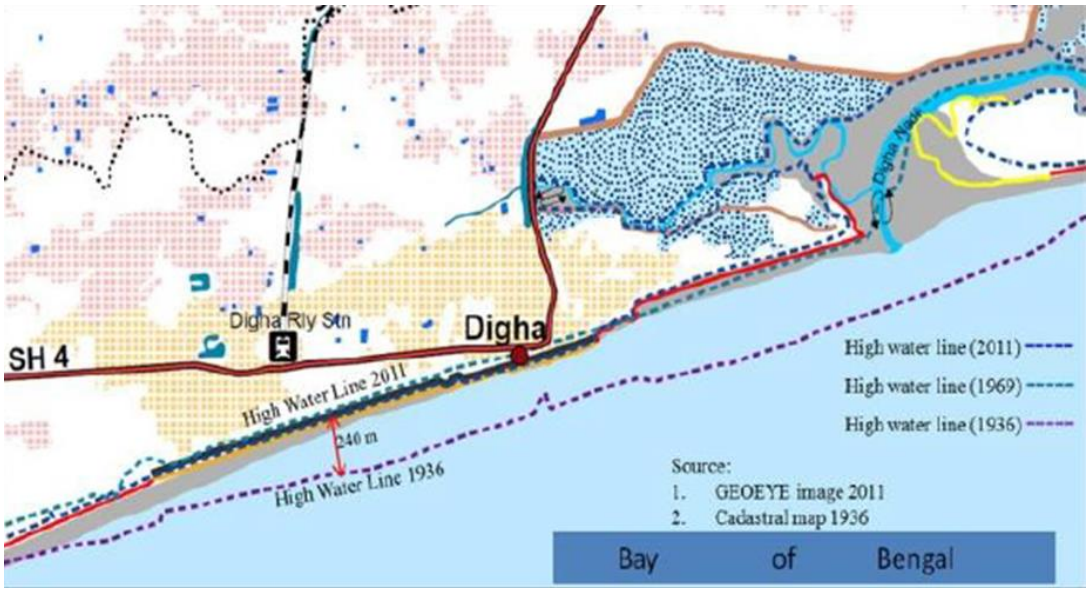


Figure2.4.2 Map indicating shifting of High Water Line from 1936 to 2011
(Source: Irrigation and Waterways Department, GoWB and Selvin,2017)

Shoreline change maps prepared by NCSCM using topo sheet (1974); multiple year satellite data up to 2010 and 2011 aerial photographs also indicate severe erosion along the coast of Digha to Sankarpur with coastal protection structure such as seawalls and groynes (Figure2.4.3).

The coast of Digha-Sankarpur is highly dynamic with coastal processes controlling and maintaining the alignment of the coast. High wave conditions prevail during monsoon, leading to erosion followed by accretion during post-monsoon. An imbalance caused in the past led to commencement of erosion at Digha resulting in loss of beach area for fishing activities and tourism. A number of steps have been taken during the last two to three decades to address coastal erosion. Initially seawalls for 1.5 km were constructed to dissipate wave energy however, it was unsuccessful. Subsequently, geotubes to absorb wave energy were deployed on the coast. During the Aila cyclone in 2009, the geo-tubes collapsed exposing the coast to wave action, resulting in erosion (Selvin and Mukherjee, 2017).

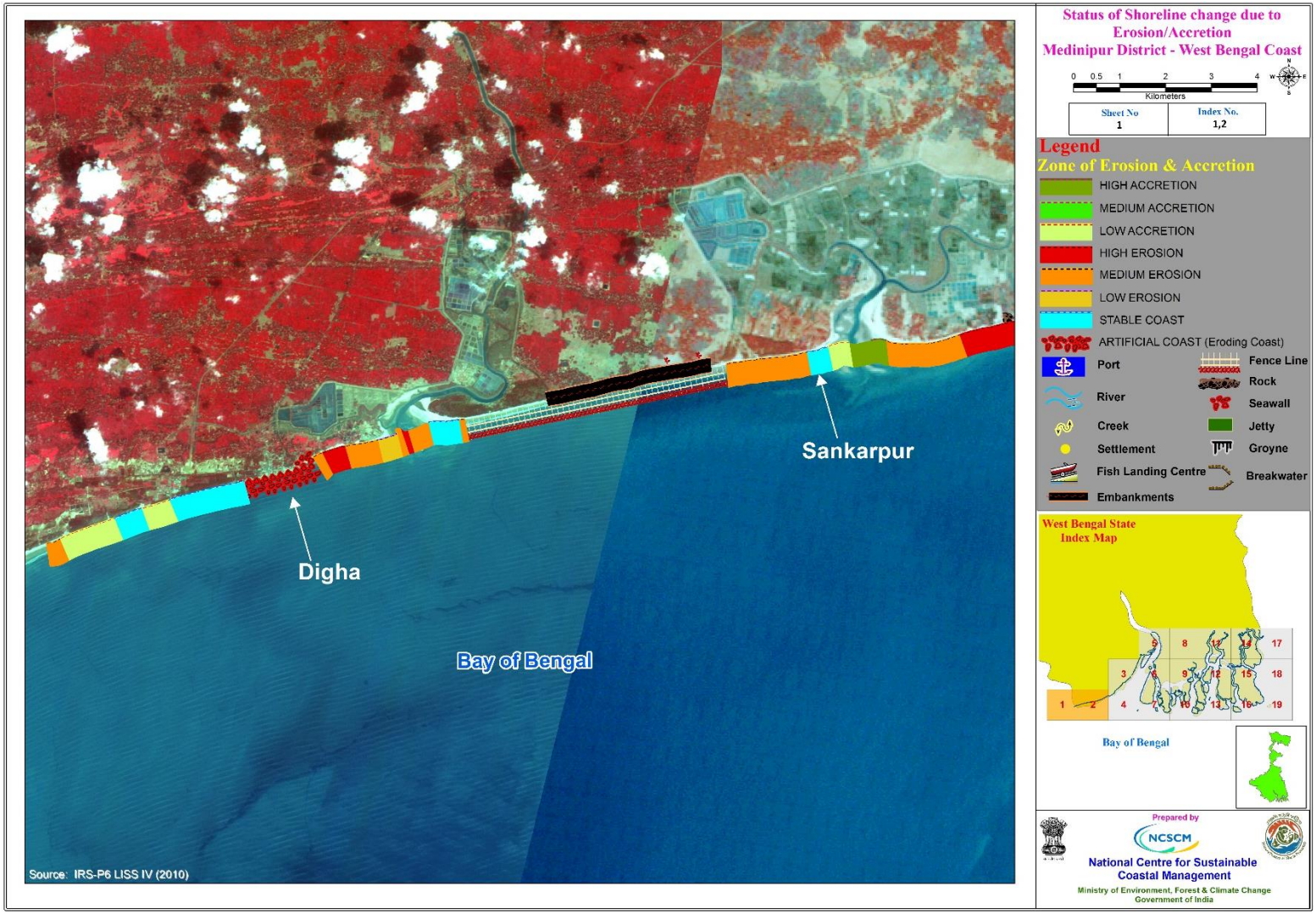


Figure2.4.3 Shoreline change map indicating status of coastal erosion between 1974 and 2011 along Digha-Sankarpur Coast

The Department of Irrigation and Waterways has prepared a Coastal Protection Scheme in 2001 as a part of the National Coastal Protection Project to solve the problem of erosion by treating 36.5 km with sea facing embankments and 10.75 km of beach protection measures. The estimated cost of the work was Rs.254.80 Crores. However, the coast requires a long-term solution to solve the problem of erosion.

Sagar Island: Sagar Island, an open sea-facing island in the Bay of Bengal is surrounded by Hooghly River in the north and west, Muriganga River in the east, and Bay of Bengal in the south. The Island extending to a perimeter length of 68.5 km is covered by the Primary Cell No. 25, which is from North of Rasulpur River to Matla. Shoreline change maps prepared by NCSCM using the data between 1974 (topo sheet) and multiple years of Satellite data up to the year 2011 indicated that the coast has been experiencing severe erosion in the south and at a few locations along the northwest and northeastern sides of the island (Figure 2.4.4).

Seawalls and embankments have been constructed to prevent erosion in the western, eastern and southern parts of eroding areas of the island. Roy Chaudhury and Sen (2013) attributed the cause of erosion to both natural processes such as cyclones, wave and tide action, and anthropogenic activities such as destruction of mangroves and coastal vegetation and coastal development. Using Survey of India topo sheets and Google earth images, it was estimated that from 1951 to 2015, the island lost a total shore area of 60.62 km^2 (Table 2.4.1). around 1 km^2 in a year.

Table 2.4.1 Shoreline Change for Sagar Island

Year	Accretion (+) in sq.km	Erosion (-) in sq.km
1951-1973	0.00	41.40
1973-1990	0.00	7.05
1990-2000	10.52	0.00
2000-2011	0.00	8.24
2011-2015	0.00	4.23
Total	**10.52**	**60.62**

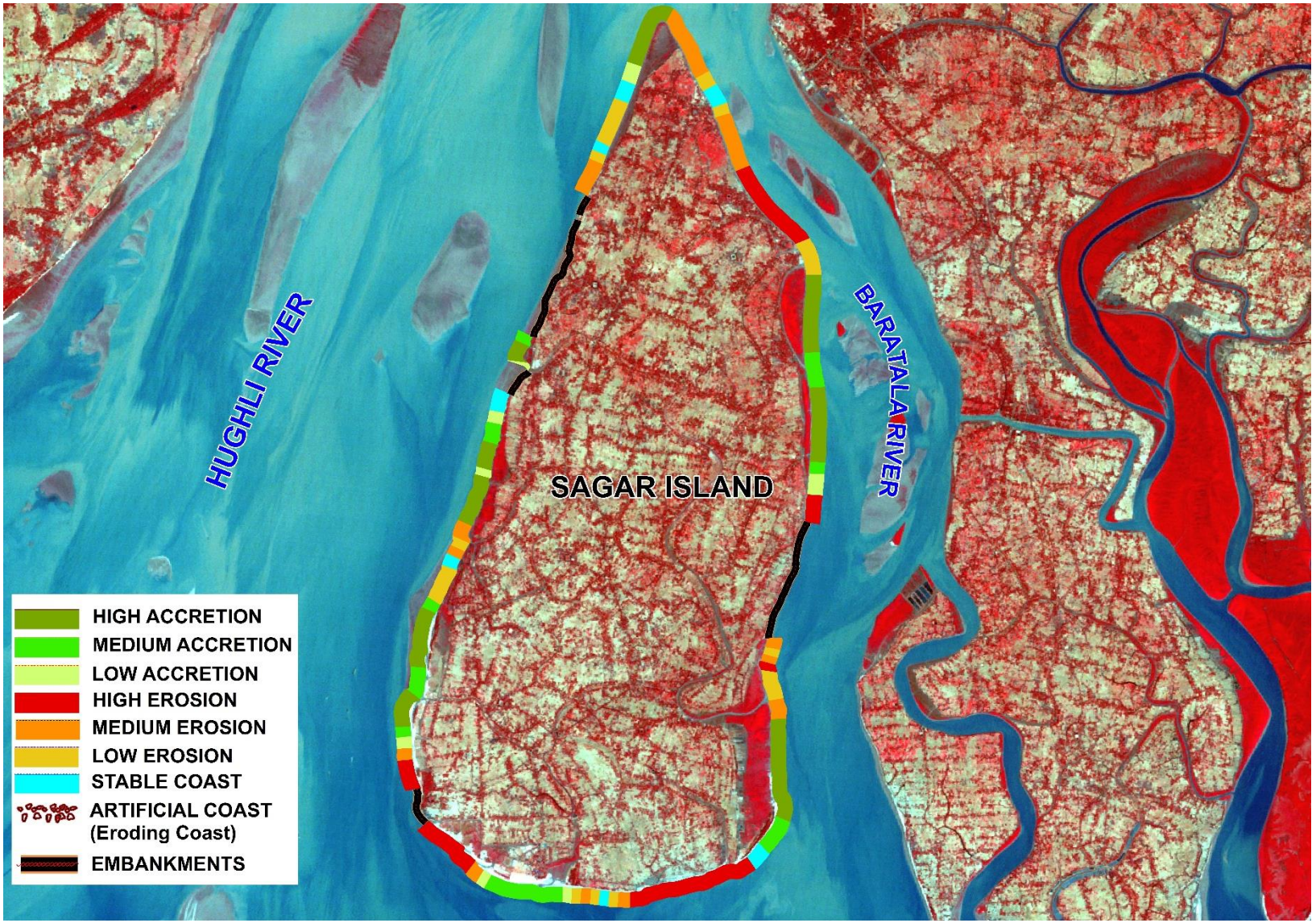


Figure 2.4.4. Shoreline change map of Sagar Island

Tasks

In order to address the problem of shoreline changes in the project area of Digha- Sankarpur and Sagar Island and to develop appropriate interventions, a thorough understanding of coastal processes prevailing in the study area is essential. Accordingly, the planned tasks are to:

a) collect and compile primary and secondary data related to coastal processes for the ICZM sites covering Primary Cells 24 and 25
b) analyse the data and identify the nature of shoreline changes
c) Identify the causes relating to shoreline changes through data collected and numerical modelling
d) determine the causes of shoreline change along the coast of Digha – Sankarpur using behavioural model using historic data and information
e) undertake process based modelling using coastal process data to address coastal erosion and propose interventions
f) predict shoreline evolution over a period of 15 to 20 years in the event of implementation of the interventions developed
g) prepare Shoreline Management Plan providing additional interventions required to address coastal erosion and its prevention in future

Plan of Action

The Action Plan will be -

a) Collection of secondary data and information to understand the problems of erosion in the past and efforts made to solve/deal with the problem. This will help in designing the field and modelling programmes
b) Project staff specialised in analysis of coastal process data and performing numerical modelling of coastal processes will be hired to assist the scientists to analyse the problems and development of solutions
c) Procurement of satellite data to understand the shoreline changes in the past
d) For collection and compilation of primary and secondary data related to coastal processes of the study area, a field programme to collect the data has been designed and it will be executed by hiring qualified consultancy firms
e) Behavioural modelling will be undertaken to assess the primary cause for erosion along the Digh-Sankarpur coast, based on historical land use

and land cover changes. This will help in predicting the future of the current coastline and suggest measures to adapt to such changes.

f) Processing of coastal process and allied data will be carried out to derive sediment transport using sediment transport model in the study area after performing hydrodynamic and wave modelling studies

g) Process based modelling will be carried out using sediment transport data to analyse the cause of problems and to develop appropriate interventions that will help to solve the problem of erosion

h) Shoreline evaluation model will be performed to study the impact of solutions developed on shoreline changes

i) Stakeholder consultations will be made to obtain views on developed interventions and then a Shoreline Management Plan will be prepared for each area containing integrated management solutions to protect the coast from erosion and to prevent future erosion.

Methodology

In order to study the coastal processes and shoreline changes, the following methodology will be followed -

i. Mapping of shoreline changes will be done using continuous position recording DGPS techniques (Differential Global Positioning System) (accuracy ± 1m) on a monthly basis for a period of 9 months.

ii. Permanent bench marks will be fixed at an interval of 10 km in both the study areas using DGPS.

iii. Estimation of beach volume by beach profile will be made using RTK GPS, 2 km from either side of the accreting area and up to 2 km from either side of the eroding area on a monthly basis for a period of 9 months. Backshore limit is the end of the beach i.e. where settlement/vegetation begins. This technique should aim for an accuracy of +/- 0.02m vertically and for an accuracy of +/- 0.05m horizontally. The survey transects should be at 20 m intervals in zones of high accretion and erosion and at 50m interval at other locations. This could be used in determining volume of beach material lost by erosion and gained due to accretion and to calculate sediment budget. The data collected should be compatible for generation of a DEM.

iv. Grain size analysis of beach material at foreshore, mid-shore and backshore will be done using standard sieves. Samples will be collected on a seasonal basis in all transects of beach profile at a

perpendicular interval of 30-50 m depending on the length of the beach profile transect.

v. Littoral Environmental Observations (wave breaker angle, height, wave direction on shore) will be made using modern compass and other devices (weekly measurements) for a period of 9 months

vi. In Subarnarekha-Rasulpur estuary south, measurement of tides and waves and currents will be made using Wave and Tide recorder and current meters respectively at 5 and 10-meter depth in two boundary locations namely off Subarnarekha and Rasulpur south and off Digha for both 5 and 10 m depths. (Locations for deployment are indicated in Figure2.4.6)

vii. In Rasulpur estuary north of Matla, measurement of tides, currents and wave will be made at 5 and 10-meter depth off Matla river as the boundary and at three locations around Sagar Island. The deployment off Rasulpur south in the former sector will also be used as boundary for the Rasulpur North to Matla river sector (Figure 2.4.6). Monitoring of mean (longshore) currents and wave velocities will be done. Monthly observations will be made in near shore area at a water depth of 3 - 6 m on either side of Digha-Sankarpur using Acoustic Doppler Velocity meter (ADV) (5 MHz).

viii. Bathymetry will be surveyed using dual beam echo sounders within the boundaries of above mentioned two sediment cells from high tide limit up to 25m depth with line interval of 300m at an accuracy of +/ - 0.2m vertically and +/-1m horizontally. Boat-mounted echo-sounding equipment of a reputable brand, corrected for tides and waves, will be employed with GPS horizontal location fixing and random spot-height method will be employed to generate a DTM. Data collected will be compatible for processing using HYPACK software.

ix. Measurement of suspended sediment by collecting water samples, including grain size in rivers, estuaries and creeks etc. will be done up to 2 km inside or more for Hooghly river, along with current measurements at the mouth to calculate sediment flux. Similarly, sediment flux will be calculated at the mouths of Subarnarekha and Rasulpur rivers. The data will be collected for two seasons. SSC data will also be collected in the surf zone and up to 500 from LTL. In addition to that, dredging sediment quantity will be collected from the Kolkata Port Trust (KPT) Authority to understand the behavior changes in the coastal processes and its impact on the shoreline change.

Modelling

Behavioral model will be made on two distinct yet inter-related aspects. The first aspect would consider the historical changes in the coastline of Digha-Sankarpur based on archived maps from 1800s (Figure 2.4.5). The entire watershed of Subarnarekha to the coast will be studied to determine the changes and its influence on coastal erosion at Digha. This will be studied by assessing the changes in land use and land cover until current conditions. The following datasets will be considered:

- Collection of 'old'/ historic maps from 1800s onwards at various time intervals (pre-independence and post-independence to current day)
- Location and construction of dams/ barrages along the watershed
- Area of reservoir
- Shrinkage of the river (if any) and sediment discharge
- Time series discharge of Subarnarekha river
- Time series rainfall
- Changes in Land use
- Changes in Land cover
- Tidal data
- Shoreline change dynamics

Based on the above datasets, the future of Digha-Sankarpur coast will be determined. Further, the same methodology will be adopted for understanding the change status for Sagar Island.

The second type of behavioural model will be through a **Process based modelling** and is used to understand the hydrodynamic environment in the study areas and to analyse the causes of erosion/accretion, and to develop the interventions for minimizing the coastal vulnerability. This process based modelling will be carried out using the suite of Mike 21 Module which contains number of numerical tools such as Hydrodynamic, wave and sediment transport models with collected field data on coastal processes.

Figure 2.4.5 Archived map of Subarnarekha and Matla Rivers in 1827

Shoreline model to understand impact of interventions developed on shoreline changes will be carried out using Mike Litpack/Litline module. This study can be explored more with the use of another numerical tool such as GENCADE. It simulates shoreline change relative to regional morphologic constraints upon which these processes take place. It also assesses the multiple interacting coastal projects and morphologic features and pathways, such as those associated with inlets and adjacent beaches may also be simulated. The model supports responses to imposed wave conditions, coastal structures, and other engineering activity. It also represents the shoreline movement which is produced by beach fills and river sediment discharges. This model simulates the response of shoreline to the structures sited in the nearshore.

Data collection – strategy for collection of secondary and primary data

Data required for preparation of the Shoreline Management Plan include decadal changes on shoreline, extent of loss of coastal land, measures taken to protect the coast, coastal geomorphology, details of natural protection measures that were protecting coast in the past and variation in coastal oceanographic characteristics including changes in wave climate, coastal currents, bathymetry, sediment flow from rivers etc. Secondary sources of data to understand the past trends of shoreline change and factors that were causing erosion and accretion will be obtained from literature, concerned Government department (e.g. Irrigation and Waterways Department, Central Water Commission), Local bodies and Authorities, academic and research institutions. Primary data listed above will be collected by engaging Consultancy firms specialized in collecting data at the locations shown in Figure 2.4.6

Table 2.4.2 Satellite Data Requirements

Historic data	Source	Status/Action
1970s	Spot	To be Procured
1980s	Spot	To be Procured
1990s	Spot	To be Procured
2000	IKONOS	Available @ NCSCM
2003		
2005		
2007		
2009		
2011		
2013	WorldView3	To be Procured
2015	WorldView3	To be Procured
2017	WorldView3	To be Procured

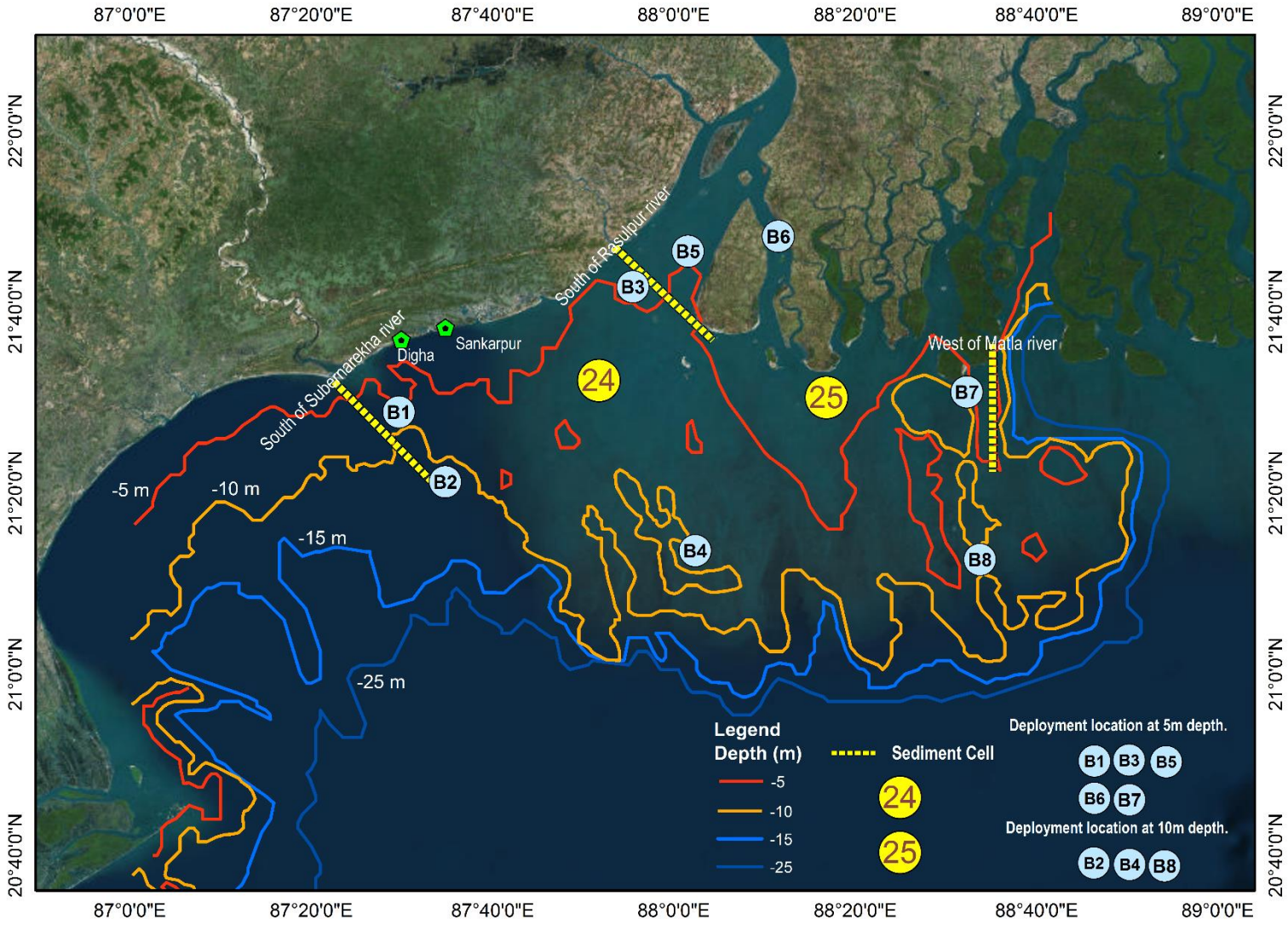


Figure 2.4.6 Locations for deployment of oceanographic instruments

Data requirement for the behavioral model would be offshore wave data, suspended sediment concentration, geomorphological features, land use features, human interventions (seawall, embankment, barrage, breakwater, groyne, jetty) and dredging of navigational channels, if any. The above data, except on human interventions will be collected as part of the primary data collection program for coastal processes study and Land Cover studies. The data on the existing human interventions will be obtained from satellite imageries as well as field surveys.

Data processing and analysis

i. **Shoreline changes**: High Tide Line from Satellite data will be extracted and as obtained from the field measurements will be analysed for extent of changes using DSAS method
ii. **Topography data:** Coastal bathymetry dataset of the study areas will be produced through an exhaustive compilation of field survey data, available nautical charts and river surveys. The processed data in x, y, z format will be brought into the hydrodynamic and wave models of Mike 21 for use in the modelling. To fill up any gap in the bathymetry data, data from C-MAP and GEBCO will be used.
iii. **Wind fields:** European Centre for Medium Range Weather Forecasts (ECMWF) provide wind field data on regional scales having resolution of 12.5 km at every 6h interval from 1975 to present. Wind data collected at the periodic interval of 6h will be fed into the hydrodynamic models for understanding the coastal processes like circulation features and wave characteristics of the study areas.
iv. **Astronomical tides:** *In situ* tidal data collected will be processed for harmonic analysis to estimate the dominant astronomical tide; its amplitude and direction. It also processes to calculate the tidal prism to estimate the water volume in the estuary. This data play vital role to give open boundary conditions for the simulation of flow field environment in the nearshore regions in the hydrodynamic model.
v. **Currents:** Currents data obtained from the deployment of current meters will be processed to analyse the peak currents and form input in the hydrodynamic model of Mike 21 to simulate current in the modelling domain.
vi. **Waves:** Analysis and interpretation of wave measurements must usually be separated into two general routines: short-term statistical

analysis of single wave measurements and long-term statistical analyses of wave measurements representing a longer period. Wave data will be obtained from the *in situ* Wave and Tide gauges and satellite observations on hourly and daily basis respectively. The data will be processed for quality control check using the standard methods. Thereafter, the noisy data will be removed from the collected *in situ* data sets. The data will be used to analyze the power spectrum to understand the wave energy impact on the coast. It will also be used to calculate the return period of the design wave heights to implement the marine structures. This data is also processed to generate the open boundary conditions for the numerical model simulations and for the validation of the model predictions. Theseanalyses have an important influence on the expressiveness of the results and the application of the derived wave information for practical engineering problems.

vii. **Sediment characteristics:** Sediment characteristics are analyzed from the collected field samples in the study areas. The sample analysis will be conducted using a Microtrac particle size analyzer to estimate the sediment size (D_{50}) and its other characteristics. The folk and ward method (ø) will be used to calculate the mean size of the sediment (D_{50}). The spatially available grain size distribution provided from field survey is fed to the model as an input parameter and the simulations will be carried to estimate the sediment transport, suspended concentration and turbidity of the sediments.

Deliverables

The deliverables will be as follows:

- Status of shoreline changes i.e., extent of erosion and accretion
- Secondary and primary data on shoreline changes along with maps in GIS
- Secondary and primary data collected on coastal processes
- Shoreline Management Plan for both Digha-Sankarpur and Sagar Island

Links with other management sub-plans – some examples

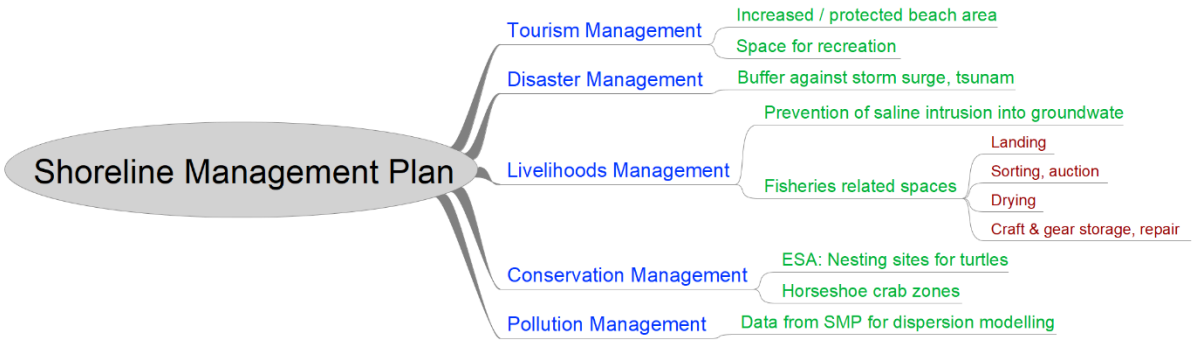


Figure 2.4.7: Potential Links of SMP with other management sub-plans

Photo 6: Livelihood activity in Hooghly River and Estuary

2.5. CONSERVATION MANAGEMENT PLAN

Rationale

Protection of biodiversity and varied habitats is essential for sustenance of all life forms including human beings, but lack of adequate information and data on marine biodiversity and its ecosystem hampers its conservation, management and sustainable utilisation. A comprehensive management plan that looks at the marine ecosystems in a holistic manner is necessary for marine biodiversity conservation. Conservation encompasses protection, preservation, management or restoration of natural environments and ecological communities that inhabit them. In this regard, as part of the larger ICZM plan for West Bengal, a comprehensive sub plan on Conservation Management Plan for the two selected sites Digha-Sankarpur and Sagar Island will be formulated. Towards this objective, the current status of the marine biodiversity in the two sites will be assessed and with the use of conservation planning methodology, conservation of biotic and natural resources will be suggested.

Study Area

Digha-Sankarpur is an Ecologically Sensitive Area (ESA) which includes turtle nesting sites and horseshoe crab habitats and has extensive sandy beaches and is important from a fisheries perspective. Sagar Island has extensive mangroves as it is part of the Sundarbans forest area, and is a recognised Ramsar site. Many sections of the coast are under threat of erosion. In addition, human interventions including beachfront activities and pollution threaten coastal fisheries and living marine resources. Degradation caused due to changes in land use is also a threat to local biodiversity.

Tasks

As preliminary steps towards preparation of the sub plan on conservation, the following tasks will be undertaken-

1. Mapping of the Ecologically Sensitive Areas (ESA)
2. Survey and assessment of the coastal and marine biodiversity
3. Determination of the status of ecosystem health
4. Identification of natural and anthropogenic threats to the naturalresources

5. Development of appropriate plans for conservation and environment management

Plan of Action

The plan of action given below is essentially a series of activities that will be carried out in a systematic manner to complete the five identified tasks.

Task 1: Mapping of the Ecologically Sensitive Areas (ESA)

a. Undertaking spatial mapping of the existing Ecologically Sensitive Areas (ESA) within the study areas (Mangroves, salt marsh, sand dunes, turtle nesting habitats etc.)
b. Identifying degraded areas and its extent

Task 2: Survey and Assessment of the Coastal and Marine biodiversity

a. Documenting the coastal and marine species diversity in the two study areas separately
b. Assessing species richness, evenness etc. by applying biodiversity indices
c. Identification of endangered species or species that are threatened/ vulnerable due to loss of habitat or overexploitation
d. Identification/ Status of a Keystone/Umbrella Species in the area and measures adopted for its conservation

Task 3: Determination of the status of aquatic environment and ecosystem health

a. Determination of ecosystem health by studying productivity, plankton, intertidal and benthic communities
b. Preparation of ecosystem health report cards for Digha-Sankarpur coast and Sagar Island

Task 4: Identification of natural and anthropogenic threats to the resources

a. Understanding the cause of destruction/ degradation to the environment naturally and/ or by anthropogenic stressors (e.g., Developmental activities, clearing for aquaculture, mineral extraction etc.)
b. Ascertain the significant impact on the ecosystem/ habitat and its associated communities

Task 5: Development of appropriate plans for conservation and environment management

a. Stakeholder consultation workshops to take into account the concerns and suggestions of indigenous and other resource dependent communities
b. Plans for conservation and management of ESA, species, habitat based on an Ecosystem Based Management (EBM) approach

Methodology

The broad methodology to complete the activities under the five tasks will be –

Task 1: Mapping of the Ecologically Sensitive Areas (ESA)

1. Identification of Ecologically Sensitive areas – Using maps of MPA and CRZ-1: Criteria for identification of ESA's will be the methodology developed by NCSCM
2. Extent of ecosystems (mangroves, salt marsh, seagrass), habitats (Horse shoe crab, turtle nesting, and bird nesting) and geo-morphological features of sand dunes and mud flats would be identified using satellite images of 2016/2017 of IRS LISS III (23.5 meter resolution) & IV (5.8 m) and LandSAT (30.0 m resolution).
3. ArcMap 10.3.1 and ERDAS Imagine 2015 version software packages will be used as the basic analysis tools for spatial identification and visual interpretation techniques. Secondary data would be used to survey and identify salt marsh at interpreted locations using satellite images
4. Frameworks for data collection and data analysis would be carried out following the methodology developed by NCSCM.

Task 2: Survey and Assessment of the Coastal and Marine biodiversity

Coastal and marine biodiversity comprises of the aquatic and terrestrial environments. As a primary step, secondary data will be collected from species checklists, monographs, research papers and other published works and the primary data will be collected from field surveys. Status of biodiversity will be determined by applying various biodiversity indices like Simpson's index (D) and the Shannon-Wiener index (H) to record species richness, abundance etc.

- Secondary information collected to arrive at a reasonable assessment and to blend with the primary data
- Extent of field data collection to fill the data gap

Task 3: Determination of the status of aquatic environment and ecosystem health

Primary productivity in the surface waters would be measured using light and dark bottle incubation technique (deck incubation). Plankton would be collected using standard plankton nets and preserved for further laboratory analysis. The phytoplankton samples would be collected in 250 ml labelled plastic containers by filtering 20 L of sea water using a phytoplankton net (20 µm).

The samples would be fixed in 4% formaldehyde and stored. The samples would be left to settle for 72 hrs and concentrated to a volume of 10ml by siphoning out the supernatant. 1 ml sample would be taken from the concentrated sample and morphological identification of the phytoplankton samples would be undertaken using a flow cam system. Microphotographs of the sample would be taken and documented. The total number of phytoplankton present in one litre of sea water sample is calculated following the equation:

$$N = \frac{n \times v \times 1000}{V}$$

Where N - The total number of phytoplankton cells per 1000ml of water filtered

n - An average number of phytoplankton cells in 1ml of sample

v- The volume of phytoplankton concentrates

V - The volume of total water filtered

Zooplankton samples would be collected at each location using a conical plankton net (200µm mesh size; 60cm mouth diameter) for 10 minutes equipped with a flow meter by adopting Harris *et al.* (2000). The collected plankton samples would immediately be fixed and preserved in 4% buffered formaldehyde for species identification and enumeration. From the collected samples, aliquots would be made using a Hensen-Stempel pipette upon thorough mixing (Omori and Ikeda 1984) and would be expressed as individuals per cubic meter (ind. m^{-3}).

Coastal/ Marine Biotic components

Table 2.5.1 Methods to assess the coastal/marine Biotic components

Parameters	Methods
Macrobenthos	• Smith McIntyre grab having a bite area of 0.2m^2 would be used to collect deep sea sediment samples whereas as Van Veen Grab of mouth area of 0.05m^2 would be used to collect coastal samples. • Test sieve of 0.5mm mesh size would be used for separating macrobenthos under gently running sea water flow. Once sieving is complete, the organisms and the residual sediments is to be fixed in 5-7% (neutral) formaldehyde containing Rose Bengal stain and stored for further examination. • The sediments would be washed again under tap water and the material preserved in 5% formaldehyde. The organisms would be separated into different taxonomic groups (polychaetes, crustaceans, molluscs and other groups) for further identification. Polychaetes would be identified up to species level. Primarily, the keys of Fauvel (1953) and Day (1967) is used for the identification and supplemented with taxonomic publications (e.g. Fauchald 1977, Maciolek 1985, Imajima 1990a-c, 1992a, b). • Validity and taxonomic status of species would be checked and updated from the World Register of Marine Species (WoRMS, www.marinespecies.org). Other groups would be identified to higher taxonomic levels to the extent possible, with the help of standard taxonomic references and available expertise. Prior to identification, wet weight of each group would be determined using a high precision electronic balance (precision 0.01 mg).
Meiobenthos	Collection and sampling of meiobenthos following Olav Gierre, 1993 (1993, 2009)
Interstitial fauna	Analysis of interstitial fauna would be carried out following Buchanan (1984) - Sediment Analysis: [(In - Methods for the Study of Marine Benthos) and (Modified approach of Priyalakshmi and Menon (2004)]

Parameters	Methods
Macroalgae	Random Quadrat Sampling method – percentage cover estimates for macroalgae (other rocky shore associates would be recorded as well).

Eco-health study will be undertaken with the objective of providing transparent, timely, and geographically detailed assessment with the purpose of rejuvenating a coastal ecosystem. Eco Health provides for a complete picture of the current state of the coastal systems. The information generated helps local Government, policy makers and other natural resource managers to better manage aquatic ecosystems and evaluate natural resource management activities for their effectiveness.

To assess the ecosystem health, a framework for setting objectives, selecting, monitoring and reporting on appropriate indicators that contribute to the overall health of a system. The aim of the Eco-Health program is to provide an integrated approach to ecosystem health monitoring with the following tasks:

- Restoring and maintaining key habitats
- Reducing pollutant loads (sediment and nutrients)
- Improving and maintaining water quality
- Restoring and maintaining key ecosystem processes
- Restoring and maintaining resilient and healthy aquatic communities (i.e. fish populations).

Ecological forecasts of coastal ecosystem will improve the fundamental understanding of role of ecosystems of land-ocean boundary; will help authorities managing the ecosystems with necessary tools for answering 'what-if' questions about coastal environments.

Task 4: Identification of natural and anthropogenic threats to the resources

Both natural and anthropogenic activities impact the health of an ecosystem. Natural calamities such as flood and sea erosion affect the life of the coastal community significantly. Practices such as mechanized fishing, dynamite fishing, untargeted exploitation of marine animals, use of destructive fishing nets, and overharvesting of fish resources are major challenges to the conservation of biodiversity.

To understand the threats to the marine ecosystem, qualitative and quantitative information will be collected and analysed to understand the

causes for the degradation of the coastal and marine resources. All natural and anthropogenic threats will be identified and listed based on the severity. A detailed conservation and management plan will be prepared providing guidelines and mitigation measures for restoration/ rehabilitation of sensitive ecosystems. The broad steps will be -

- Primary and secondary data/information collection to arrive at current level of management
- Assessment of changes in biodiversity, mineral wealth, fishery resources, and geomorphology
- Collections of fish catch data and modelling to arrive at increase/ decline in fishery resources

Task 5: Development of appropriate plans for conservation and environment management

Ecosystem-based management (EBM) is an integrated management approach that goes beyond examining single issues, species or ecosystem functions in isolation and provides sustainable delivery of ecosystem services in an equitable way. It recognizes our ecosystems as a rich mix of elements that interact with each other in important ways. What sets, EBM apart, is its holistic, integrated approach. It seeks to link previously sector-based management and to consider the full range of uses that affect a system. Embarking on EBM entails a strategic and iterative process that occurs in three general phases (UNEP 2010) as follows:

(a) Establishing the foundation for EBM

EBM is established by identifying the key environmental issues in the selected geographical area. Integration of the associated sectors and expansion of the community participation in the EBM approach is to be carried out. It is essential to develop a common understanding of the system and the existing management practices.

i) Planning the EBM approach

- Assessment of the health of the ecosystem
- Evaluation of the regulatory frameworks
- Identify threats to Endemic/ Endangered/ Keystone species
- Strategies for a community based mangrove management

ii) Implementing and adapting EBM

- Periodic monitoring of the changes in the ecosystem
- Afforestation in cleared sites and restoration in the degraded sites
- Setting up of nurseries, wherever needed
- Communicate and educate the plantation techniques

An integrated Ecosystem based management plan involving various components is needed for building resilience into ecosystem conservation. The component of the plans shall focus on understanding of how mangroves will respond to climate changes, what factors help them survive these changes, and, consequently, which species are most likely to survive these changes (Figure 2.5.1).

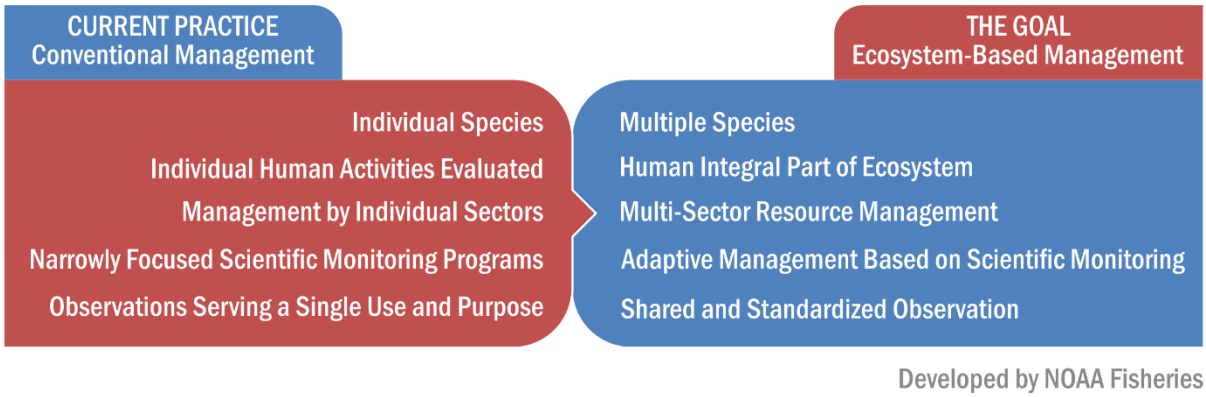


Figure 2.5.1 Ecosystem Based Management - Reasons

Overall, the management plan includes the following common strategies to increase the viability of an ecosystem and its species by enhancing their resilience, though these are often site-specific. A case for mangroves is as follows:

- Apply risk-spreading strategies to address the uncertainties of climate change
- Identify and protect critical areas that are naturally positioned to survive climate change
- Manage human stress on mangroves
- Establish greenbelts and buffer zones to allow for mangrove migration in response to sea-level rise, and to reduce impacts from adjacent land-use practices
- Restore degraded areas that have demonstrated resistance or resilience to climate change

- Understand and preserve connectivity between mangroves and sources of freshwater and sediment, and between mangroves and their associated habitats
- Implement adaptive strategies to compensate for changes in species ranges and environmental conditions
- Develop alternative livelihoods for mangrove-dependent communities as a means to reduce pressure on mangroves (cross-cutting with Livelihood Management Plan)
- Build partnerships with a variety of stakeholders to generate the necessary finances and support to respond to the impacts of climate change

Additionally, the site specific faunal diversity /marine species /fishes will also be considered for case study regarding the climate changes in addition to mangrove species.

Deliverables

a) A comprehensive report containing all data sets (both primary and secondary) in the format as follows:
   - Introduction detailing the need, objectives of the study etc.
   - Existing environmental and infrastructure (including ports &harbours, power plants, industries, structures of archaeology and maritime history) characteristics
   - Area extent of ESA and its type
   - Socio-economic status and trends
   - Major ecosystem goods and services
   - Endangered marine species of the study area
   - Mineralogical resources (rare earth minerals etc.)
   - Coastal communities involved in fishing, aquaculture and agriculture
   - Ecological and socio-economic impacts and consequences
   - Major problems, issues and opportunities
   - Integrated solutions proposed to address the problems, issues etc.,
   - Conclusions and recommendations

b) A sub-section of the report (e.g. Annexure) will give the details of methodology, with the justifications, followed for data collection and analysis. This section would also contain photographs taken during the

study, reference copies of important secondary data collected, sources etc.

c) Maps and drawings in approved scales as notified in EIA and CRZ notifications.

Potential links with other sub-plans

Figure 2.5.2 Potential links with other management sub-plans

Photo 7: Tidal creeks of Bichitrapur mangroves

Photo 8: *Acanthus ilicifolius* along the tidal creeks of Bichitrapur mangroves

2.6. SUSTAINABLE LIVELIHOODS MANAGEMENT PLAN

Rationale

The two plan areas are rural with agriculture and fisheries as the dominant livelihoods. Tourism in both plan areas is another important activity. The primary objective is to assess and quantify the socio-economic and livelihood status for the coastal stretches of Digha-Sankarpur and Sagar Island of Sundarbans, to prepare a sustainable Livelihood Management Plan.

Study Area

Digha-Sankarpur

Digha-Sankarpur Development Authority is responsible for developmental projects and schemes, having a jurisdiction over 42 *mouzas* under Digha P.S. and Ramnagar P.S. covering an area of 8752.63 acres (3501 ha) of land. The area comprises 42 *mouzas* under Contai Sub-division, of which 17 are in Ramnagar P.S. in the east and 25 in Digha P.S. in the west. 5 complete *mouzas* and 21mouzas partly are under CRZ. Digha-Sankarpur area has a population of approximately 47,999 and has a gross density of 6 persons per acre (Census 2011). The coastal region of Sankarpur has nine *mouzas* (Digha, Paypur, Jhawa, Kiagoria, Chandpur, Chapra Sairampur, Balarampur, Sankarpur, and Jamra Syampur) of which five (Digha, Paypur, Jhawa, Kiagoria, Chandpur) falling adjacent to the Bay of Bengal coast. (87° 34' – 35' E — 21° 38'N). The people residing in the region are mainly dependent on fishing, aquaculture, tourism and handicrafts. Digha is the largest fish landing centre of West Bengal. However, Digha's economy is primarily dependent on tourism sector. Sankarpur region is predominantly occupied by agriculture other rural activities.

Sagar Island is the largest island in the Sundarbans of West Bengal and is in the administrative jurisdiction of South 24 Parganas District. It has 6 Gram Panchayats, comprising 9 *mouzas* with 43 villages' (Source: Gangasagar Bakkhali Development Authority). The total land area is 282.11km^2 with a population of 2,12,037 constituting 43,716 households (2011 Census). The population mainly depends on agriculture, fishing, forest resources and tourism for the livelihood. 54.97% of rural households are engaged in daily/agricultural/other labour. 29.45% are cultivators and 3.86% are self-employed rural artisans (HDR, 2009).

An earlier report identified four livelihood zones in the coastal regions of West Bengal (delineating 15 zones overall for West Bengal), based on factors, like climate, population, livelihood practices, poverty, water related issues etc.

Tasks

- Stakeholder and livelihood analysis using sustainable livelihood framework (DFID, 2000)
- Assessment of available resources through PRAs, FGDs etc., and identifying the livelihood related issues and constraints and infrastructure gaps limiting the access and utilisation of resources and needs considering the future development also.
- Preparation of Livelihood zoning map.
- Sourcing and suggesting new livelihood opportunities for adoption as for enhancement, addition and/or as alternative options.
- Evaluation of techno-economic prospects of such livelihood options, from available models.
- Selection and proposal of appropriate indicators for monitoring and evaluation of the progress of livelihood related entry point activities and other interventions for ensuring positive outcome.

Plan of Action

The study would focus on the socio-economic and livelihood status of coastal villages (including details of income sources from fisheries, agriculture, aquaculture, tourism and other activities such as SMEs/ agro-processing/ food processing units etc.). The scope of the work includes collection, collation, compilation and analysis of the representative sampled data of the coastal community to be done *mouza*-wise. From the analysis, an integrated (sustainable) livelihood plan with decision supporting system would be designed to facilitate the implementation of the plan.

a) The DFID Sustainable Livelihoods Framework will be used to understand the status of livelihoods in the Plan Area. The data on the five capitals – Human, Natural, Physical, Social and Financial – will be collected *mouza*-wise to build livelihood profiles. This work will be outsourced to a consultancy firm.
b) Based on the above data, livelihood zoning exercise would be carried out. This will involve mapping the geographical areas within which similar patterns of livelihoods are followed sharing the access to same resources and markets for identifying nearly homogenous livelihood

patterns. This will enable identifying appropriate livelihood opportunities, constraints, impact of market dynamics, intermediaries, opportunity lost/gained and intervention priorities in the respective zone.

c) The study would also highlight the availability of natural resource endowments, potential coastal hazards and risks to coastal communities' *vis-a-vis* livelihood opportunity, assessment of the current and cumulative pressures on the coastal and marine resources, and valuation of the traditional and current resource use and dependence amongst the stakeholders or the community at large.
d) A decision-making framework, for prioritizing management actions in ICZM would be designed. This would be help in making balanced decisions taking into account the trade-offs in land-use options and resource use.
e) Institutions in the Plan area: A study bringing out key features of SHGs and their federations along with other community based collectives engaged in different trade and professions including their: (i) inclusiveness; (ii) governance and accountability features and practices; (iii) functional effectiveness; (iv) credit, financial and non-financial intermediation facilitated including role played in promoting the livelihoods of the members; (v) financial and managerial self-reliance and auditing of accounts; (vi) sustainability features; (vii) relationship with federations and federating units; (viii) relationship with PRIs. This work will be outsourced to a consultancy firm.
f) Livelihood Diversification and Enhancement: Based on the livelihoods profile, recommendations for diversification and enhancement of livelihoods in the plan area are to be proposed. Appropriate indicators for monitoring and evaluation of changes during the implementation of the plan would be proposed.

Methodology

Sustainable Livelihood Framework proposed by DFID (2000) will be used for collecting data on 5 asset categories. The data would include but not limited to the following: -

1. **Human Capital**: Household composition, detailed profile of education levels in male and female, health status, nutritional level, food security, technical skills/ capacities/knowledge-base, on farm and non-farm

based activities including computer literacy, occupational pattern of the household, etc.

2. Natural Capital: ownership and access to land, possession of livestock, access to forest resources, availability of water for drinking, sanitation and other domestic usages, access to fish resources, access to biodiversity, soil fertility, water quality in the *mouzas*, etc.
3. Physical Capital: Different kinds of amenities and infrastructures e.g. schools, health centres, hospitals, water & sanitation facilities, roads, transport facilities, shelter, clean & affordable energy, communication system, extent of farm mechanization, seed / grain bank, vermi compost and biogas plant along with harnessing of traditional knowledge/ good scientific practices, fishing boats &nets, harbours, jetties, post-harvest processing units, markets, etc.
4. Social Capital: Formal/informal community organizations, networks, activities, connectedness, relationship of community trust, level of cooperation enjoyed. Co-operative societies, clubs, etc., (separate focus on SHGs - Male, Female and Mixed Groups).
5. Financial Capital: Size and composition of household savings and level of income generation, household assets fixed and those easily convertible to liquidity, remittances/grants/entitlements, access to credit, wage and self-employment generation, debt/liabilities at the household level, livestock, etc.

Additionally,

a) All livelihood options in tune with coastal and marine ecosystems along with alternative livelihood opportunities would be identified and evaluated. The varied livelihood options related to the fishery (inland and marine) along with other climate resilient farm and non-farm based options would be explored. Extent of development of local markets, cold chains, warehouses, value chains and linkages to markets of the main produce (farm and non-farm) would be assessed.
b) The study also would highlight the availability of natural resource endowments, potential coastal hazards and risks to coastal communities' *vis a vis* livelihood opportunity, assessment of the current and cumulative pressures on the coastal and marine resources, and valuation of the traditional and current resource use and dependence amongst the stakeholders or the community as a whole.

c) Profiling of SHGs and their federations along with other community based collectives engaged in different trade and professions including their: (i) inclusiveness; (ii) governance and accountability features and practices; (iii) functional effectiveness; (iv) credit/financial and non-financial intermediation including the role played in promoting the livelihoods of the members; (v) financial and managerial self-reliance and auditing of accounts; (vi) sustainability features; (vii) relationship with federations and federating units; (viii) relationship with PRIs would be attempted.

d) Livelihood Zoning Exercise: Mapping the geospatial areas within which similar patterns of livelihoods are followed by way of accessing the same resources and markets would be undertaken in order to identify nearly homogenous livelihood patterns.

Data Collection

- Data collection will be made using both primary surveys and secondary sources.
- The surveys will be made in representative sample households in *mouzas*, using appropriately structured questionnaires primarily to collect information from officials/subject experts/NGOs and other relevant institutional resources; and collect information from local people engaged in different livelihood activities.
- The secondary sources for obtaining data and information would be the Census reports, State Line department statistical handbooks and reports, Economic survey reports, plan documents, scientific reports and papers relevant to subject under consideration and also other miscellaneous documents relevant to livelihood status and development as applicable to present preparation of sustainable livelihood management plan document. Attempts would be made to seek information from individuals and community groups working in the area with good understanding of the issues at the ground.

Data Processing &Analysis

Sustainable Livelihood Index (SLI) is a composite index which is determined following the Sustainable Livelihood Framework developed by DFID (2000). SLI is analysed by considering the available assets or capitals which positively influence the livelihoods of people. SLI considers five different capitals/assets *viz*., *human capital, social capital, natural capital, financial*

capital and *physical capital.* Each capital would comprise of different attributes.

Scores would be assigned for different attributes in each capital and the calculation of weighted total will be done. It is assumed that each attribute has equal weightage to the corresponding capitals. For each *mouza*/village in a coastal zone stretch, capital-wise index would be estimated by summing up the weighted total values of all attributes in the capital and converted into the range 0 to 1 by using the following formula:

$$\text{Index value} = \frac{\text{weighted total of the village} - \text{minimum value in the block range}}{\text{maximum value in the block range} - \text{minimum value in the block range}} \ldots\ldots \text{Eq (1)}$$

To estimate SLI, weighted total values of the capital for each village in a Mouza/village would be summed up and converted into index value by using the Eq (1). SLI and capital-wise indices at *mouza*/village level would be determined by taking the averages of the estimated index values for all villages in the respective coastal *mouzas*. For the respective coastal zone stretch, all indices would be determined by taking the averages of respective indices obtained for each *mouza*, within the particular coastal stretch.

By evaluating the index values of capitals, the accessibility of different capitals to the stakeholders in respective *mouzas*/villages can be understood. The low values would indicate poor access to the respective capital and as the values increase more accessibility can be presumed. The perceptions of the local people obtained through the primary surveys (e.g. PRAs, FGDs), regarding the livelihood issues and constraints, infrastructure gaps and the preferences for selected interventions (entry point activities focussed on different livelihood options with the aim to strategize as livelihood enhancement, diversification, addition and/or alternative pursuit) to improve their socio-economic status, would be ranked according to their preferential priority. The access status to different capitals indicated by the capital index values and SLI values would help to determine the capability of the local community. Moreover, this approach would help them to successfully adopting the interventions by addressing the weak capital issues for improvement and taking advantage of the strong capitals endowed with the households/community of the respective *mouza*/village. Based on the data analyses and resulting inferences, the Sustainable Livelihood Management Plan can be prepared with the support of decision matrix tool

designed using the SLI in relation to implementable livelihood options and appropriate recommendations.

Deliverables

- Inception report detailing the proposed methodology, work plan, and outline of the proposed baseline report.
- *Mouza*-wise current livelihood status gathered from surveys.
- Maps based on SLI indices and Livelihood zoning exercise.
- Assessment outcome from livelihood analysis and prepared maps on sustainable livelihood indices (*Mouza*-wise/village wise) for Digha-Sankarpur and Sagar Island coastal zone stretches.
- Identification of appropriate livelihood opportunities, constraints, impact of Market dynamics, intermediaries, Opportunity lost / Opportunity gained may also be considered in assessment of livelihood opportunities and diversifications and associated assessing the risk factors.

Potential Links with other management sub-plans

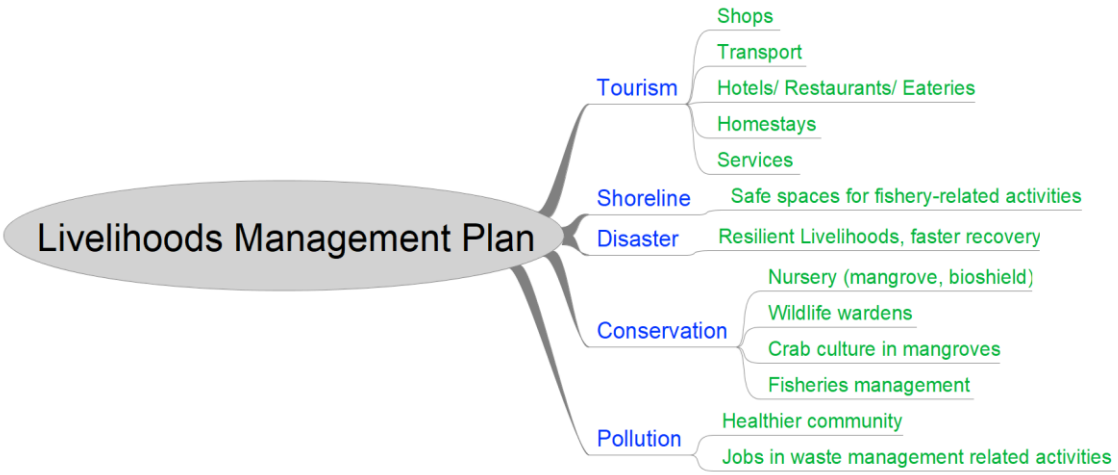


Figure 2.6.1 Potential Link of LMP with other management sub plans

2.7. DISASTER MANAGEMENT PLAN

Rationale

Disaster Management Plans are available at the district level for both locations, the huge tourist influx into the two plan areas makes a DMP for the plan areas essential. The two plan areas are affected by cyclones and periodic flooding; while potential anthropogenic hazards could include, *inter alia*, fire and oil spills.

Study Area

Digha-Sankarpur stretch has beaches and mudflats, Sagar is an island in the Sundarbans. Both areas have faced natural calamities like cyclones, heavy flooding due to seasonal rains, erosion of the coast which increases the impact of storm surges, sea level rise due to climate change etc. Another issue is the huge influx of tourists during certain seasons, potentially increasing the risk of occurrence of hazardous situations such as fires, stampedes and accidents such as ferry capsize (especially in the case of Sagar Island).

Tasks

Plans will have to be developed separately for Digha-Sankarpur and Sagar Island. The Tasks to be carried out include the following:

1) **Hazard-Vulnerability-Risk-Capacity Analysis (HVRC) Analysis:** In Hazard assessments, the different types of hazards (natural and man-made) that are likely to affect the plan area are listed. Rainfall (days, maximum, trends) values are examined to understand potential floods. The seismic location of the plan area is obtained to determine probability of earthquake hazards. Tsunami models are used to locate areas that are likely to be impacted due to tsunami. In case of man-made hazards, the potential hazards that are likely to affect the plan area including fire, accidents (during transportation, industrial accidents etc.), oil spills etc. are listed. These are especially of concern because of the large floating population during the tourist season (Figure 2.7.1).

2) In Vulnerability Analysis, the physical, environmental and social vulnerabilities are determined. Under the physical aspects, availability of housing, cyclone shelters etc., is assessed. Under the environmental

aspects the distance from shore/ embankments; the status of the beach/ mangroves/ bioshields etc., are examined while under socio-economic, the status of the population (current population based on the projection from senses of 2011 and decadal growth) in terms of their incomes, livelihoods etc., are assessed.

3) Risk Assessment looks at the worst case experience to understand the area and infrastructure under risk. Maps indicating areas of risk are prepared and evacuation routes will be suggested.

4) Under Capacity Assessment, the access and status of early warning systems as well as access to services including financial services in a post-disaster scenario are examined.

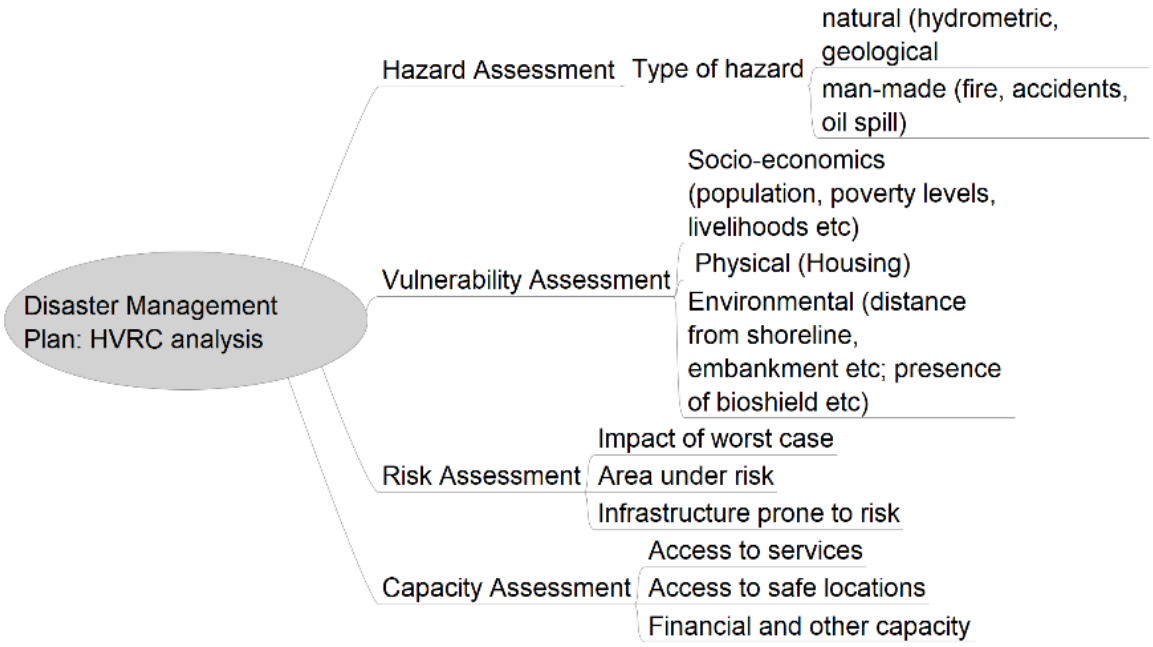


Figure 2.7.1 HRVC Analysis

Plan of Action

The Disaster Management Plan will be prepared based on the guidelines from the National Disaster Management Authority for the preparation of DMP. The disaster management paradigm has shifted from being response-centric to being preparedness-centric. Disasters are also times of chaos when quick action is required. Hence the disaster management plan will focus on capacity building and last mile connectivity in terms of early warning systems. The main objectives of the DMP are as to:

- ascertain the status of existing resources and facilities available with the various agencies involved in the management of disaster in the plan area
- assess their adequacies and shortfalls, if any, in providing a multi-disaster response
- suggest institutional strengthening, technology support, up gradation of information system and data management for improving the quality of administrative responses to disaster at the district level and finally, evolve a Multi Hazard Disaster Management Plan as an effective managerial tool for the plan area

Methodology

Data will be collected on the various required parameters largely from secondary sources to which appropriate value addition will be made (such as mapping, modelling). In addition, primary data will be obtained through specific structured and unstructured focus group discussions, key informant interviews and select household surveys (some of this will be drawn from the data to be collected for livelihood analysis as well as shoreline management, tourism management and conservation management). A third source of information will be the land use maps. Information with respect to early warning systems, response mechanisms, SOP etc., will be collected from the state and district DMP as well as the WBSDMA and local authorities.

Based on the above, Vulnerability profiles of high risk locations based on historical information and modelling will be prepared. The current disaster management plan will be analysed and the location, status and adequacy of EWS (especially last mile connectivity) and cyclone shelters as well as action plans will be evaluated. Recommendations and Strategy for action will also include links with various other plans to develop disaster resilience.

Deliverables

- Assessment on prevalence of various types of hazards and damages caused to various sectors in the past
- Multi-hazard maps containing essential aspects like 0.5m and 1m contour intervals, land use, land cover, resources, shelters etc. along with appropriate numbers of scenarios prepared using GIS
- Propose evacuation routes in case of disaster

- Assessment of vulnerability to various sectors, resources, livelihood sectors and estimated damages to each sector and pertinent maps for each scenario prepared in GIS
- Disaster management plan

Potential links with other management sub-plans

Figure 2.7.2 Linking DMP with other management sub-plans

Photo 10: Erosion control measures at Sagar Island

2.8. TOURISM MANAGEMENT PLAN

Rationale

The Digha-Sankarpur and the Sagar Islands receive heavy tourist influx especially for its scenic beaches and religious purposes but if tourism is not managed well, it can lead to rapid degradation of the area in the long run. Thus, it is imperative to preserve and manage the tourism sector through a well thought of plan which can both aid in the preservation of the natural beauty and resources of the area and also support to sustain the local livelihoods. The main objective of the tourism management plan is the balanced management of the existing tourism activities and their proposed development in a sustainable manner incorporating ecological, environmental (including heritage structures) resources and social concerns.

Study Area

a) **Digha** - Digha in East Medinipur district is a major coastal tourist attraction of West Bengal., receiving nearly 43% of the tourist flow of the State. About one lakh foreign and about 25 lakh domestic tourists visit Digha annually. Amongst the tourists, a large number are day visitors belonging mostly to middle and low income groups. For these day tourists there is only one facility at Digha (Khanika). Infrastructural facilities and civic amenities are limited in Digha, New Digha and Sankarpur. There are a large number of budget hotels, star accommodation available in Digha, New Digha and Sankarpur. Beaches located along the Digha-Sankarpur coast are the primary tourist destinations (Figure 2.8.1).

b) Coastal erosion and construction of structures to prevent coastal erosion has resulted in reduced accessibility to the Digha coast and loss of natural beauty. The beaches have also become dangerous in some stretches especially during high tides during late monsoon when surging water suddenly cut off all escape routes for people who have inadvertently strayed into beach. In spite of all these draw backs, Old Digha, New Digha and Sankarpur have tremendous potential to attract a large number of tourists if an integrated (development) management plan is drawn up and implemented.

c) The list of tourist places along the stretch between Digha and Sankarpur are as follows:

- New Digha
- Marine Aquarium
- Amaravati Lake
- Shiva Temple, Chandaneswar
- Sankarpur
- Tajpur
- Mandarmani
- Junput

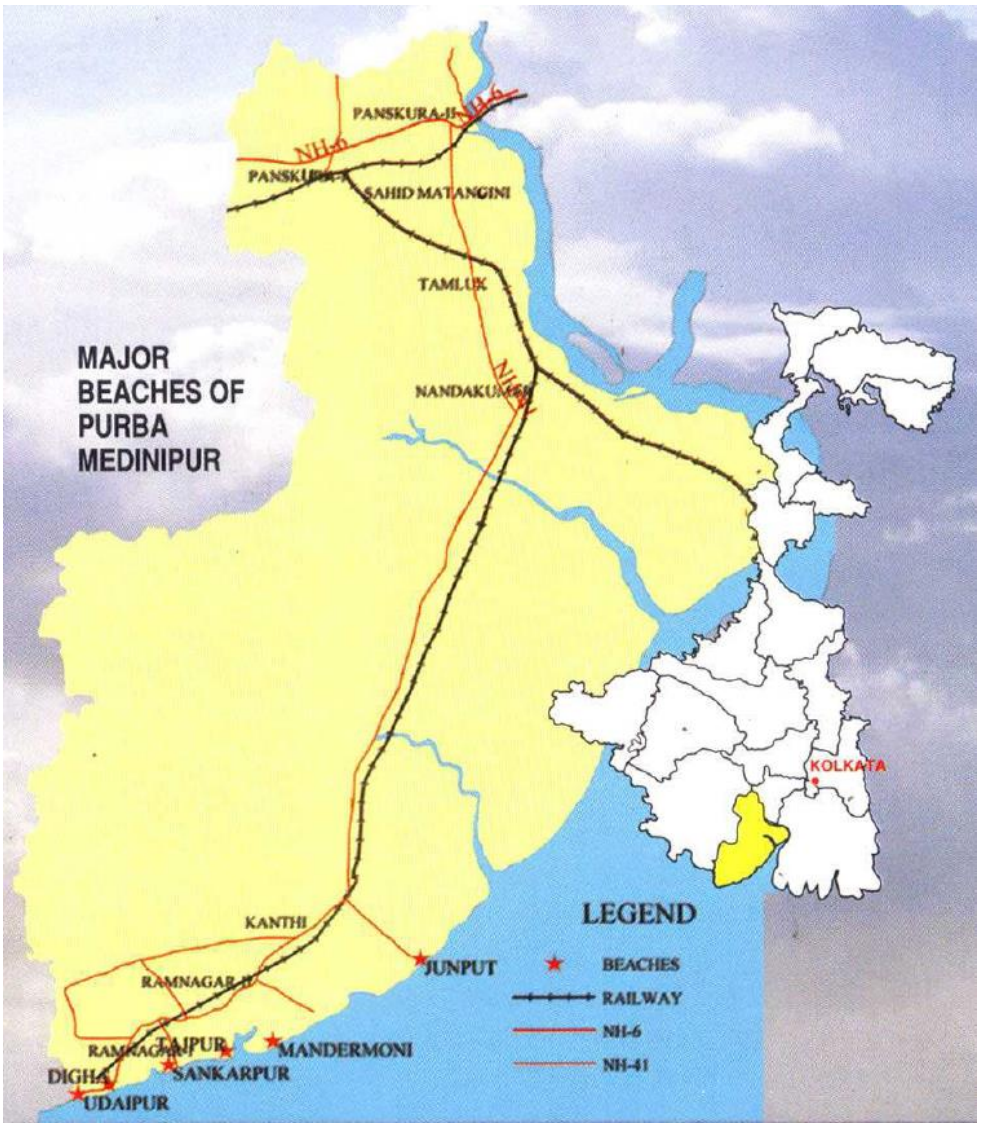


Figure 2.8.1Location of beaches along the Digha – Sankarpur Coast

d) **Sagar Island:** Sagar Island is an island in the Ganges delta, lying on the continental shelf of Bay of Bengal about 100 km (54 nautical miles) south of Kolkata. The island has an area of 224.3 km², lying between 21°36' to 21°56' north latitude and 88°2' to 88° 11' east latitude. It has 43

villages and a population of over 160,000. This island, also known as Gangasagar or Sagardwip, is a place of Hindu pilgrimage. Every year on the day of Makar Sankranti (14 January), hundreds of thousands of Hindus gather to take a holy dip at the confluence of river Ganges and Bay of Bengal and offer prayers (puja) in the Kapil Muni Temple. From Kolkata, Diamond Harbour Road (NH-117) runs south around 90 km to Harwood Point, near Kakdwip, where a ferry runs to Kachuberia at the north end of the island. The ferry travels about 3.5 km across a distributary of the Ganges River (also known as Hooghly River or Muriganga River locally) to reach Kachuberia. Small boats also cross from Harwood Point to Kachuberia. Private cars and buses travel the roughly 32 km to the pilgrimage site at Sagardwip.

Tasks

The broad tasks to be undertaken to complete the tourism management plan will be -

i. ***Description of the area*** in terms of infrastructure, ecology, resources, environment, nature of development, socio-economics and existing types of tourism activities and their scale of operation with their multiple benefits to economy and the dependent population.

ii. ***Assessment of involvement of local communities in tourism*** and evaluation of livelihood diversification requirements (e.g. capacity building, microfinance) for local communities to support their involvement in sustainable tourism activities

iii. ***Assessment of existing level of coastal tourism;*** related ancillary developments and their impact on ecology, environment, resources and socio-economics of the region

iv. ***Determination of Carrying Capacity of Tourism*** for the ICZM sites with respect to resources, livelihood activities etc., that are likely to be affected and evaluating whether the current levels of activities are within the carrying capacity or exceeded. Determination of possible allowances for scaling up of existing activities in case capacity is available or determination of the extent to which the scale of activities is to be reduced where the capacity has been exceeded.

v. ***Preparation of an integrated management plan*** to develop/regulate tourism activities incorporating identified concerns of ecology, environment, resource depletion and socio- economics, keeping in

mind, future challenges due to issues such as climate change and sea level rise impacts in the plan areas.

vi. ***Recommendation and monitoring mechanisms*** considering existing institutional arrangements, regulations, laws related to environment, forest, CRZ, pollution etc.

Methodology

Internationally, the widely accepted method for sustainable development and management of tourism is developing the tourism and related activities based on 'Carrying Capacity Study' (CCS). It helps in assessing the capacity of ecology, resources, environment and society to absorb the negative impacts caused by tourism without having adverse effects on these vital sectors. This allows defining the extent of tourism activities that could be permitted on a long-term basis and ensures sustenance of all sectors. Upon its successful implementation and functioning, it should assure longevity in employment and earning opportunities to the dependent population, besides simplifying the management tasks relating to tourism. Therefore, the Plan subsumes CCS within the ICZM planning process for sustainable development of coastal tourism. The essential elements of the study include:

i. Description of area, infrastructure, ecology, environment and living standard of the community; existing types of tourism, benefits to local area, revenue earned and current employment level (especially of local communities). This aspect is termed as "Coastal Tourism Profile".

ii. An indicative list of data are : type of tourism, resources, trade and transportation, ecological habitats, history of hydro-meteorological events, number of tourists, other public facilities available, waste generated and method of waste disposal (solid wastes – biodegradable, non-biodegradable; liquid wastes), resources utilized by tourism, water availability, quality and demand versus supply, land use and land cover and socio-economics.

iii. SWOT analysis of current status of tourism will provide information on the reasons for high tourist influx in the plan area and the nature of problems, threats, risks, issues and concerns that exist currently. A plan can consequently be made to assess future growth requirements along with ancillary developments with definition of thresholds and desired levels.

iv. Stakeholder consultations on impact of current level of tourism and inviting opinions about suitable tourism and related activities for existing and planned locations as well as a strategy for participation in tourism related activities
v. Defining goals and prioritizing the tourism related activities
vi. Determination of carrying capacity of the above sectors to accommodate identified and current level of tourism activities
vii. Assessment of revenue potential and preparation of action plan for maintenance of existing and proposed tourism infrastructure including heritage sites, natural scenic sites, beaches and other attractions
viii. Preparation of an integrated coastal tourism management plan containing suggestion of strategies for reduction/alternative tourism to existing ones in case of negative impacts and extent to which the newly identified tourism activities can be carried out in an integrated manner without causing any adverse effects on nature, resources, socio-economics other sectors.
ix. Stakeholder consultation on the draft plan
x. Identification of capacity building requirements specially to involve local communities through livelihood diversification/enhancement (e.g. training as guides, lifesavers along the beach, handicrafts using local resources, business empowerment etc.)
xi. An action plan to ensure that the tourism related activities do not cause adverse environmental impact. This will include public awareness programmes as well as guidance and awareness for tourists regarding appropriate behaviour in tourist areas
xii. Recommendation of an implementation mechanism along with institutional arrangements taking into account adequacy of existing rules and regulations.
xiii. Recommendation of a regular monitoring, assessment and enforcement mechanism for ensuring sustainable coastal tourism
xiv. Cross-cutting with other management sub-plans such as Livelihood, Disaster, Conservation and Shoreline management plans

Data Collection & Analysis

Following is the brief list of secondary data that would be collected:

1. Tourist footfall (20 years)
2. Accommodation facilities (Number of hotels, resorts, lodges etc., with bed capacity)

3. Existing and proposed infrastructures
    a. Road network, Connectivity
    b. Parking, toilets,
    c. Medical facilities,
    d. Tourist Information Centre,
    e. Watch tower in beach areas,
    f. Drinking water,
    g. Solid waste management,
    h. Sewage waste management,
4. Activities in tourist spots (swimming, boating, water sports, religious etc.)
5. Existing tourism policies
6. Existing tourism development plan
7. Proposed development plan for tourism
8. Potential areas for tourism development

Tentative model for carrying out tourism management plan is represented in the Figure 2.8.2 below:

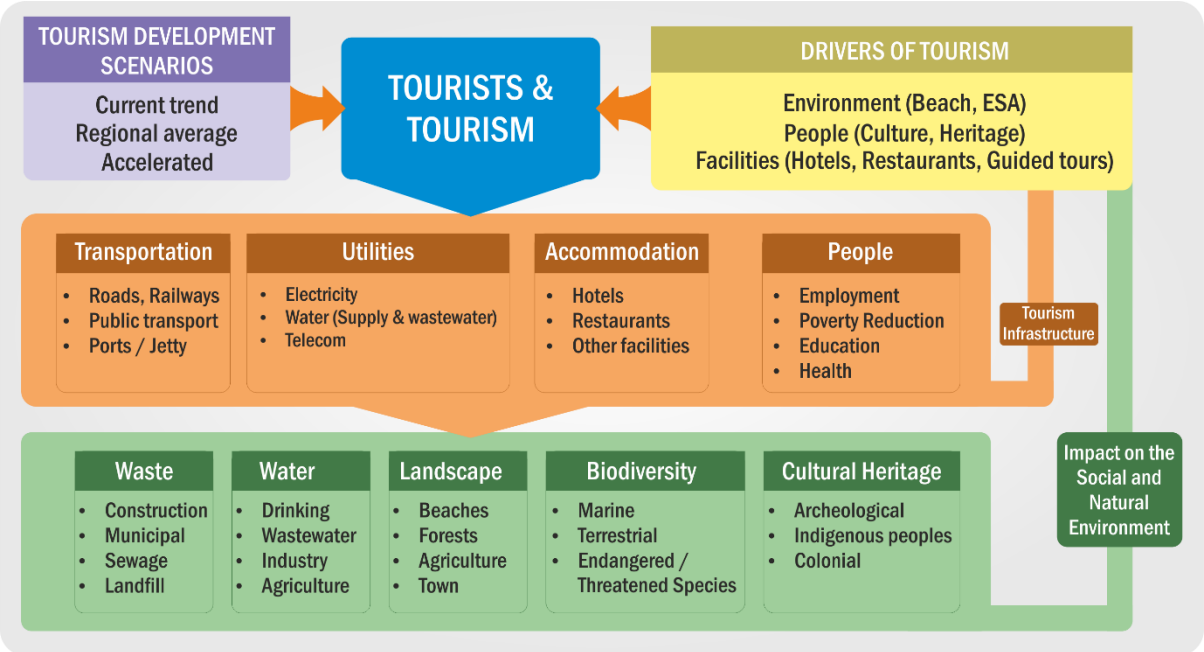


Figure 2.8.2 Tentative model for carrying out tourism management plan

Deliverables

1. Report on coastal tourism describing the area and its multiple features, existing activities and problems
2. Report on assessment of impact of tourism on coastal ecology, environment, resources and socio-economics

3. Report on revenue potential and maintenance plan for existing and proposed tourism infrastructure for sustainable tourism.
4. Report on Carrying Capacity of tourism for the area selected
5. Draft Integrated management plan for coastal tourism
6. Final Integrated management plan for coastal tourism
7. Primary and secondary data collected, maps etc., in digital and hard copies

Potential Links with other Management Sub-Plans

Figure 2.8.3 Linking Tourism Management Plan with other management sub plans

2.9. POLLUTION MANAGEMENT PLAN

Rationale

Management of pollution directly contributes to environmental protection and conservation, and is one of the key aspects in Integrated Coastal Zone Management. It involves adoption of series of steps ranging from sources of pollution, its current status and assessment of its impact on ecology and socio-economics, measures taken to treat the wastes, prediction of trend of key pollution parameters for the future and determining solutions to ensure that the levels of pollutants do not exceed the acceptable or safe limits, assessment of existing policy, legislations and institutional mechanisms to deal with pollution and evaluation of their adequacy and suggestions for amendments to achieve best possible control of pollution.

The *Pollution Management Plan* intends to address the issues pertaining to the solid waste and water quality management in the two planning sectors (a) Digha-Sankarpur and (b) Sagar Island. The two sites comprise of both semi-rural and rural areas. Digha - Sankarpur stretch is a popular tourism destination with floating population from different parts of the country round the year. Sagar Island is associated with cultural tourism as the Ganga-Sagar is considered as auspicious place for Hindus. More than 20 lakhs pilgrims visit the Ganga Sagar during Makar-Sankranti. Significant quantity of waste (solid waste and sewage) from household and commercial establishments is generated. These wastes often find their way to the coastal waters without proper treatment, thus posing severe threat to environmental health.

Significant quantity of sewage discharge to the Digha coastal waters has been reported in various research publications. Since it is a tourist place, sewage is mainly generated from residential houses and commercial outlets like hotels and guest houses. The wastes are mainly organic in nature containing carbon, nitrogen and phosphorous among others with a relatively high concentration of microbes. The untreated sewage from all the sources discharged into the sea is estimated to be around 2.0 million litres per day (MLD). In addition to that, considerable quantities of toxic substances were released into the coastal waters through non-point sources such as discharges from fishing vessels and trawlers and runoff from adjacent landmasses. In order to improve the sanitation, hygienic condition and

coastal water quality of the Digha, a sewage treatment plan with 6.7 MLD capacity (for the projected population in 2025) is being constructed under the Integrated Coastal Zone Management (ICZM) Project funded by the World Bank. However, the efficacy of the plant in the reducing the sewage pollution has not been assessed yet. However, assessment of physicochemical characteristics in these coastal waters indicated that the levels of dissolved oxygen (DO), biological oxygen demand (BOD), total dissolved solid (TDS) and nutrients were within the permissible limit (Selvin *et al*, 2016).

Similarly, the environmental condition of Sagar Island is influenced by various industrial and anthropogenic activities in the upstream areas. Additionally, local activities in fish landing stations, tourism destinations, domestic sewage etc., have also been identified as the major threats to the coastal environment here. These activities promote the increase in the inorganic and organic pollution load in the surrounding water bodies. Under the implementation of environmental infrastructure and programs by Sundarban Infrastructure Development Corporation Ltd at the seafront, several temporary toilet blocks with leach pit based onsite treatment have been constructed.

However, a comprehensive solid waste management plan for the island is not available yet. The closest STP for Sagar Island is the South Suburban East STP in the Kolkata Municipality area, at a distance of around 110 km. Considering high user load and production of domestic solid waste (including during the pilgrimage time at Ganga Sagar mela), comprehensive solid waste management plan for the island is essential. Additionally, limited information is available on the ground water quality of the study area.

Plan of Action

Development of the Pollution Management Plan will be based on:

i. Assessment of solid waste management issues and providing a long-term solution to solve the problem
ii. Assessment of current status of coastal water quality, prediction of their trends for the future and suggest Waste load allocations appropriately to achieve/maintain accepted water quality in the planned sectors

This will include the following:

Solid waste Management

Assessment of quantity and types of solid waste generated, present mode of disposal and other treatment procedures adopted; and suggestions for better management of solid wastes.

Water quality management

i. Assessment of the current status of sources of pollution, load and their levels in coastal water bodies and impact of water quality on resources, aesthetics and socio-economics. Secondary and primary data on pollution and related parameters will be collected for this purpose. A list of parameters on which data will be collected is given in Table 2.9.1 and Table 2.9.2
ii. Determination of designated use and fixing of ambient water quality criteria
iii. Collection of data relating to pollution load from domestic and industrial sources and their impact on resources, aesthetics and socio-economics through field programmes around the coastal water bodies and in the coastal waters
iv. Prediction of pollution especially for DO, BOD, ammonia, nitrate, phosphate, silicate, microbes (e.g. *Streptococcus faecalis*) and one or two industrial pollutant against various load conditions through modelling techniques
v. Prescription of ideal waste load allocation to ensure safe seawater quality and specifying reduction of load along with quantity where it is exceeding
vi. Development of a water quality management plan

(a) *Water Quality*

In situ measurement of water physico-chemical parameters such as (temperature, transparency, salinity, pH, DO) would be carried out for surface and bottom water. For chemical analysis, water samples collected in 1 lit bottle would be kept in ice chest until transfer to the laboratory. The water quality parameters would be analysed using standard methods as mentioned in Table 2.9.1.

Table 2.9.1 Selected water quality parameters and methodologies

Parameters	Methods
Physico chemical parameters (Temperature, Transparency, Salinity, pH, DO)	*In situ* measurement using Hydrolab Sonde
Dissolved nitrite, Dissolved nitrate, Ammonia (as Ammonium), Silicate, Total Nitrogen, Total Phosphorus	Spectrophotometric analysis using Continuous flow analyser (SKALAR)
BOD COD	Grasshoff, *et al.* 1999, APHA 2005
Fecal microbes	USEPA Method 1680
Total Petroleum Hydrocarbons	Hydrocarbon Analyzer
PAHs in water	Solid phase extraction (SPE) system from water (EPA methods 3535A)
Heavy metals – Zinc, Manganese, Cobalt, Chromium, Arsenic, Copper, Cadmium, Lead	

(b) Sediment Quality

Surface sediments would be collected at various locations. Grab samples would be used to collect the bed sediments during the transect studies. The collected sediments would be stored in zip lock bags and air dried in laboratory. The analysis of various physico-chemical parameters would be carried out as mentioned in Table 2.9.2

Table 2.9.2Sediment quality parameters and respective methodologies

Parameters	Methods
Texture (sand, clay and silt)	Sediment grain size analysis using sieve shaker and laser particle size analyser
Total Organic Carbon	Elemental Analyser
Heavy metals – Zinc, Manganese, Cobalt, Chromium, Copper, Cadmium, Lead and Mercury	Tri acid (Aqua regia and HF) digestion (USEPA Method 3050) and analysed in AAS For Hg, the measurement would be done using Cold vapour techniques (USEPA Method 245.1)

(c) Coastal and Marine Biota

Plankton would be collected using standard plankton nets and preserved for further laboratory analysis. Chlorophyll-a and phaeophytin would be estimated by filtering 250 ml of sea water, followed by estimation using a

Spectrophotometer. The phytoplankton samples would be collected in 250 ml labelled plastic containers by filtering 20 L of sea water using a phytoplankton net (20 µm).

The samples would be fixed in 4% formaldehyde and stored. The samples would be left to settle for 72 hrs and concentrated to a volume of 10ml by siphoning out the supernatant. 1 ml sample would be taken from the concentrated sample and morphological identification of the phytoplankton samples would be undertaken using a flow cam system. Microphotographs of the sample would be taken and documented. The total number of phytoplankton present in one litre of sea water sample is calculated following the equation:

$$N = \frac{n \times v \times 1000}{V}$$

Where N - The total number of phytoplankton cells per 1000ml of water filtered

n - An average number of phytoplankton cells in 1ml of sample

v- The volume of phytoplankton concentrates

V - The volume of total water filtered

Zooplankton samples would be collected at each location using a conical plankton net (200µm mesh size; 60cm mouth diameter) for 10 minutes equipped with a flow meter by adopting Harris *et al.* (2000). The collected plankton samples would immediately be fixed and preserved in 4% buffered formaldehyde for species identification and enumeration. From the collected samples, aliquots would be made using a Hensen-Stempel pipette upon thorough mixing (Omori and Ikeda 1984) and would be expressed as individuals per cubic meter (ind. m^{-3}).

(d) <u>*Coastal/ Marine Ecology*</u>– various methods that will be used to assess the coastal and marine biodiversity is highlighted in Table 2.9.3

Table 2.9.3Methods to assess the coastal/marine ecology

Parameters	Methods
Macrobenthos	• Smith McIntyre grab with a bite area of 0.2m^2 would be used to collect deep sea sediment samples whereas Van Veen Grab of mouth area of 0.05m^2 would be used to collect coastal samples. • Test sieve of 0.5mm mesh size would be used for separating macrobenthos under gently running sea water flow. Once sieving is complete, the organisms and the residual sediments is to be fixed in 5-7% (neutral) formaldehyde containing Rose Bengal stain and stored for further examination. • The sediments would be washed again under tap water and the material preserved in 5% formaldehyde. Polychaetes would be identified up to species level. Primarily, the keys of Fauvel (1953) and Day (1967) is used for the identification and supplemented with taxonomic publications (e.g. Fauchald 1977, Maciolek 1985, Imajima 1990a-c, 1992a, b). • Validity and taxonomic status of species would be checked and updated from the World Register of Marine Species (WoRMS, www.marinespecies.org). Other groups would be identified to higher taxonomic levels to the extent possible, with the help of standard taxonomic references and available expertise. Prior to identification, wet weight of each group would be determined using a high precision electronic balance (precision 0.01 mg)
Meiobenthos	Collection and sampling of meiobenthos following Olav Gierre, 1993 (1993, 2009)
Interstitial fauna	Analysis of interstitial fauna would be carried out following Buchanan (1984) - Sediment Analysis: [(In - Methods for the Study of Marine Benthos) and (Modified approach of Priyalakshmi and Menon (2004)]

Macroalgae	Random Quadrat Sampling method – percentage cover estimates for macroalgae (other rocky shore associates would be recorded as well). http://www.salemsound.org/mis/misquadrat.htm

Data Collection & Sampling Strategy

Secondary data collection

Secondary data will be collected from PWD, WBPCB, CPCB, Digha-Sankarpur Development Authority, Gangasagar Bakkhali Development Authority, State health department, Sundarban Infrastructure Development Corporation Ltd etc.

i. Collection of data on solid waste generation, transport and treatment and Point and non-point sources of aquatic pollution, types of pollution along with other details
ii. Current status of solid waste management and suggestions for best practices proposed to be adopted for better management through a solid waste management plan
iii. Current status of water quality/coastal sediments in terms of BOD, DO, nutrients heavy metals, organic chemicals and pathogenic bacteria in estuaries, creeks and other tidal water bodies and in coastal waters, based on secondary data.
iv. Determination of designated use and fixing of ambient seawater quality criteria proposed to be used and suggest draft designated use of coastal waters.

Sampling and primary data collection

i. Collection of data on pollution and related parameters for 2 seasons (pre-monsoon, and post-monsoon) in water bodies connected to the sea as well as in the coastal water
ii. Obtaining of data on physical oceanographic parameters required for Hydrodynamic and water quality modelling from Shoreline Management Programme.

Methodology

i. Analysis of data to assess current status of surface and ground water quality (Grasshoff, *et al*. 1999, APHA 2005) and load of pollutants.

ii. Construction of hydrodynamic and water quality models to determine waste load allocation. Determine coefficients required to simulate the stipulated parameters.
iii. Determination of threshold waste load allocation for stipulated parameters for each designated use.
iv. Current state of water quality against the present load
v. Evaluation of the existing waste disposal standards of corresponding chemicals and suggest modifications to achieve the reduction of load
vi. Preparation of a Solid waste and Water quality management plan encompassing the above aspects with suggestion of post- project monitoring arrangements.

Deliverables

The Pollution Management Plan will have the following deliverables –

i. The current status of environmental quality in the two sites
ii. Issues pertaining sewage and solid waste generated in the two sites
iii. Details of the ecological stress created due to the waste generated
iv. Recommendations for the management of pollution

Potential Links with other management sub-plans

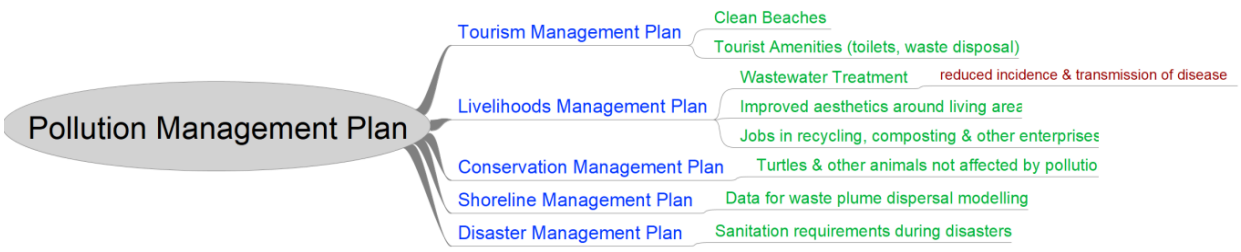


Figure 2.9.1 Linking Pollution Management Plan to other management sub plans

3. IMPLEMENTATION STRATEGY

3.1. PROJECT IMPLEMENTING PARTNERS

The West Bengal State Project Management Unit (WB-SPMU) and the National Centre for Sustainable Coastal Management (NCSCM) will work together for the preparation of the ICZM Plan. The WB-SPMU will ensure necessary permission and other formalities towards carrying out the assignment by the NCSCM. WB-SPMU will facilitate conducting field and lab studies at pilot sites in West Bengal.

The two Consultancies related to "Coastal Process Study (Data Collection)" and Socio-economic Study (Data Collection)" will be procured by SPMU as per the agreed terms and ToR. NCSCM will assist WB-SPMU in technical matters regarding selection of Consultancies required for Coastal Process Study, Sample Survey & Ground truthing of Land Cover data and Socio-Economic Data collection. SPMU will be responsible for ensuring delivery of output in time bound manner from the outsourced consultancies. NCSCM will provide assistance to SPMU in periodic assessment and review of the performance of the external/outsourced Consultancies. NCSCM will undertake Ground truthing Sample survey and collection of primary data regarding Land Cover data.

Additionally, a separate team will work on primary and secondary data relating to Land Use pattern and changes in the two pilot ICZM sites, which will be used for disaster management and tourism management in addition to other management sub-plans, where deemed essential.

3.2. PARTICIPATION OF STAKEHOLDERS

Stakeholders refers to “an institution, organisation, or group that has some interest in a particular sector or system”. In the context of coastal areas, stakeholders include government departments that are involved in the implementation of projects such as the Fisheries Department, Public Health Engineering Department, Tourism Department, Environment Department etc.; Non-governmental organisations who may assist in the implementation of projects or serve as a link between the government and the community, landowners, Businesses situated in the coastal area as well as universities,

scientific institutions, and other educational entities. The roles played by the different stakeholders are given in Table 3.2.

Table 3.2 Roles of Major Stakeholders in Integrated Coastal Management[5]

Stakeholders	Roles
Coastal/ocean users – e.g. fisheries, tourism development and recreation, aquaculture, military, shipping and port operations, mining, subsistence activities, and offshore oil operations	• Articulate their special needs and concerns regarding coastal ocean space and resources • Ensure stewardship of coastal ocean space and resources
Non-governmental Organizations (NGOs) and CBOs – e.g. local and international environmental NGOs women's organizations, religious groups, , and youth groups	• Organize the community • Work with citizens to assess their main priorities and needs • Conduct community education programmes • Provide feedback to government agencies • Monitor and manage resources • Act as public advocates • Provide extensive local knowledge about the quality and quantity of coastal resources and trends in their use
Landowners	• Ensure stewardship of land and special habitats • Avoid erosion, floods and disasters How?
Businesses situated in or near coastal areas	• Provide capital for development projects, facilities and equipment • Provide investments that lead to employment opportunities • Pay taxes that can be used to help finance coastal management
Users of coastal and upland resources – e.g. agriculturists, foresters, loggers, and miners.	• Adopt sustainable, environmental benign soil management and water allocation practices
Universities, scientific institutions, and other educational entities	• Raise public awareness through outreach activities • Provide data and information for making informed management decisions • Develop special education and training programmes at all levels • Serve as advocates for rational, scientifically based management of ocean and coastal resources

Table 3.3 gives an overview of the stakeholder matrix for Preparing the ICZM Plan-West Bengal while Table 3.4 gives a detailed list of the different departments and their potential role in preparing the ICZMP.

[5] Roles of Major Stakeholders in Integrated Coastal Management. https://www.gdrc.org/oceans/ocn-stakeholder.html

Table 3.3: Overview of Stakeholders for ICZMP in the two pilot sites

S. No.	Stakeholder(s)
1	WBSPMU
2	NCSCM
3	State Govt. Line Departments
4	State Undertakings/ Agencies
5	Plan area
	Dish-Sankarpur Development Authority (DSDA)
	Gangasagar Bakkhali Development Authority (GBDA)
6	Local communities of
	Digha
	Sankarpur
	Gangasagar
	Bakkhali
7	Academic Institutions
8	Non-Governmental Organizations

Table 3.4: Stakeholders: West Bengal State Line Departments

Department	Potential Role			
	Direct/ Primary	Indirect/ Secondary	Capacity Building	Support
Agriculture				
Disaster Management and Civil Defence				
Environment				
Finance				
Fire and Emergency Services				
Fisheries				
Food and Supplies				
Forest				
Health and Family Welfare				
Higher Education, Science & Technology and Biotechnology				
Housing				
Irrigation and Waterways				
Industry, Commerce and Enterprises				
Mass Education Extension & Library Services				

Department	Potential Role			
	Direct/ Primary	Indirect/ Secondary	Capacity Building	Support
Micro Small and Medium Enterprise and Textiles				
Panchayat and Rural Development				
Planning, Statistics & Programme Monitoring				
Power and Non-Conventional Energy Sources				
Public Health Engineering				
Public Works				
Self Help Group and Self Employment				
Sundarban Affairs				
Technical Education, Training & Skill Development				
Tourism				
Transport				
Urban Development and Municipal Affairs				
Water Resources Investigation and Development				
Women and Child Development and Social Welfare				

Stakeholder interactions will be held throughout the project period at different levels. At the State Level, the Inception Workshop was the first formal Stakeholder Interaction that involved the different Government Line Departments. During this interaction, the representatives of the various departments those attended agreed to help by providing data / information as per requirement on a formal request. During the project period, interactions at the local and community level will be carried out where required in the form of Household Interviews, Focus Group Discussions, Key Informant Interviews and Participatory Rural Appraisal[6].

[6] HHI: Household interviews = individual house surveys; KII: Key Informant Interview; FGD: Focus Group Discussion; PRA: Participatory Rural Appraisal

3.3. WORK-PLAN

Monthly work plans for individual management sub-plans and their integration to the ICZM plan is given in the relevant sections above. All management sub-plans (with the exception of shoreline management) will be finalized in September 2018. Integration of the management sub-plans will be undertaken in October-November 2018 and submitted to the SPMU-West Bengal.

3.4. WORK DONE

As part of the inception phase, a team with diverse expertise required to execute the ICZM Plan from NCSCM is in place. The West Bengal SPMU is the nodal agency for the implementation of the ICZM Plan and hence close contacts with the SPMU are being maintained.

A Project Office established at Kolkata exclusively for the ICZM Plan preparation shall ensure the following:

a) Collect secondary data for all management sub-plans and legal instruments
b) Collect primary data for coastal process study, livelihoods, tourism, disaster and pollution
c) Coordinate closely with the WB-SPMU and other state government agencies to understand the local issues and to make the state government inclusive while preparing the ICZM plan

3.5. STAKEHOLDER CONSULTATION

A stakeholder consultation was held on 20th of February 2018. This consultation was to present the Plan of Action to prepare the ICZM Plan for the two sectors. Representatives of the various Departments of the Government of West Bengal attended. Dr Barnali Biswas, Project Director, SPMU, West Bengal, informed that two committees have been established to support NCSCM and monitor the progress periodically during the preparation of the ICZM Plan.

The first is the State Level Monitoring Committee (SLMC) of which the Principal Secretary, Department of Environment, Govt. of West Bengal is the Chairperson and include Secretaries of various Departments.

The second is the Technical Advisory Committee (TAC) which would function under the PSC and included representatives from eleven departments. The ICZM Plan prepared needs to be accepted by the State Government for implementation. This stakeholder consultation was also the first meeting of the State Level Monitoring Committee. Detailed minutes of the first stakeholder meeting is sent separately.

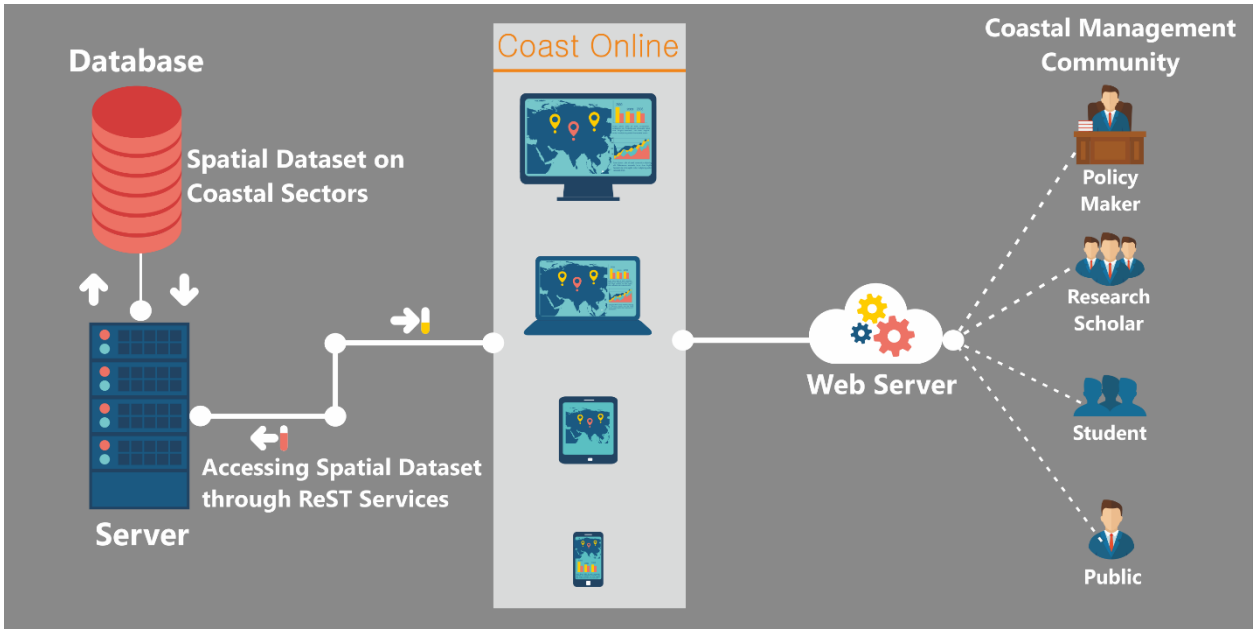
Photo 12: Site visit of NCSCM Team to beaches along Digha-Sankarpur coast

Photo 13: Site visit of NCSCM Team to Subarnarekha River mouth

Coast Online

The Coast Online has been developed by NCSCM to disseminate coastal information to the coastal community along the Indian coast. It is an innovative portal with a compressive database for researchers, policymakers, and community. This portal enables the geographical visualization, by providing the information on coastal resources for sustainable management of coastal resources along the Indian coast.

The advancement in web based applications on the Geographic Information System (GIS) software makes wide applications for the visualization of geographic information of the coastal resources. It consists several important base layers of coastal dynamics features. The base layers have been converted into the thematic layers and are published as ReST (Representational State Transfer) services using ArcGIS server. Web map application developed using HTML, CSS, and Java Script to visualize and extract the features information from the ReST services using ArcGIS API (Application Programming Interface) for Java Script. The web portal consists more than 20 applications with the combination of 130 ReST services (base layers).



The Coast Online provides the spatio-temporal distribution information on Coastal Regulation, Shoreline management, Conservation management, Tourism management, Disaster management, livelihood

management, and pollution management. In addition, this portal can be used for Site Suitability Analysis, data crawling and for geo-processing in online.

The major thematic web map applications developed at NCSCM are:

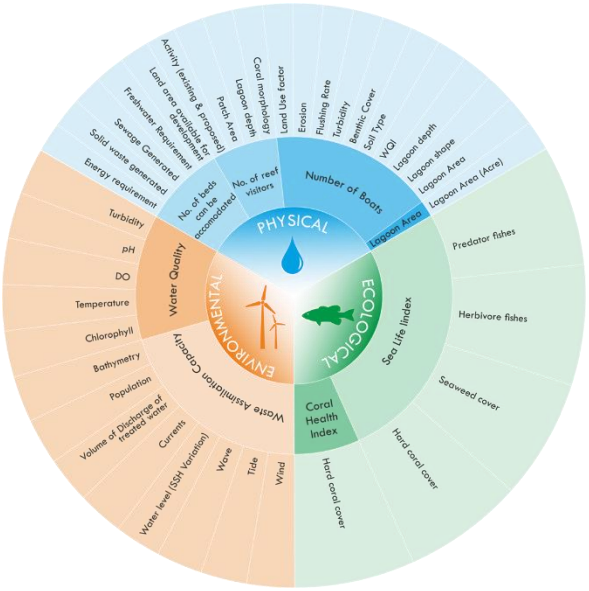
1. Delineation of Coastal Sediment cell
2. National Assessment of Shoreline Change
3. Hazard line Mapping
4. Mapping of Ecologically Sensitive Area
5. Potentials of Offshore Wind Energy
6. Mapping of High Tide Line
7. Island Coastal Regulation Zone (ICRZ) for Andaman Islands
8. Integrated Island Management Plan (IIMP) for Lakshadweep Islands
9. Demographic Information of Census Town
10. Conservation and Climate Mitigation
11. Assessment of Cumulative Coastal Environmental Impacts
12. Mapping of Coastal Infrastructure
13. Critically Vulnerable Coastal Areas
14. Coastal Zone Management Plan
15. Coastal and Marine Biodiversity Integration Network (CoMBINe)
16. Data Web on Island Environment and Protection (DWIEP)

PILOT STUDIES: TOURISM MANAGEMENT

VIII PILOT STUDIES: TOURISM MANAGEMENT

1. Integrated Carrying Capacity for Lakshadweep Islands

Land carrying capacity (determining number of beds and number of boats in the lagoon) and ecological carrying capacity (determining the lagoon water quality, coral health, zonation of tourism activities and determining the number of snorkelers, divers etc. in the lagoon waters) were assessed. An approximate of 1847 beds was estimated for the ten inhabited islands. The supporting population for serving the tourism sector was determined. All the aspects related to the water & energy requirement, waste water and solid waste for the tourists and the supportive population was estimated. Considering the critical and fragile environment of the islands, major recommendations were proposed including construction practices, water supply, waste water treatment, solid waste management, energy etc. to promote sustainable tourism.



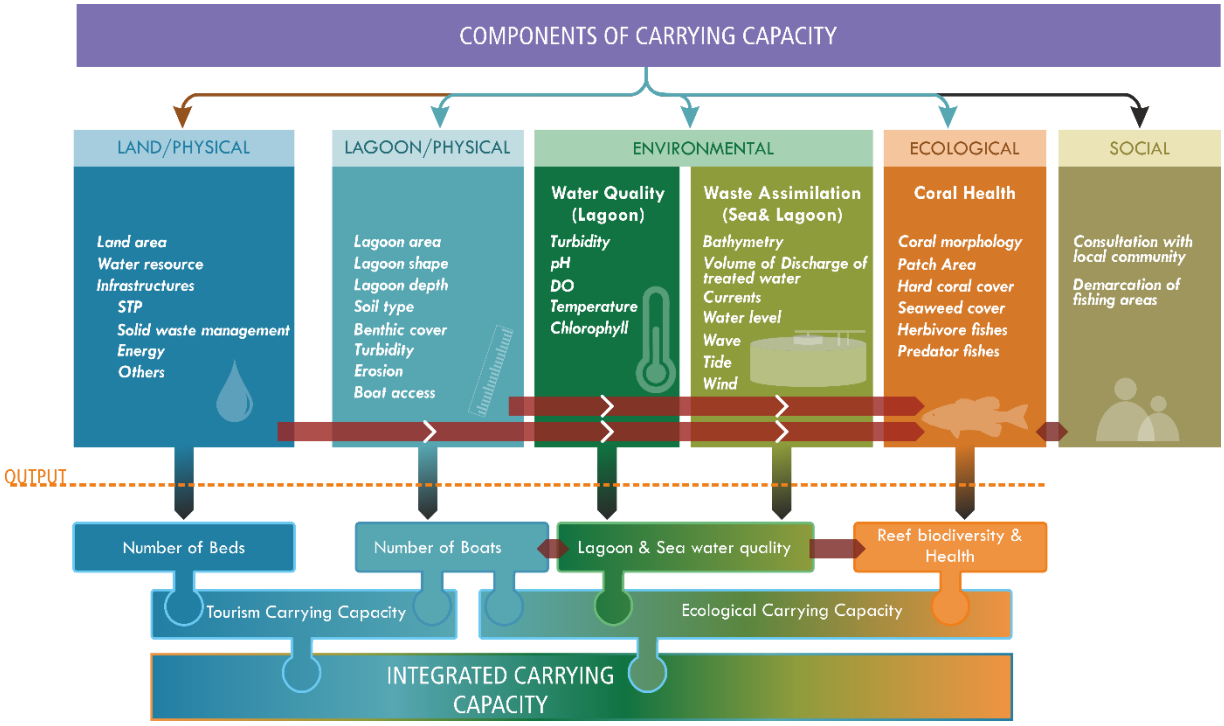


Figure 33: a) Components of ICC and b) Framework for ICC

2. Carrying Capacity of Beaches for Shacks and other Temporary Structures of Goa

Guidelines to determine the beach carrying capacity for the private shacks/ resorts i.e. in the area between high tide line and the 200m for temporary structures were developed. The aspects that were taken into consideration were Ecologically Sensitive Areas (including Sand dunes and turtle nesting sites), fishing space area, entry points, erosion prone areas, tourist footfall during peak season, existing shacks, existing beach and vacant areas, etc. Environment and safety guidelines were provided along with various recommendations for particular beach areas. The study was carried out for all the 38 beach stretches along the 105km long coastline of entire Goa. The carrying capacity for erection of Beach Shacks was available in all the Beach stretches except from Baga to Siquerim where is it exceeded by 8 shacks and by 5 shacks in Ozran.

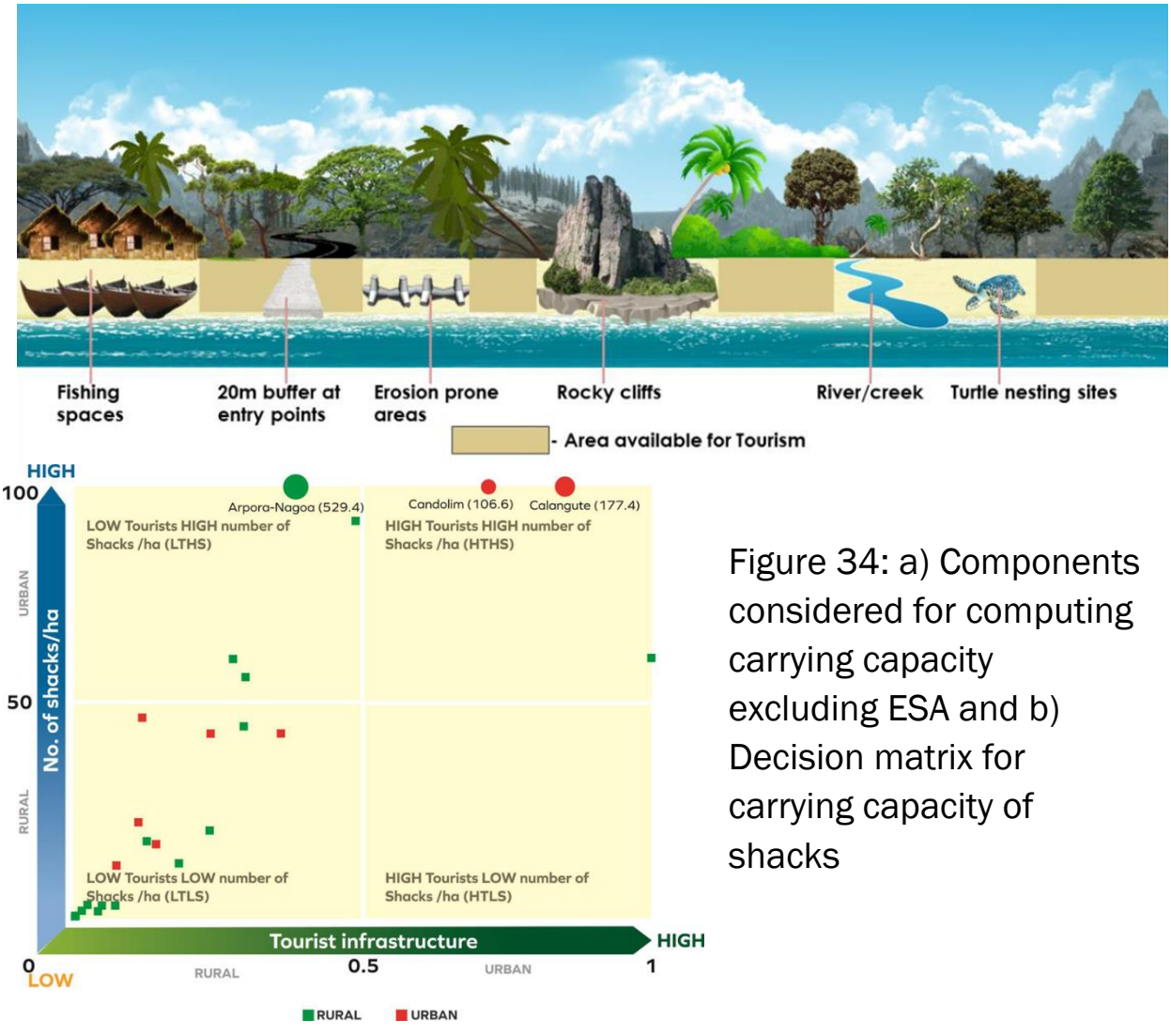


Figure 34: a) Components considered for computing carrying capacity excluding ESA and b) Decision matrix for carrying capacity of shacks

DISASTER MANAGEMENT

IX DISASTER MANAGEMENT

3. Oil Spill along Chennai Coast: Environmental and Ecological Impacts

On Saturday January 28, 2017 two vessels *BW Maple* (UK), an LPG tanker, collided with oil tanker *Dawn Kanchipuram* (India) carrying petroleum oil lubricants (POL) at 17 kmph, about two nautical miles off the Kamarajar Port (KPL) at Ennore north of Chennai city. The collision resulted in an oil spill from the vessel Dawn Kanchipuram at 1.8 nautical miles (3.3 km) from the coast within the KPL Limits. NCSCM carried out the (i) Assessment report on ecological damage, (ii) prepared the Action Plan to remedy negative environmental impacts and (iii) furnished the requirement of facilities designed, installed and operated to minimize the possibility of oil spill and contain its impact as an immediate response.

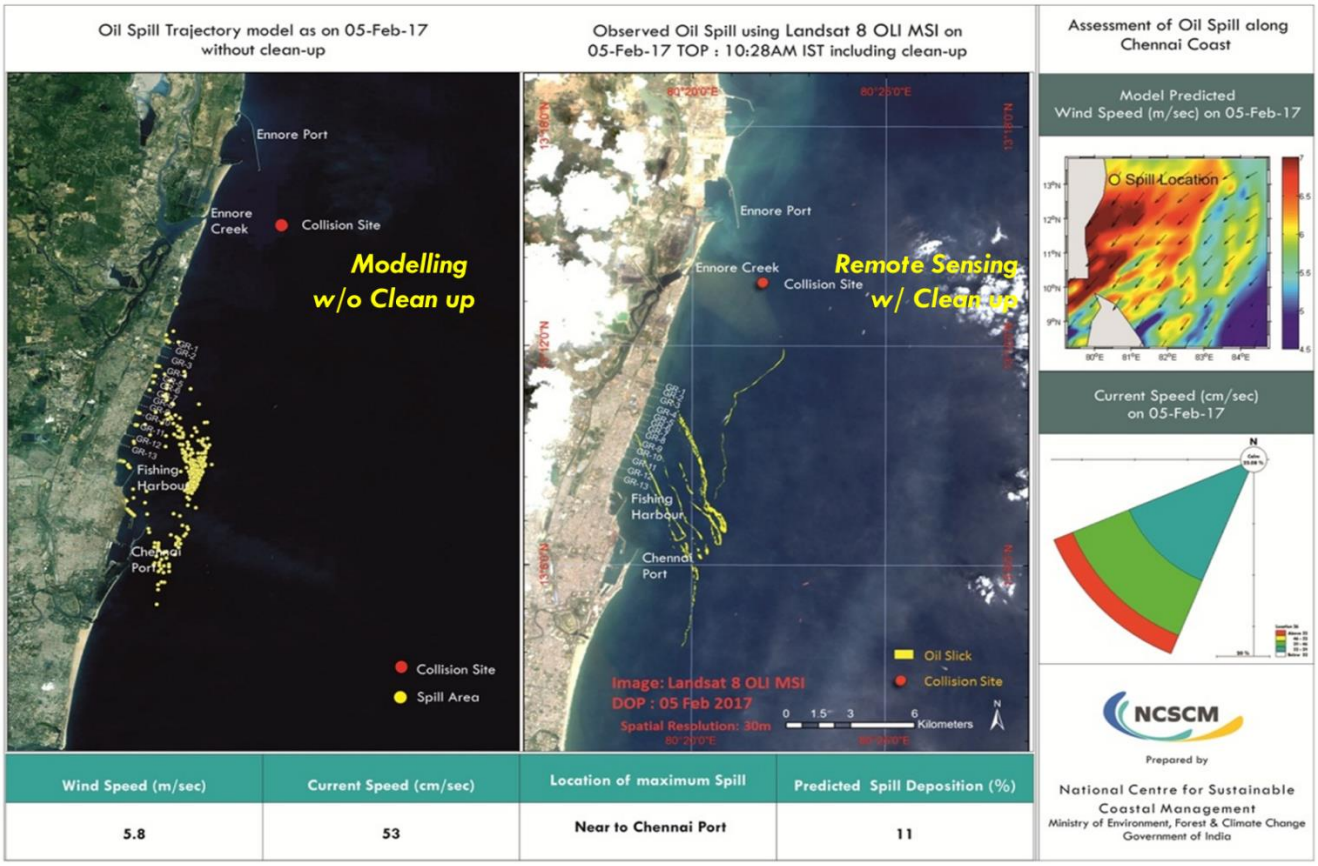


Figure 35: a) Modelling of oil spill trajectory and b) remote sensing based assessment of oil slick movement

Figure 36: Infographic of events post- oil spill and clean-up operations at Chennai

CONSERVATION MANAGEMENT

X CONSERVATION MANAGEMENT

4. Long-term monitoring plan for ecosystem-based conservation management of Bhitarkanika Conservation Area

1 Background

In recent years, various studies have documented the social, economic, and ecological benefits of mangroves, thus emphasizing on the protection and conservation of these area. Odisha, being no exception, the state government has taken several steps for the conservation of mangroves along the coastal tracts of Balasore, Puri, Ganjam and Kendrapada. Quite often programs for conservation and restoration of mangroves are target-oriented (e.g. afforestation and reforestation) are undertaken in silos. While human interference is rapidly increasing stress on the ecosystem, there is an urgent need to reinforce management practices in the mangrove ecosystem with an integrated approach involving various components such as environmental variables, socio-economic, human interventions, tourism etc. Under the Odisha Forestry Sector Development Project Phase II (OFSDP-II) this management gap is envisioned to be bridged by developing a Long-term Ecosystem Based Management Plan (EBM) for Bhitarkanika Conservation Area (BCA), the largest mangrove ecosystem of Odisha. Wildlife Sanctuary and parts of the Gahirmatha Marine Sanctuary and adjacent agricultural lands constitute Bhitarkanika Conservation Area (BCA).

The BCA is a rich, lush green, vibrant ecosystem lying in the estuarine region of Brahmani, Dhamra and Baitarani rivers in the northeastern corner of Kendrapara District, Odisha, east coast of India. There are 490 villages around the sanctuary and 410 villages within the sanctuary with a population of 0.9 million. The unique biodiversity of Bhitarkanika warrants high conservation priority. Although the protection and the effort for conservation of species by the Forest Department, Government of Odisha is adequate, a comprehensive ecosystem based approach to strengthen the current conservation measures is important. Considering the possible impact of climate change, increasing human interventions and the conservation priority for Bhitarkanika ecosystem, a long-term study under OFSDP-II, is undertaken to develop an ecosystem based management program. Under this program, a comprehensive monitoring protocol will be developed with an aim to generate annual **"Ecosystem Health Report Card"**, which would be used as a management tool for monitoring the health of the Bhitarkanika ecosystem.

2 Objectives

The study is intended to develop an integrated science-based management plan involving various components for the sustainable management of the mangrove ecosystem. These components focus on understanding of response of mangroves to climate change and their natural adaptation mechanisms. The specific work objectives envisaged for the long-term assessment of BCA are as follows:

Objective 1: Identification of ecosystem values & pressures

Objective 2: Creation of a long term database for physical, chemical and biological components of BCA for conservation and maintenance of ecosystem health

Objective 3: Delineation of stress and interventions (Social, environmental and climatic)

Objective 4: Quantification of tourism and ecological carrying capacity for Bhitarkanika

Objective 5: Development of an Ecosystem Health Report Card as a management tool

Objective 6: Development of ecosystem based conservation and management plan

Objective 7: Capacity Building of Forest Department personnel to carry out in house monitoring of ecosystem health

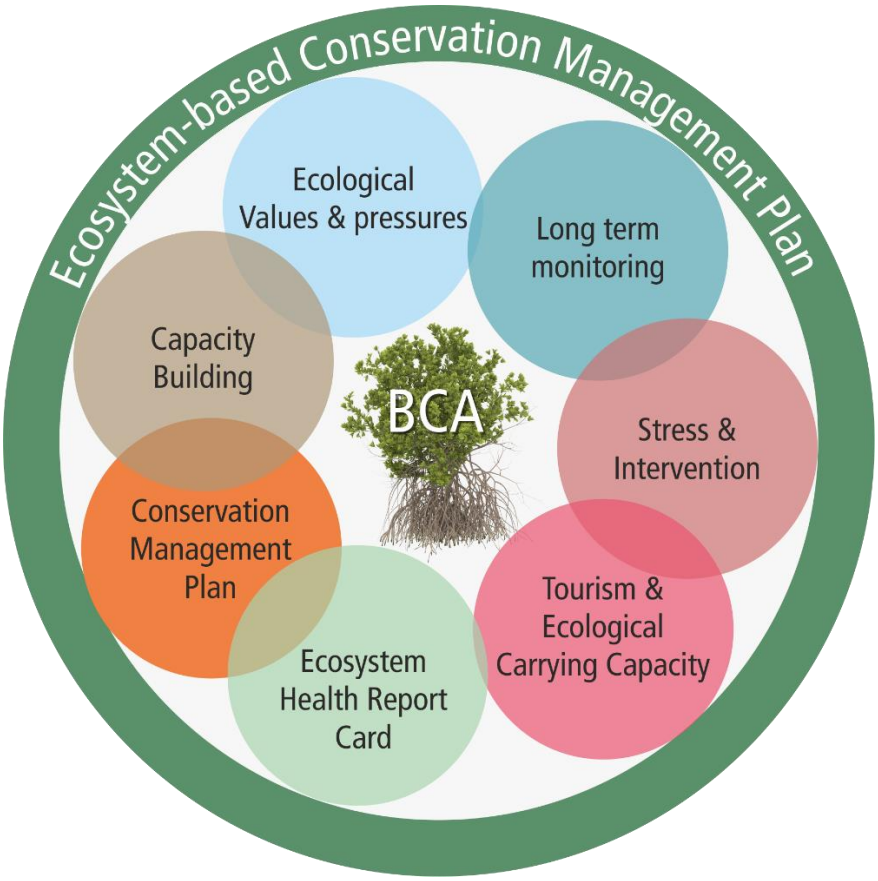


Figure.1: Concept of ecosystem-based conservation

3 Bhitarkanika Conservation Area

Bhitarkanika Conservation Area is surrounded by the Bay of Bengal in the east, villages of Kendrapara District in the west, Baitarani and Dhamra Rivers in the north and the Mahanadi delta in the south. A network of creeks with Bay of Bengal on the east intersects the area. The site has four different ecosystems: i) terrestrial, ii) freshwater, iii) estuarine and iv) marine ecosystems with varying ecological diversity. The peripheral areas in the buffer zones have numerous ornithologically important wetlands and are listed as IN 310(A1, A4i) under Important Bird Areas (IBA).

The estuarine region of the Bhitarkanika Conservation Area (BCA) can be classified into the outer funnel shaped estuarine zones and the inner narrow estuary. Tidal inundation causes heavy silt deposition and detrital content of the mangrove vegetation. Saltwater crocodiles (*Crocodylus porosus*) and a variety of other wildlife inhabit in this ecosystem. The Government of Odisha, declared this area as a sanctuary in 1975 for better protection of the habitat. Later, the core area (145 km2) of the sanctuary was declared as National Park in 1998. The total mangrove area is a mixture of 13 protected reserve forests (PRF), 12 protected forests (PF) and one newly formed island (Pattanaik et al., 2008)

Due to its rich diversity in flora and fauna, this mangrove area has been declared as a Ramsar site (No. 1205) in 19 August 2002, as wetland of international importance. This region experiences tropical warm and humid climate, with distinct seasonal variation. Precipitation occurs due to the southwest monsoon from May to September, and northeast monsoon from November to December. The average rainfall is about 1,642 mm, the bulk of which is received during June to October. Maximum temperature recorded is 41°C and the minimum is 9°C during May and January, respectively. Mean relative humidity ranges from 70 to 85% throughout the year. The soils of the mangrove areas are fine-grained silt or clay, formed by the sedimentation of Mahanadi and Brahmani rivers.

The BCA has 300 plant species belonging to 80 families of both mangroves and non-mangroves. It supports one of the largest mangrove plant diversity in India and has more than 82 species of mangroves and its associates. Fifty-five of the 58 Indian mangrove species and 3 species of Sundari trees (*Heritiera* spp.) including *Heritiera kanikensis*, are the endemic species recorded in the BCA.

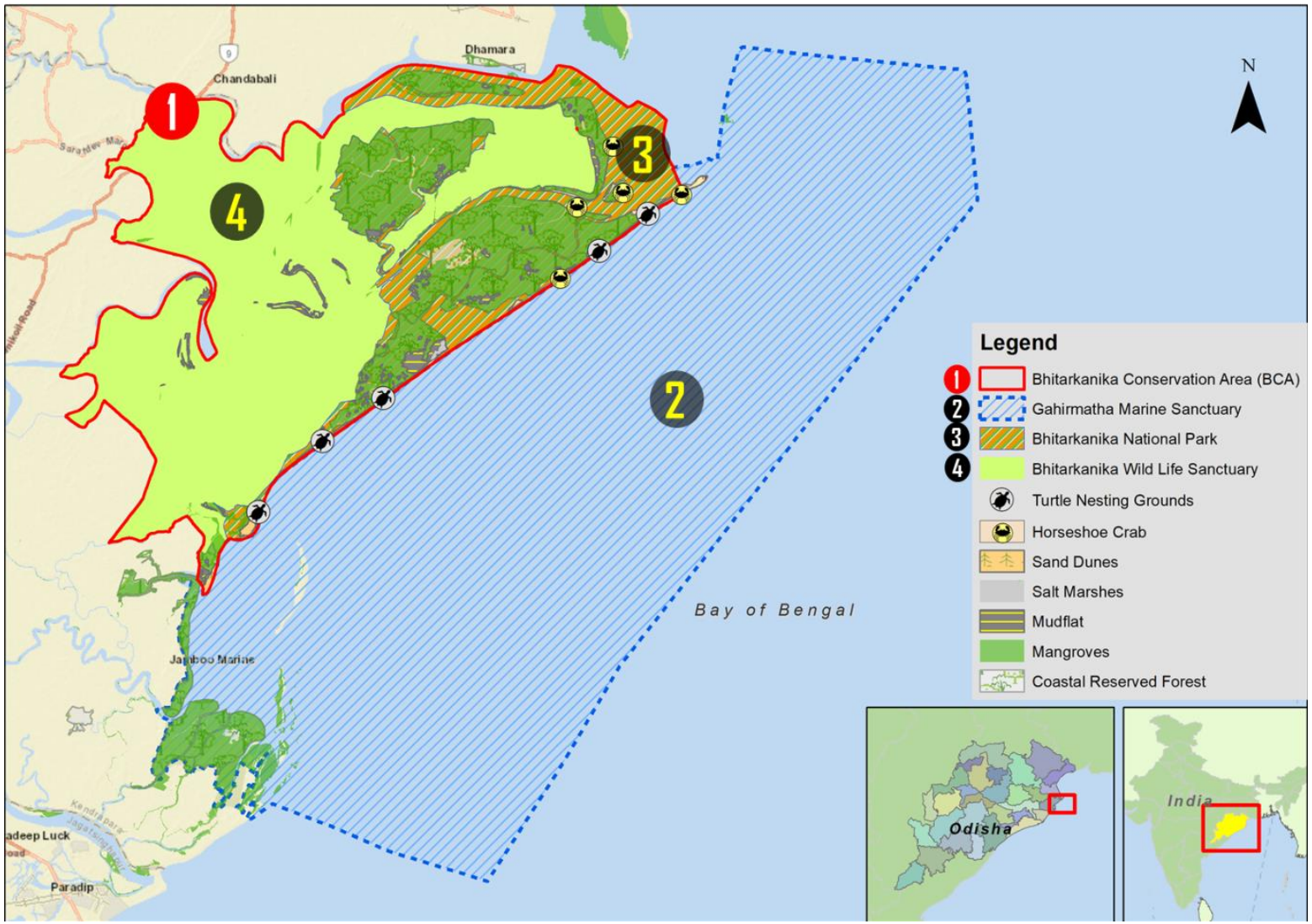


Figure 2: Map of Bhitarkanika Conservation Area

Characteristic mangrove species include *Avicennia alba, A. officianalis, Rhizophora mucronata, Excoecaria agallocha, Acanthus illicifolius, Sonneratia apetala* and Heritiera minor. Bhitarkanika presents a variety of habitats, microhabitats and climatic conditions. Therefore, the faunal component and its diversity are extremely high in comparison to other mangrove forest areas of Odisha. The food and shelter is not a limiting factor in Bhitarkanika, hence the biodiversity is extremely rich in this mangrove ecosystem.

Bhitarkanika Sanctuary is a home for the largest number of saltwater crocodiles in the country. The wetland also hosts a large and diverse population of resident and migratory birds from Central Asia and Europe, that congregate in Bagagahan heronry, an area of approximately 4 hectares within the Bhitarkanika Forest Block near Suajore creek during June to October every year providing living space for about 80,000 birds. The animals that are associated with the mangroves cover a wide range of vertebrate and other invertebrates including protozoans and plankton. The vertebrate fauna includes a wide variety of fishes, amphibians, birds, reptiles and mammals (including aquatic mammals). In addition, the numerous wetlands scattered throughout the sanctuary serve as feeding and wintering grounds for more than 50,000 migratory birds during winter and early summer months. The Sanctuary is the World's largest nesting ground, Gahirmatha Beach, which separates the mangroves from the Bay of Bengal, for the endangered Olive Ridley sea turtles (*Lepidochelys olivacea*).

Apart from being rich in biodiversity, BCA has immense social and cultural values. A large proportion of the local economy is reliant on the thriving fishing industry of *Hilsa illisha*, and *Mullet* spp. The area is also an important source of *Lates calcarifer, Mystus gulio* prawn such as *Penaeus indicus* and *Penaeus monodon*. Nearly 3000 to 5000 kg of honey is collected every year from February to May (Chadha and Kar, 1990) especially by the honey collecting tribe, 'Daleis'. Nalia grass *Myriostachia wightiana*, found in the tidal banks and Bahumurga climber *Flagellaria indica*, found in the mangrove forest, are used for basket and rope making. *Phoenix paludosa* is exploited for thatching purposes. Wild strains of salt-resistant paddy occur in these habitats and have immense potential for cultivation along the east coast of India. Despite strict regulation, the mangrove forest is under severe anthropogenic pressure. Changes are also observed in the river creeks, which may be, attribute due to sedimentation or tidal inundation or the fast growing aquaculture farms on the estuarine banks.

4 Identification of Ecosystem Values & Pressures

5.1. Evaluation of Ecosystem Goods and Services

The local population for their day-to-day needs, ranging from firewood and fiber to timber, fishing poles and posts, is extensively using the mangrove forest. However, the area has protected status and legally no extraction is permitted, the villagers living in mangrove areas or in the vicinity is poor and depends on the mangrove resources for their livelihood. As per the current scenario, there are 900 revenue villages and hamlets in and around the Bhitarkanika Biosphere Reserve. The bulk of the population residing in the sanctuary is significantly dependent on mangrove resources for daily sustenance and livelihood.

In coastal regions dominated by sandy beaches, where timber species are scarce, mangrove plants are often the only available source of fuelwood and timber for construction of houses. The linkages between mangroves and fisheries have also been documented in several ecological literatures. Even though the absolute economic value (monetary value) of the resources may not be high, (e.g. some species of snails and crabs have no market value but they are consumed when no other food or protein source is available), the relevance of these biological resources may be paramount for the communities' dependent on them. Mangrove forests are also important for their role in providing protection against recurrent storms and other natural hazards. The dense networks of roots bind the soil and trap the sediment and suspended particulate matter in deltaic settings. Mangroves are also known to be the most carbon rich forests in the tropics, reported to have 1023 Mg C per hectare of forest including soil carbon. The loss and degradation of mangrove may seriously undermine the ability to provide valuable Ecosystem Services for present and future generations.

The role of Bhitarkanika mangroves in fisheries, coastal protection, protection from sedimentation and provisioning for wood and timber were identified to be the top three Ecosystem Services of mangrove ecosystems. Three of these services fall under the category of regulation and maintenance services, with "fisheries" being spread over both provisioning (nutrition) and regulation and maintenance (nursery function). Mangrove ecosystems were also identified to be important environmental risk indicators and carbon sequesters. In the context of climate change, the emphasis on coastal protection and protection from sedimentation are particularly

important, given the location of mangroves close to the coast and the rapid decline of mangrove area in the past few decades.

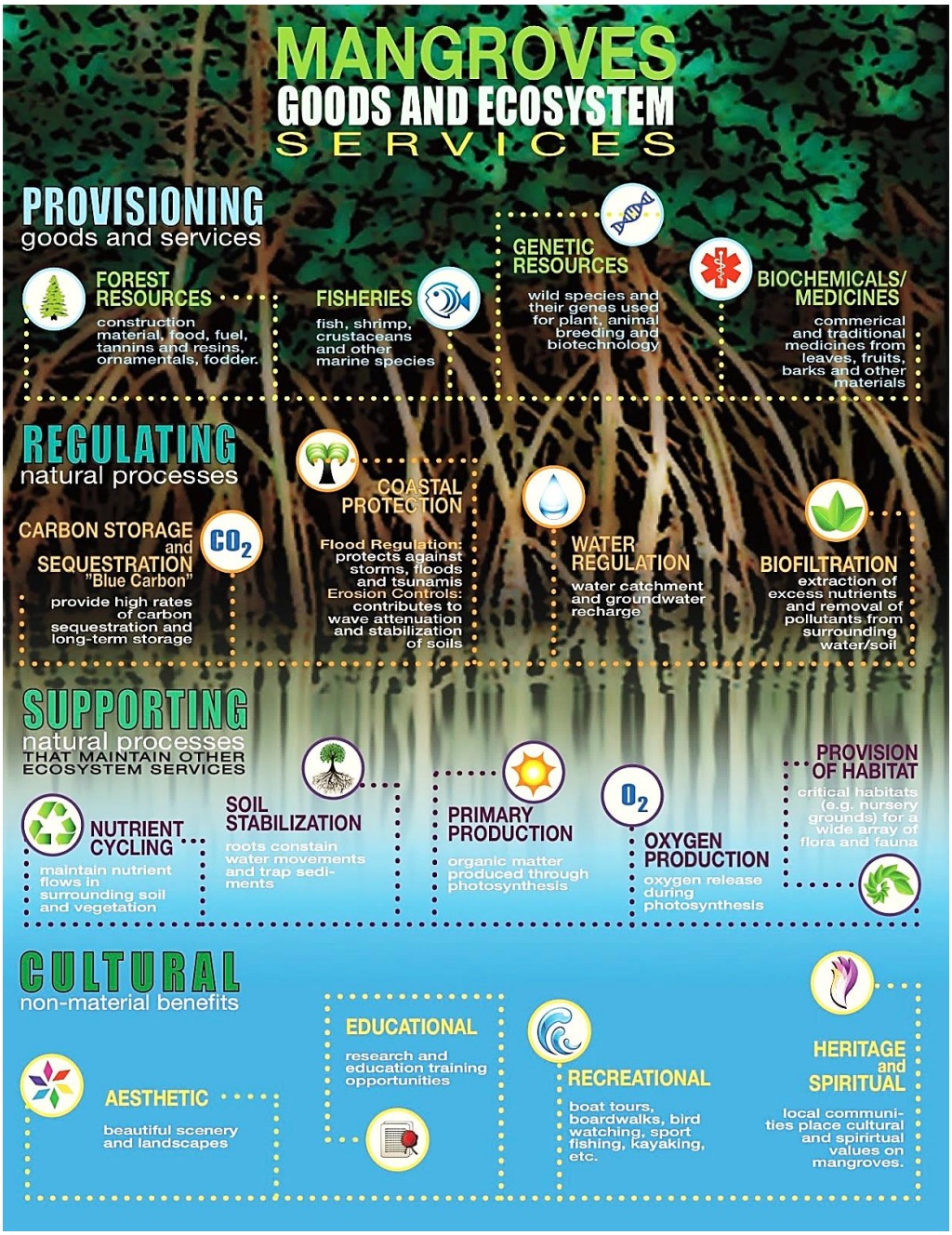


Figure 3. Conceptual diagram of Mangrove Ecosystem Goods and Services

Valuation of Mangrove Ecosystem goods and services involves the following tasks:

- Collection of literature and secondary information from relevant data sources.
- Undertake surveys to understanding the area, livelihood pattern, and stress on ecosystems, human animal conflicts and livelihood related concerns.

- Conduct interviews with the village officers in the dependent study area.
- Finalize the conceptual framework and data selection tool to be conducted as part of the primary survey among stakeholders.

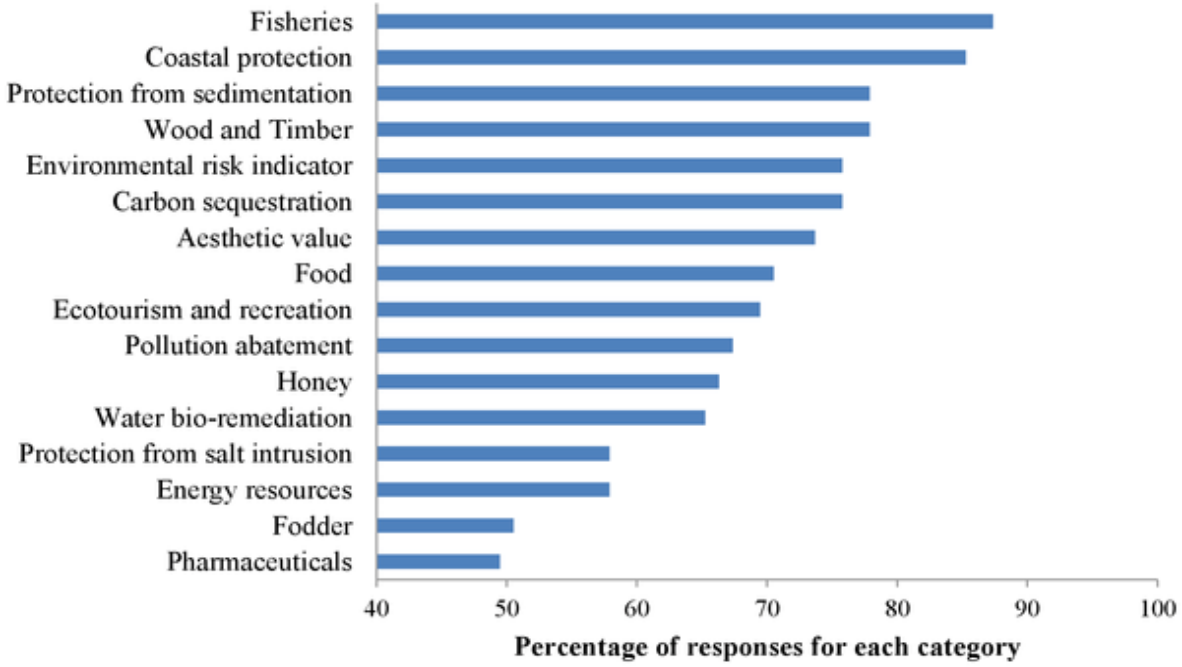


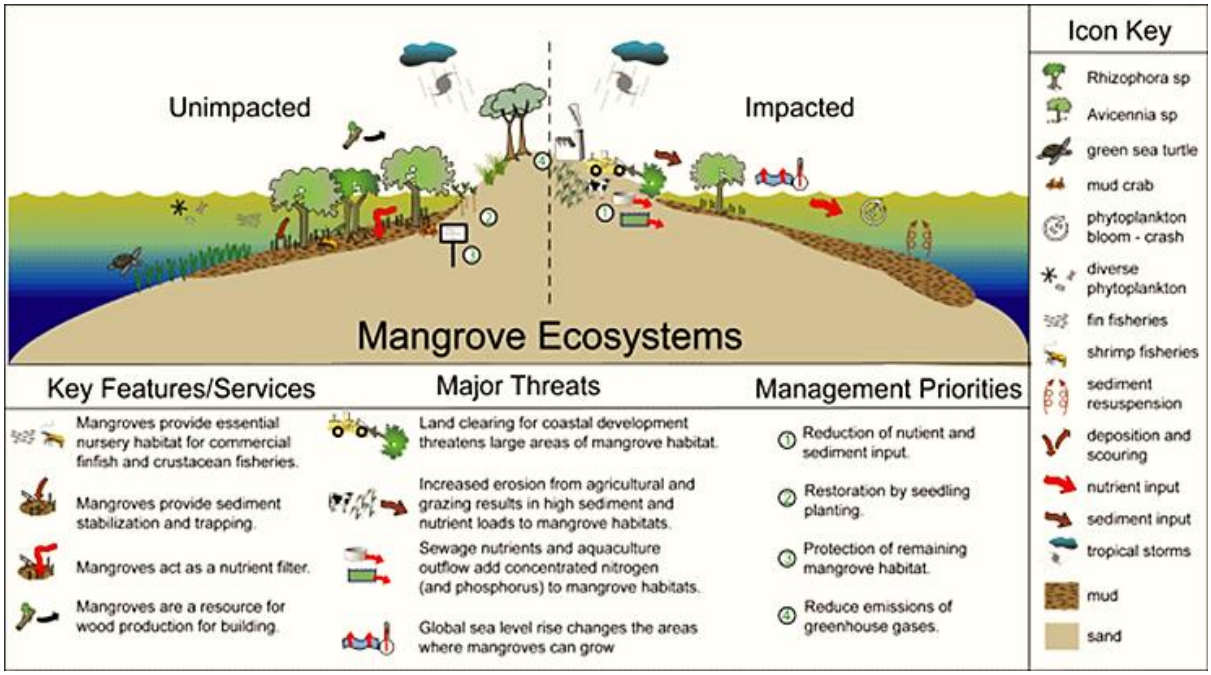
Figure 4: Ranking of the ecosystem service categories of mangroves based on the scores given by the experts in the Delphi technique. [Source: Mukherjee et al., 2014]

People living in the villages adjoining mangrove forest blocks earn a part of their livelihood from the mangrove ecosystem, which constitutes about 100 villages. The livelihood patterns of rest of the villages directly or indirectly influence the very existence and survival of the flora and fauna of the mangrove ecosystem. Mangroves form an intricate component of socio-economic development of the local communities. The local inhabitants are benefitted directly and indirectly as a source of medicine, honey, sugar, vinegar, alcohol and fuel.

The current project aims to analyze resource availability, dependency, social stress and pressures of people in the study area. In addition to this, suitable and relevant strategic interventions that alleviate the stress factors will be facilitated. To accomplish this, quantification of services of mangroves is important. The identified values play a significant role in developing suitable mitigation measures for climate change.

5.2. Delineation of values, stress and pressures

The mangrove forest of Bhitarkanika Conservation Area (BCA), located in the state of Odisha is the second largest mangrove forest of mainland India. Ambastha et al (1989), estimated the area of the mangroves of Bhitarkanika to be 672 km^2.The mangrove forest in the BCA consists of 145 km^2 of intact forest notified as a National Park, and 385 km^2 of degraded forest comprising the Bhitarkanika Wildlife Sanctuary (Hussain and Badola, 2010). The National Park is free of human habitation whereas the Sanctuary is interspersed with 336 villages. The mangrove forests are also being exploited for firewood and as construction materials by the local population. Developmental activities such as construction of jetties, roads, defense structures, missile testing site, inshore fisheries by mechanized vessels and the proposed major port, threaten the existence of this unique ecosystem (Badola and Hussain, 2010).



a) Physical pressures

Coastal erosion is a chronic problem and is often thought as a predictable problem along most open-shores of the country. The coastal region of Odisha where BCA is situated, was formed by accumulation of alluvium in the coastal littoral zone by sediment/silt brought down by rivers such as the Mahanadi, Brahmini and Baitarani. Flooding during monsoons as well as extreme weather events allows transport of large quantities of fine mineral silt, which is deposited in these areas. Annual sediment load at the terminal point of Mahanadi, Brahmini and Baitarani

Rivers was estimated to be ~ 13.2 x 10^9, 13.2 x 10^9 and 5.9 x 10^9 kg, respectively (Chandramohan et al. 2001). Most of the coastal sediments in this area are dominated by fine to very fine grain size, which are poorly sorted throughout the year. This poorly sorted, positively skewed fine-grained sand indicate depositional process in a low energy environment. The loss (erosion) and gain (accretion) of land is reported in various shoreline change studies in this area. In particular, a net erosion of 35.6 km^2 towards Gahirmatha beach and Kanika Island and a net deposition of 8.2 km^2 near the Maipura river of Bhitarkanika ecosystem from 1989 to 2013 has been reported through Remote sensing analysis (Barik et al., 2016).

Sea level rise probably is the greatest threat facing coastal mangroves. Recent studies (Sandilyan, 2014) have shown that larger changes in sea level can lead to mangrove ecosystem collapse. Increased intensity of cyclones has also been found to damage the mangroves through defoliation, uprooting and death of mangrove trees (Ward et al, 2016). In addition to tree mortality, the nature of soil sediments is also modified, leading to ecosystem conversion. Studies also show that cleared mangrove forests fail to recover due to changed hydrodynamics, salinity and acidity as well as low nutrient levels and poor essential substrates (Sandilyan, 2011). In addition, higher temperatures are predicted to have an impact on various species, and sea level rise can strongly affect the mangrove forests of Bhitarkanika. It has been predicted that the mangroves could face species composition change as well as changes in the flowering and fruiting periods due to temperature changes.

Continuous monitoring and detailed analysis indicate that the maximum temperature has been increasing during the last century over all the Mangrove regions of India (Dash et al, 2007). It has been predicted that inconsistent rainfall, increased evaporation and reduction of sediment transport due to various irrigation activities can lead to rise in the salinity of mangrove ecosystem. These environmental changes can lead to decreased productivity, poor seedling and growth survival. It can also lead to the decreased diversity of mangrove zones and may also cause reduction in mangrove area by altering competition of existing species (Khan et al, 2014). Detailed study on the ecosystem level response by the Bhitarkanika mangroves against various physical changes is essential for their sustainable management.

b) Pollution pressures

The Bhitarkanika mangrove ecosystem is fed by two main rivers namely Brahmani and Baitarani, and is undergoing anthropogenic stress due to agriculture, prawn culture and, diesel boats from the fishing harbor. The impact of anthropogenic pollution on river chemistry is reported in the Brahmani River, where high elemental concentrations correspond to the presence of several industrialized areas. River Brahmani receives effluent discharged from industrial complexes in the region. These industries utilize coal and are active source of fluorides, nitrogen compounds, cyanide, chromium, fly ash, and other suspended solids. The end result of all three industries is a collective discharge of effluent, in which the concentrations of most elements are enriched over 10 times the upstream values.

Anthropogenic pressures on Bhitarkanika mangroves include, among others, clear cutting and reclamation for agriculture and aquaculture, urban expansion, developmental activities, harvest of mangroves for fuel wood, fishing poles and other material and nonpoint source impacts such as industrial and oil pollution, agricultural runoff, etc. (Fransworth and Ellison, 1997). Pressures for fuel wood, poles, fodder and other Non-Timber Forest Products (NTFPs) often exceed sustainable levels. In addition, commercial use of wood, for pulp in particular, results in some areas being more or less clear-felled.

Conversion of mangrove areas to aquaculture is a particular threat in this region. Further, conversion of mangrove area for extraction of salt, cause extensive damage to mangroves. Significant differences in Carbon (C) stocks between highly degraded (aquaculture land use type) sites and intact (dense mangrove) sites has indicated a considerable loss of C and corresponding regulating ecosystem services

from the former. Additionally, high concentrations of CO_2 have been reported as detrimental for a number of mangrove species leading to substantial changes in vegetation along salinity gradients. However, the actual impact of CO_2 on the life cycle of tropical mangroves is poorly understood.

c) Biological pressures

The Bhitarkanika mangrove forests develop less basal area compared to other terrestrial tropical forests of India (Upadhyay And Mishra, 2014). Reduced flow of freshwater results in reduction in nutrient input to mangrove areas and increases the salinity level with increase in evaporation.

Seasonal diversion or alteration of freshwater flow has been identified as a major threat to Bhitarkanika mangroves. In certain areas, the mangroves are particularly dependent on periodic inputs of freshwater, but in these regions there is a high demand for freshwater and its flow into the oceans is regarded as wasteful. Consequently, rivers are dammed or diverted so that their waters can be used for irrigation. Changes in land use/ land cover upstream, such as the logging of a forest, can also affect the freshwater flow into the mangroves. The reduction in freshwater resulted in the gradual replacement of mangrove species with more salt tolerant and possibly less useful species. Mammals within the mangroves are affected by the lack of freshwater while fishery resources may be depleted by the higher or lower salinity and reduced nutrients.

d) Social pressures

In the year 1975, the Odisha government declared an area (672 km^2) surrounded by Maipura, Dhamra and Brahmini Rivers as Bhitarkanika Wildlife Sanctuary under the Wildlife (Protection) Act, 1972 to ascribe protection to the existing flora and fauna. Later in 1998, a core area of 145 km^2 within the wildlife sanctuary was designated as Bhitarkanika National Park (Chadha and Kar, 1999). In 1994-95, the Odisha revenue department legalized a large number of illegal human settlements within the Sanctuary area. Consequently, the sanctuary contains 336 villages with a total human population of ~ 150,000 people (Hussain and Badola, 2003).

There is a high degree of resource extraction by the local people because of the fact that the local people do not have any other livelihood options other than paddy cultivation and fishing. Consequently, more and more mangrove areas are being converted into paddy fields. Moreover, developmental activities all around the area

also threaten the ecological integrity of the Bhitarkanika Mangrove Ecosystem. Bhitarkanika mangroves experienced immense deforestation pressure during 1951-61 due to a surge in population growth following the resettlement of refugees from Bangladesh (Chadha and Kar, 1999). This population influx resulted in mangrove deforestation to have land for settlement, agriculture and aquaculture.

Despite the protected status, Bhitarkanika mangrove forests are exploited for fuel wood, timber and cattle grazing. These forests are also impacted by developmental activities such as construction of jetties, roads, defense structures and illegal embankments to reclaim land for agriculture and aquaculture (Badola and Hussain 2003, Badola and Hussain, 2005). The most common land use type in BCA is agriculture (53.7%), followed by mangroves (22.3%), open water (13.77%), mud flats (4.47%), human settlements (2%) and aquaculture ponds (1.7%) (Ambastha et al. 2010). Using GIS tools, Ambastha et al. (2010) determined that within BCA, aquaculture, stunted mangrove formations, saltwater/ brackish mixed mangrove and dense mangrove forests covered an area of 11.8 km^2, 24.4 km^2, 92.6 km^2 and 37.8 km^2areas, respectively.

Mangroves undergo changes due to natural and anthropogenic impacts; however, the past decline in mangrove cover within BCA is primarily attributed to negative impacts due to population pressure and human activities. Despite the protection status, exploitation of resources and conversion of mangroves into agriculture, aquaculture, construction of roads and embankments has resulted in mangrove cover decline within BCA. In order to understand the livelihood challenges, necessary secondary information has been collected and collated. Since the key

aim was to identify the type of livelihood, a village profile survey was carried out. The survey aims to understand the livelihood pattern in agriculture, fisheries, tourism and related activities to delineate the sector specific stress factors and suitable interventions. The villages near to the sanctuary area were chosen for the pilot study. In order to finalize the conceptual framework, it was necessary to collect information about the ecosystem dependency and current livelihood scenario. An unstructured in-depth interview was conducted with the village Sarpanch/ Officer.

A team of three scientists from NCSCM visited 15 Village Panchayats and collected the basic information. The questions were related to the number of villages, livelihood, problems and difficulties faced, support from institutions and their anticipations towards enhancing the livelihood. The officers were cordial and supportive in delivering the necessary information. Apart from livelihood issues, human - animal conflicts were reported in many villages of Bhitarkanika. This interview with the village officers and few households portrayed a clear picture of the same. Although Government initiates measures to support people, strategies that are more appropriate would aid the livelihood security.

Table 2: Structure of the pilot survey

No	Place/ Village	No. of Villages	Livelihood		Total Population	Concern
			Primary	*Secondary*		
1	Dangmal	18	Aquaculture	Agriculture	1502	Crocodile attack, increasing aquaculture, less alternative jobs
2	Krushna Nagar	8	Agriculture		973	Less options for additional income
3	Khamarsahi	10	Agriculture		923	Aquaculture, Less Options for Additional income
4	Talchua	16	Agriculture		843	Aquaculture, less options for additional income
5	Rangani	20	Agriculture		824	Less Options for Additional income
6	Ghadiamala	7	Agriculture		355	Less additional and alternative livelihood options
7	Khandira	36	Aquaculture		344	Less additional and alternative livelihood options
8	Baghamari	7	Agriculture	Fishing	1037	Less additional and alternative livelihood options
9	Keruapala	9	Aquaculture		1026	Less additional and alternative livelihood options
10	Ramnagar	4	Agriculture	Fishing	5563	Less additional and alternative livelihood options
11	Kharinasi	3	Agriculture	Fishing	6396	Less additional and alternative livelihood options
12	Petachela	8	Agriculture	Fishing		Aquaculture, Less Options for Additional income
13	Baradanga	8	Agriculture	Fishing		Aquaculture, Less Options for Additional income
14	Baulakarani	8	Aquaculture	Agriculture, Toddy	5167	Aquaculture, Less Options for Additional income

5 Delineation of stress and interventions (Social, environmental and climatic)

6.1. Assessment of pollution status

Mangrove ecosystem being suitable for brackish water shrimp culture, a large number of aquaculture ponds have been developed on the periphery of Bhitarkanika National Park area. These ponds are regularly fed by brackish water from nearby Brahmani-Baitarani river system and the same water is ultimately discharged into the mangrove ecosystem. Literature reviews indicate that trace metals, Polycyclic Aromatic Hydrocarbons (PAHs), Persistent Organic Pollutants (POPs), Pharmaceuticals and Personal Care Products (PPCPs) and Endocrine Disrupters Compounds (EDCs) have been detected in various mangrove compartments (water, sediments and biota). These pollutants affect the mangrove ecosystem species, with potential impact on populations and biodiversity. River Brahmani receives aqueous effluent discharged from various surrounding industries, which utilize coal, fluorides, nitrogen compounds, cyanide, Chromium, Fly ash, and other suspended solids. Mahanadi River also receives effluents from prawn farms.

6.2. Influence of river catchments

Bhitarkanika conservation area comprised of the catchments from both Brahmani and Baitarini rivers, which covers an area of 51822 km^2. Major part of the catchment is covered with agricultural land accounting for 52.04% of the total area and has a cultivable area of about 3.2 M.ha. Forest covers an area of 34.4%, followed by wasteland 6.02%, built up land 4.62% and waterbodies 2.95% (Land use 2005-06). Tanks (86%), aquaculture ponds and saltpans are also present. River discharge is maximum during the southwest monsoon from June to October. Precipitation from the catchment and the flow regime showed a wider variation between seasons. Nutrient inputs from the catchment area through various sources e.g. agricultural and domestic activities; influence the riverine flux to the estuary. Mass balance and flux studies of water, nutrients and sediments through various models are vital to understand the influence of the catchments in Bhitarkanika mangroves.

Catchments influence the river systems through large-scale effects on the hydrological regime, sediment delivery and its chemistry. Assessments of key

indicator parameters from the catchment are vital. Land use changes can alter the hydrological regimes by affecting the rate and quantity of water and nutrient fluxes. Cumulative effects of catchment-scale features and local features including habitat, hydrology, and nutrients and suspended sediment loads were brought together by determining the Environmental Index. Evaluation of Environmental index consists of sub index groups such as

i) Land use (Changes in the land use pattern)
ii) hydrological disturbance (changes in the flow pattern and quantity)
iii) nutrient and suspended load (changes in the nutrient and SPM load
iv) Habitat (Changes in the habitat supporting aquatic life). As land use, change pattern and hydrological process studies are yet to be start, the influence from river catchments are in the preliminary stage; to apply the mass-balance model using the nutrients data.

6.3. Human interventions and social implications

Analysis of resource availability, dependency, social stress and pressures of people in the study area will be conducted in the next quarters as the work on quantification of services from mangroves are in progress.

6.4. Role of mangrove in climate change Mitigation

Mangrove ecosystem with its unique physiology and strong carbon sequestration capacity can perform positively in offsetting climate change at a regional scale. Bhitarkanika with its wide diversity with healthy mangroves have a vital potential in sequestering the carbon from the atmosphere. Quantification of net carbon sequestration & storage at a differential spatio-temporal scale in Bhitarkanika mangroves will help to understand the complex dynamics involve in it. Abiotic carbon storage potential is assessed from the collected sediment cores from selected locations from Bhitarkanika mangroves. Preliminary stage analytical measurement for the carbon stock from the collected sediment slices of the cores is going on. Further biotic component carbon stocks of mangroves, the Above Ground Biomass (AGB) and Below-Ground Biomass (BGB) were calculated using allometric equations. Mangrove wood density and tree DBH measurements for different species ant different growth stages will be carry out during our future months. This method is environmentally friendly, time and cost effective, and requires less effort. This study will justify the regional and global significance of the Bhitarkanika Mangrove forest as a net sink / source of carbon and role of the mangrove ecosystem in regulation the regional energy budget.

Suitable criteria based on the scientific analysis for the restoration of degraded mangroves and creation of new mangrove plantation will be developed based on hydrodynamics, sediment dynamics and environmental variable. The factors inducing the growth of blue carbon ecosystems will be identified to facilitate the creation of new areas of carbon sinks. The work will be supplemented by the modelling exercises to predict the future ecosystem scenarios, essential for better adaptation strategies. The InVEST Coastal Vulnerability model produces a qualitative estimate of such exposure terms of a vulnerability Index, which differentiates areas with relatively high or low exposure to erosion and inundation during storms. By coupling these results with human population, the model can predict most vulnerable areas along Bhitarkanika coastline, in changing mangrove cover. The InVEST model will be applied for change detection studies for the entire ecosystem, to provide an estimation of net loss or gain of the Bhitarkanika mangroves under various climate scenarios.

6 Development of an Ecosystem Health Report Card as a management tool

7.1. Assessing health of the ecosystem using key indices

Monitoring campaigns are being carried out in Bhitarkanika Conservation Area by scientists of NCSCM to develop a database of physical, chemical and biological variables. The synthesis of database will be carried out to understand the

environment variability, stress and pressures. Various indices such as water quality index, sea life index (in case of coastal water), metal enrichment index (index of geo-accumulation, enrichment factor and pollution load index) will be derived to provide a complete and detailed picture of the current state of ecosystem. Ecological forecasts of coastal ecosystem by numerical modelling will improve the fundamental understanding of role of ecosystems of land-ocean boundary; will help authorities managing the ecosystems with necessary tools for answering 'what-if' questions about coastal environments. The main aim of the Eco-Health program is to provide an integrated approach to ecosystem health monitoring of the Bhitarkanika mangroves with the following tasks:

- Restoring and maintaining key habitats
- Reducing pollutant loads (sediment and nutrients)
- Improving and maintaining water quality
- Restoring and maintaining key ecosystem processes
- Restoring and maintaining resilient and healthy aquatic communities (i.e. fish populations).

7.2. Preparation of Ecosystem Health Report Card

The ecosystem health report card is a transformative assessment and communication product that compares environmental data to scientific or management threshold and is delivered to a wide audience on a regular basis. The Health report card addresses the issues of transparency and accountability for environmental management. The information generated thus allows local Government, Policy makers and other natural resource managers to better manage aquatic ecosystems and evaluate natural resource management activities for their effectiveness. The formulation of ECOHEALTH report card is proposed to provide a transparent, timely, and geographically detailed assessment of the environmental and ecological database with the purpose of rejuvenating a coastal ecosystem.

C. Participation in Events

India International Science Festival (IISF) - 2017

India International Science Festival (IISF) was held from 13 to 16 October, 2017, at Chennai, Tamil Nadu. NCSCM participated in the Mega Science, Technology & Industry Expo during the event and presented its research outcome on sustainable coastal management, CRZ, real time monitoring of coral reefs etc. NCSCM was awarded the Second Best Pavilion of the IISF 2017 in an event participated by 300 national and international institutions.

World Environmental Day 2018 at Vigyan Bhawan, New Delhi, India (1-5 June 2018)

The biggest and most globally celebrated day for positive environmental action, through which the United Nations Environment Programme (UNEP) with the cooperation of the local Government, enables everyone to realise the responsibility to care for the Earth, and to become agents of change. As part of MoEFCC's Theme pavilion, NCSCM participated in the conference and the exhibition to showcase the achievements and activities of the Centre and to popularize awareness against plastic pollution.

4th India International Science Festival, Lucknow 5-8 October, 2018, Indira Gandhi Pratishthan, Lucknow

The prime objective of the India International Science Festival is to instil scientific temper among the public and showcasing India's contribution in the field of science and technology over the years. NCSCM participated in the Mega Expo theme pavilion of the festival with the theme of Blue Economy and Islands.

7 Preliminary Findings

S.No.	Details	Key Findings
1	Identifications of Ecosystem values & pressures	
a)	*Ecosystem Goods and Services Evaluation*	*The bulk of the population residing in the sanctuary is significantly dependent on mangrove resources for daily sustenance and livelihood. The loss and degradation of mangrove may seriously undermine the ability to provide valuable Ecosystem Services for present and future generations.*
b)	*Delineation of stress and pressures*	Physical pressures like coastal erosion, sea level rise, increased intensity of cyclones, and higher temperatures have known to collapse mangroves ecosystem. Mangroves are under biological pressures due to reduction of fresh water flow and low nutrients; and under social pressure by over exploitation for the daily needs of villagers. Pollution pressures like, eutrophication/ land based inputs, conversion of mangrove land to aquaculture has led to anthropogenic stress and significant differences in Carbon (C) stocks.
2	Creation of a long term database for Bhitarkanika Conservation Area	
a)	*Mapping mangrove of Bhitarkanika*	32 classes of mangrove species/communities have been created with varying density composition of species and pure mangrove species using Landsat 8 OLI (4 March 2017).
b)	*Mapping land cover and land use*	Recently, high-resolution satellite data using LISS IV of 5.8m is being utilized for the year 2018 on 1:10,000 scale. Mangroves covered 42% of the land in the high altitude (3m) and 36% was occupied for agriculture in the low altitude (6m). 5.8% was under settlement with vegetation, 1.55% under mudflat, 1.36% under sandy beach, 0.47% under dune with vegetation, 0.027% under wasteland and 0.02% of marsh vegetation.

S.No.	Details	Key Findings
c)	*Long term database creation for physical, chemical and biological variables*	***Water quality***- Current state of water characteristics reveals relatively high tidal intrusion through the Maipura sector than the Dhamra sector. It is evident from the nutrient distribution that apart from the river source, internal estuarine processes regulate its concentration. Preliminary clustering of water quality data shows the role of salinity in the BCA region. ***Sediment quality*** - Preliminary observations from the sediment characteristics reveal distinct pattern of sediment deposition with the different environmental hydrodynamic condition; and the association of organic carbon with finer fractions. ***Biota***- *Phytoplankton* communities of 67 species belonging to 40 genera has been recorded in the Bhitarkanika mangrove region. Phytoplankton diversity, species composition and abundance were high in the Bhitarkanika core mangrove region. Mahanadi mangroves is the region with low phytoplankton diversity and abundance. 45 species of zooplankton community have been observed with domination by copepod. Dhamra region and the fresh water sectors are dominated by Copepod; whereas Naupilii is the dominant species from Bhitarkanika core region and Maipura sector. ***Benthos*** - Bhitarkanika mangrove region were shown to support rich biodiversity in the benthic ecosystem. 18 different taxa of macrofaunal communities were found in Bhitarkanika region. Polychaeta, followed by Amphipoda, Tanaidacea, Isopoda, Bivalve and Ophiuroidea, led dominance in terms of abundance. ***Biodiversity*** - An updated species checklist containing validated names of all taxa recorded in the BCA is being prepared and new species reported from the area will be highlighted.

S.No.	Details	Key Findings
d)	*Understanding on the coastal processes through ecosystem modelling*	**Planned for Q3**
3	**Delineation of stress and interventions (Social, environmental and climatic)**	
a)	*Assessment of status of pollution status*	Trace metals, Polycyclic Aromatic Hydrocarbons (PAHs), Persistent Organic Pollutants (POPs), Pharmaceuticals and Personal Care Products (PPCPs) and Endocrine Disrupters Compounds (EDCs) have been reported in water, sediments and biota of Bhitarkanika mangroves. Majorly Brahmani and Mahanadi rivers bring these compounds to the system.
b)	*Understand the influence of the river catchments*	As land-use change, pattern and hydrological process studies are yet to be start, the influence from river catchments are in the preliminary stage; to apply the mass-balance model using the nutrients data.
c)	*Identify human intervention and social implications*	Analysis of resource availability, dependency, social stress and pressures of people in the study area will be initiated in the next quarters as the work on quantification of services from mangroves are in progress.
d)	*Quantification of role of mangrove as an intervention to climate change in reference to India's INDC*	Quantification of net carbon sequestration and storage at a differential spatio-temporal scale in Bhitarkanika mangroves will be initiated in the next quarter.
4	**Quantification of carrying capacity for Bhitarkanika**	
a)	*Ecological carrying capacity*	**Planned for Q4**
b)	*Tourism carrying capacity*	**Planned for Q4**
5	**Development of an Ecosystem Health Report Card as a management tool**	
a)	*Assessing health of the ecosystem using key indices*	**Planned for Q4**
b)	*Preparation of Ecosystem Health Report Card*	**Planned for Q4**

PUBLICATIONS, REPORTS AND FACTSHEETS

Knowledge Products

1. Research Publication in Peer Reviewed Journals (2017-2018)

Year	S.No.	Details
2018	57	Neethu CS, C.Saravanakumar, R.Purvaja, R.S.Robin, Ramesh R (2018). Oil spill triggered shift in microbial structre and functional dynamics in different environmental matrices. Scientific Reports-Nature. (Impact factor- 4.5)
	56	Prasad MHK., Ganguly D., Paneerselvam A., Ramesh R., and Purvaja R. (2019). Seagrass litter decomposition: an additional nutrient source to shallow coastal waters. Environmental monitoring and assessment, 191(1), 5. (Impact Factor:1.804).
	55	Banerjee K., Paneerselvam A., Purvaja R., Ganguly, D., Singh G and Ramesh R (2018) Seagrass and macrophyte mediated CO_2 and CH_4 dynamics in shallow coatal waters. PLOS One (Impact Factor:2.766).
	54	Karthik R., Robin RS., Purvaja R., Ganguly D, Anandavelu I., Raghuraman R., Hariharan G., Ramakrishna A., Ramesh R. (2018). Microplastics along the beaches of southeast coast of India. Science of The Total Environment. 645; 1388-1399. (Impact Factor:4.610)
	53	Glaser M., Breckwoldt A., Carruthers TJ., Forbes DL., Costanzo S., Kelsey H., Ramesh R., Stead S. (2018). Towards a framework to support coastal change governance in small islands. Environmental Conservation. Pp:1-11. doi:10.1017/S0376892918000164 (Impact Factor: 1.71).
	52	Krishnan P., Ananthan PS., Purvaja R., Jeevamani JJ., Infantina JA., Rao, CS, Mahendra RS., Sekher I., Karemulla K., Biswas A., Sastry RK., Ramesh R. (2018). Framework for mapping the drivers of coastal vulnerability and spatial decision making for climate-change adaptation: A case study from Maharashtra, India. Ambio.1-21. doi: 10.1007/s13280-018-1061-8. (Impact Factor: 3.616).
	51	Sridhar R., Dhivya P., Purvaja R., Ramesh R. (2018). National Green Tribunal of India—an observation from environmental judgements. Environmental Science and Pollution Research 25;11313–11318. (Impact Factor: 2.741).
	50	Kantharajan G., Pandey PK., Krishnan P., Ragavan P., Joyson JJ, Purvaja R., Ramesh R. (2018). Vegetative structure and species composition of mangroves along the Mumbai coast, Maharashtra India. Regional Studies in Marine Science. 19; 1-8. (Impact Factor: 0.608).
	49	Arumugam K., Srinivasalu S., Purvaja R., Ramesh R. (2018). Distribution of Major and Trace elements in Koppunuru area, Guntur

Year	S.No.	Details
		district, Andhara Pradesh, India. Data in Brief 03/2018, DOI:10.1016/j.dib.2018.02.060
	48	Krishnan P., Purvaja R., Sreeraj CR., Raghuraman R, Robin R.S, Abhilash K.R, Mahendra R.S, Anand A, Gopi M, Mohanty PC., Venkataraman K., Ramesh R. (2018). Differential bleaching patterns in corals of Palk Bay and the Gulf of Mannar. Current science.114(3); 679-685. (Impact Factor: 0.843)
	47	Marimuthu N., Purvaja R., Sathish M., Dinesh N., Ramesh R. (2018). Recruitment pattern of Scleractinian coral spats on neighbouring artificial substrates at Kurusadai Reef Complex, Gulf of Mannar, India. Aquatic Ecosystem Health and Management. doi.org/10.1080/14634988.2018.1435941 (Impact Factor: 1.033)
	46	Ramesh R., Banerjee K., Paneer Selvam A., Purvaja R Ahanalakshmi, and Krishnan, P. (2018). Legislation and policy options for conservation and management of seagrass ecosystems in India. Ocean & Coastal Management. 159; 46-50. (Impact Factor: 2.276).
	45	Krishnan P., Purvaja R., Sreeraj C.R., Raghuraman R., Robin R.S., Abhilash, K.R., Mahendra R.S., Anand A., Gopi M., Mohanty P.C., Venkataraman K. and Ramesh R. (2018). Differential bleaching patterns in corals of Palk Bay and Gulf of Mannar. Current Science. 114 (3),879-885. (Impact Factor: 0.843).
	44	Samuel DV., Krishnan P., Abhilash KR., Sreeraj CR., Patro S., Sankar R., Margi Purohit., Purvaja R and Ramesh R. (2018). Diversity of marine molluscs in the bycatch from lobster nets, Erwadi, Gulf of Mannar. Indian Journal of Geo-Marine Sciences. 47(01):170-175. (Impact Factor: 0.289).
	43	George G., Krishnan P., Mini KG., Salim SS., Ragavan P., Tenjing SY., Ramesh, R. (2018). Structure and regeneration status of mangrove patches along the estuarine and coastal stretches of Kerala, India. Journal of Forestry Research, 1-12. doi: 10.1007/s11676-018-0600-2 (Impact Factor: 0.774).
2017	42	Kiruba Sankar R., Krishnan P., Dam Roy S., Raymond JA., Goutham Bharathi Lohith-Kumar K., P Ragavan M., Kaliamoorthy., Muruganandam R., Rajakumari S., Purvaja R., Ramesh, R. (2017). Structural complexity and tree species composition of mangrove forests of Andaman Islands, India. Journal of coastal conservation. 22(2); 217-234. (Impact Factor: 1.160).
	41	Sathiyabama VP., Ramesh R., Purvaja R., Robin RS., Suganya M.D., Hariharan G. and Ganguly D. (2017). Assessment of human induced stress on the Karaikal coast: A multi-dimensional approach for evaluating the pollution status. Eco. Env. & Cons. 24 (1), 340-349. (Impact Factor: 0.06)
	40	Gejo Anna G., Akhil A., Magesh G., Krishnan P., Purvaja, R and Ramesh R. (2017). A comprehensive geospatial assessment of seagrass

Year	S.No.	Details
		distribution in India. Ocean and Coastal Management. 159; 16-25. (Impact Factor: 2.276).
	39	Singh KS., Bonthu S., Purvaja R., Robin RS., Kannan, BAM and Ramesh R. (2017). Prediction of heavy rainfall over Chennai Metropolitan City, Tamil Nadu: Impact of microphysical parameterization schemes. Atmospheric Research. 202, 219-234. (Impact Factor: 3.817).
	38	Deepak Samuel V., Krishnan P., Sreeraj CR., Chamundeeswari K., Parthiban C., Sekar V., Purvaja, R. and Ramesh R. (2017). An updated checklist of Echinoderms from Indian waters. Zootaxa, 4354(1), 1-68. (Impact Factor: 0.931)
	37	Ganguly D., Singh G., Purvaja R., Bhatta1 R., Paneer Selvam A., Banerjee K., and Ramesh R. (2017). Valuing the carbon sequestration regulation service by seagrass ecosystems of Palk Bay and Chilika, India. Ocean and Coastal Management. 159; 26-33. (Impact Factor: 2.276).
	36	Viswanathan C., Goutham S., Deepak Samuel V., Purvaja R and Ramesh R. (2017). Symbiotic brachyuran crab Eumedonus zebra Alcock, 1895 (Crustacea: Decapoda: Pilumnidae) – A first record from South east coast of India. Indian Journal of Geo-Marine Sciences. (Impact Factor: 0.289).
	35	Rocktim RD., Kantharajan G., Goutham S., Deepak SK, Krishnan P., Rajkumar Rajan Purvaja R, (2017). First report of Antigona somwangi HUBER, 2010 (Mollusca: Bivalvia: Veneridae) from India. Journal of Conchology, 42(5):379-380
	34	Kantharajan, G., Pandey, P.K., Krishnan, P., Deepak S.V., Bhartia V.S. and Purvaja, R. (2017). Molluscan diversity in the mangrove ecosystem of Mumbai, west coast of India. Regional Studies in Marine Science Vol: 14, 102–111. (Impact Factor: 1.189).
	33	Rocktim RD., Joyson JJ., Sankar R., Deepak Samuel V., Krishnan P., Purvaja, R and Ramesh R. (2017). Limited distribution of Devil snail Faunus ater (Linnaeus, 1758) in tropical mangrove habitats of India. Indian Journal of Geo-Marine Sciences, 47 (10); 2002-2007. (Impact Factor: 0.289).
	32	Banerjee K., Swati MS., Purvaja R and Ramesh R. (2017). Salt Marsh: Ecologically Important, Yet Least Studied Blue Carbon Ecosystems in India. Journal of Climate Change. 3; 59-72.
	31	Sachithanandam V., Mageswaran T., Sridhar R., Arumugam K., Purvaja, R. and Ramesh R. (2017). Rapid assessment on mass mortality of fishes in ennore estuary of Tamil Nadu, India. Indian Journal of Geo-Marine Sciences. 46(8):1647-1650. (Impact Factor: 0.289).
	30	Travnikov O., Angot H., Artaxo P., Bencardino M., Bieser J., and Ramesh R., et al., (2017). Multi-model study of mercury dispersion in the atmosphere: Atmospheric processes and model

Year	S.No.	Details
		evaluation. Atmospheric Chemistry and Physics, 17(8), 5271. (Impact Factor: 5.318).
	29	Marimuthu N., Purvaja R., Robin RS., Debasis Tudu., Hariharan G., and Ramesh R. (2016). Spatial variation in the health of coral reef communities of Palk Bay, southeast coast of India. Aquatic Ecosystem Health & Management. 19(4), 360-367. (Impact Factor: 0.455).
	28	Ganguly D., Singh G., Purvaja P., Paneer Selvam A., Banerjee K and Ramesh R. (2017). Seagrass metabolism and carbon dynamics in a tropical coastal embayment. Ambio, Vol 46(6); 667-679. (Impact Factor: 3.616).

2. Edited Volumes /Books (2011- 2018)

S.No	Edited Books/Volumes
3.	CLIMATE CHANGE AND THE VULNERABLE INDIAN COAST Edited by Ramesh. R, Bhatt J.R. **(2018)** Ministry of Environment, Forest and Climate Change, New Delhi. ISBN 978-93-5346-195-9
2	Coasts and Estuaries:The Future . Eds Eric Wolanski John Day Mike Elliott Ramachandran Ramesh (2019) ISBN**:** 9780128140031. Elsevier
1	Initial Strategic Research Plan for Future Earth in Asia. Eds. Manton M., Yasunari T., Ailikun Mallee H., Lasco R. and Ramesh R. (2015) China Meteorological Press, 133pp.

3. Chapters in Peer-reviewed Books and Edited Volumes (2011- 2018)

Year		Details
2018	16	Ramesh R., Dharmaraj M., Varun Kumar G., Muruganandam R., Mary Divya Suganya G, Sathishkumar S., Badarees KO., Manik Mahapatra, Deepak Samuel. V and Purvaja. R. (2018). Hazard line for the coast of India and its implications in coastal management. Climate Change and The Vulnerable Indian Coast. Edited by Ramesh. R, Bhatt J.R. Ministry of Environment, Forest and Climate Change, New Delhi. Pp: 15-53.
	15	Deepak Samuel V., Purvaja R., Subba Reddy Bonthu., Abhilash KR., Viswanathan C., Mary Divya Suganya., Deepika B., Muruganandam R., Rajakumari S and Ramesh R. (2018). Vulnerability of coastal ecosystems and habitats due to erosion. Climate Change and The Vulnerable Indian Coast. Edited by Ramesh. R, Bhatt J.R. Ministry of Environment, Forest and Climate Change, New Delhi. Pp: 73-92.

Year		Details
	14	Purvaja R., Paneerselvam A., Banerjee B., Sappal S M and Ramesh R. (2018). Greenhouse gas emissions from blue carbon ecosystems. Climate Change and The Vulnerable Indian Coast. Edited by Ramesh. R, Bhatt J.R. Ministry of Environment, Forest and Climate Change, New Delhi. Pp: 305-327.
	13	Purvaja R., Singh G., Gejo Anna Geevarghese., Ganguly D., Harikrishna Prasad M., Saha A, Arumugam K and Ramesh. R. (2018). Carbon sequestration in coastal ecosystems of India. Climate Change and The Vulnerable Indian Coast. Edited by Ramesh. R, Bhatt J.R. Ministry of Environment, Forest and Climate Change, New Delhi. Pp: 329-346.
	12	Purnima Jalihal., Purvaja R., Subba Reddy Bonthu and Ramesh R. (2018). Renewable energy technologies for mitigating climate change. Climate Change and The Vulnerable Indian Coast. Edited by Ramesh. R, Bhatt J.R. Ministry of Environment, Forest and Climate Change, New Delhi. Pp: 359-375.
	11	Ramesh R, Bhatt J R, Ahana Lakshmi and Purvaja R. (2018). Coastal governance in times of climate change. Climate Change and The Vulnerable Indian Coast. Edited by Ramesh. R, Bhatt J.R. Ministry of Environment, Forest and Climate Change, New Delhi. Pp: 377-394.
2017	10	Asir Ramesh., Priya P., Priya Narayanan., Karthik N., Senthil Vel A., and Ramesh R. 2016. Decentralised planning for sustainable livelihoods of fishermen: A study in two fishing villages of Tamil Nadu. The New Rural Paradigm : Policies and Governance (Eds.) pp 169-184.
	9	Krishnan P., Deepak Samuel V., Sreeraj CR., Abhilash, KR., Seshdev-Patro, Sankar R., Margi Purohit Dharani G., Purvaja R. and Ramesh, R. 2016. Digital repositories for coastal wetland biodiversity in South Asia: A conceptual framework from India. In: Prusty et al., (Eds), Wetland Science: Perspectives from South Asia, Springer. pp.51-65.
	8	Shesdev Patro, Krishnan P., Deepak Samuel V., Purvaja R., Ramesh, R. 2016. Seagrass and salt marsh ecosystems in South Asia - An overview of diversity, distribution, threats and conservation status. In: Prusty et al., (Eds), Wetland Science: Perspectives from South Asia, Springer. pp.87-104.
	7	Pasupalati N., Nath M., Sharan A., Narayanan P., Bhatta R., Ramesh R and Purvaja R (2017). Economic Valuation of Wetland Ecosystem Goods and Services. In Wetland Science; Springer India, pp. 259-284.
	6	Ramesh R., Purvaja R., Krishnan P., Ahana Lakshmi., Abhilash, KR., Kingsley PW. (2017). Conservation of Coastal Wetlands - An Appraisal of the Policy and Legal Framework among South Asian Nations. Wetland Science: Perspectives from South Asia, Springer, pp. 515-544.
	5	Roy SD., Krishnan P., Patro S., George G., Velmurugan A., Sankar RK., and Purvaja, R. (2017). Wetlands of Small Island Nations in South Asia vis-à-vis

Year	Details
	the Mainland and Island Groups in India: Status and Conservation Strategies. In Wetland Science (pp. 31-48). Springer India.
	4 Ramesh R., Abhilash KR., Margi Purohit., Krishnan P., Ahana Lakshmi., Purvaja R., Kingsley PW. (2016). Involvement of Community in Managing Coastal Wetlands in South Asia: Status, Issues and Challenges. Wetland Science: Perspectives from South Asia, Springer, pp. 545-562.

4. Technical Reports (2011- 2018)

Year	Title	Report No
2017	Impact of Kappaphycus Cultivation on the Coastal Environment in India_Y2017	NCSCM_TR_59
2017	Landscape Level plan for Sindhudurg Coastal Marine Ecosystem_Y2017	NCSCM_TR_60
2017	Sindhudurg Phase II Mapping Coastal Vulnarability and Hazard Mitigation Potential of ESAs_Y2017	NCSCM_TR_61
2017	Guidelines and resource manual for decentralized micro planning in coastal fishing villages	NCSCM_TR_62
2017	Sand dunes of Goa	NCSCM_TR_63
2017	Knowledge Benchmarks	NCSCM_TR_64
2017	IIMP for Bangaram Islands_Y2017	NCSCM_TR_65
2017	IIMP for Tinnakara Island_Y2017	NCSCM_TR_66
2017	IIMP for Suheli Island_Y2017	NCSCM_TR_67
2017	IIMP for Cheriyam Island_Y2017	NCSCM_TR_68

5. Atlases (2017- 2018)

Year	Title	Atlas No
2017	Coastal Zone Management Plan for South Goa	NCSCM_AT_16
2017	Coastal Zone Management Plan for North Goa	NCSCM_AT_17
2017	Assessment of High Resolution Shoreline Change of Goa	NCSCM_AT_18
2017	ATLAS for Offshore Wind Energy Potential in India	FTR
2017	GHG Atlas of Chilka lagoon	FTR
2017	Atlas on coastal sediment cells along the West and East coasts of India	GEO

6. Factsheets (2017- 2018)

Year	Title	Report No
2017	CvCA Report Cards	NCSCM_FS_10
2017	COP24 Side Event Factsheet	NCSCM_FS_11

7. Annual reports (2011- 2018)

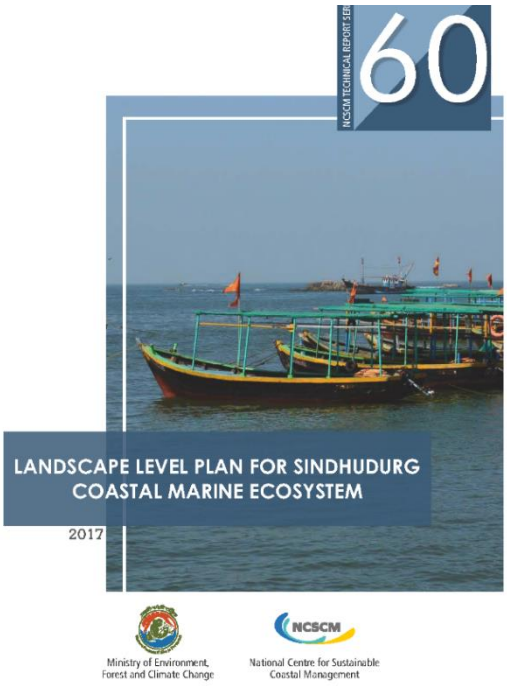
S.No	Year	Title	Report No
1	2010	NCSCM_Inception Report_2010-2011	NCSCM_AR_1
2	2011	NCSCM_Annual Report_2011-2012	NCSCM_AR_2
3	2012	NCSCM_Annual Report_2012-2013	NCSCM_AR_3
4	2013	NCSCM_Annual Report_2013-2014	NCSCM_AR_4
5	2014	NCSCM_Annual Report_2014-2015	NCSCM_AR_5
6	2015	NCSCM_Annual Report_2015-2016	NCSCM_AR_6
7	2016	NCSCM_Annual Report_2016-2017	NCSCM_AR_7
8	2017	NCSCM_Annual Report_2016-2018	NCSCM_AR_8

C) Publications & Report

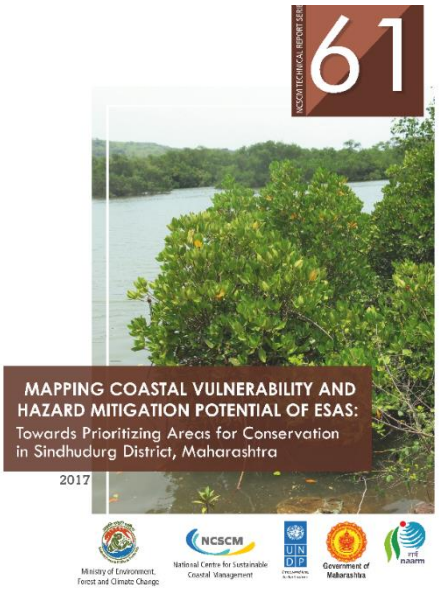
Reports & Manuals

Impact of Kappaphycus cultivation on the coastal Environment in India

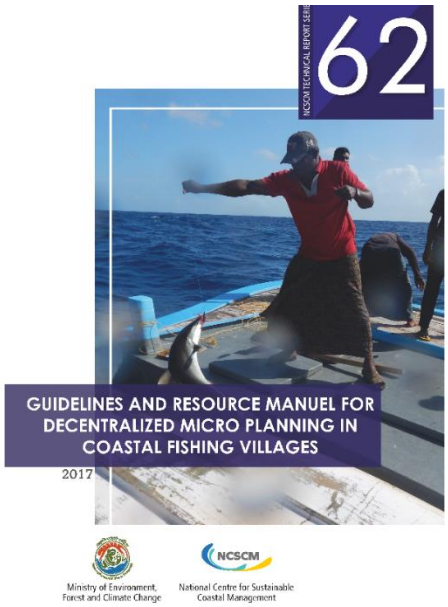
Landscape Level Plan for Sindhudurg Coastal Marine Ecosystem



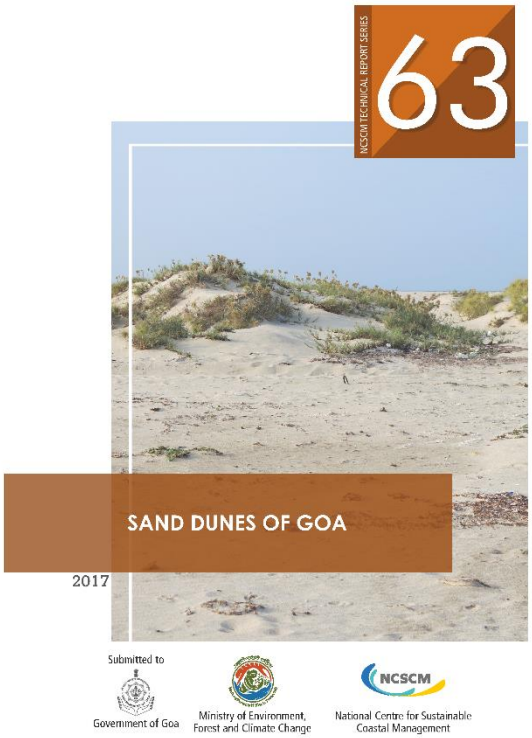
Mapping of Coastal Vulnerability and Hazard Mitigation Potential of ESA's, Sindhudurg



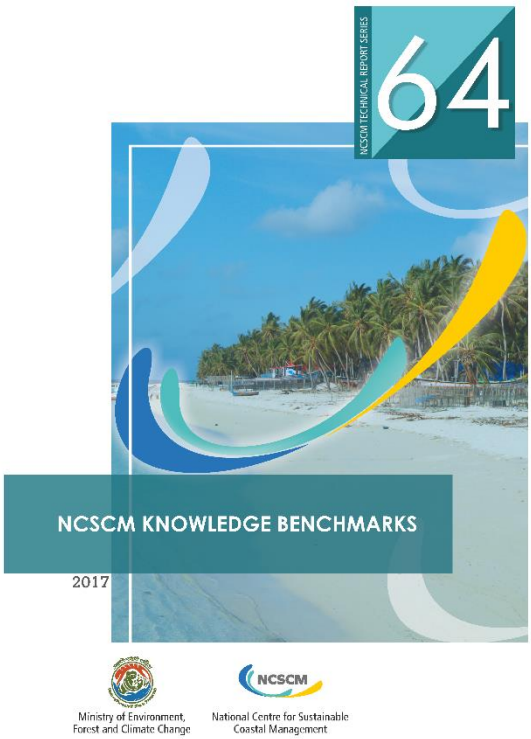
Guidelines of Resource Manual for Decentralized Micro Planning in Coastal Fishing Villages



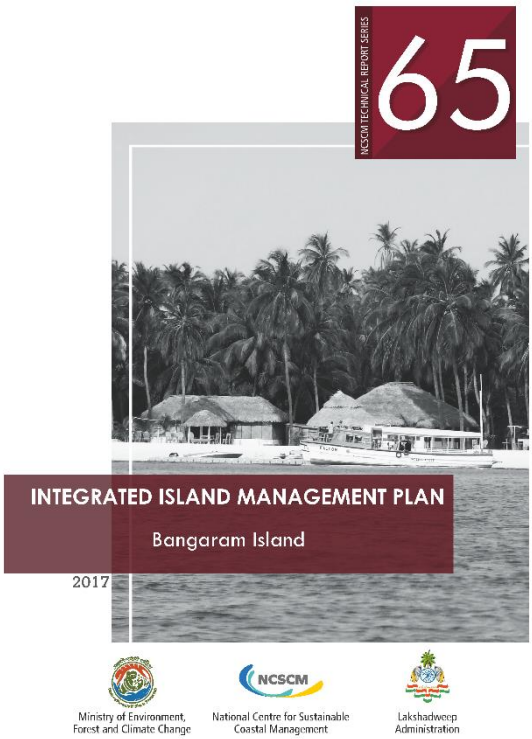
Sand Dunes of Goa



NCSCM Knowledge Benchmarks



IIM Plan – Bangaram Island



IIM Plan – Tinnakara Island

IIM Plan – Suheli Island

IIM Plan – Cheriyam Island

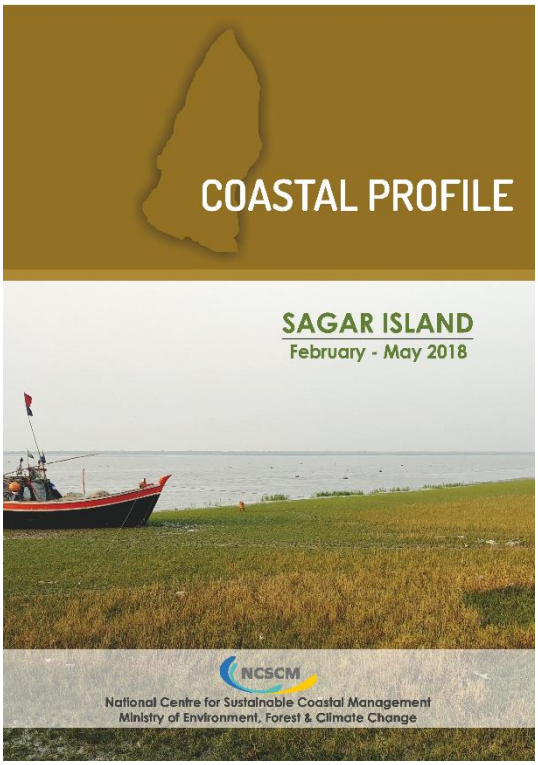
Research Action Plan April 2018 – June 2019

Project Preliminary Report NCSCM_ICZM_Phase II

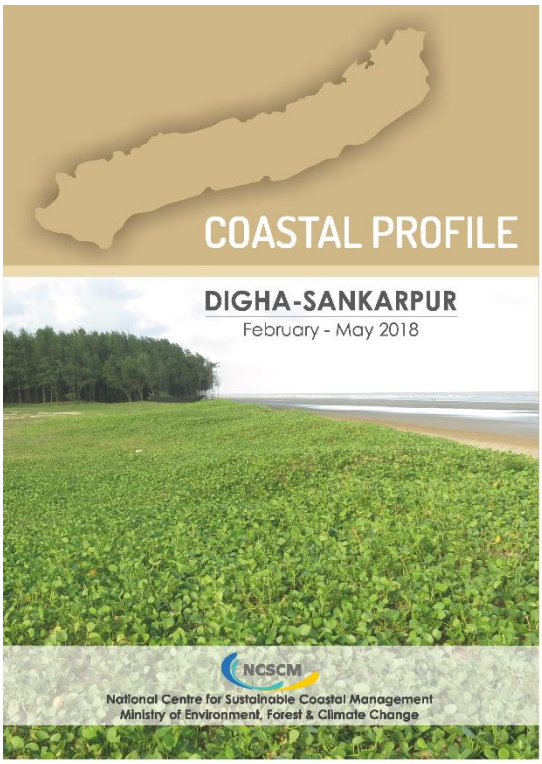
ICZM – West Bengal Reports

Inception Report

Coastal Profile – Sagar Island



COASTAL PROFILE – Digha - Sankarpur

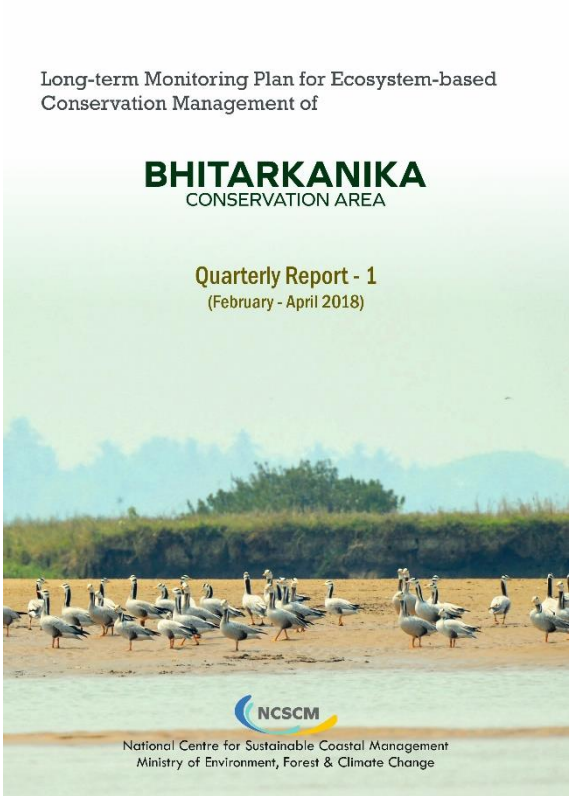


ICZM – WB – A Conceptualization

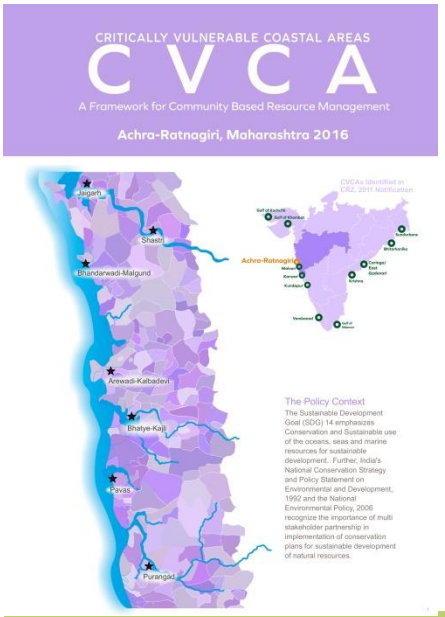
EMP Phase II – KPCL Port

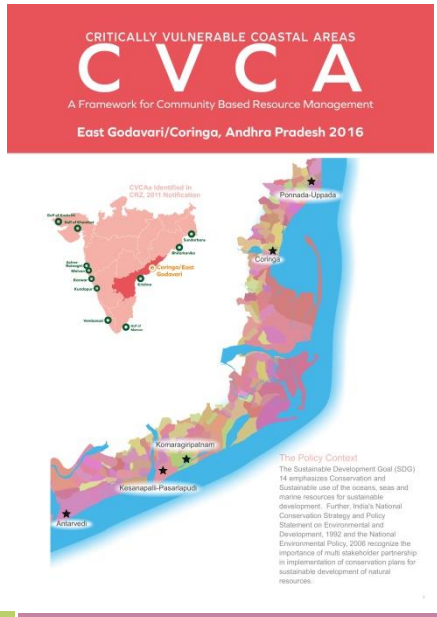
Assessment of Coastal Biodiversity for Shamuka Beach - Odisha

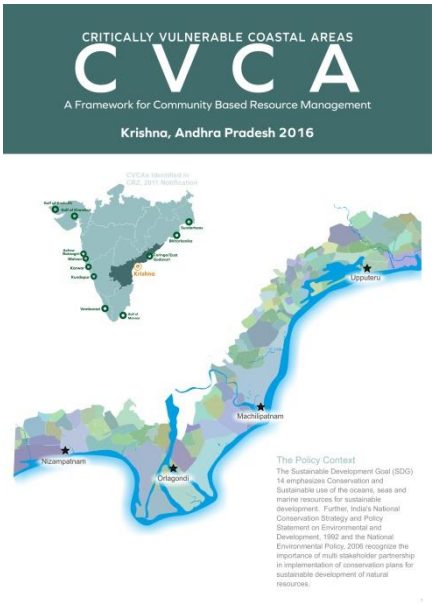
Ecosystem based Conservation Management of Bhitarkanika

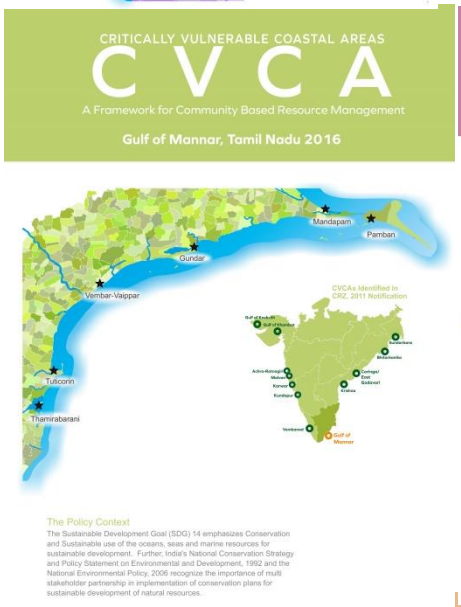


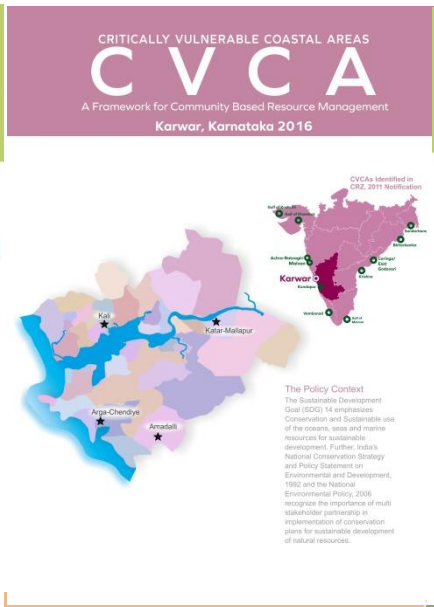
CVCA Report Cards 2016-2017

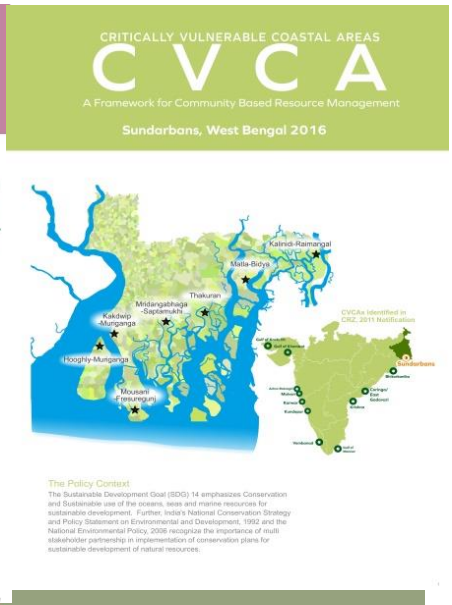


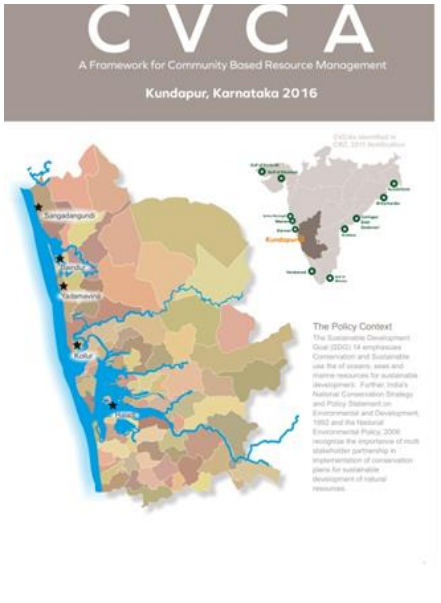


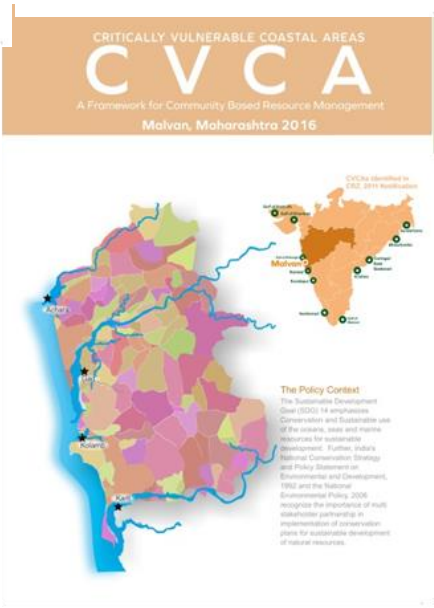


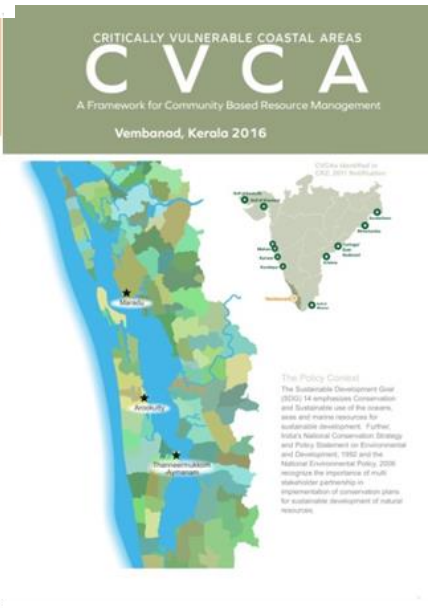












India @ COP24 Y 2018

INDIAN INCOME TAX RETURN ACKNOWLEDGEMENT

[Where the data of the Return of Income in Form ITR-1 (SAHAJ), ITR-2, ITR-3, ITR-4 , ITR-5, ITR-6,ITR-7 transmitted electronically with digital signature]

Assessment Year 2018-19

PERSONAL INFORMATION AND THE DATE OF ELECTRONIC TRANSMISSION

Name			PAN
NATIONAL CENTRE FOR SUSTAINABLE COASTAL MANAGEMENT			AABAN2289A
Flat/Door/Block No	**Name Of Premises/Building/Village**		**Form No. which has been electronically transmitted**
KOODAL BUILDING	ANNA UNIVERSITY CAMPUS		ITR-7
Road/Street/Post Office	**Area/Locality**		
GUINDY	CHENNAI		**Status** AOP/BOI
Town/City/District	**State**	**Pin/ZipCode**	**Aadhaar Number/Enrollment ID**
CHENNAI	TAMILNADU	600025	

Designation of AO(Ward/Circle) DCIT(EXEMP) CHENNAI CIRCL — Original or Revised: ORIGINAL

E-filing Acknowledgement Number: 334897021141018 — Date(DD/MM/YYYY): **14-10-2018**

COMPUTATION OF INCOME AND TAX THEREON

1	Gross total income			1	0
2	Deductions under Chapter-VI-A			2	0
3	Total Income			3	0
3a	Current Year loss, if any			3a	0
4	Net tax payable			4	0
5	Interest and Fee Payable			5	0
6	Total tax, interest and Fee payable			6	0
7	Taxes Paid	a Advance Tax	7a 0		
		b TDS	7b 873863		
		c TCS	7c 0		
		d Self Assessment Tax	7d 0		
		e Total Taxes Paid (7a+7b+7c +7d)		7e	873863
8	Tax Payable (6-7e)			8	0
9	Refund (7e-6)			9	873860
10	Exempt Income	Agriculture	0	10	0
		Others	0		

This return has been digitally signed by R RAMESH in the capacity of DIRECTOR

having PAN AAMPR9940A from IP Address 14.139.173.68 on 14-10-2018 at CHENNAI

Dsc Sl No & issuer 24554344 13769520333CN=SafeScrypt sub-CA for RCAI Class 2 2014,OU=Sub-CA,O=Sify Technologies Limited,C=IN

DO NOT SEND THIS ACKNOWLEDGEMENT TO CPC, BENGALURU

K. RAMANAN & CO
Chartered Accountants

#778, D-Sector, 9th Street, Syndicate Bank Colony,
Anna Nagar West Extn, Chennai - 600 101.
Mob : +91-9840149391 | Ph : 044-48575362
E-mail : kramanan1949@gmail.com
Web : www.caramanan.com

INDEPENDENT AUDITOR'S REPORT

To

The Project Director,

National Centre for Sustainable Coastal Management

Chennai

Report on the Financial Statements

We have audited the financial statements of National Centre for Sustainable Coastal Management(NCSCM), which comprise the Balance Sheet as at 31 March 2018, the Income & Expenditure Accounts and Receipts & Payments Accounts for the year then ended, and a summary of significant accounting policies, notes to accounts and other explanatory information.

Management's Responsibility for the Financial Statements

Management is responsible for the preparation of these financial statements that give a true and fair view of the financial position, financial performance and cash flows of the Society in accordance with the Accounting Standards applicable and issued by the Institute of Chartered Accountants of India. The Society has prepared and maintained accounts in accordance with the Financial Manual adopted by the society. This responsibility includes the design, implementation and maintenance of internal financial control relevant to the preparation and presentation of the financial statements that give a true and fair view and are free from material misstatement, whether due to fraud or error.

Auditor's Responsibility

Our responsibility is to express an opinion on these financial statements based on our audit. We conducted our audit in accordance with the Standards on Auditing issued by the Institute of Chartered Accountants. Those Standards require that we comply with ethical requirements and plan and perform the audit to obtain reasonable assurance about whether the financial statements are free from material mis-statement.

An audit involves performing procedures to obtain audit evidence about the amounts and disclosures in the financial statements. The procedures selected depend on the auditor's judgment, including the assessment of the risks of material misstatement of the financial statements, whether due to fraud or error. In making those risk assessments, the auditor considers

internal control relevant to the Society's preparation and fair presentation of the financial statements in order to design audit procedures that are appropriate in the circumstances. An audit also includes evaluating the appropriateness of accounting policies used and the reasonableness of the accounting estimates made by management, as well as evaluating the overall presentation of the financial statements.

We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our audit opinion.

Opinion

In our opinion and to the best of our information and according to the explanations given to us, the financial statements read along with the Notes to accounts give the information required by the Act in the manner so required and give a true and fair view in conformity with the accounting principles generally accepted in India:

a) in the case of the Balance Sheet, of the state of affairs of the Company as at March 31, 2018;

b) in the case of the Income & Expenditure Account the excess of income over expenditure and in the case of Receipts & Payments Account, of the cash flows for the year ended on that date.

For K.Ramanan & Co.
Chartered Accountants
(FRN: 02926N)

(CA.K.RAMANAN)
PROPRIETOR
M.NO. 019177

Place: Chennai
Date : 13/10/2018

K. RAMANAN & CO.
K. RAMANAN
M. No. 019177
778, 9TH STREET
ANNA NAGAR W.E.,
CHENNAI - 101
Chartered Accountants

NATIONAL CENTRE FOR SUSTAINABLE COASTAL MANAGEMENT

NATIONAL CENTER FOR SUSTAINABLE COASTAL MANAGEMENT
ANNA UNIVERSITY CAMPUS
GUINDY, CHENNAI-600025.

Consolidated Receipts and Payments Account for the year ended on March 31st, 2018

(in Rs.)

RECEIPTS	AMOUNT	PAYMENTS	AMOUNT
Opening Balance			
Bank Accounts	23,89,92,505.05	Advance for ESA	55,40,000.00
		ADVANCES	84,86,888.29
Advance to Institutes	1,79,512.00	Advertisement Charges	25,269.00
Arrear EPF Recovery	1,19,535.00	Capacity Building & Projects	17,26,050.00
Bid Security	14,38,972.00	CGST INPUT CREDIT	5,43,731.00
DELTA - Professional Tax	1,095.00	CGST INPUT CREDIT -OFSDS	3,235.00
Deposit with CMWSB	25,92,000.00	Communication	4,30,941.00
EPF	17,76,802.00	CONTINGENCY ADV	8,68,601.00
EPF - Project Staff	4,16,633.00	DEFERRED CPEX-CTG-A	39,76,851.00
FUND RECEIVED	23,16,000.00	Deferred Overhead Expenses	19,10,448.00
Interest on Grants in Aid	1,48,105.00	Deferred Revenue Expenses	1,94,46,141.00
Interest on Saving Bank A/c	70,72,785.20	Duties & Taxes	1,08,51,300.00
Interest on Short Term Deposit	5,895.12	EPF	3,70,921.00
Interst on Saving Bank Acccount	31,596.00	GPF	20,000.00
Labour Cess	12,63,540.00	Group Insurance Claim	22,44,677.00
Liabilities for ZSI Port Blair	2,30,000.00	ICZMP-WB-EXP	7,11,295.23
Liquidity Damages	26,967.00	IGST INPUT CREDIT	2,44,941.00
Miscellaneous Income	20.00	Investment Cost	11,54,578.00
NCSCM	96,41,046.00	NCR Recoveries	28,64,656.00
NCSCM-ICZMP	5,22,369.00	NCSCM - Revenue Activity	2,19,069.00
Notice Pay	16,000.00	NCSCM-ICZMP	24,782.00
NPMU	1,54,49,260.00	NPS	42,414.00
NPMU - Fund Received	64,00,00,000.00	OFSDS PROJECTS EXP	3,03,326.00
NPMU - Interest on FD	1,11,42,327.00	Operational Cost	13,00,60,036.28
NPMU -SB Interest	6,76,553.00	Other Grant IN AD-SP-2	34,508.00
Other Recoveries - Staff	20,000.00	OTHER GRANTS IN PROJECTS	6,50,472.00
Performance Guarantee	65,49,779.00	Physical	23,79,70,457.85
Recovery for Pending Work -METEC	8,53,773.00	Professional Tax	96,935.00
Recovery for Pending Work-RPP	96,33,275.00	Project Management	29,23,290.00
Retention Money	31,50,406.00	Provisions	22,913.00
REVENUE ACTIVITY	1,56,03,422.00	Refund of Arears EPF	39,260.00
Revenue Officer, Corporation, Chennai	13,425.00	Retention (Kewaunee)	12,662.00
Sundry Creditors	1,60,70,311.00	Retention Money-Renaatus	4,12,398.00
Sundry Debtors	12,18,22,958.75	Revenue Activity	70,576.00
TDS - 194J	33,000.00	REVENUE ACTIVITY EXP PAYABLE	2,60,000.00
TDS Payable - Others	4,78,865.00	SGST INPUT CREDIT-OFSDS	3,235.00
TDS Payable - Staff	15,11,891.00	SGST INPUT TAX CREDIT	5,43,731.00
TRUC - Professional Tax	2,190.00	SICOM-OVERHEADS	8,94,591.00
Unpaid Bill Vinayaka Caterers	5,133.00	SINDHUDURG- PROJECT-REV EXP	22,07,737.68
UNPAID EXP- SRLPS	3,239.00	Sundry Creditors	27,086.00
Unpaid Hire Vehicle Charges-Grace	6,471.00	Sundry Debtors	1,61,07,415.00
Unreconiled Deposit-Sedimentcell	450.00	TA ADV	5,35,685.00
User's Fees	58,000.00	TAX CREDIT-C-A	51,19,675.00
Wrong Deposit by Staff	9,675.00	TAX CREDIT-C-B	1,91,666.00
		Tax Credit-RD	4,314.00
		TCS-CREDIT	19,129.00
		TDS Refund	41,319.00
		Term Deposit-059440100002870	3,44,000.00
		Tools & Plants	1,34,295.00
		TRUCK&DELTA	41,30,000.00
		Utilisation of Fund - DELTA	46,359.00
		Utilisation of Fund - TRUC	54,606.00
		VAT TDS	8,18,136.00
		Closing Balance	
		Bank Accounts	64,40,99,178.79
TOTAL	**1,10,98,85,781.12**	**TOTAL**	**1,10,98,85,781.12**

For National Centre for Sustainable Coastal Management

Director
National Centre for Sustainable Coastal Management
Ministry of Environment, Forest and Climate Change
Government of India, Anna University Campus
Chennai - 600 025, India

Director

Place: Chennai
Date : 13-10-2018

As per the Audit Report of even date attached
For K.Ramanan & Co
Chartered Accountants

K. RAMANAN & CO.
K. RAMANAN
M. No. 019177
778, 9TH STREET
ANNA NAGAR W.E.,
CHENNAI - 101
Chartered Accountants

(CA. K.Ramanan)
(M.No. 019177)
FRN: 02926S

NATIONAL CENTRE FOR SUSTAINABLE COASTAL MANAGEMENT
MINISTRY OF ENVIRONMENT, FOREST & CLIMATE CHANGE
GOVERNMENT OF INDIA
ANNA UNIVERSITY CAMPUS
CHENNAI-600025

Consolidated Income and Expenditure Account for the year ended 31st March, 2018

(In Rs.

Particulars	Amount	Amount	Particulars	Amount	Amount
1. NCSCM		**13,92,45,788.38**	**1. NCSCM**		**37,84,22,471.23**
Capacity Building & Projects	55,05,657.60		Grants in Aid	37,84,00,099.23	
Communication	4,30,941.00		Miscellaneous Income	22,372.00	
Operational Cost	13,33,09,189.78				
2. TRUC & DELTA		**1,00,965.00**	**2. TRUC & DELTA**		**1,00,965.00**
Utilisation of Fund Delta	46,359.00		Grants in Aid (DELTA)	46,359.00	
Utilisation of Fund Truc	54,606.00		Grants in Aid (TRUC)	54,606.00	
3. ESA & CVCA MAPPING		**3,46,039.00**	**3. ESA & CVCA MAPPING**		**32,69,329.00**
Operational Cost	3,46,039.00		Grants in Aid	32,69,329.00	
4. REVENUE ACTIVITY		**77,66,341.00**	**4. REVENUE ACTIVITY**		**2,27,93,460.61**
Advertisement Charges	25,269.00		Material Income	14,09,201.00	
TA/DA Expenses	16,38,409.00		Manpower Income	39,42,500.00	
Manpower Expenses	38,89,909.00		TA/DA Income	25,05,000.00	
Contingency Expenses	2,54,635.00		Contingency Income	33,13,000.00	
Overhead Expenses	19,58,119.00		NCSCM Overheads	20,73,940.00	
			IC Consultancy	24,08,637.00	
			IC RD	24,138.61	
			Interest on Savings A/c	70,72,785.20	
			Interest on Term Deposit	8,028.80	
			Interest on Tax Credit	11,230.00	
			Other Receipts	25,000.00	
5. OTHER GRANTS IN AID		**29,45,644.04**	**5. OTHER GRANTS IN AID**		**29,77,240.04**
Bank Charges	320.68		Grants In Aid: SDS 2	6,76,906.36	
Manpower Expense	6,86,453.00		Grants In Aid: SP 2	22,68,737.68	
Installation Charges	3,76,000.00		Interest on Saving Bank Account	31,596.00	
Consultancy Expense	7,80,000.00				
Contingency Expense	2,44,618.00				
Travel Expense	8,58,252.36				
Excess of income over expenditure		**25,71,58,688.46**			
Total		**40,75,63,465.88**	**Total**		**40,75,63,465.88**

For National Centre for Sustainable Coastal Management

Director
National Centre for Sustainable Coastal Management
Ministry of Environment, Forest and Climate Change
Government of India, Anna University Campus
Chennai - 600 025, India

Dr. R.Ramesh
Director, NCSCM
Place: Chennai
Date : 13-10-2018

As per the Audit Report of even date attached
For K.Ramanan&Co
Chartered Accountants

K.Ramanan

(CA K RAMANAN)
(M.NO 019177)
FRN: 02926S

K. RAMANAN & CO.
K. RAMANAN
M. No. 019177
778, 9TH STREET
ANNA NAGAR W.E.,
CHENNAI - 101
Chartered Accountants

NATIONAL CENTRE FOR SUSTAINABLE COASTAL MANAGEMENT

MINISTRY OF ENVIRONMENT, FOREST & CLIMATE CHANGE
GOVERNMENT OF INDIA
ANNA UNIVERSITY CAMPUS
CHENNAI-600025

Consolidated Balance Sheet as on 31st March 2018

(In Rs.)

Liabilities	Sch. No.	Amount	Assets	Sch. No.	Amount
Capital Account:-			**Fixed Assets:-**		
Corpus Fund	1	1,16,21,36,196.90	Investment Cost	-	5,12,71,590.00
			Physical	-	1,02,82,95,242.32
			Tools & Plants	-	1,34,295.00
Current Liabilities:-			Project Management (ESA)	-	3,96,53,309.00
Provisions	-	14,888.00	Equipment (DELTA)	-	9,37,864.00
NCR Recoveries	-	1,201.00	Equipment (TRUC)	-	1,37,528.00
Perfomance Guarantee	2	76,03,144.00	IT Equipments (Revenue Activity)	-	51,85,578.00
Bid Security	-	17,12,775.00			
Income Recognition Deferred	3	15,12,45,626.00	**Investment:-**		
Duties & Taxes	4	1,26,88,338.57	Fixed Deposit (UBI)	-	3,80,375.00
Labour Cess	5	40,18,685.00	Deposit	14	3,66,117.00
MS Cholamandalam Tax Credit	-	44,920.00			
Notional Recoveries from Salary	6	24,63,264.00	**Current Assets:-**		
Notice Pay	7	50,000.00	Bank Accounts	15	64,40,99,178.79
NPMU - Fund Received	8	43,26,74,660.62	Tax Credit (Revenue Activity)	16	1,07,59,117.68
Interest on MOES Funds (T&D)	-	4,29,348.00	Expense Recognition Deferred	17	2,29,83,276.50
Fund Received from SP2	-	15,42,212.32	Group Insurance Claim	-	22,44,677.00
Fund Received from SDS	-	1,28,23,093.64	Sundry Debtors	18	2,30,18,997.85
Retention Money	-	2,63,80,867.00	Advances	19	3,23,37,186.26
SICOM Overhead	9	1,22,85,206.88	Contingency Advance	20	76,650.00
Sundry Creditors	10	1,79,73,585.00	TA Advance	21	96,024.19
TDS Payable - Others	11	13,32,270.89	IZMP WB Expense	-	8,80,302.23
TDS Payable - Staff	12	16,05,079.00	Tax Credit of SDS	-	13,50,000.00
Unreconciled Deposits from Staff	-	56,867.00	TCS Credit (Deferred)	-	19,129.00
VAT TDS	-	10,58,459.00	Tax Credit Claimed (NCSCM)	-	2,235.00
MOES- DELTA	-	31,46,516.00			
MOES- TRUC	-	62,147.00			
Unpaid Hire Vehicle Charges	-	6,471.00			
Liabilities for ZSI Port Blair	-	2,30,000.00			
Liquidity Damages	-	26,967.00			
Recovery for Pending work	-	1,04,87,048.00			
User's Fee	-	58,000.00			
Unpaid Bills	-	8,372.00			
Wrong Deposit	13	37,633.00			
Inter Party A/c Balance	-	24,831.00			
TOTAL		**1,86,42,28,672.82**	**TOTAL**		**1,86,42,28,672.82**

For National Centre for Sustainable Coastal Management

Sd.
Dr. R. Ramesh
Director, NCSCM

Director
National Centre for Sustainable Coastal Management
Ministry of Environment, Forest and Climate Change
Government of India, Anna University Campus
Chennai - 600 025, India

Director

Place: Chennai
Date : 13-10-2018

As per the Audit Report of even date attached
For K.Ramanan & Co
Chartered Accountants

(CA. K.Ramanan)
(M.No. 019177)
FRN: 02926S

K. RAMANAN & CO.
K. RAMANAN
M. No. 019177
778, 9TH STREET
ANNA NAGAR W.E.,
CHENNAI - 101
Chartered Accountants

NATIONAL CENTRE FOR SUSTAINABLE COASTAL MANAGEMENT

MINISTRY OF ENVIRONMENT, FOREST & CLIMATE CHANGE
GOVERNMENT OF INDIA
ANNA UNIVERSITY CAMPUS
CHENNAI-600025

Schedules forming part of the accounts for the Year ended 31st March, 2018

Schedule-1 : Corpus Fund

Particulars	Amount
NCSCM	1,07,99,03,800.32
ESA & CVCA	3,96,53,309.00
TRUCK & DELTA	10,75,392.00
REVENUE ACTIVITY	4,14,72,099.58
OTHER GRANTS IN AID	31,596.00
TOTAL	**1,16,21,36,196.90**

Schedule-2 : Performance Guarantee/Security

Particulars	Amount
NCSCM	72,59,144.00
REVENUE ACTIVITY	3,44,000.00
TOTAL	**76,03,144.00**

Schedule-3 : Income Recognition Deferred (Revenue Activity)

Particulars	Amount
Material Income Deferred	1,56,41,691.57
Manpower Income Deferred	4,89,49,295.37
TA/DA Income Deferred	2,13,77,658.19
Contingency Income Deferred	2,51,82,737.96
NCSCM Overheads Deferred	1,97,20,219.00
IC Consultancy Deferred	2,03,74,023.91
TOTAL	**15,12,45,626.00**

Schedule-4 : Duties & Taxes

Particulars	Amount
REVENUE ACTIVITY	1,26,78,640.21
OGIA	9,698.36
TOTAL	**1,26,88,338.57**

Schedule-5 : Labour Cess

Particulars	Amount
NCSCM	40,17,429.00
ESA & CVCA	1,256.00
TOTAL	**40,18,685.00**

Schedule-6 : Notional Recoveries from Salary

Particulars	Amount
NCSCM	22,22,314.00
REVENUE ACTIVITY	2,17,394.00
ESA	4,707.00
TRUC & DELTA	7,224.00
OTHER GRANTS IN AID	11,625.00
TOTAL	**24,63,264.00**

Schedule-7 : Notice Pay

Particulars	Amount
NCSCM	34,000.00
REVENUE ACTIVITY	-
ESA	16,000.00
TOTAL	**50,000.00**

Schedule-8 : NPMU Fund Received

Particulars	Amount
NCSCM	43,35,81,412.14
ESA & CVCA	-9,06,751.52
TOTAL	**43,26,74,660.62**

Schedule-9: SICOM Overheads

Particulars	Amount
SICOM-OVERHEAD-CTG-A	1,09,54,271.88
SICOM-OVERHEAD-CTG-B	5,56,297.00
SICOM-OVERHEAD-CTG-C	7,44,838.00
SICOM-OVERHEAD-RD	29,800.00
TOTAL	**1,22,85,206.88**

Schedule-10 : Sundry Creditors

Particulars	Amount
NCSCM	18,98,511.00
TRUC & DELTA	4,763.00
OGIA	1,60,70,311.00
TOTAL	**1,79,73,585.00**

Schedule-11 : TDS Payable - Others

Particulars	Amount
NCSCM	13,63,432.89
ESA & CVCA	10,539.00
TRUC & DELTA	-3,153.00
REVENUE ACTIVITY	-38,548.00
TOTAL	**13,32,270.89**

Schedule-12 : TDS Payable - Staff

Particulars	Amount
NCSCM	15,95,463.00
ESA & CVCA	434.00
REVENUE ACTIVITY	9,182.00
TOTAL	**16,05,079.00**

Schedule-13 : Wrong Deposit

Particulars	Amount
NCSCM	9,675.00
REVENUE ACTIVITY	27,958.00
TOTAL	**37,633.00**

Schedule-14 : Deposits

Particulars	Amount
NCSCM	22,117.00
REVENUE ACTIVITY	3,44,000.00
TOTAL	**3,66,117.00**

Schedule-15 : Bank Accounts

Particulars	Amount
NCSCM	41,96,42,274.77
ESA & CVCA	2,13,94,105.48
REVENUE ACTIVITY	17,11,22,833.64
TRUC & DELTA	39,43,478.00
OTHER GRANTS IN AID	2,79,96,486.90
TOTAL	**64,40,99,178.79**

Schedule-16 : Tax Credit (Revenue Activity)

Particulars	Amount
TAX CREDIT CLAIMED	10,60,814.68
TAX CREDIT DEFERRED	96,98,303.00
TOTAL	**1,07,59,117.68**

Schedule-17 : Expense Recognition Deferred (Revenue Activity)

Particulars	Amount
TA/DA Expense Deferred	52,77,304.50
Contingency Expense Deferred	13,52,368.00
Manpower Expense Deferred	1,40,45,204.00
Material Expense Deferred	1,22,400.00
Outsourcing Expense Deferred	21,86,000.00
TOTAL	**2,29,83,276.50**

Schedule-18 : Sundry Debtors

Particulars	Amount
NCSCM	1,60,87,311.00
REVENUE ACTIVITY	67,81,686.85
OGIA	1,50,000.00
TOTAL	**2,30,18,997.85**

Schedule-19 : Advances

Particulars	Amount
NCSCM	2,84,55,112.26
ESA & CVCA	29,24,574.00
REVENUE ACTIVITY	1,57,500.00
TRUC & DELTA	-
OTHER GRANTS IN AID	8,00,000.00
TOTAL	**3,23,37,186.26**

Schedule-20 : Contingency Advance

Particulars	Amount
REVENUE ACTIVITY	42,460.00
OGIA	34,190.00
TOTAL	**76,650.00**

Schedule-21 : TA Advance

Particulars	Amount
REVENUE ACTIVITY	32,703.00
OGIA	63,321.19
TOTAL	**96,024.19**

NATIONAL CENTRE FOR SUSTAINABLE COASTAL MANAGEMENT

Annexure to the Balance Sheet as on March 31st,2018

ACCOUNTING POLICIES & NOTES TO ACCOUNTS

A Significant Accounting Policies :

1. ***Basis of Accounting :***
   a) The Society follows the cash basis system of accounting in the preparation of accounts.
   b) The accounts are prepared under the historical cost convention and on the basis of going concern concept.
2. ***Fixed Assets & Depreciation :***
   a) Fixed assets are stated at their original cost of acquisition inclusive of inward freight, duties & expenditure incurred in the acquisition, construction/installation including part of salaries and wages paid to own staff.
   b) The assets transferred as grant in aid are written off as revenue expenses.
   c) The depreciation is not charged on the fixed assets by the society.
3. ***Current Assets And Loans & Advances:***
   In the opinion of the management, current assets, loans and advances as shown in the Balance Sheet have a value of realization in the ordinary course of business at least equal to the amount at which they are stated.

B Notes to Accounts :

1. Being a Society it is not mandatory to give previous year's figures in the Balance Sheet.

For National Centre for Sustainable Coastal Management

Director

Director
National Centre for Sustainable Coastal Management
Ministry of Environment, Forest and Climate Change
Government of India, Anna University Campus
Chennai - 600 025

As per Audit Report of even date attached
For K.Ramanan & Co
Chartered Accountants

(CA.K.Ramanan)
Proprietor
Place: Chennai
Date : 13.10.2018

K. RAMANAN & CO.
K. RAMANAN
M. No. 019177
778, 9TH STREET
ANNA NAGAR W.E.,
CHENNAI - 101
Chartered Accountants

NATIONAL CENTRE FOR SUSTAINABLE COASTAL MANAGEMENT

ANNA UNIVERSITY CAMPUS

GUINDY

CHENNAI - 600025

Receipts and Payments Account for the year ended on March 31st, 2018

(In Rs.)

RECEIPTS	AMOUNT	PAYMENTS	AMOUNT
Opening Balance			
Bank Accounts	14,97,23,936.00	Refund of Arr Epf-Sunadrmanikandan	6,680.00
		TDS Refund ROBIN RS	9,212.00
Miscellaneous Income	20.00	TDS Refund to Deepak Samuel	9,673.00
Unreconiled Deposit-Sedimentcell	450.00	Refund of Arr Epf-Subba Reddy	12,600.00
UNPAID EXP- SRLPS	3,239.00	Retention (Kewaunee)	12,662.00
Unpaid Bill Vinayaka Caterers	5,133.00	Refund of Epf Arr to Bindu	19,980.00
Wrong Deposit by Staff	9,675.00	GPF	20,000.00
Notice Pay	16,000.00	TDS Refund to Mary Divya	22,434.00
Other Recoveries - Staff	20,000.00	Other Grant IN AD-SP-2	34,508.00
Liquidity Damages	26,967.00	NPS	42,414.00
Retention Money- Ensysy Tech	38,333.00	Revenue Activity	70,576.00
Retention - Cold Room Eackon	43,553.00	Professional Tax	96,935.00
User's Fees	58,000.00	Tools & Plants	1,34,295.00
Retention Money (METEC DESIGN)	2,45,592.00	EPF Arrear - Project Staff	3,61,969.00
Retention Money-Eakcon-Cleanroom	3,76,990.00	Retention Money-Renaatus	4,12,398.00
EPF - Project Staff	4,16,633.00	Communication	4,30,941.00
Retention (KPL FURNITURE)	4,20,971.00	VAT TDS	8,18,136.00
TDS Payable - Others	4,78,865.00	Investment Cost	11,54,578.00
NPMU -SB Interest	6,76,553.00	Capacity Building & Projects	17,26,050.00
Retention Money - Goderj	8,28,200.00	Group Insurance Claim	22,44,677.00
Recovery for Pending Work -METEC	8,53,773.00	NCR Recoveries	28,64,656.00
Retention Money-MACRO	11,96,767.00	TRUCK&DELTA	41,30,000.00
Labour Cess	12,63,540.00	Advance for ESA	55,40,000.00
Bid Security	14,38,972.00	Advances	77,58,155.10
TDS Payable - Staff	15,11,891.00	Sundry Debtors	1,59,57,415.00
EPF	17,46,230.00	Operational Cost	12,98,13,987.28
Deposit with CMWSB	25,92,000.00	Physical	23,79,70,457.85
Performance Guarantee	65,49,779.00		
Recovery for Pending Work-RPP	96,33,275.00		
NPMU - Interest on FD	1,11,42,327.00	**Closing Balance**	
NPMU - Fund Received	64,00,00,000.00	Bank Accounts	41,96,42,274.77
Total	**83,13,17,664.00**	**Total**	**83,13,17,664.00**

For National Centre for Sustainable Coastal Management

Director
National Centre for Sustainable Coastal Management
Ministry of Environment, Forest and Climate Change
Government of India, Anna University Campus
Chennai - 600 025, India

Director

Place: Chennai
Date : 13-10-2018

As per the Audit Report of even date attached
For K.Ramanan & Co
Chartered Accountants

(CA. K.Ramanan)
(M.No. 019177)
FRN: 02926S

K. RAMANAN & CO.
K. RAMANAN
M. No. 019177
778, 9TH STREET
ANNA NAGAR W.E.,
CHENNAI - 101
Chartered Accountants

NATIONAL CENTRE FOR SUSTAINABLE COASTAL MANAGEMENT

MINISTRY OF ENVIRONMENT FOREST &CLIMATE CHANGE
GOVERNMENT OF INDIA
ANNA UNIVERSITY CAMPUS
CHENNAI-600025

Income and Expenditure Statement for the year ended 31st March,2018

(In Rs.

Particulars	Amount	Amount	Particulars	Amount	Amount
Indirect Expenses		13,92,45,788.38	**Indirect Incomes**		37,84,22,471.23
Capacity Building & Projects	55,05,657.60		Grants in Aid	37,84,00,099.23	
Communication	4,30,941.00		Miscellaneous Income	22,372.00	
Operational Cost	13,33,09,189.78				
Excess of income over expenditure		23,91,76,682.85			
Total		37,84,22,471.23	**Total**		37,84,22,471.23

For National Centre for Sustainable Coastal Management

Director
National Centre for Sustainable Coastal Management
Ministry of Environment, Forest and Climate Change
Government of India, Anna University Campus
Chennai - 600 025, India

Director

Place: Chennai
Date : 13-10-2018

As per the Audit Report of even date attached
For K.Ramanan&Co
Chartered Accountants

(CA K RAMANAN)
(M.NO 019177)
FRN: 02926S

K. RAMANAN & CO.
K. RAMANAN
M. No. 019177
778, 9TH STREET
ANNA NAGAR W.E.,
CHENNAI - 101
Chartered Accountants

NATIONAL CENTRE FOR SUSTAINABLE COASTAL MANAGEMENT

MINISTRY OF ENVIRONMENT, FOREST & CLIMATE CHANGE
GOVERNMENT OF INDIA
ANNA UNIVERSITY CAMPUS
CHENNAI-600025

Balance Sheet as on 31st March, 2018

(In Rs.)

Liabilities	Sch. No.	Amount	Assets	Sch. No.	Amount
Capital Account:-			**Fixed Assets:-**		
Corpus Fund	1	1,07,99,03,800.32	Investment Cost	3	5,12,71,590.00
			Physical	4	1,02,82,95,242.32
			Tools & Plants	5	1,34,295.00
Current Liabilities:-					
Sundry Creditors	-	18,98,511.00	**Investments:-**		
NCR Recoveries	-	1,201.00	Fixed Deposit - UBI	-	3,80,375.00
Performance Guarantee	2	72,59,144.00			
Bid Security	-	17,12,775.00	**Current Assets:-**		
Labour Cess	-	40,17,429.00	Advances	6	2,84,55,112.26
Notional Recovery from Salary	9	22,22,314.00	Bank Accounts	7	41,96,42,274.77
Notice Pay	-	34,000.00	Deposit	-	22,117.00
NPMU - Fund Received	10	43,35,81,412.14	Sundry Debtors	8	1,60,87,311.00
Liquidity Damages	-	26,967.00	Advance to ESA	-	2,49,62,495.00
Retention Money	11	2,63,80,867.00	Other Grants in Aid	-	33,000.00
Recovery for Pending work	-	1,04,87,048.00	Group Insurance Claim	-	22,44,677.00
TDS Payable - Others	-	13,63,432.89	Tax Credit - Claimed	-	2,235.00
TDS Payable - Staff	-	15,95,463.00			
User's Fee	-	58,000.00	Revenue Activity	-	35,477.00
Unpaid Bills	-	8,372.00	Truck & Delta	-	1,09,536.00
Unreconcilied Deposits From Staff	-	56,867.00			
VAT TDS	-	10,58,459.00			
Wrong Deposit by Staff	-	9,675.00			
TOTAL		**1,57,16,75,737.35**	**TOTAL**		**1,57,16,75,737.35**

For National Centre for Sustainable Coastal Management

Director
National Centre for Sustainable Coastal Management
Ministry of Environment, Forest and Climate Change
Government of India, Anna University Campus
Chennai - 600 025, India

Director

Place: Chennai
Date : 13-10-2018

As per the Audit Report of Even date Attached
For K.Ramanan & Co
Chartered Accountants

(CA. K.Ramanan)
(M.No. 019177)
FRN: 02926S

K. RAMANAN & CO.
K. RAMANAN
M. No. 019177
778, 9TH STREET
ANNA NAGAR W.E.,
CHENNAI - 101
Chartered Accountants

NATIONAL CENTER FOR SUSTAINABLE COSATAL MANAGEMENT

MINISTRY OF ENVIRONMENT, FOREST & CLIMATE CHANGE
GOVERNMENT OF INDIA
ANNA UNIVERSITY CAMPUS
GUINDY
CHENNAI-600025

Schedules forming part of the accounts for the Year ended 31st March, 2018

Schedule-1 : Corpus Fund

Particulars	Amount
Opening Balance	84,07,27,117.47
Add: Excess of Income over Expenditure	23,91,76,682.85
Closing Balance	**1,07,99,03,800.32**

Schedule-2 : Performance Guarantee

Particulars	Amount
AMC/CMC PERORMANCE SECURITY	1,79,495.00
ABP ENGINERING LEAFE AREA INDEX METER	34,250.00
AMKETTEE ANALYTICS	69,300.00
Creations	70,717.00
MICRO SCIENCE	1,32,000.00
MICRO SCIENCE -DC	1,45,197.00
PERFORMANCE SECURITY-AMC-CURRENT METER	1,78,647.00
PERFORMANCE SECURITY-AMC-DIRECT READING CURRENT	20,651.00
PERFORMANCE SECURITY-AMC-WAVE&TIDE RECORDER	1,34,414.00
PERFORMANCE SECURITY-MACRO	30,47,427.00
Performance Security -Metec	17,66,347.00
Performance Security-Networks	1,54,210.00
Performance Security -RPP	12,48,083.00
SWAN ENVIRONMENT PVT LTD	41,632.00
Universal Technologies	36,774.00
TOTAL	**72,59,144.00**

Schedule-3 : Investment Cost

Particulars	Amount
COMPUTERS & SYSTEMS	3,32,22,497.00
EQUIPMENTS & FACILITIES	55,60,623.00
CIVIL WORKS	1,00,86,461.00
FURNITURE & FITTINGS	14,92,303.00
VEHICLE	9,09,706.00
TOTAL	**5,12,71,590.00**

Schedule-4 : Physical

Particulars	Amount
CONSTRUCTION OF NEW BUILDING & FACILITIES	56,90,04,077.74
GOODS & EQUIPMENTS (SCIENTIFIC)	43,84,32,861.58
OFFICE& IT EQUIPMENTS	1,92,83,303.00
MOBILE CONTAINER	15,75,000.00
TOTAL	**1,02,82,95,242.32**

Schedule-5 : Tools & Plants

Particulars	Amount
ARGON CYLINDER	12,180.00
H2 CYLINDER	28,770.00
NITROUS OXIDE CYLINDER	16,065.00
OXYGEN CYLINDER	48,510.00
ZERO AIR CYLINDER	28,770.00
TOTAL	**1,34,295.00**

Schedule-6 : Advances

Particulars	Amount
ADVANCE TO CONTRACTOR	19,01,142.26
ADVANCE TO OTHER INSTITUTIONS	13,41,556.00
ADVANCE TO PARTNER INSTITUTIONS	11,08,804.00
CONTINGENCY ADVANCE	11,21,235.00
TA ADVANCE	3,91,126.00
Advances to Staff Others	-65,583.00
Advances to Staff TA	46,284.00
ADVANCE TO NRSC, HYDERABAD	2,03,36,909.00
DEPOSIT BY HARIHARAN G	6,000.00
GAYATRI AUTO SERVICE	6,000.00
Ramnathpuran Dist Central Co Bank	5,000.00
Imprest Account Employee	35,060.00
Metro Water - CMWSSB	18,58,260.00
Special Account Imprest	3,63,319.00
TOTAL	**2,84,55,112.26**

Schedule-7 : Bank Accounts

Particulars	Amount
UBI CURRENT A/C	26,05,37,053.57
STATE BANK OF INDIA	32,94,221.20
FLEXI BALANCE	11,75,00,000.00
LC MARGIN	3,83,11,000.00
TOTAL	**41,96,42,274.77**

Schedule-8 : Sundry Debtors

Particulars	Amount
Esd Ecoventure Pvt Ltd	14,100.00
ICZMP-WB	1,60,00,000.00
Thermofisher Scientific	31,551.00
XYLEM ANALYTICS SOUTH ASIA	41,660.00
TOTAL	**1,60,87,311.00**

Schedule-9 : Notional Recovery from Salaries

Particulars	Amount
EPF	22,25,071.00
GPF	10,000.00
GPF Advance	11,400.00
GSLI	120.00
NPS	-37,215.00
PF	-5,000.00
Professional Tax	-3,462.00
Car Advance	1,400.00
Other Recoveries - Staffs	20,000.00
TOTAL	**22,22,314.00**

Schedule-10 : NPMU Fund Received

Particulars	Amount
Opening Balance	16,01,62,631.37
Add: Fund received	64,00,00,000.00
Add: Interest on funds received during the year	1,11,42,327.00
Add: Savings Bank Interest	6,76,553.00
Less: Funds transferred as Grants in Aid	37,84,00,099.23
TOTAL	**43,35,81,412.14**

Schedule-11 : Retention Money

Particulars	Amount
ETA	18,21,546.00
Cold Room Eackon	2,17,766.00
Kewaunee	17,65,369.00
KPL Furniture	4,20,971.00
Eakcon-Cleanroom	3,76,990.00
Ensysy Technologies	1,29,358.00
Godrej	10,72,010.00
Macro	30,47,427.00
Metec Design	17,66,347.00
Renaatus	1,57,63,083.00
TOTAL	**2,63,80,867.00**

NCSCM REVENUE ACTIVITY

MINISTRY OF ENVIRONMENT, FOREST & CLIMATE CHANGE
GOVERNMENT OF INDIA
ANNA UNIVERSITY CAMPUS
CHENNAI-600025

Receipts and Payments Account for the year ended on March 31st, 2018

(in Rs.)

RECEIPTS	AMOUNT	PAYMENTS	AMOUNT
Opening Balance			
Bank Accounts	8,51,15,381.57	DEFERRED REV EXP-CTG-B	77,54,688.00
		DEFERRED REV EXP-CTG-A	63,48,271.00
Arrear EPf Recovery, IHR, Thirumalai Sundari	2,916.00	DEFERRED REV EXP-CTG-C	53,43,182.00
Arrear EPF Recovery,IHR, Jayalakshmi	5,007.00	TAX CREDIT-C-A	51,19,675.00
Arrear of EPF Recovery IHR, Pandi Selvam	5,550.00	DEFERRED OVER EXP	19,10,448.00
Interest on Short Term Deposit	5,895.12	CGST INPUT CREDIT	5,43,731.00
Unpaid Hire Vehicle Charges-Grace	6,471.00	SGST INPUT TAX CREDIT	5,43,731.00
Revenue Officer, Corporation, Chennai	13,425.00	TA ADV	5,35,685.00
ARREAR EPF FOR IHR -HARIHARAN G	15,960.00	CONTINGENCY ADV	4,99,104.00
Arrear EPF Recovery IHR, Semanti Paul	18,406.00	IGST INPUT CREDIT	2,44,941.00
Arrear of EPF Recovery IHR, Arumgum	18,851.00	TAX CREDIT-C-B	1,91,666.00
EPF	30,572.00	ADVANCES	1,57,500.00
ARREAR EPF RECOVERY	40,845.00	TCS-CREDIT	19,129.00
NCSCM-ICZMP	5,22,369.00	Tax Credit-RD	4,314.00
Interest on Saving Bank A/c	70,72,785.20	Advertisement Charges	25,269.00
Sundry Debtors	12,18,22,958.75	Sundry Creditors	27,086.00
		SICOM-OVERHEAD-C-C	48,787.00
		SICOM-OVERHEAD-RD	1,49,442.00
		SICOM-OVERHEAD-C-B	2,01,600.00
		Term Deposit-059440100002870	3,44,000.00
		SICOM-OVERHEAD-C-A	4,94,762.00
		OTHER GRANTS IN PROJECTS	6,50,472.00
		DEFERRED CPEX-CTG-A	39,76,851.00
		Duties & Taxes	84,40,225.00
		Closing Balance	
		Bank Accounts	17,11,22,833.64
Total	**21,46,97,392.64**	**Total**	**21,46,97,392.64**

For National Centre for Sustainable Coastal Management

Director
National Centre for Sustainable Coastal Management
Ministry of Environment, Forest and Climate Change
Government of India, Anna University Campus

Director

Place: Chennai
Date : 13-10-2018

As per the Audit Report of even date attached
For K.Ramanan & Co
Chartered Accountants

(CA. K.Ramanan)
(M.No. 019177)
FRN: 02926S

K. RAMANAN & CO.
K. RAMANAN
M. No. 019177
778, 9TH STREET
ANNA NAGAR W.E.,
CHENNAI - 101
Chartered Accountants

NCSCM REVENUE ACTIVITY

NATIONAL CENTRE FOR SUSTAINABLE COASTAL MANAGEMENT

MINISTRY OF ENVIRONMENT, FOREST & CLIMATE CHANGE

ANNA UNIVERSITY CAMPUS

GUINDY

CHENNAI-600025

Income and Expenditure Statement for the year ended 31st March, 2018

Particulars	Amount	Particulars	Amount
Advertisement Charges	25,269.00	Material Income	14,09,201.00
TA/DA Expenses	16,38,409.00	Manpower Income	39,42,500.00
Manpower Expenses	38,89,909.00	TA/DA Income	25,05,000.00
Contingency Expenses	2,54,635.00	Contingency Income	33,13,000.00
Overhead Expenses	19,58,119.00	NCSCM Overheads	20,73,940.00
		IC Consultancy	24,08,637.00
		IC RD	24,138.61
Excess of income over expenditure	**1,50,27,119.61**	Interest on Savings A/c	70,72,785.20
		Interest on Term Deposit	8,028.80
		Interest on Tax Credit	11,230.00
		Other Receipts	25,000.00
Total	**2,27,93,460.61**	**Total**	**2,27,93,460.61**

For National Centre for Sustainable Coastal Management

Director
National Centre for Sustainable Coastal Management
Ministry of Environment, Forest and Climate Change
Government of India, Anna University Campus
Chennai - 600 025, India

Director

Place: Chennai

Date : 13-10-2018

As per the Audit Report of even date attached
For K.Ramanan&Co
Chartered Accountants

(CA K RAMANAN)
(M.NO 019177)
FRN: 02926S

K. RAMANAN & CO.
K. RAMANAN
M. No. 019177
778, 9TH STREET
ANNA NAGAR W.E.,
CHENNAI - 101
Chartered Accountants

NCSCM REVENUE ACTIVITY

NATIONAL CENTRE FOR SUSTAINABLE COASTAL MANAGEMENT
MINISTRY OF ENVIRONMENT, FOREST & CLIMATE CHANGE
GOVERNMENT OF INDIA
ANNA UNIVERSITY CAMPUS
CHENNAI-600025

Balance Sheet as on 31st March, 2018

(In Rs.)

Liabilities	Sch. No.	Amount	Assets	Sch. No.	Amount
Capital Account			**Fixed Assets**		
Corpus Fund	1	4,14,72,099.58	IT equipments	10	51,85,578.00
			Investments		
			Deposit	-	3,44,000.00
Current Liabilities			**Current Assets**		
Duties & Taxes	2	1,26,78,640.21	Sundry Debtors	11	67,81,686.85
Provisions	-	14,888.00	TDS Payable	9	29,366.00
Material Income Deferred	3	1,56,41,691.57	Bank Accounts	12	17,11,22,833.64
Manpower Income Deferred	4	4,89,49,295.37	Advance to Gujarat Ecology	-	1,57,500.00
TA/DA Income Deferred	5	2,13,77,658.19	Contingency Advance	13	42,460.00
Contingency Income Deferred	6	2,51,82,737.96	TA/DA Expense Deferred	14	52,77,304.50
NCSCM Overheads Deferred	7	1,97,20,219.00	Contingency Expense Deferred	15	13,52,368.00
IC Consultancy Deferred	8	2,03,74,023.91	Manpower Expense Deferred	16	1,40,45,204.00
Performance Security	-	3,44,000.00	Material Expense Deferred	17	1,22,400.00
Notional Recovery from Salaries	20	2,17,394.00	Outsourcing Expense Deferred	-	21,86,000.00
Tax Credit : MS Cholamandalam	-	44,920.00	TA Advance	18	32,703.00
Unpaid Hire Vehicle Charges	-	6,471.00	Tax Credit - Recognised	19	10,60,814.68
SICOM Overhead - CTG-A	-	1,09,54,271.88	Tax Credit - Deferred	19	96,98,303.00
SICOM-Overhead - CTG-B	-	5,56,297.00	TCS Credit - Deferred	-	19,129.00
SICOM-Overhead - CTG-C	-	7,44,838.00	NCSCM	-	42,323.00
SICOM-Overhead - RD	-	29,800.00	Truc & Delta	-	4,35,120.00
Wrong Deposit	-	27,958.00	Other Grants in Aid	-	4,02,110.00
Total		**21,83,37,203.67**	**Total**		**21,83,37,203.67**

For National Centre for Sustainable Coastal Management

Director
National Centre for Sustainable Coastal Management
Ministry of Environment, Forest and Climate Change
Government of India, Anna University Campus
Chennai - 600 025, India

Director

Place: Chennai
Date : 13-10-2018

As per the Audit Report of even date attached
For K.Ramanan & Co
Chartered Accountants

(CA. K.Ramanan)
(M.No. 019177)
FRN: 02926S

K. RAMANAN & CO.
K. RAMANAN
M. No. 019177
778, 9TH STREET
ANNA NAGAR (W.E.),
CHENNAI-101
Chartered Accountants

NCSCM REVENUE ACTIVITY

MINISTRY OF ENVIRONMENT, FOREST & CLIMATE CHANGE
GOVERNMENT OF INDIA
ANNA UNIVERSITY CAMPUS
GUINDY
CHENNAI-600025

Schedules forming part of the accounts for the Year ended 31st March, 2018

Schedule- 1: Corpus Fund

Particulars	Amount
Cash Corpus	4,03,49,072.58
Capital Corpus	11,23,027.00
TOTAL	**4,14,72,099.58**

Schedule-2 : Duties & Taxes

Particulars	Amount
GST PAYABLE	1,31,78,302.20
CGST INPUT CREDIT	-5,43,731.00
SGST INPUT CREDIT	-5,43,731.00
IGST INPUT CREDIT	-2,44,941.00
KKC PAYABLE	-9,075.99
SERVICE TAX PAYABLE	8,02,001.07
SWATCH BHARAT CESS PAYABLE	39,815.93
TOTAL	**1,26,78,640.21**

Schedule-3 : Material Income Deferred

Particulars	Amount
CONSULTANCY : CTG- A	1,34,55,098.96
CONSULTANCY : CTG- B	21,35,000.00
CONSULTANCY : CTG- C	51,491.00
CONSULTANCY : CTG- RD	101.61
TOTAL	**1,56,41,691.57**

Schedule-4 : Manpower Income Deferred

Particulars	Amount
CONSULTANCY : CTG- A	3,74,32,141.73
CONSULTANCY : CTG- B	47,57,987.40
CONSULTANCY : CTG- C	67,02,166.24
CONSULTANCY : CTG- RD	57,000.00
TOTAL	**4,89,49,295.37**

Schedule-5 : TA/DA Income Deferred

Particulars	Amount
CONSULTANCY : CTG- A	1,50,95,688.19
CONSULTANCY : CTG- B	29,49,000.00
CONSULTANCY : CTG- C	33,32,970.00
CONSULTANCY : CTG- RD	-
TOTAL	2,13,77,658.19

Schedule-6 : Contingency Income Deferred

Particulars	Amount
CONSULTANCY : CTG- A	60,80,340.96
CONSULTANCY : CTG- B	1,51,27,500.00
CONSULTANCY : CTG- C	39,72,397.00
CONSULTANCY : CTG- RD	2,500.00
TOTAL	2,51,82,737.96

Schedule-7 : NCSCM-Overhead Income Deferred

Particulars	Amount
CONSULTANCY : CTG- A	1,33,02,797.00
CONSULTANCY : CTG- B	50,37,898.00
CONSULTANCY : CTG- C	13,67,604.00
CONSULTANCY : CTG- RD	11,920.00
TOTAL	1,97,20,219.00

Schedule-8 : IC Consultancy Income Deferred

Particulars	Amount
CONSULTANCY : CTG- A	1,36,69,843.52
CONSULTANCY : CTG- B	49,10,742.00
CONSULTANCY : CTG- C	17,80,924.00
CONSULTANCY : CTG- RD	12,514.39
TOTAL	2,03,74,023.91

Schedule-9 : TDS Payable

Particulars	Amount
TDS : Others	38,548.00
TDS : Salary	-9,182.00
TOTAL	29,366.00

Schedule-10 : IT Equipments

Particulars	Category - B	Category - C	Capital Exp A (Deferred)
HP Laser Printer	13,600.00	-	-
HP Pro One 600 Non Touch Aio	3,64,875.00	-	-
APPLE MAC BOOK PRO	-	1,76,711.00	-
EPSON PROJECTOR-EB1980WV	-	1,29,385.00	-
LENOVO YOGA 500 LAPTOP	-	66,000.00	-
WORKSTATION-HP Z640-E5-3620	-	3,72,456.00	-
Camera	-	85,700.00	-
Innova Crysta - ZX	-	-	19,76,851.00
ARC Gis Software	-	-	20,00,000.00
TOTAL	**3,78,475.00**	**8,30,252.00**	**39,76,851.00**

Schedule-11 : Sundry Debtors

Particulars	Amount
CZMP Karnataka State	22,26,971.50
DIRECTOR-DST-LAKSHDWEEP-HTL	25,35,567.00
DIRECTOR-DST-LAKSHDWEEP-TCC	10,00,000.00
EXECUTIVE ENGINEER R&B SURAT 2	-0.20
Global Management and Engineering Consultants Inter	2,41,276.00
HINDUJA INDIA LTD-SOLAR FEASIBILITY STUDY	1,85,438.00
Mumbai International Airport	-0.20
National Institute of Wind Energy	2,08,656.00
Odisha Tourism Development Ltd	23.00
SURAT MEGA TEXTILE PROCESSING PARK ASSOCIATION	2,65,098.00
The Assistant Engineer(Civil) Garrison Engineer	1,18,657.75
TOTAL	**67,81,686.85**

Schedule-12 : Bank Accounts

Particulars	Amount
YES Bank	15,49,37,257.46
State Bank Of India	1,61,85,576.18
TOTAL	**17,11,22,833.64**

Schedule-13: Contingency Advances

Particulars	Amount
Maria Fernandes	25,000.00
Prabhakaran	17,000.00
Sachithanandanam	460.00
TOTAL	**42,460.00**

Schedule-14 :TA/DA Expense Deferred

Particulars	Amount
CONSULTANCY : CTG- A	16,94,631.00
CONSULTANCY : CTG- B	7,30,761.00
CONSULTANCY : CTG- C	28,51,912.50
TOTAL	**52,77,304.50**

Schedule-15 : Contingency Expense Deferred

Particulars	Amount
CONSULTANCY : CTG- A	21,674.00
CONSULTANCY : CTG- B	4,30,537.00
CONSULTANCY : CTG- C	9,00,157.00
TOTAL	**13,52,368.00**

Schedule-16 : Manpower Expense Deferred

Particulars	Amount
CONSULTANCY : CTG- A	13,48,285.00
CONSULTANCY : CTG- B	54,77,348.00
CONSULTANCY : CTG- C	72,19,571.00
TOTAL	**1,40,45,204.00**

Schedule-17 : Material Expense Deferred

Particulars	Amount
CONSULTANCY : CTG- A	1,22,400.00
CONSULTANCY : CTG- B	-
CONSULTANCY : CTG- C	-
TOTAL	**1,22,400.00**

Schedule-18 : TA Advances

Particulars	Amount
Anadavelu	2,900.00
Armoury Kazip	2,900.00
Arumugam	2,900.00
Darwin Ramteke	2,900.00
DEBASIS T	-4,261.00
Dipnarayn Ganguly	150.00
GOPI M	500.00
ISSAC RAJAN	6,920.00
MANIKANDAN	153.00
Maria Fernadeds	2,900.00
MUGILARSAN	-9.00
PEARLIN SAM	13,500.00
Raghuraman R	1,250.00
TOTAL	**32,703.00**

Schedule-19 : Tax Credit

Particulars	Recognised	Deferred
Tax Credit - CTG-A	4,45,521.00	60,71,250.00
Tax Credit - CTG-B	5,99,936.00	33,94,664.00
Tax Credit - CTG-C	-	2,32,389.00
Tax Credit - CTG- RD	13,224.00	-
Tax Credit - Interest	2,133.68	-
TOTAL	**10,60,814.68**	**96,98,303.00**

Schedule-20 : Notional Recovery from Salaries

Particulars	Amount
EPF	56,952.00
Professional Tax	13,710.00
Arrears EPF Recovery	1,46,732.00
TOTAL	**2,17,394.00**

ESA & CVCA MAPPING

NATIONAL CENTER FOR SUSTAINABLE COASTAL MANAGEMENT
MINISTRY OF ENVIRONMENT, FOREST & CLIMATE CHANGE
ANNA UNIVERSITY CAMPUS
GUINDY
CHENNAI - 600025

Receipts and Payments Account for the year ended on March 31st, 2018

(in Rs.)

RECEIPTS	AMOUNT	PAYMENTS	AMOUNT
Opening Balance			
Bank Accounts	31,87,585.48	Provisions	22,913.00
		Project Management	29,23,290.00
NCSCM	55,40,000.00	Operational Cost	2,46,049.00
Liabilities for ZSI Port Blair	2,30,000.00		
NPMU	1,54,49,260.00	**Closing Balance**	
Advance to Institutes	1,79,512.00	Bank Accounts	2,13,94,105.48
Total	**2,45,86,357.48**	**Total**	**2,45,86,357.48**

For National Centre for Sustainable Coastal Management

Director
National Centre for Sustainable Coastal Management
Ministry of Environment, Forest and Climate Change
Government of India, Anna University Campus
Chennai - 600 025, India

Director

Place: Chennai
Date : 13.10.2018

As per the Audit Report of even date attached
For K.Ramanan & Co
Chartered Accountants

(CA. K.Ramanan)
(M.No. 019177)
FRN: 02926S

K. RAMANAN & CO.
K. RAMANAN
M. No. 019177
778, 9TH STREET
ANNA NAGAR W.E.,
CHENNAI - 101
Chartered Accountants

ESA&CVCA MAPPING

NATIONAL CENTRE FOR SUSTAINABLE COASTAL MANAGEMENT
MINISTRY OF ENVIRONMENT, FOREST & CLIMATE CHANGE
ANNA UNIVERSITY CAMPUS
GUINDY
CHENNAI-600025

Income and Expenditure Statement for the year ended 31st March, 2018

(In Rs.)

Particulars	Schedule	Amount	Particulars	Schedule	Amount
Indirect Expenses			**Indirect Incomes**		
Operational Cost	6	1,87,667.00	Grants in Aid	-	32,69,329.00
Excess of income over expenditure		**30,81,662.00**			
Total		**32,69,329.00**	**Total**		**32,69,329.00**

For National Centre for Sustainable Coastal Management

Director
National Centre for Sustainable Coastal Management
Ministry of Environment, Forest and Climate Change
Government of India, Anna University Campus
Chennai - 600 025, India

Director

Place: Chennai
Date : 13.10.2018

As per the Audit Report of even date attached
For K.Ramanan&Co
Chartered Accountants

(CA K RAMANAN)
(M.NO 019177)
FRN: 02926S

K. RAMANAN & CO.
K. RAMANAN
M. No. 019177
778, 9TH STREET
ANNA NAGAR W.E.,
CHENNAI - 101
Chartered Accountants

ESA & CVCA MAPPING

NATIONAL CENTRE FOR SUSTAINABLE COASTAL MANAGEMENT
MINISTRY OF ENVIRONMENT, FOREST & CLIMATE CHANGE
GOVERNMENT OF INDIA
ANNA UNIVERSITY CAMPUS
CHENNAI-600025

Balance Sheet as on 31st March, 2018

(In Rs.)

Liabilities	Sch. No.	Amount	Assets	Sch. No.	Amount
Capital Account:-			**Fixed Assets:-**		
Corpus Fund	1	3,96,53,309.00	Project Management	3	3,96,53,309.00
Current Liabilities:-			**Current Assets:-**		
NPMU Funds	2	-9,06,751.52	Advances to Institutes	4	29,01,741.00
NCSCM	-	2,49,62,495.00	TA Advance	-	22,833.00
Notice Pay	-	16,000.00	Bank Accounts	5	2,13,94,105.48
TDS Others	-	10,539.00			
TDS Salary	-	434.00			
Labour Cess	-	1,256.00			
Notional Recovery from Salaries(PT)	-	4,707.00			
Liabilities for ZSI Port Blair	-	2,30,000.00			
TOTAL		**6,39,71,988.48**	**TOTAL**		**6,39,71,988.48**

For National Centre for Sustainable Coastal Management

Director
National Centre for Sustainable Coastal Management
Ministry of Environment, Forest and Climate Change
Government of India, Anna University Campus
Chennai - 600 025, India

Director
Place: Chennai
Date : 13.10.2018

As per the Audit Report of even date attached
For K.Ramanan & Co
Chartered Accountants

(CA. K.Ramanan)
(M.No. 019177)
FRN: 02926S

K. RAMANAN & CO.
K. RAMANAN
M. No. 019177
778, 9TH STREET
ANNA NAGAR (W.E.),
CHENNAI - 101
Chartered Accountants

ESA & CVCA MAPPING

NATIONAL CENTRE FOR SUSTAINABLE COASTAL MANAGEMENT
MINISTRY OF ENVIRONMENT, FOREST & CLIMATE CHANGE
GOVERNMENT OF INDIA
ANNA UNIVERSITY CAMPUS
CHENNAI-600025

Schedules forming part of the accounts for the Year ended 31st March, 2018

Schedule-1 : Corpus Fund

Particulars	Amount
Opening Balance	3,67,30,019.00
Add: Excess of Income over Expenditure	29,23,290.00
TOTAL	**3,96,53,309.00**

Schedule-2 : NPMU Funds

Particulars	Amount
Opening Balance	-1,37,46,312.52
Add: Funds received from SICOM	1,50,00,000.00
Add: Interest received from NPMU funds	11,08,890.00
Less: Expenses incurred during the year	32,69,329.00
TOTAL	**-9,06,751.52**

Schedule-3 : Project Management

Particulars	Amount
3G DONGLE	13,000.00
AIR CONDITIONERS	2,59,900.00
APPLE MAC BOOK PRO	2,00,664.00
AUDIO CONFERENCING SYSTEM	30,500.00
CEPTOMETER	3,97,110.00
CIVIL WORKS	15,88,991.00
CORELDRAW GRAPHICS	1,29,000.00
DESKTOP COMPUTER	38,45,849.00
HP COLOUR LASER JET	22,03,724.00
HP ENVY LAPTOP(15u483cl)	3,40,000.00
HR SOFTWARE	13,48,320.00
JAVASCRIPT CHART SOFTWARE	18,571.00
LG 84 INCH DISPLAY	31,29,180.00
LPS IMAGE STATION	1,14,20,550.00
NAS STORAGE BOX	85,000.00
NAS STORAGE BOX	6,50,000.00
OTHER FACILITIES & EQUIPMENTS	1,51,580.00
PANASONIC PROJECTOR-PT-EZ770ZD	6,04,000.00
PRIMER 7-SOFTWARE	1,12,998.00
PROJECTR WITH SCREEN	9,52,000.00
SCANNER & PRINTER	13,067.00
SOFTWARES INCLUDING CUSTOMISATION	6,74,160.00
STORAGE SYSTEM INTERFACE (HP)	50,000.00
TABLETS	20,83,360.00
UNDER WATER CAMERA	32,000.00
UPS	98,685.00
WORK STATION COMPUTER	92,21,100.00
TOTAL	**3,96,53,309.00**

Schedule-4 : Advance to Institutes

Particulars	Amount
CEE AHEMADABAD	27,17,000.00
CMFRI KOCHI	57,312.00
KVFSU-BIDAR	1,27,429.00
TOTAL	**29,01,741.00**

Schedule-5 : Bank Accounts

Particulars	Amount
FLEXI BALANCE	50,00,000.00
STATE BANK OF INDIA	-59,715.00
UNION BANK OF INDIA	1,64,53,820.48
TOTAL	**2,13,94,105.48**

Schedule-6 : Operational Cost

Particulars	Amount
BANK CHARGES	2,580.00
TRAVEL BOARDING	47,725.00
CONSULTANCIES/STUDIES	99,990.00
LAB CONSUMABLES	1,87,667.00
TRAVEL, BOARDING, ACCOMODATION	8,077.00
TOTAL	**3,46,039.00**

TRUC & DELTA

NATIONAL CENTER FOR SUSTAINABLE COASTAL MANAGEMENT

MINISTRY OF ENVIRONMENT, FOREST & CLIMATE CHANGE

ANNA UNIVERSITY CAMPUS

GUINDY

CHENNAI - 600025

Receipts and Payments Account for the year ended on March 31st, 2018

(in Rs.)

RECEIPTS	AMOUNT	PAYMENTS	AMOUNT
Opening Balance			
Bank Accounts	18,440.00	NCSCM - Revenue Activity	2,19,069.00
		Utilisation of Fund - DELTA	46,359.00
NCSCM	41,01,046.00	Utilisation of Fund - TRUC	54,606.00
DELTA - Professional Tax	1,095.00	EPF Arrears	7,364.00
TRUC - Professional Tax	2,190.00		
Interest on Grants in Aid	1,48,105.00	**Closing Balance**	
		Bank Accounts	39,43,478.00
Total	**42,70,876.00**	**Total**	**42,70,876.00**

For National Centre for Sustainable Coastal Management

Director
National Centre for Sustainable Coastal Management
Ministry of Environment, Forest and Climate Change
Government of India, Anna University Campus
Chennai - 600 025, India

Director

Place: Chennai

Date : 13-10-2018

As per the Audit Report of even date attached
For K.Ramanan & Co
Chartered Accountants

(CA. K.Ramanan)
(M.No. 019177)
FRN: 02926S

K. RAMANAN & CO.
K. RAMANAN
M. No. 019177
778, 9TH STREET
ANNA NAGAR W.E.,
CHENNAI - 101
Chartered Accountants

TRUC&DELTA

NATIONAL CENTRE FOR SUSTAINABLE COASTAL MANAGEMENT

MINISTRY OF ENVIRONMENT, FOREST & CLIMATE CHANGE

ANNA UNIVERSITY CAMPUS

CHENNAI-600025

Income and Expenditure Statement for the year ended 31st March, 2018

(In Rs.)

Particulars	Schedule	Amount	Particulars	Schedule	Amount
Indirect Expenses			**Indirect Incomes**		
Utilisation Of Fund - DELTA	5	46,359.00	Grants In Aid DELTA	-	46,359.00
Utilisation Of Fund - TRUC	6	54,606.00	Grants In Aid TRUC	-	54,606.00
Excess of income over expenditure	-	-			
Total		**1,00,965.00**	**Total**		**1,00,965.00**

For National Centre for Sustainable Coastal Management

Director

Director

Place: Chennai

Date : 13-10-2018

As per the Audit Report of even date attached

For K.Ramanan&Co

Chartered Accountants

(CA K RAMANAN)

(M.NO 019177)

FRN02926S

K. RAMANAN & CO. Chartered Accountants
K. RAMANAN
M. No. 019177
778, 9TH STREET
ANNA NAGAR W.E.,
CHENNAI - 101

TRUC & DELTA

NATIONAL CENTRE FOR SUSTAINABLE COASTAL MANAGEMENT

MINISTRY OF ENVIRONMENT, FOREST & CLIMATE CHANGE

GOVERNMENT OF INDIA

ANNA UNIVERSITY CAMPUS

CHENNAI-600025

Balance Sheet as on 31st March 2018

(In Rs.)

Liabilities	Sch.No	AMOUNT	Assets	Sch.No	AMOUNT
Capital Account:-			**Fixed Assets:-**		
Corpus Fund	1	10,75,392.00	Facilities & Equipments - DELTA	2	9,37,864.00
			Facilities & Equipments - TRUC	3	1,37,528.00
Current Liabilities:-					
Notional Recovery from Salaries	7	7,224.00	**Current Assets:-**		
Interest on MOES Funds	-	4,29,348.00	Bank Accounts	4	39,43,478.00
MOES - DELTA	-	31,46,516.00	TRUC- TDS Others	-	3,153.00
MOES - TRUC	-	62,147.00			
Sundry Creditors	-	4,763.00			
Revenue Activity	-	2,16,051.00			
NCSCM	-	80,582.00			
Total		**50,22,023.00**	**Total**		**50,22,023.00**

For National Centre for Sustainable Coastal Management

Director
National Centre for Sustainable Coastal Management
Ministry of Environment, Forest and Climate Change
Government of India, Anna University Campus
Chennai - 600 025, India

Director

Place: Chennai
Date : 13-10-2018

As per the Audit Report of even date attached
For K.Ramanan & Co
Chartered Accountants

(CA. K.Ramanan)
(M.No. 019177)
FRN: 02926S

K. RAMANAN & CO.
K. RAMANAN
M. No. 019177
778, 9TH STREET
ANNA NAGAR W.E.,
CHENNAI - 101
Chartered Accountants

TRUC & DELTA

NATIONAL CENTRE FOR SUSTAINABLE COASTAL MANAGEMENT
MINISTRY OF ENVIRONMENT, FOREST & CLIMATE CHANGE
GOVERNMENT OF INDIA
ANNA UNIVERSITY CAMPUS
CHENNAI-600025

Schedules forming part of the accounts for the Year ended 31st March, 2018

Schedule-1 : Corpus Fund

Particulars	Amount
CORPUS DELTA	9,37,864.00
CORPUS TRUC	1,37,528.00
TOTAL	**10,75,392.00**

Schedule-2 : Facilities & Equipments - DELTA

Partculers	Amount
PRINTERS	1,27,679.00
ALMIRAH	51,000.00
WORKSTATION	7,47,285.00
CHAIR	11,900.00
TOTAL	**9,37,864.00**

Schedule-3 : Facilities & Equipments - TRUC

Partculers	Amount
ALMIRAH	20,500.00
DESKTOPS	56,722.00
PRINTERS	60,306.00
TOTAL	**1,37,528.00**

Schedule-4 : Bank Accounts

Partculers	Amount
SBI	-10,802.00
UNION BANK OF INDIA	14,54,280.00
FLEXI DEPOSIT	25,00,000.00
TOTAL	**39,43,478.00**

Schedule-5 : Utilisation Of Fund - DELTA

Partculers	Amount
Consumables	30,089.00
Project Staff Salaries	16,270.00
TOTAL	**46,359.00**

Schedule-6 : Utilisation Of Fund - TRUC

Partculers	Amount
Project Staff Salaries	54,606.00
TOTAL	**54,606.00**

Schedule-7: Notional Recovery from Salaries

Partculers	Amount
Professional Tax	3,383.00
EPF	3,841.00
TOTAL	**7,224.00**

Other Grants In Aid

NATIONAL CENTER FOR SUSTAINABLE COASTAL MANAGEMENT

MINISTRY OF ENVIRONMENT, FOREST & CLIMATE CHANGE

ANNA UNIVERSITY CAMPUS

GUINDY

CHENNAI - 600025

Receipts and Payments Account for the year ended on March 31st, 2018

(in Rs.)

RECEIPTS	AMOUNT	PAYMENTS	AMOUNT
Opening Balance		SDS PROJECTS EXP	3,03,326.00
Bank Accounts	9,47,162.00	SINDHUDURG- PROJECT-REV EXP	22,07,737.68
		Duties & Taxes	24,11,075.00
Arrear EPF Recovery RA, Durga Prasad	12,000.00	ICZMP-WB-EXP	7,11,295.23
Interst on Saving Bank Acccount	31,596.00	ADVANCES	5,71,233.19
TDS - 194J	33,000.00	CONTINGENCY ADV	3,69,497.00
FUND RECEIVED	23,16,000.00	REVENUE ACTIVITY EXP PAYABLE	2,60,000.00
REVENUE ACTIVITY	1,56,03,422.00	Sundry Debtors	1,50,000.00
Sundry Creditors	1,60,70,311.00	NCSCM-ICZMP	24,782.00
		CGST INPUT CREDIT -OFSDS	3,235.00
		SGST INPUT CREDIT-OFSDS	3,235.00
		EPF	1,588.00
		Closing Balance	
		Bank Accounts	2,79,96,486.90
Total	3,50,13,491.00	Total	3,50,13,491.00

For National Centre for Sustainable Coastal Management

Director
National Centre for Sustainable Coastal Management
Ministry of Environment, Forest and Climate Change
Government of India, Anna University Campus
Chennai - 600 025, India

Director

Place: Chennai
Date : 13-10-2018

As per the Audit Report of even date attached
For K.Ramanan & Co
Chartered Accountants

(CA. K.Ramanan)
(M.No. 019177)
FRN: 02926S

K. RAMANAN & CO.
K. RAMANAN
M. No. 019177
778, 9TH STREET
ANNA NAGAR W.E.,
CHENNAI - 101
Chartered Accountants

Other Grants In Aid

NATIONAL CENTRE FOR SUSTAINABLE COASTAL MANAGEMENT
MINISTRY OF ENVIRONMENT, FOREST & CLIMATE CHANGE
ANNA UNIVERSITY CAMPUS
CHENNAI-600025

Income and Expenditure Statement for the year ended 31st March, 2018

(In Rs.)

Particulars	Schedule	Amount	Particulars	Schedule	Amount
Indirect Expenses			**Indirect Incomes**		
Bank Charges	-	320.68	Grants In Aid: SDS 2	-	6,76,906.36
Manpower Expense	-	6,86,453.00	Grants In Aid: SP 2	-	22,68,737.68
Installation Charges	-	3,76,000.00	Interest on Saving Bank Account	-	31,596.00
Consultancy Expense	-	7,80,000.00			
Contingency Expense	-	2,44,618.00			
Travel Expense	-	8,58,252.36			
Excess of income over expenditure	-	**31,596.00**			
Total		**29,77,240.04**	**Total**		**29,77,240.04**

For National Centre for Sustainable Coastal Management

Director
National Centre for Sustainable Coastal Management
Ministry of Environment, Forest and Climate Change
Government of India, Anna University Campus
Chennai - 600 025, India

Director
Place: Chennai
Date : 13-10-2018

As per the Audit Report of even date attached
For K.Ramanan&Co
Chartered Accountants

(CA K RAMANAN)
(M.NO 019177)
FRN02926S

K. RAMANAN & CO.
K. RAMANAN
M. No 019177
778, 9TH STREET
ANNA NAGAR W.E.,
CHENNAI - 101
Chartered Accountants

Other Grants In Aid

NATIONAL CENTRE FOR SUSTAINABLE COASTAL MANAGEMENT

MINISTRY OF ENVIRONMENT, FOREST & CLIMATE CHANGE

GOVERNMENT OF INDIA

ANNA UNIVERSITY CAMPUS

CHENNAI-600025

Balance Sheet as on 31st March 2018

(In Rs.)

Liabilities	Sch.No	AMOUNT	Assets	Sch.No	AMOUNT
Capital Account:-			**Fixed Assets:-**		
Corpus Fund - Cash	-	31,596.00	Facilities & Equipments	-	-
Current Liabilities:-			**Current Assets:-**		
Fund from SP2	-	15,42,212.32	Bank Accounts	-	2,79,96,486.90
Fund from SDS	-	1,28,23,093.64	Advance to Institutes	-	8,00,000.00
NCSCM	-	6,710.00	TA Advance	-	63,321.19
Revenue Activity	-	7,79,054.00	Contingency Advance	-	34,190.00
Notional Recoveries from Salary	1	11,625.00	IZMP WB Expense	-	8,80,302.23
Duties & Taxes	2	9,698.36	Tax Credit of SDS	-	13,50,000.00
Sundry Creditors	-	1,60,70,311.00	Sundry Debtors	-	1,50,000.00
Total		**3,12,74,300.32**			**3,12,74,300.32**

For National Centre for Sustainable Coastal Management

Director
National Centre for Sustainable Coastal Management
Ministry of Environment, Forest and Climate Change
Government of India, Anna University Campus
Chennai - 600 025, India

Director

Place: Chennai
Date : 13-10-2018

As per the Audit Report of even date attached
For K.Ramanan & Co
Chartered Accountants

(CA. K.Ramanan)
(M.No. 019177)
FRN: 02926S

K. RAMANAN & CO.
K. RAMANAN
M. No. 019177
778, 9TH STREET
ANNA NAGAR (W.E.),
CHENNAI - 101
Chartered Accountants

OTHER GRANTS IN AID

NATIONAL CENTRE FOR SUSTAINABLE COASTAL MANAGEMENT
MINISTRY OF ENVIRONMENT, FOREST & CLIMATE CHANGE
GOVERNMENT OF INDIA
ANNA UNIVERSITY CAMPUS
CHENNAI-600025

Schedules forming part of the accounts for the Year ended 31st March, 2018

Schedule 1 - Notional Recovery from Salaries

Particulars	Amount
Professional Tax	-375.00
Arrears EPF Recovery	12,000.00
TOTAL	**11,625.00**

Schedule 2 - Duties & Taxes

Particulars	Amount
ICZMP-WB Tax Liability	19,300.00
CGST INPUT CREDIT	-4,800.82
SGST INPUT CREDIT	-4,800.82
TOTAL	**9,698.36**


www.ncscm.res.in