NCSCM

NATIONAL CENTRE FOR
SUSTAINABLE COASTAL MANAGEMENT

Ministry of Environment, Forest and Climate Change
Government of India

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Preface

Complex and diverse types of natural processes that occur on the coastal zone bring in physical, chemical, and biological changes to the fragile coastlines. Human activities in the coastal zone add yet another dimension affecting changes to our coastlines. Considering the growing need for sustainability of the coast, the Ministry of Environment and Forests (MoEF), Government of India established the National Centre for Sustainable Coastal Zone Management (NCSCM) in February 2011 to be a world class institution for sustainable coastal management witha strong research and knowledge base.

NCSCM, MoEF identified research institutes in each of the Coastal State/UTs under the "Anna University Declaration" to enable representative coastal universities and institutions function in a Consortium mode. NCSCM has an advanced and multi-disciplinary research agenda, spanning physical, chemical, biological, social and economic disciplines through field surveys and extensive remote sensing and GIS applications. NCSCM has for the first time mapped the entire coastline of India to assess the shoreline change and to enhance the country's preparedness to coastal hazards. The MoEF has evolved the concept of preparing the Integrated Coastal Zone Management (ICZM) Plan for the Country's coastline for which NCSCM is providing the Guidelines to the Coastal States! UTs. NCSCM is also undertaking the delineation of Coastal Sediment Cells and mapping of Ecologically Sensitive Areas, with emphasis on traditional knowledge.

I wish to thank the Hon'ble Union Minister of Environment and Forest and Climate Change and the High Power Research Steering Committee for setting high standards of research goals for NCSCM. I would like to thank Secretary E&F for the continued support and guidance on the research programmes. The support provided by the Vice Chancellor, Anna University & Chairman, Governing Council, the Registrar and all the members of the Governing Council is greatly acknowledged. The immense support of National Project Director and Shri Tapas Paul, Task Team Leader, World Bank are gratefully acknowledged. The activities and periodic updates are available at the NCSCM website www.ncscm.res.in

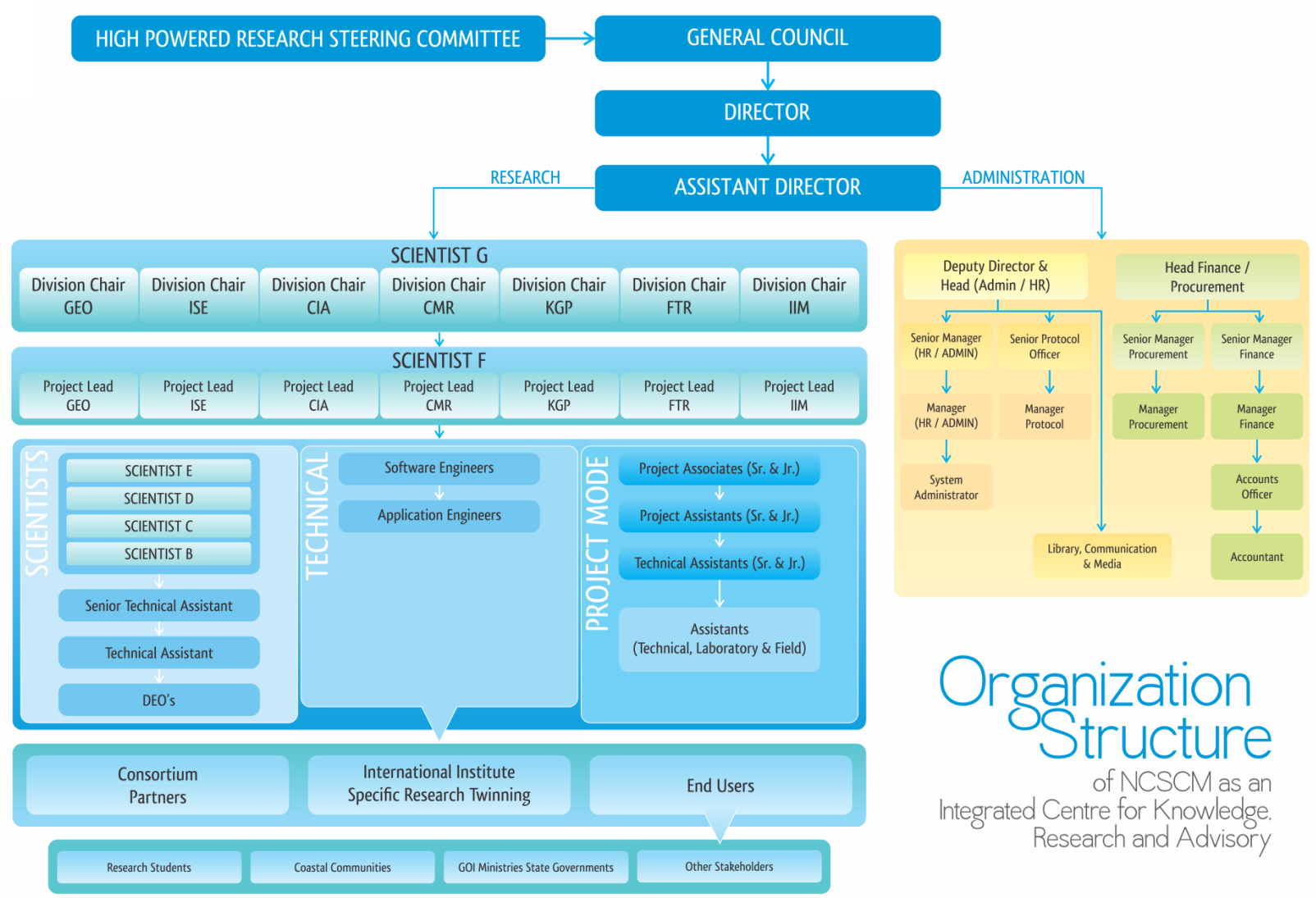
An Introduction

National Centre for Sustainable Coastal Management (NCSCM) is established as an autonomous institution, with an aim to become a world-class institution for coastal and marine area management with adequate human resources, facilities and assured long-term funding. It would promote integrated and sustainable management of coastal and marine areas in India and advice the Union and State Governments and other associated stakeholder(s) on policy, and scientific matters related to Integrated Coastal Zone Management (ICZM).

The Centre is established within the Anna University Campus, Chennai. Fourteen institutions have formed a consortium with NCSCM, with Anna University Chennai as the Hub. The Centre will become a centre for excellence within India on coastal research, management. The outputs from research at NCSCM would aid in the better protection, conservation, rehabilitation, management and policy design of the coast.

NCSCM would guide and coordinate the implementation of ICZM approaches leading to enhanced conservation of coastal resources and sustainable development along the coast of India through applied and futuristic research. The centre would develop a central repository of information and knowledge on ICZM practices in India and elsewhere. The centre will partner with national and similar international institutes to share knowledge in protection, conservation and management of the coastal areas. Further, NCSCM would promote technically sound and practical management approaches to ICZM.

Organization Structure



Organization Structure

of NCSCM as an Integrated Centre for Knowledge, Research and Advisory

1 Background

India has 7500 km long coastline with about 25% of population living along the coast. The coastal and marine areas of the country harbor some of the unique biodiversity. The enormous population located along the coastal area exerts pressure on this fragile coastal environment. The local communities living along the coastal areas depend upon natural resources for their livelihood. The coastal and marine waters are also potential areas for development, which is being promoted in a large scale by the Government in order to meet the economic aspirations of the country.

Integrated Coastal Zone Management (ICZM) Project

To implement the National Environment Policy 2006, recommendations of Final Frontier 2009, recommendations of Public Accounts Committee (2009-10) [PAC], and CRZ Notification, 2011 and IPZ Notification, 2011 regulatory framework with public participation, Government of India embarked upon implementation of the ICZM project. This project was approved by the Expenditure Finance Committee [EFC] and Cabinet Committee on Economic Affairs [CCEA] during 2010. The project is being taken up on a pilot scale with the assistance of the World Bank in the identified stretches in the States of Gujarat, Odisha and West Bengal. To implement this project the Ministry of Environment, Forests and Climate Change, has set up the Society of Integrated Coastal Management [SICOM] which is located in New Delhi.

Objectives of ICZM Project

The objectives of the ICZM Project are to achieve the following:

a) Develop the capacity and institutions to implement the Coastal Regulation Zone Notification, 2011 and achieve the objectives of integrated and sustainable coastal management as per the National Environmental Policy, 2006.

b) Address the issues relating to climate change which have a major implication on the coastal areas and coastal communities especially with respect to sea level rise and increased frequency of cyclones and storm surges. Under the programme, an exercise of hazard mapping will be carried out to protect the coastal people and infrastructure located in the coastal regions.
c) Develop an institution to carry out studies and research in the area of coastal and marine management.
d) Conserve and protect the fragile coastal ecosystems such as the mangroves, brackish water wetlands, coral reefs, etc.
e) Control pollution of coastal waters from land based sources.
f) Demonstrate and pilot improved livelihood option of coastal communities threatened by coastal hazard and pollution.
g) Develop Integrated Coastal Zone Management Plans for better Management of coastal areas.

2 ICZM Phase -1: *Mission on Coast*

Mission on coastal areas has broadly considered the following key aspects:

- Coastal flooding, erosion and submergence
- Coastal risk, population and assets
- Human pressures on coastal ecosystems due to population growth, economic development & urbanization
- Implementation of coastal adaptation for climate resilient and sustainable coasts

Under the Integrated Coastal Zone Management (ICZM) Project implemented by the Ministry of Environment, Forests and Climate Change, Government of India, the above issues have been given a huge thrust for implementation both at the regional and national levels. The IPCC estimates that even under its most conservative scenario, sea levels in 2100 will be about 40cm higher than today, which will cause flooding in the coastal areas in Asia, effecting 80 million people, the majority of which will be in India.

Sea level along the Indian coast has been rising at the rate of 1.3mm/year and is likely to rise in consonance with the global sea level rise in the future. Further projections indicate that the frequency of cyclones is likely to decrease in 2030s, with increase in cyclonic intensity. An average rise in sea level could effectively deurbanize the region along the coast suggesting that a large urban and rural population will be affected. Significant numbers of people will likely migrate toward large urban settlements in the interior of the country rather than get dispersed in the hinterland of existing coastal cities. Further, the large infrastructure investments in ports, industries and other facilities in the coastal areas will be at greater risk due to rising sea levels.

Based on the above facts, the ICZM Project focuses for the first time in the country, on demarcation of the "Hazard Line", which will define the

boundaries of the coastal zone in mainland India and will incorporate the effects of recurrent coastal hazards, including potential incremental effects induced by climate change (most notably sea level rise) within ICZM plans. The hazard line for the mainland coast is being mapped and delineated as the landward composite of the coastal 100 year flood lines (including sea level rise impacts), and the 100 year predicted erosion lines. Preparation of state/local level ICZM plans is currently underway based on the delineation of the hazard line and the coastal sediment cells or sub-cells.

Due to increasing intensity of coastal hazards, threat to economic and livelihood security is increasing along the Indian coastline. The Indian coast is subject to severe weather events, particularly of cyclones and storm surges (at an average of nine cyclones per year) inflicting great loss of lives and property, especially among the rural coastal communities that always had low resilience to extreme weather variability, mostly due to impoverishment and lack of preparedness. In recent years, accelerated erosion of coastal land has affected coastal agriculture and built habitats. Climate change aggravates the risks to coastal communities and infrastructure

Indian coastline has seen a significant rise in coastal erosion in the past decade, causing irreparable loss to coastal resources and coastal communities. The ICZM Programme therefore includes (a) conservation and protection of coastal resources including mangrove and coastal shelterbelt (mangrove) plantation; (b) shoreline protection using soft measures such as artificial reefs, beach nourishment etc. and (c) dune rehabilitation Three main types of response strategies to coastal erosion are generally recognized: (1) Protect: several options are identified including both hard and soft solutions for arresting acute or chronic coastal erosion; (2) Accommodate: allow erosion to take place and accommodate change by changing land-use; and (3) Retreat: allow the erosion to take place, people and habitats to move landward.

The ICZM project is also designed particularly to improve resilience within the coastal communities and provide livelihood security. Resilience of the rural coastal communities to extreme weather events is low, mostly due to lack of understanding and preparedness. Many coastal communities have

weak, undiversified and limited livelihoods that rely heavily on unsustainable utilization of natural resources. Another significant issue in the rural coastal areas is accelerated erosion of coastal land, which threatens the sustenance of coastal agriculture, and built habitats along the coast.

On the other side, resilience of marine ecosystems has been subjected to great pressure through over-extraction of resources, increased pollution, and physical alterations in coastal ecosystems. ICZM Programme addresses appropriate process to tackle current and long-term coastal management issues, including habitat loss, degradation of water quality, changes in hydrological cycles, depletion of coastal resources, and adaptation to sea level rise and other impacts of global climate change. The ICZM project of the Government of India has invested over Rs. 1500 Crores at the national regional/ State level to address priorities relating to conservation and protection of coastal resources, environment and pollution management, and livelihood security of coastal communities that will assist in adaptation to impacts of climate change.

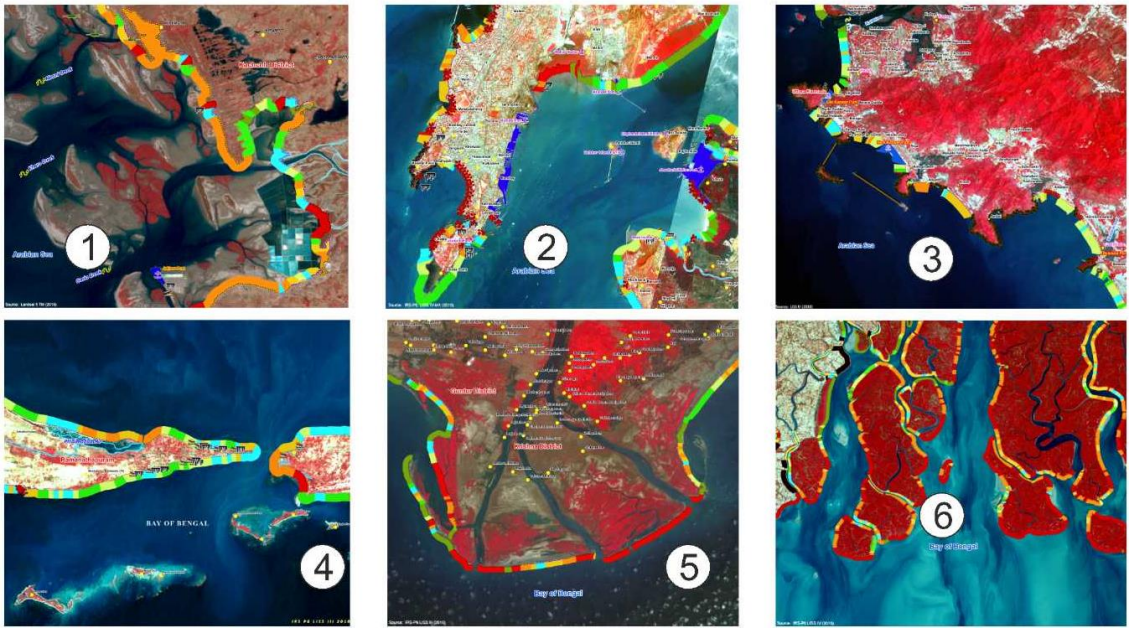
3 Shoreline Management

(a) National Assessment of Shoreline Change

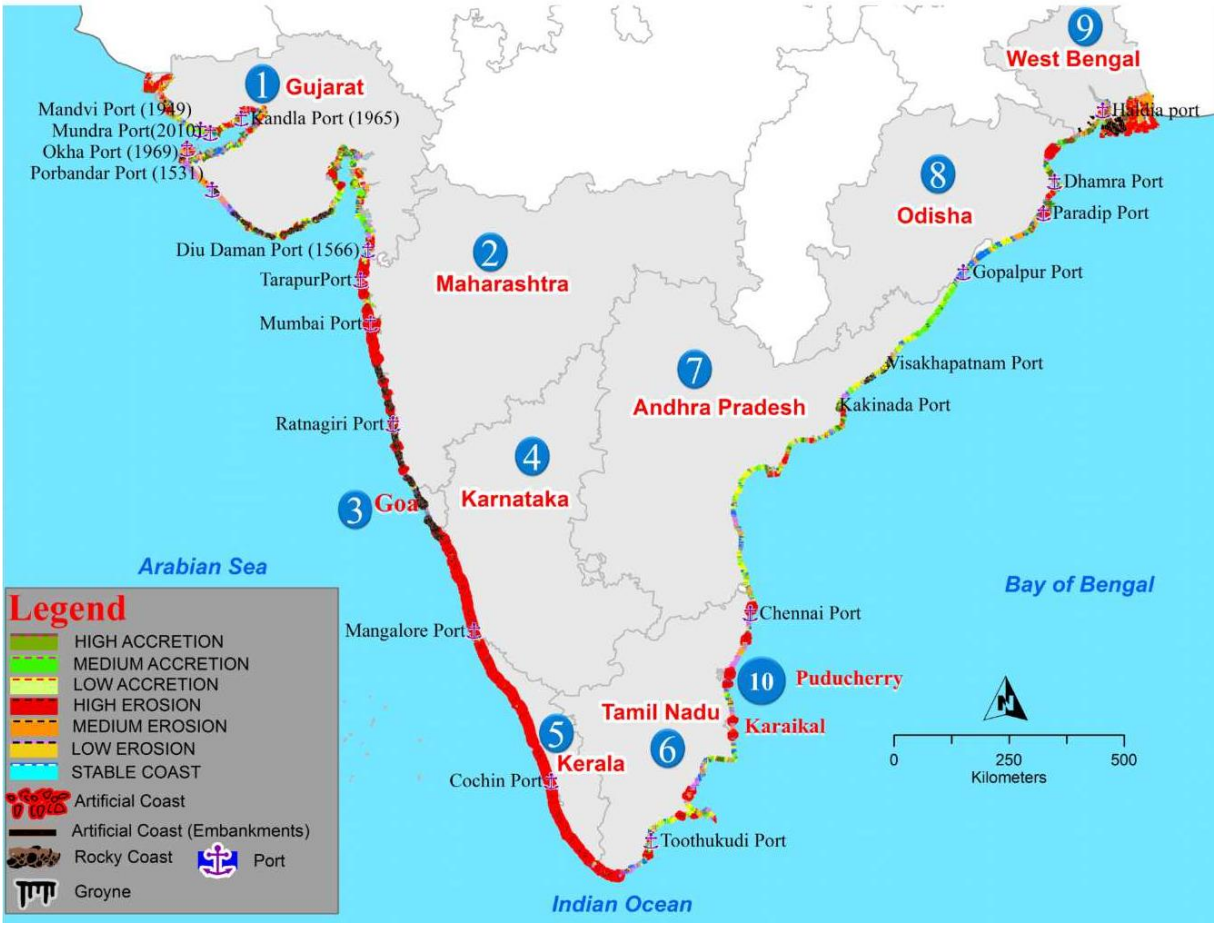
Coastline of India is 7500 km long; of which mainland coast extends to 5500 km and island territories form 2000 km. The coast is subjected to multiple coastal processes and anthropogenic pressures, making it vulnerable to erosion. The loss (erosion) and gain (accretion) of coastal land is a visible result of the way shorelines are reshaped in the face of these dynamic conditions. In this study, appropriate use of remote sensing technology coupled with limited Digital Geo-Positioning System (DGPS) surveys was integrated in GIS platform to obtain historical shoreline information. Rate of shoreline changes and the Erosion/ Accretion zones were calculated using Digital shoreline Analysis System (DSAS) a model compatible in GIS by U.S Geological Survey.

Key Results

- 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



1. Gulf of Kachchh, Gujarat; 2. Mumbai, Maharashtra; 3. Karwar, Karnataka; 4. Rameshwaram, Tamil Nadu; 5. Krishna Delta, Andhra Pradesh; 6. Sundarban, West Bengal. *Please see India map with locations marked and legend (above).*



Recommendations

- It is advisable to implement any anti-erosion strategy considering a broader perspective
- Drawing up site specific shoreline management plan and integrated coastal zone management plan are essential for effective shoreline protection
- Promoting soft protection measures i.e. restoration/ conservation of protective ecosystems such as beaches/ coastal wetlands
- Including options such as beach nourishment, dune rehabilitation and planting bioshields
- Ensure that the Shoreline Management Plan aligns with the aspirations of the people, achieved by stakeholder engagement and improving awareness of coastal issues
- Support the planning system (CRZ, EIA and CC Guidelines) to minimize inappropriate developments in the long term.
- There are no documents which compare the various coastal protection methods being adopted in India, and so understanding the effectiveness of these measures is a priority for sustainable outcomes

Erosion at Chandipur, Odisha

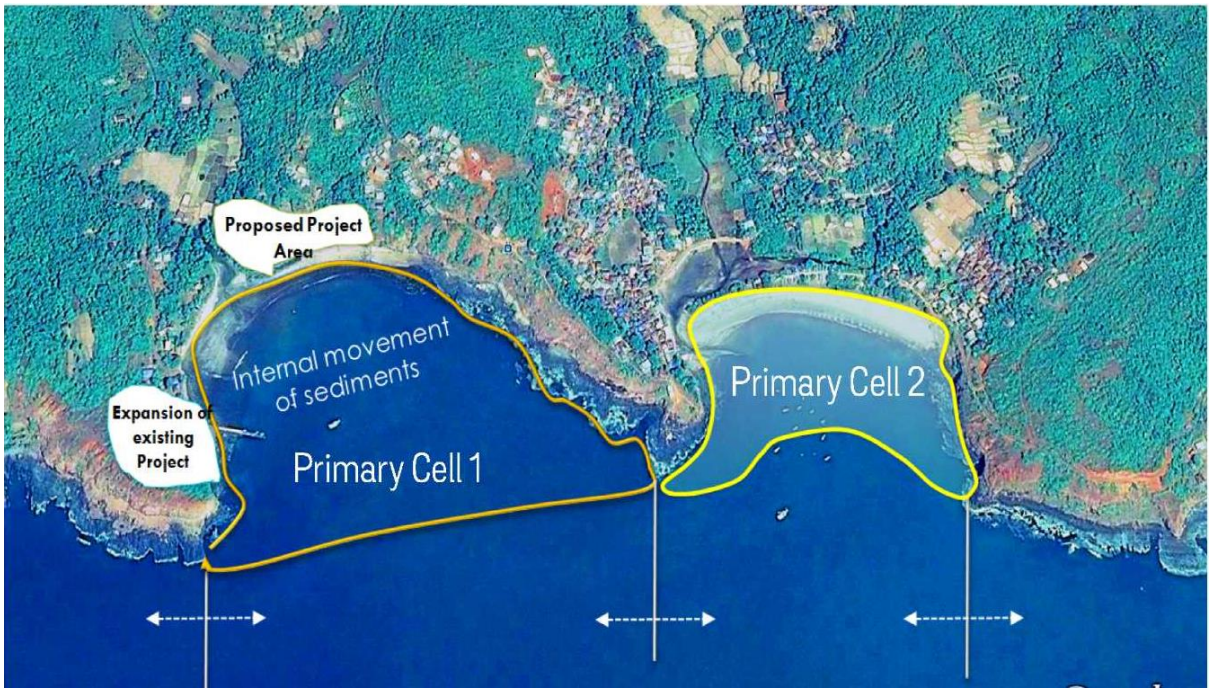
3 Shoreline Management

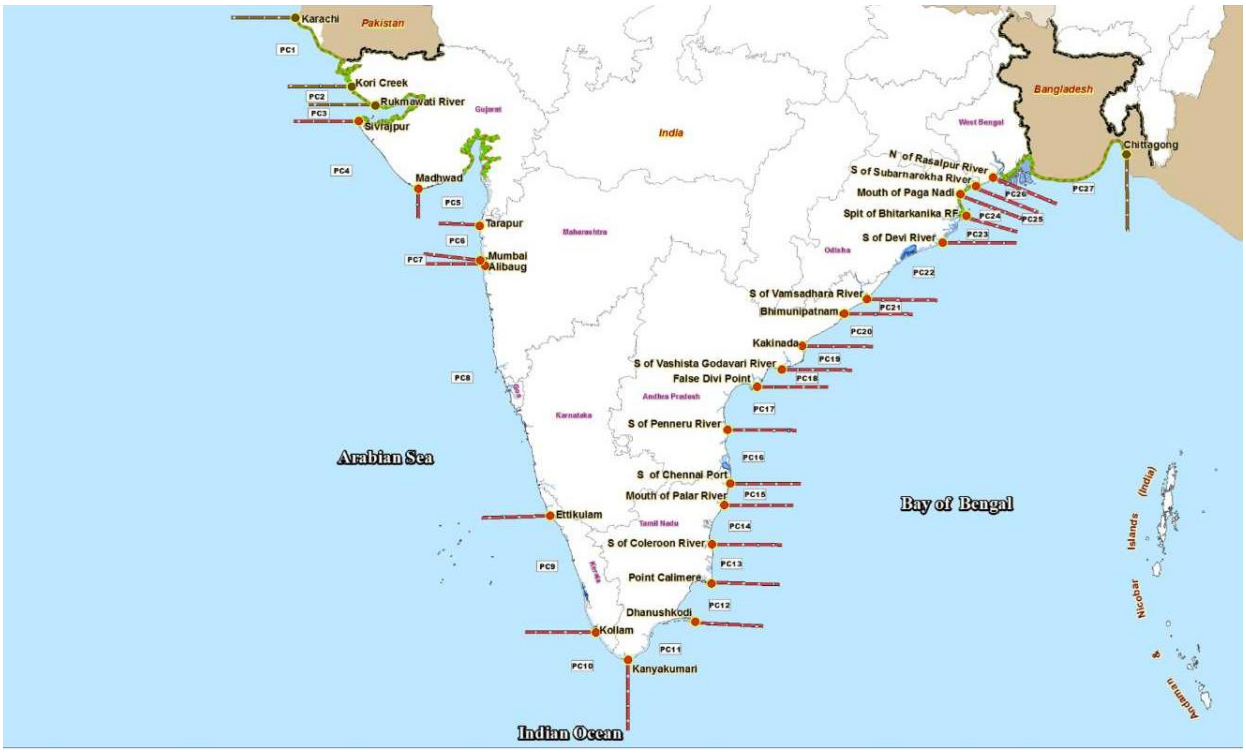
(b) Coastal Sediment Cells

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. It is essential that we understand the way in which this complex area functions so that we may manage it effectively to minimize its dangers and maximize its benefits. A central concept in developing such an understanding is the sediment cell.

A sediment cell serves two purposes:

- It is the basic functional unit of the coast. Within its boundaries coastal processes act as a coherent, integrated system. 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.





Key Results

- West coast of India is delineated into 10 and east coast into 17 primary cells of varying coastal lengths
- The 10 primary cells of West coast were further divided into 21 sub cells and 17 primary cells of the east coast were divided into 39 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

Recommendations

- The sediment cell, once defined, provides the basis for a behavioral model, which, in essence, describes how the coast works within the cell boundaries.
- This in turn makes it possible to develop practical measures for the coast that will deliver objectives of the community with minimum

interruption of natural processes, in other words sustainable development

- These practical measures are set out in the Shoreline Management Plan
- With sediment cells as a base, ICZM Plan is prepared, setting out the collaborative, integrated objectives of all stakeholders, communities and managers and the means of its delivery
- Within this ICZM Plan nests the Shoreline Management Plan as a vital but subsidiary unit, designed to deliver the objectives of ICZM in a sustainable manner

3 Shoreline Management

(c) *Hazard Line Mapping (along with Survey of India): High resolution erosion mapping*

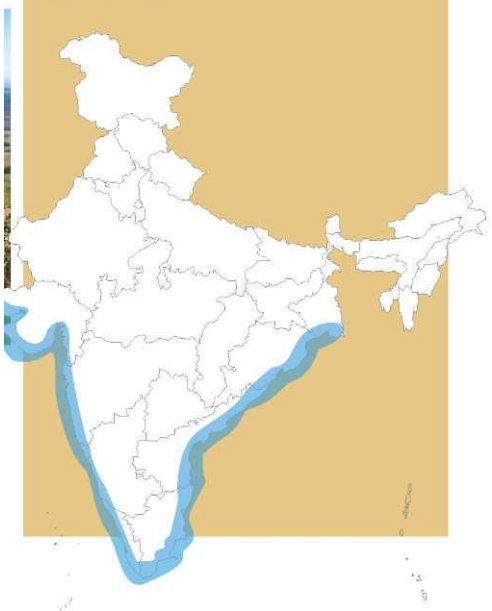
Demarcation of Coastal Hazard Line

- 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

Aerial Photography

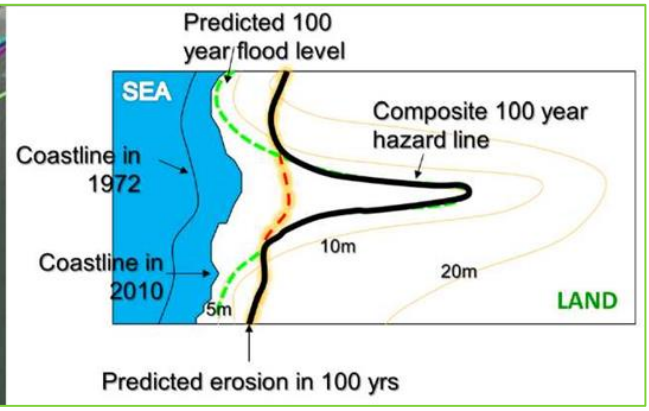
- Digital Stereo Aerial photography all along the coast covering a 7 km stretch from the shore, inter-tidal zones
- Photography using Fixed-Wing Aircraft
- Airborne Differential GNSS/GPS & IMU Control
- Large format frame camera
- Spatial resolution: 9cm GSD in panchromatic band
- Aerial Triangulation (AT) of 2 old vintages of aerial Photography/High resolution satellite imagery of different vintages
- Generation of Automatic DTM and ortho-imagery
- Different time series of coastlines extracted in 2D mode from the ortho-imageries

Threat of coastal hazards on livelihood security and development is increasing. India coast is subject to severe weather events, such as cyclones, storm surges inflicting great loss of lives and property. Currently, the hazard line for the entire mainland coast is being mapped and delineated.

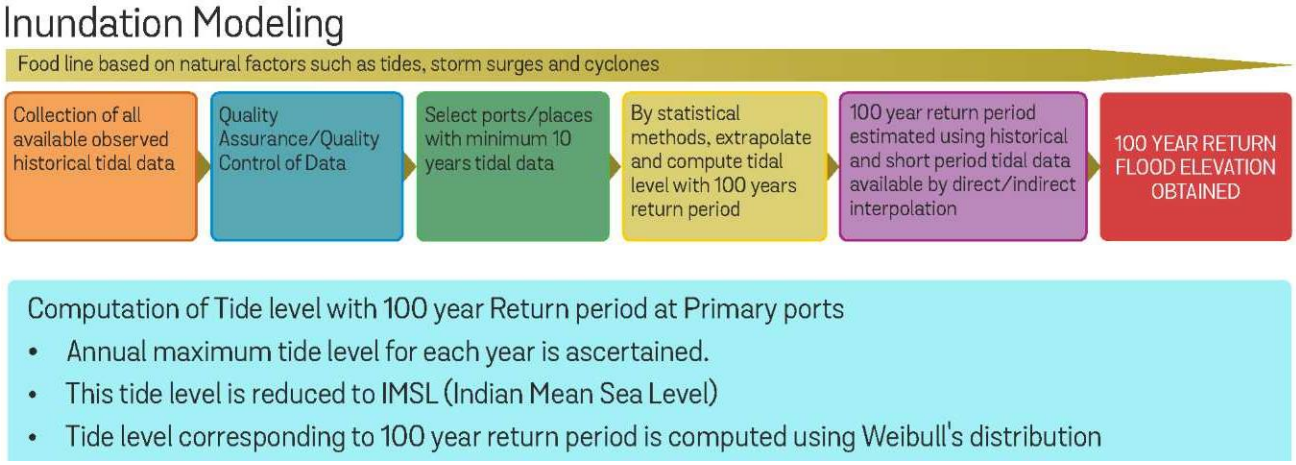


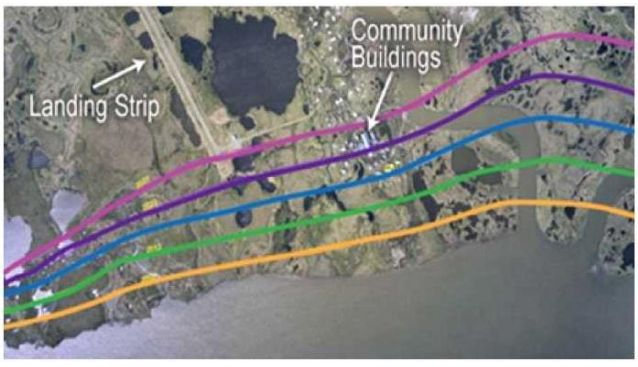
- Digital shoreline Analysis of different time series coastline data used to arithmetically project shoreline for next 100 years
- Higher the erosion and flood line, the higher the hazard line.
- This line is demarcated on the Digital Elevation Model (DEM) developed from aerial photography being carried out all along the coast up to 7 km from the coast.

Example of Shoreline change



Concept of Hazard Line





Output from Hazard Line

- Contours with 0.5m (2.5 m for hills)
- Flood level with 100 years return period
- Predicted shoreline of 100 years
- Composite hazard line (the most landward of the 100-year flood line & erosion line)

Shoreline Management: Challenges & Opportunities

Predictions of shoreline change through erosion and accretion have serious implications for coastal communities as well as policy makers at all levels of government. Demand for uses of the shoreline, and the subsequent pressure for development, places a high economic and social value on coastal property. Furthermore, 30-40 thousand sq km of the coastal area is facing the problem of salinity intrusion in agriculture land as well as ground water resources. Shoreline management will be planned based on the sediment cell movement models and the micro-level sediment transport models. Fresh water demand management through awareness, water saving measures (rainwater recharge, Check dams, watershed development) and policy interventions will be formulated and implemented at pilot scale. Region specific integrated agriculture practices will be suggested such as Halophyte culture, Poly culture Integrated fish–paddy farming in coastal regions etc.

Benefits and Outcome:

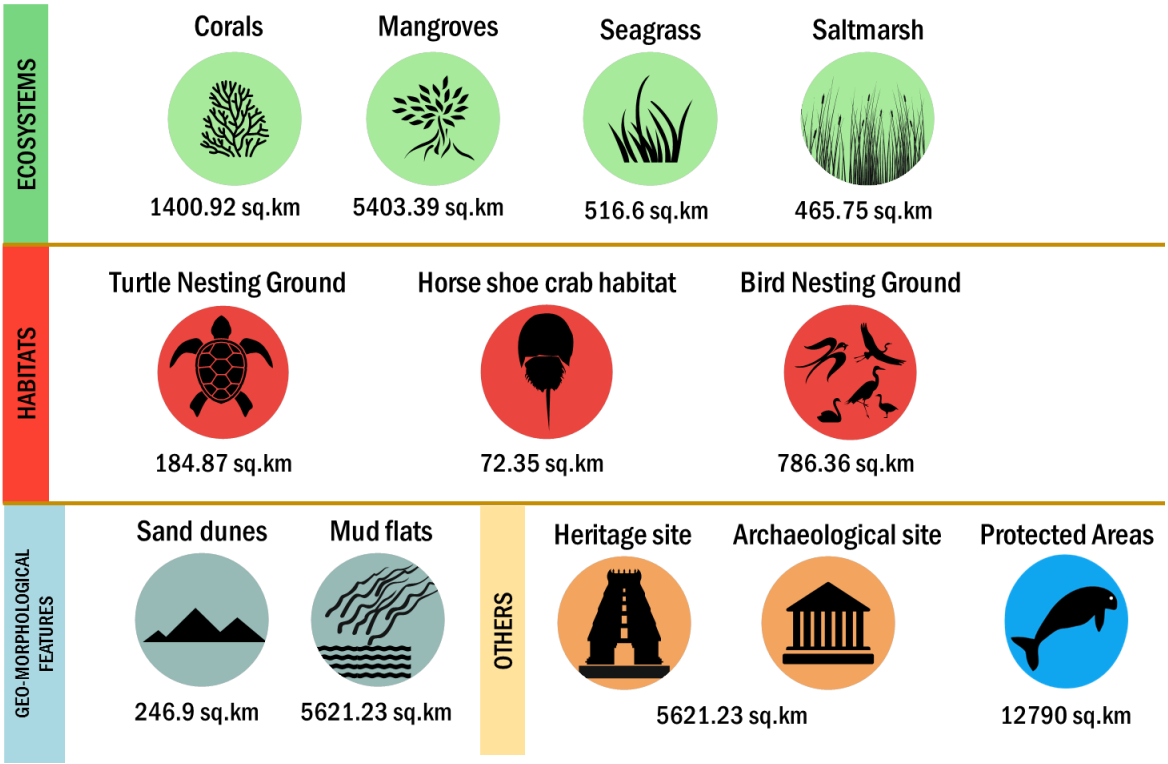
Soft and hard measures (seawalls, breakwaters, etc.) including rejuvenation of 20,000 ha of degraded areas shall be undertaken for the shoreline protection. Improvement of coastal fisheries including eco-tourism and resource management will be carried out. Fishing spaces along the coast will be protected. Protection of 32 cr. people living along coastal districts including Utilization of 40,000 sq km of saline lands for agriculture and aquaculture in 1,80,000 ha (culture of fish, shellfish, seaweeds etc.)

4 Conservation & Climate Mitigation

(a) *Mapping of Coastal Ecologically Sensitive Areas (ESA)*

The Coastal (Regulation) Zone, 2011 notified under the Environment (Protection) Act, 1986 has listed various coastal ecosystems, habitats, geo-morphological features, habitats and other areas such as archaeological and heritage sites, national parks, sanctuaries and reserve forests as Ecologically Sensitive Areas.

- The extent of coastal ecosystems viz., mangroves, coral reefs, seagrass and salt marshes in India including its Island territories has been mapped to be ~7800 sq.km
- Habitats such as turtle nesting sites and horse shoe crab habitats occupy about 260 sq.km
- Geomorphological features such as sand dunes and mudflats account for 5868 sq.km
- Marine Protected Areas and the coastal Reserved Forest account for about 12800 sq.km.
- The coastal and marine protected areas (106 Nos) in India •< account for about 5% of the territorial waters



Key Results:

- An ESA knowledge system has been developed
- A framework has been developed for identification and demarcation of Highly Sensitive Zones within the coastal ecosystems using scientific criteria. The sensitivity thresholds, would aid in preparation of location-specific Conservation Management Plans.
- A Digital Architecture for hosting the spatial, ecological and health data of coastal ecologically sensitive areas has been developed to serve as a National Knowledge System on coastal ESAs.

Recommendations

- Appropriate institutional mechanism has to be put in place for mapping the coastal ecosystems periodically and for assessing their ecological health
- Capacity building and strengthening institutional structure for the management of highly sensitive ecosystems are needed.
- The spatial, ecological and the socio-economic data on the coastal ecosystems need to integrated for developing a decision support system to aid in evidence-based location-specific conservation planning by the coastal States and union territories.

Conservation Management: Challenges & Opportunities

The marine environment, which includes the adjacent coastal areas, supports productive and protective habitats such as mangroves, coral reefs and sand dunes. The marine environment is facing a number of pressures, arising out of the needs of people, and the multiple uses that coastal and marine areas can be put to. These pressures contribute to the depletion of marine resources and degradation of the marine environment. Coastal and marine biodiversity information for the conservation of resources as well as eco-tourism promotion will be prepared by NCSCM. Detailed site specific management plans for the prevention of resource degradation in the marine areas shall be prepared. Preparation and periodical update of the health report status of the coastal ecosystems will aid in management. Site specific marine resources and biodiversity information shall be prepared for eco-tourism promotion.

Benefits and Outcome:

Conservation and protection of the coastal and marine resources would help enhance fishery resources, promote tourism and recreational activities (including water sports) and improved biodiversity. Management of coastal fishery resources shall be improved based on the biodiversity information.

4 Conservation & Climate Mitigation

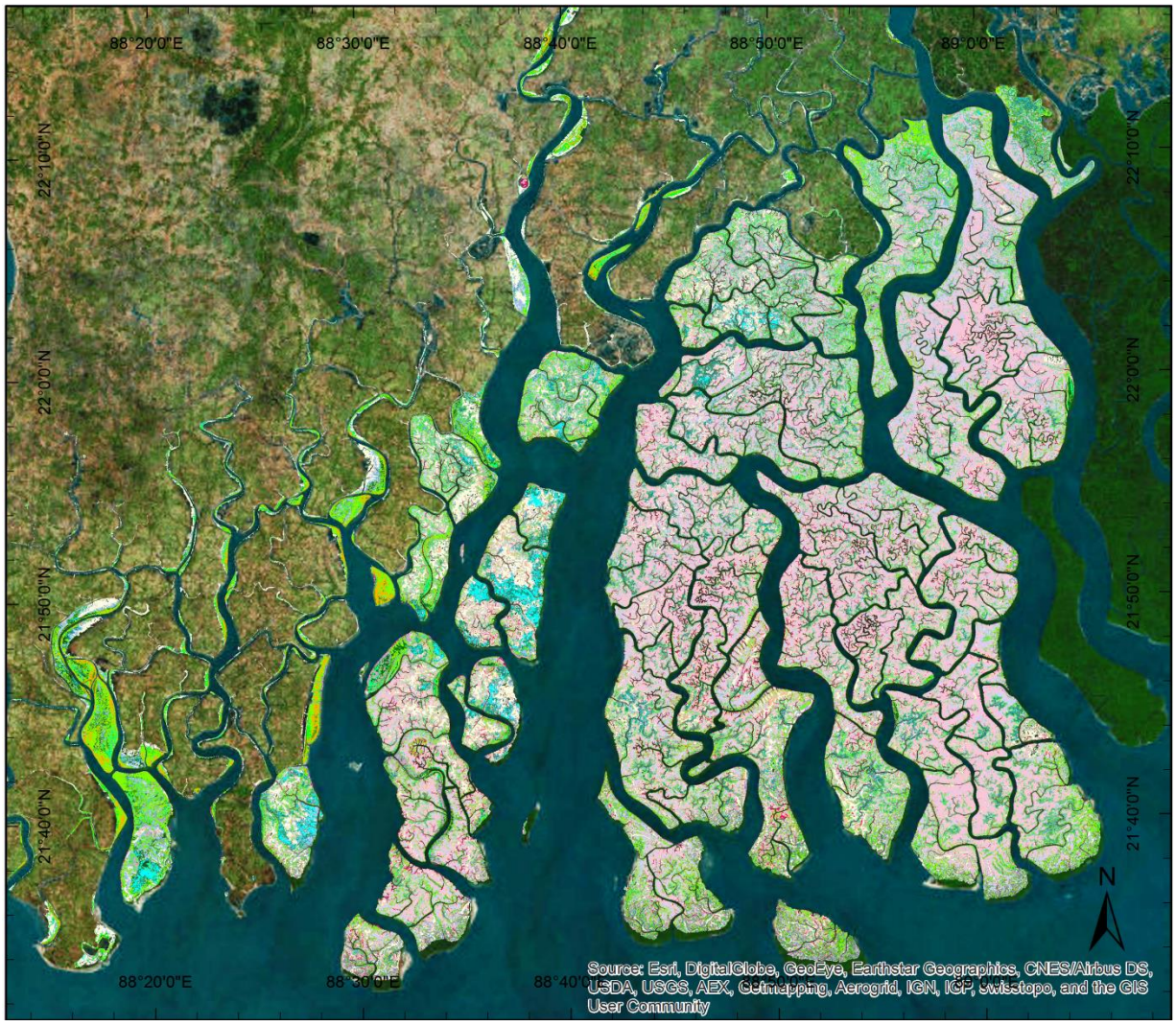
(b) Net photosynthesis production of mangrove ecosystems

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. Leaf area index (LAI) which represents the crown closure provides a measure of the photosynthetic biomass or the size of the photosynthetic system which converts solar energy to chemical energy.

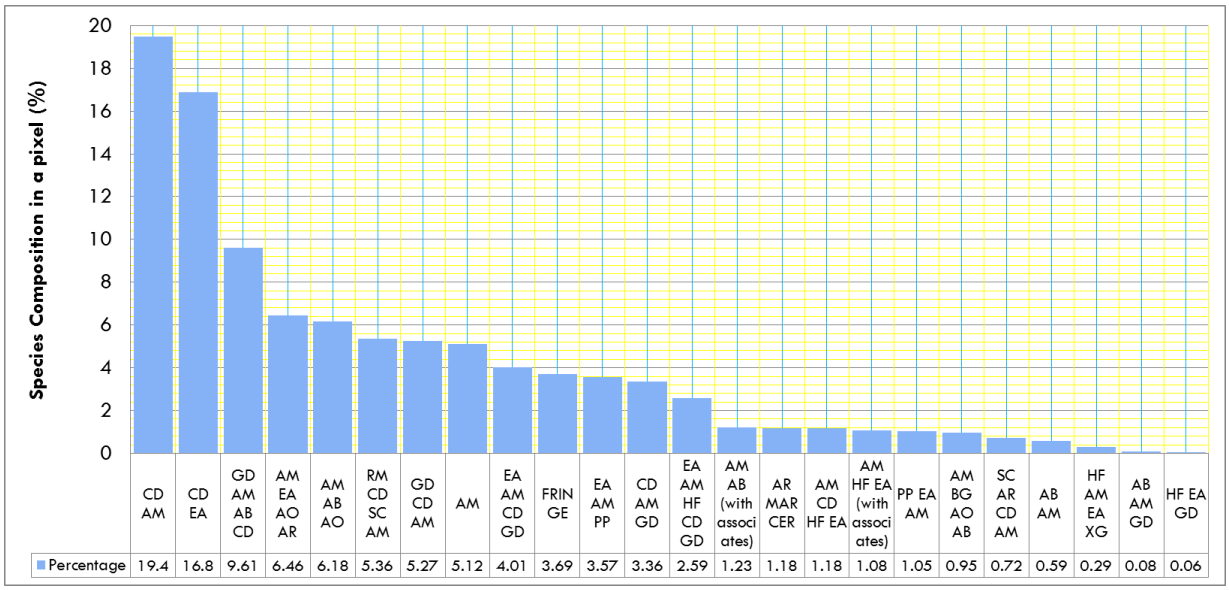
The behavior of vegetation to Red and near IR/SWIR wavelengths is utilized to develop the vegetation indices, a measure of the vigour of the plant. A correlation between direct field estimations of LAI and the Vegetation indices is established, which in turn is utilised to develop the LAI map. Net Photosynthetic 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 both on the western (Kerala) and eastern (Tamil Nadu and West Bengal) coast of India.

Key Results:

- Dominant mangrove zones of Sundarban are *Avicennia marina*, *Avicennia alba*, *Ceriops decandra*, *Exoecaria agallocha*, *Heritiera fomes* and *Phoenix paludosa* mixed other mangrove species of lesser proportion
- Community/species zonation map of Sundarban mangroves with 24 class definitions of varied species composition
- Total area of Sundarban is estimated as 2111.59 sq.kms for the year 2016
- Net Photosynthetic Production of mangroves of Sundarban 5.819 Mtons/year NPP and ranged between 3.78 tonsC/ha/year to 67.68 tonsC/ha/year



Map of Mangrove species/ community zonation



Percent composition of Mangrove species in a 30m x 30m pixel

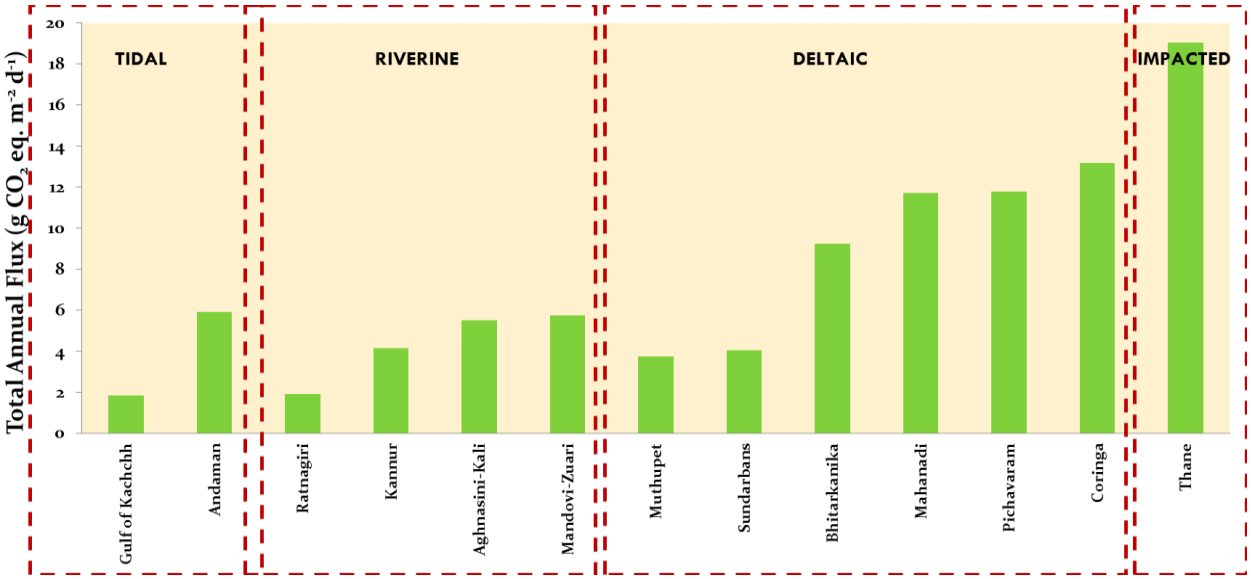
4 Conservation & Climate Mitigation

(c) *Greenhouse Gas Emission Inventory from Coastal Ecosystems of India*

Coastal ecosystems are known for their source/sink nature of various bioactive greenhouse gases such as CO_2, CH_4, N_2O. These dynamic ecosystems receive massive inputs of organic matter, which triggers various microbial processes, and generate greenhouse gases. The emissivity is governed by a number of factors such as salinity, human intervention and seasonality.

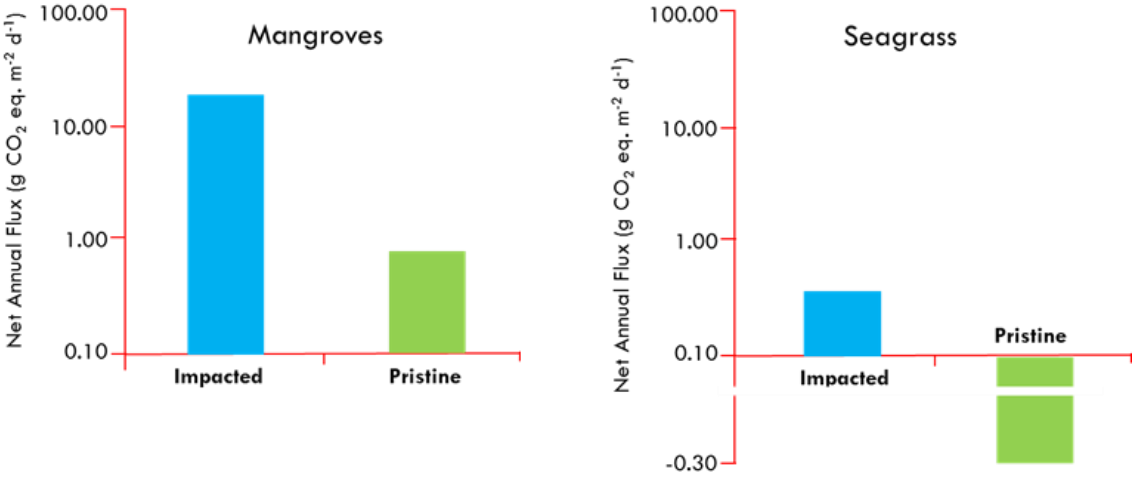
Key Results:

- Mangrove canopy is a net sink of carbon; despite of water and sediment acting as source of greenhouse gases
- Seagrass ecosystems are perennial sinks of CO_2; though act as a minor source of CH_4, subject to environmental conditions
- Mangroves are comparatively higher emitters of GHGs than Seagrass ecosystems
- Higher emissions from Deltaic mangroves are due to large altered watershed area, high water discharge rate and higher organic load



Total annual flux of GHG from tidal, riverine, deltaic and impacted mangrove ecosystems of India

- Most impacted systems are the altered natural mangroves and acts as a major emitters
- Net annual GHG flux (water-air) from Indian mangroves is estimated as ~40 Kg CO_2 eq. m^{-2}
- A 20% increase in mangrove cover along the Indian coast may create an additional sink of ~669 x10^3 tonnes CO_2 per year
- Conservation and restoration of 100 ha of the degraded mangrove forest may reduce 144 x10^3 tonnes CO_2 emissions per year
- A 20% increase in seagrass area cover in India may create an additional sink of ~82.4 x10^3 tonnes CO_2 per year
- Conservation and restoration of 100 ha of degraded seagrass may reduce 52.2 x10^3 tonnes CO_2 emission per year



Net annual flux of GHG from pristine and impacted mangrove and seagrass ecosystems of India

Conservation and Restoration of degraded blue carbon ecosystems could significantly reduce atmospheric CO_2 emission at a shorter term scale

4 Conservation & Climate Mitigation

(d) *Enhancing Blue carbon Sequestration*

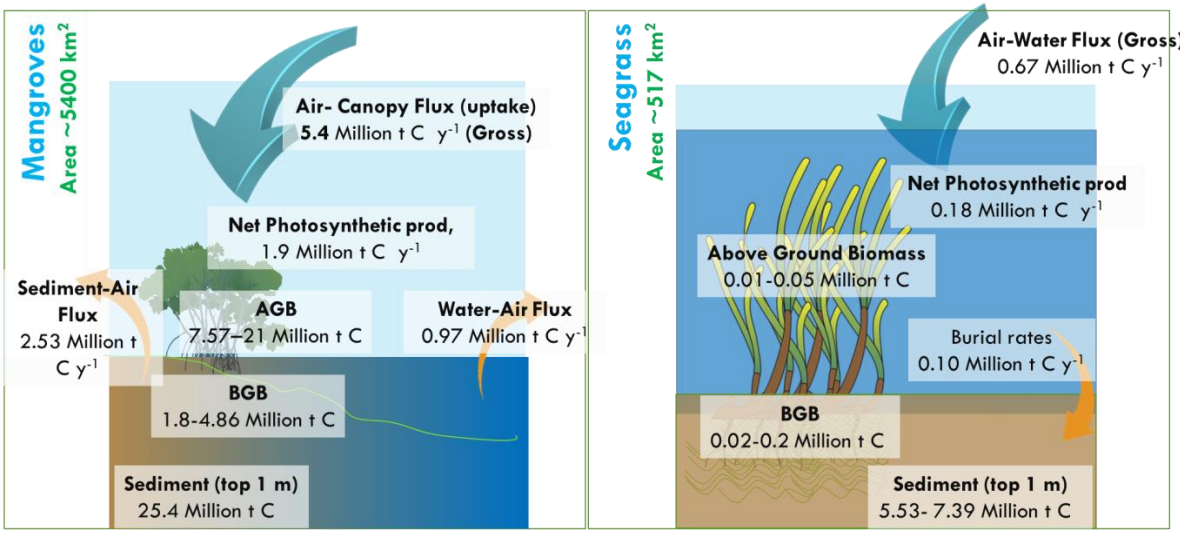
The term "blue carbon" is defined as the carbon captured and stored through biological processes in the coastal and marine ecosystems which includes salt marsh, mangroves, seagrass, phytoplankton etc.

- Annual growth in global mean CO_2 during 2000-2015 is 2.053+0.43 ppm
- At present growth rate greenhouse gas emissions would reach almost 685 ppm CO_2-equivalent by 2050.
- Atmospheric CO_2 can be stabilized by
  - *Creation of new carbon sinks*
  - *Reduction in GHG emissions*
    - Coastal Vegetative Ecosystems can store carbon ~10 times higher than terrestrial forest ecosystems (McLeod et al. 2011)
- Sediments act as a long term sink for the captured atmospheric CO_2 by living biomass
- Mangrove, seagrass and salt marsh sediment store carbon for 100s to 1000s of years.

Key Results

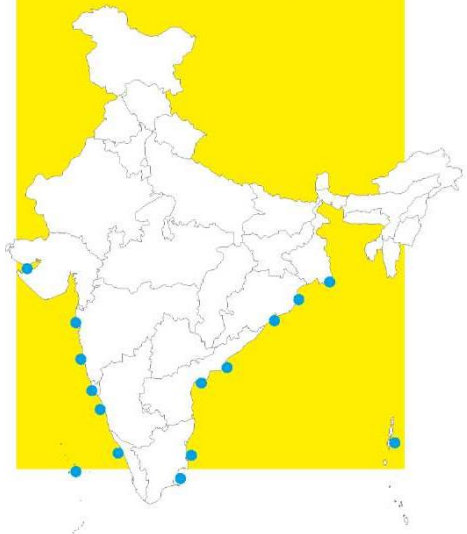
- Net C accrual as mangrove biomass is 1.69 tonnes C per hectare per year)
- A 20% increase in mangrove area cover may create an additional sink of ~669 $x10^3$ tonnes CO_2 per year.
- Conservation and restoration of 100 ha of the degraded mangrove forest may reduce CO_2 emissions of upto 144 $x10^3$ tonnes CO_2 per year.
- A 20% increase in the seagrass area cover in India may create an additional sink up to ~82.4 $x10^3$ tonnes CO_2 per year
- Conservation and restoration of 100 ha of degraded seagrass may reduce 52.2 $x10^3$ tonnes CO_2 emission per year.

- Annual carbon sequestration potential by salt marshes in India is ~101 x10^3 tonnes C per year.



India's Intended Nationally Determined Contribution #5. Enhancing Forests Carbon Sink.
To create an additional carbon sink of 2.5 to 3 billion tonnes of CO_2 equivalent through additional forest and tree cover by 2030

Ecosystems	Area in ha.
Mangrove	5,40,000
Seagrass	51,700
Salt Marsh	46,500



Recommendations

- Existing Blue Carbon Ecosystems in India will create ~55 million tonnes of CO_2 sink by 2030.
- A 20 % increase in area of blue carbon ecosystems by 2030 may create an additional sink of 10.89 million tonnes of CO_2
- Net C accumulation rate by mangroves and seagrass ecosystems of India are ~3.4 and ~2.7 times greater than global mean of tropical forests.
- Conservation and Restoration of degraded blue carbon ecosystems could significantly reduce atmospheric CO_2 emission at a short term scale.
- Afforestation/reforestation by creating new areas of blue carbon ecosystems can offset anthropogenic CO_2 emission at a longer time scale.

5 Pollution Management

(a) 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).

Indian Coast facts and Figures

S.No.	Coastal Information	
1	Length of coast *(including Andaman and Nicobar & Lakshadweep)*	7500 km
2	Number of coastal states	9
3	Number of Union Territories	4
4	Number of Coastal districts	78
5	Class 1 Cities on the coast	52
6	Population in coastal districts	202.87 Million
7	Number of Dams	174
8	Number of Ports	195
	(a) Major	13
	(b) Minor	182
9	Industries on the coast	5,20,285
	(a) Small Scale industries	5,16,384
	(b) Medium and Large Scale industries	3901
10	Thermal power Plants	62
11	Nuclear power Plants	5
12	Islands	1382
	(a) Oceanic	868
	(b) Continental	514

Types of waste generated along the coast

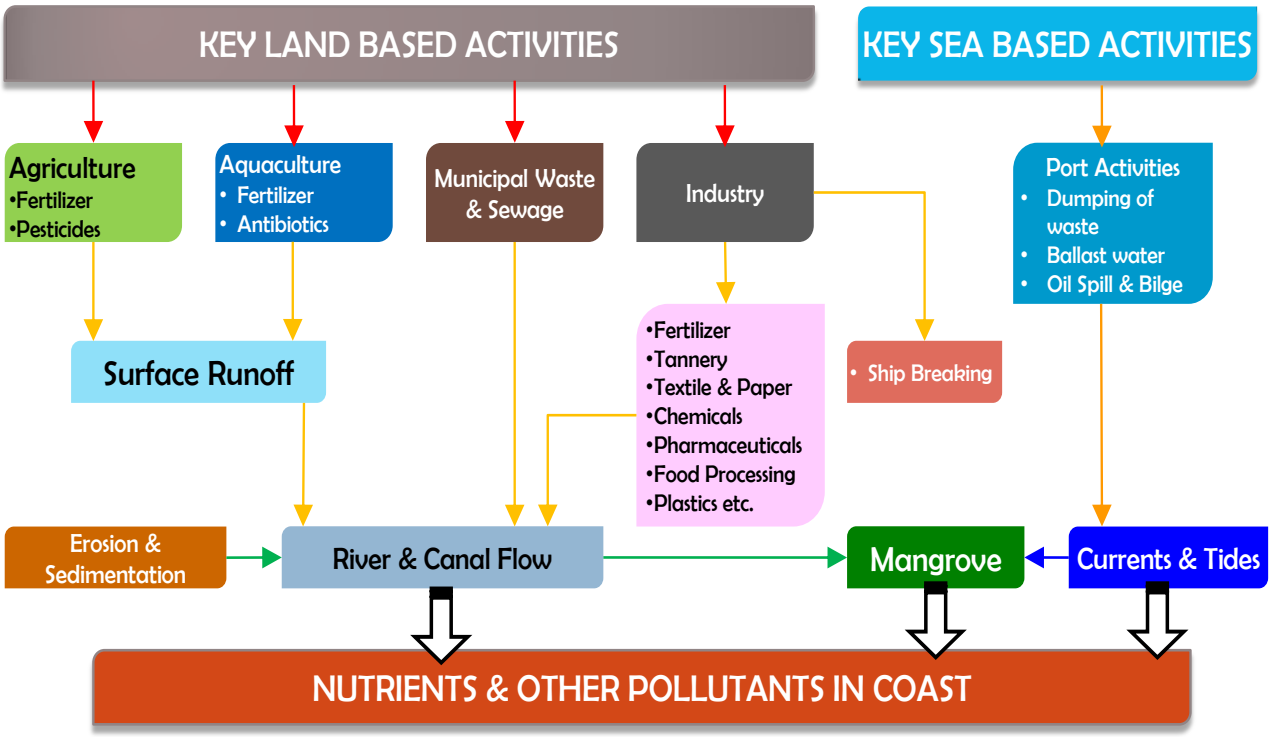
a) Nature of pollution

- *Solid waste*
  - *"Biodegradable Waste"*
  - *"Non-biodegradable Wastes"*
- *Liquid waste*
  - *"Black water": Black water includes wastewater from residential, commercial, and industrial sites, including human waste, grey water*
  - *"Grey water": Grey water can be defined as any domestic wastewater produced, excluding sewage*

b) Pollution Characteristics

- *Domestic and municipal waste*
- *Industrial waste*
- *Agricultural waste*
- *Thermal waste*

Sources of coastal and marine pollution



(a) Sewage Outfall (treated/untreated)

Coastal State	Total Sewage Generated (MLD)	Sewage generated from coastal districts (MLD)	No. of STPs (Coastal Districts)	Capacity of STPs (MLD)	Quantity treated (MLD)	Total untreated Sewage (MLD)
Gujarat (including Daman & Diu)	1680.9	748.6	18	1256.5	623	125.6
Maharashtra	9986.2	2695.4	11	2852.9	2652	200.9
Goa	11377.2	-	-	-	-	-
Karnataka	1790.4	133.96	4	48	61.36	72.6
Kerala	864.27	756.85	7	137.88	137.88	267.9
Tamil Nadu	1077.21	307.64	-	518.37	247.63	5.52
Puducherry	56.46	36.40	6	68.5	24.2	12.2
Andhra Pradesh	1760.60	421.93	5	91	91	67.08
Odisha	660.73	60.32	1	15	15	21.06
West Bengal	2345.21	250.05	11	139.01	6.7	19.95
Andaman and Nicobar (UT)	-	12	-	-	-	-
Lakshadweep (UT)	-	-	-	-	-	-

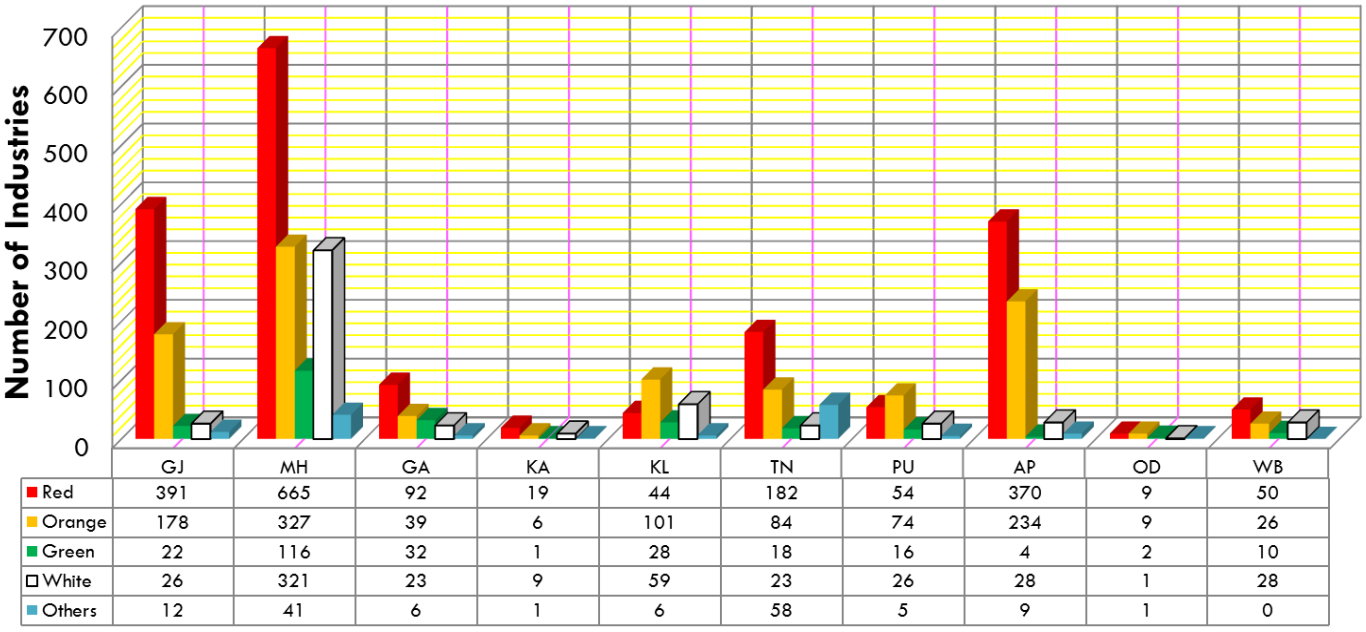
(b) Solid Waste

State	Solid waste generated (TPD)	MSW collected (TPD)	MSW treated (TPD)	Number of Landfills	Landfill Capacity (Sq. m)
Gujarat (including Daman & Diu)	748.61	-	-	-	-
Maharashtra					
Goa	4260.6	32.0	-	1	-
Karnataka	576.3	353.05	12.5	3	29,250
Kerala	1296.5	102	75	1	8.53
Tamil Nadu	5989.65	5433.37	3573.14	11	4916
Puducherry	335	-	-	-	-
Andhra Pradesh	5045.41	4462.7	45.43	-	-
Odisha	706.58	-	-	1	-
West Bengal	381.3	-	-	-	-
Andaman and Nicobar (UT)	-	-	-	-	-
Lakshadweep (UT)	-	-	-	Waste is incinerated	-

(c) Industries

Coastal Districts	Small	Medium	Large	Categories (Medium + large)				
				R	O	G	W	Others
Gujarat (including Daman & Diu)	81813	181	448	391	178	22	26	12
Maharashtra	30343	95	1375	665	327	116	321	41
Goa	0	0	192	92	39	32	23	6
Karnataka	35254	7	29	19	6	1	9	1
Kerala	112243	146	90	44	101	28	59	6
Tamil Nadu	198913	30	335	182	84	18	23	58
Puducherry	118	132	43	54	74	16	26	5
Andhra Pradesh	25501	115	479	370	234	4	28	9
Odisha	29600	6	16	9	9	2	1	1
West Bengal	0	16	41	50	26	10	28	
Andaman and Nicobar (UT)	1626	5				5		
Lakshadweep (UT)	74							

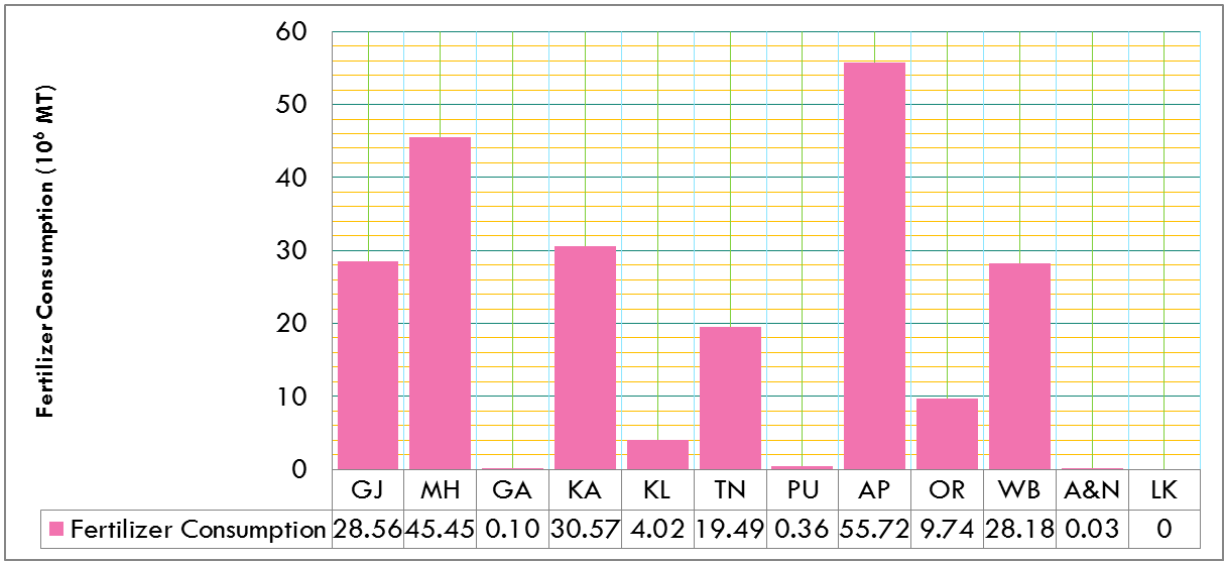
India: Industrial Categories on the Coast



	GJ	MH	GA	KA	KL	TN	PU	AP	OD	WB
Red	391	665	92	19	44	182	54	370	9	50
Orange	178	327	39	6	101	84	74	234	9	26
Green	22	116	32	1	28	18	16	4	2	10
White	26	321	23	9	59	23	26	28	1	28
Others	12	41	6	1	6	58	5	9	1	0

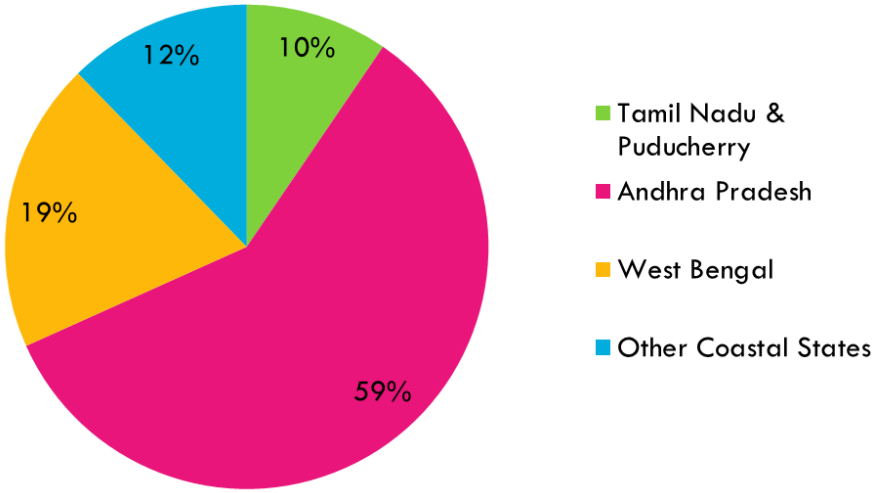
(d) Agriculture

- Total Cropping Area on the coast: 9.85 Mha and consists of 6.99% of total cropping area of India
- Total Agricultural production from coastal areas: 59.02 MT
- Fertilizer consumption: 3.06 *10^6 MT and consists of 6.21 % of Total fertilizer consumption of India
- Pesticide consumption: 1900 tonnes



(e) Coastal Aquaculture

The area used for aquaculture is estimated to be 1,75,525 ha with a production of 2,70,756 tonnes.



Coastal Aquaculture Production (tonnes) in India

(f) Tourism

Tourism areas along the coast of India are classified as i) recreational tourism and ii) cultural tourism. Recreational tourism is predominantly on the beaches and islands. There are ~1000 beaches along the coast of India with 641 beaches along the mainland coast and remaining in the Island territories. The beaches are largely subjected to intense pollution from solid waste disposal and sewer inflow from the hotels and restaurants located on the beaches. Disposal of untreated sewage into the coast

adjoining these beaches causes a decline in the bathing water quality of these beaches to a large extent.

(g) Oil Pollution:

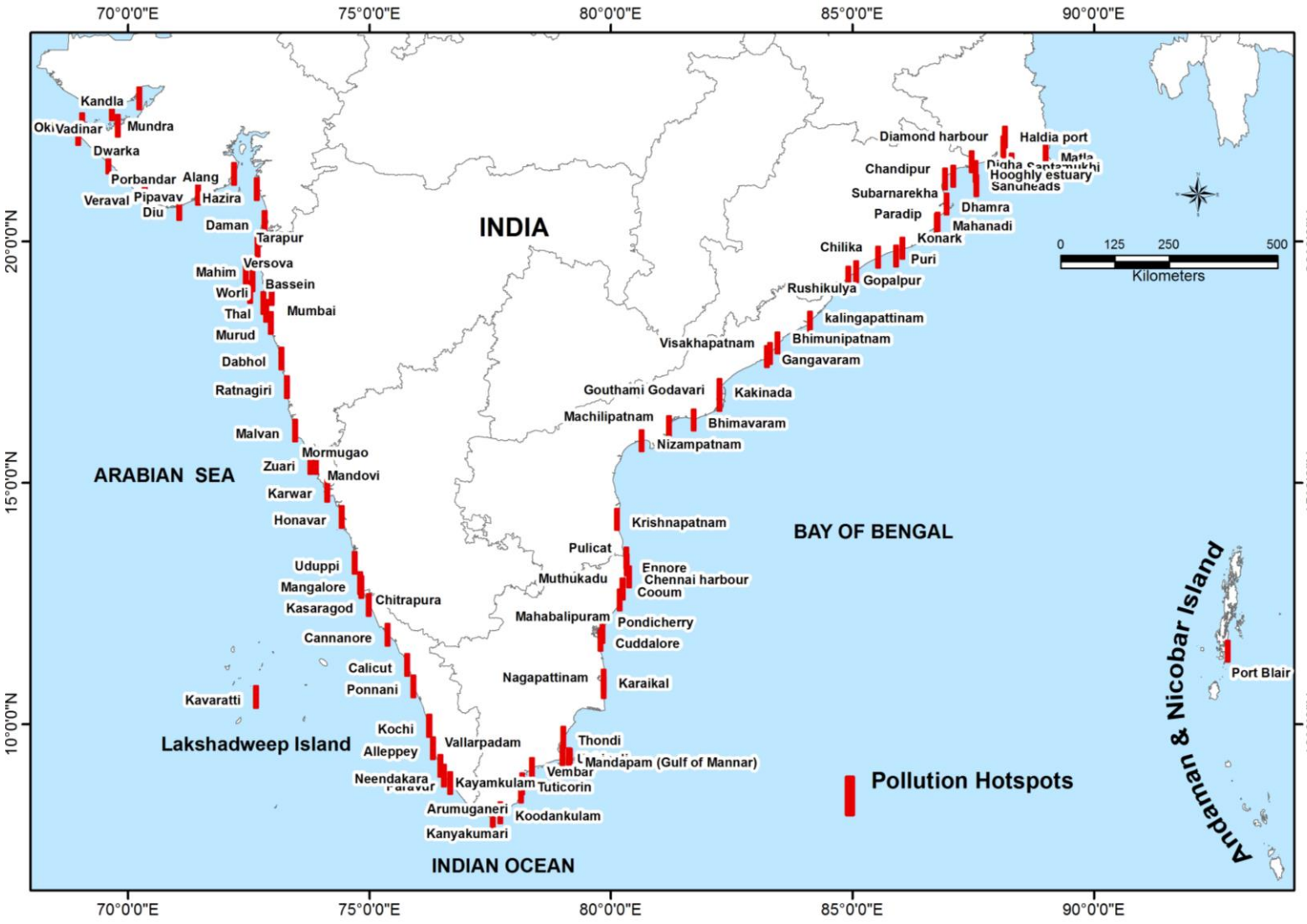
S.No	Location	Latitude	Longitude	Date	Spillage (tonnes)
1	Chennai, Ennore Port (collision of MV Dawn Kancheepuram & MV Mapple)	13°13' 41	80°21'46	28-01-2017 to present (91 days)	194
2	Mumbai, Arabian Sea (Mumbai-Uran pipeline spill)	19°01'44	72°74'44	21-Jan-11	55
3	Mumbai, Arabian Sea (Mumbai oil spill / MV MSC Chitra and MV Khalijia 3)	18°51	72°49	7 August 2010 – 9 August 2010	800
4	About 80 NM from the shoreline north of Bombay (Rupture in a feeder 'riser' pipeline from Bombay High)	19°32'	71°18'	17-May-93	6000

Oil Spill along Chennai Coast in January 2017

(h) Water Quality Index

State	River/ Estuary	O_2 (mg l^{-1})	Oxygen Saturation (%)	BOD (mg l^{-1})	Turbidity (NTU)	Chlorophyll (µg/l)	DIN (µmol/l)	DIP (µmol/l)	Water Quality Index
Gujarat	Tapi	4.6	70.1	3.6	90.8	3.7	5.4	1.6	
	Narmada	6.9	96.9	4.5	72.2	1.9	17.3	3.1	63
Maharashtra	Thane Creek	6.2	86.5	1.3	21.2	1.7	16.8	2.9	77
Goa	Zuari River	5.7	94.1	0.9	8.3	4	14.9	2.8	
	Mandovi River	5.7	81.8	1.1	11.2	3.4	17	3.4	75
Karnataka	Aghanashini River	5.7	80.7	1.2	91.6	5.9	12.5	1.3	
	Kali River	6.8	88	0.9	83	7	11.2	0.9	77
Kerala	Valapattanam	4.8	78.2	1.1	30	3.2	29.4	0.9	
	Dharmadam	5.5	93.4	0.9	44	2.8	18.2	0.9	72
	Kochin backwater	5.4	81.7	3.1	89.3	4.4	8.8	1.6	
Tamil Nadu	Vellar River	6.5	96	0.9	8.2	3.3	22.3	4.1	
	Coleroon River	6.1	97.2	0.9	6.4	1.7	16.3	6.5	75
Andhra Pradesh	Krishna	7.2	111.9	1.9	5.6	3.6	6.4	3.6	
	Godavari	6.1	93	1.4	7.9	2.1	22.4	0.9	
	Coringa	6.4	84.8	1.4	40.1	3.4	18.5	5.1	77
Odisha	Bhitarkanika	6.9	107.4	0.8	16.2	3.6	5.6	1.3	
	Mahanadhi	7	96.4	0.8	20.1	1	5.1	3.4	
	Chilika	6.2	96.3	0.5	68.2	2.4	4.5	0.4	83
West Bengal	Hooghly estuary	7.2	89.5	1.1	22.7	2	23.6	1	80

Major pollution hotspots along India's coast



5 Pollution Management

(b) Cumulative Environmental Impact Assessment (CEIA) Framework & Gulf of Kachchh – Case Study

With the increased focus on coastal areas as hubs for development, the precautionary principle must be kept in mind to ensure sustainable development using tools such as cumulative impact assessment which address the collective impact of multiple activities. CEIA is useful for making available information on 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.

Two major approaches for assessment of cumulative impacts are:

(i) stressor based approaches and

(ii) effects based methods

The former is used for examining whether a new project is perceived to have additional impact on the environment while the latter is largely used for regional planning. The logical framework for carrying out a CEIA is the Valued Environmental Component (VEC) centred approach as opposed to the project-centered approach in traditional EIA. It includes environmental and social attributes considered important in assessing risks.

In the VEC centered approach, the risk to the VEC is considered due to multiple causes which could be direct, indirect and/or cumulative. These stressors on the VEC could be of natural or anthropogenic or both. The Cumulative Environmental Impact Assessment Process can be structured into five key steps; which are structured into tasks.

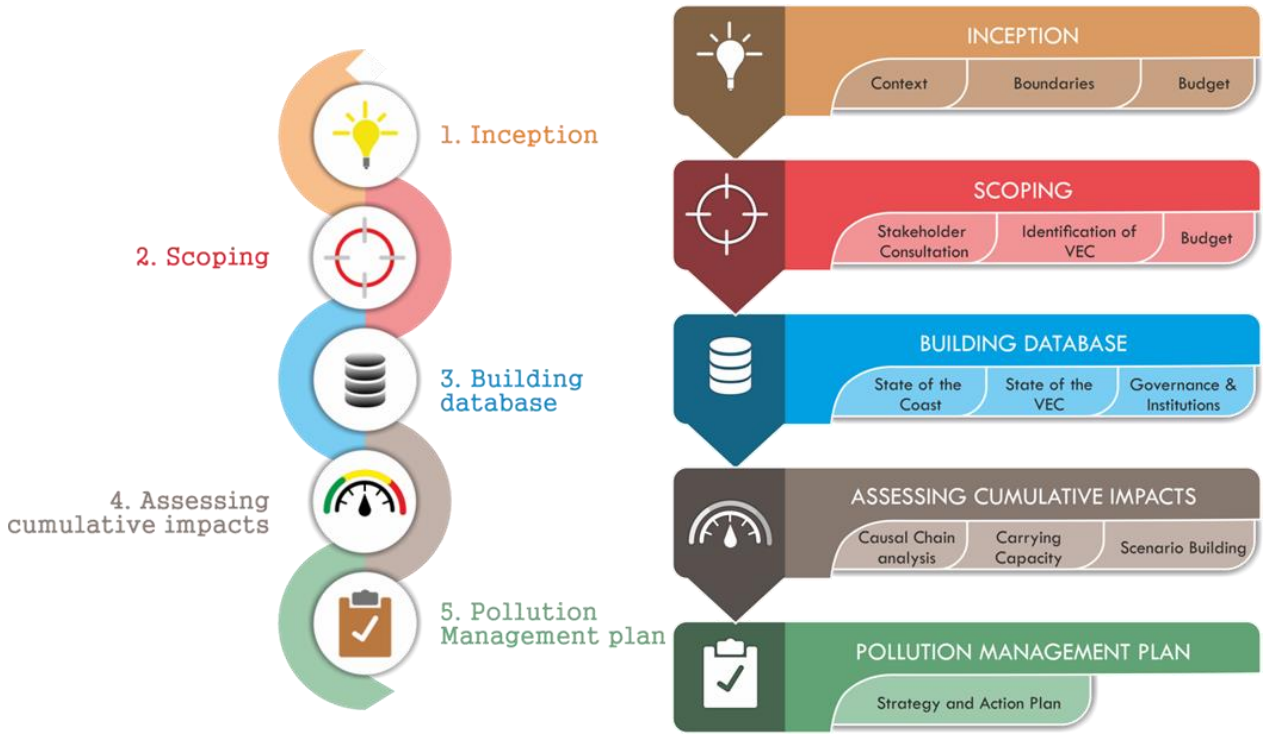
Step 1: In **Inception,** the context of the study is defined followed by indication of the broad spatial and temporal boundaries.

Step 2: **Scoping** requires a focused Stakeholder Consultation to identify the Valuable Environmental Components (VEC) in the study area that are under stress (or will be potentially under stress), those (people) directly and indirectly affected by the stressed VEC and the anthropogenic and natural stressors of the VEC.

Step 3: The third step is **Building the Database** and results in a profile of the area based largely on secondary data with additional primary data where required.

Step 4: In the fourth step, **Cumulative Impact Assessment,** causal chain analysis helps in identifying the sources, pathways and receptors. Scenarios are built to see what factors when changed will improve the status of the VEC.

Step 5: Finally a **Pollution Management Plan** is prepared provding strategies and action plans to promote sustainable coastal development that will directly integrated with the ICZM Plan of the area.

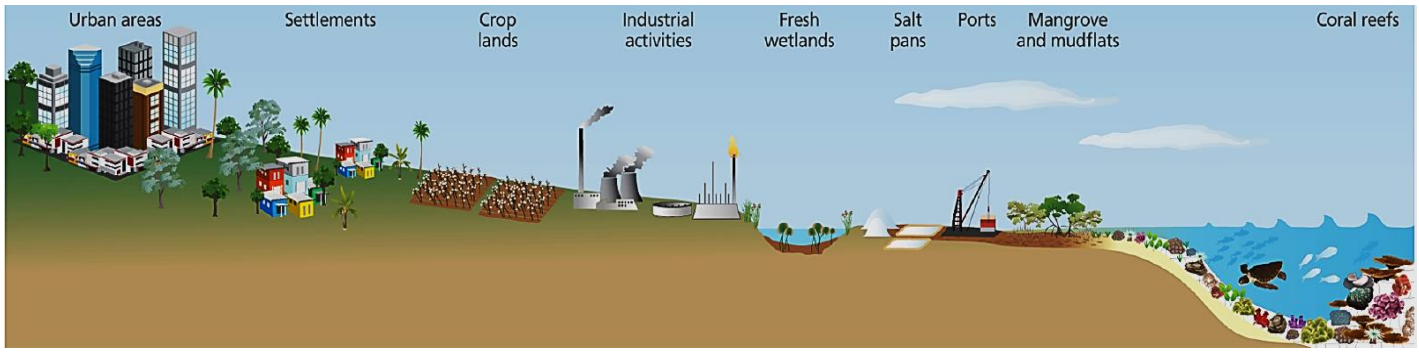


Cumulative Environmental Impact assessment has been developed for a pilot case study for the Gulf of Kachchh region. The Gulf of Kachchh is situated between Saurashtra and Kachchh Peninsula in the western state of Gujarat, India. A relatively shallow and well mixed waterbody, the Gulf

covers an area of 7350km^2, is approximately 170km long and upto 70km wide.

Gulf of Kachchh – Case Study

The Cumulative Environmental Impact Assessment (CEIA) framework is a 5-step process that will lead to improved management planning for the Gulf of Kachchh region.



Key Results

SECTOR 1 – WESTERN MNPS

Sector 1 was characterised as having moderate pressure from agricultural runoff and turbidity.

SECTOR 2 – CENTRAL MNPS

Sector 2 was characterised as having moderate-high pressure from sewage and urban waste, turbidity, and industrial development, and low-moderate pressure from salt pan discharge.

SECTOR 3 – EASTERN MNPS

Sector 3 was characterised as having moderate pressure from agricultural runoff, turbidity, and salt pan discharge, and low-moderate pressure from industrial development.

SECTOR 4 – ISLANDS MNPS

Sector 4 was characterised as having moderate pressure from industrial development, and low pressure from sewage and urban waste and turbidity. Fishing has also been identified as an additional activity in this sector.

SECTOR 5 – SOUTHEASTERN GULF OF KACHCHH

Sector 5 was characterised as having high-moderate pressure from turbidity, and moderate pressure from salt pan discharge and industrial development.

SECTOR 6 – NORTHEASTERN GULF OF KACHCHH

Sector 6 was characterised as having moderate pressure from sewage and urban waste, and low-moderate pressure for agricultural runoff, turbidity, salt pan discharge, and industrial development.

SECTOR 7 – EASTERN CENTRAL GULF OF KACHCHH

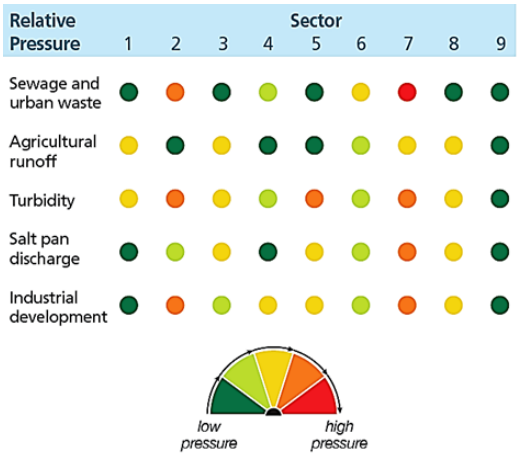
Sector 7 was characterised as having high pressure from sewage and urban runoff, moderate pressure from agricultural runoff, and moderate-high pressure from turbidity, salt pan discharge, and industrial development.

SECTOR 8 – WESTERN CENTRAL GULF OF KACHCHH

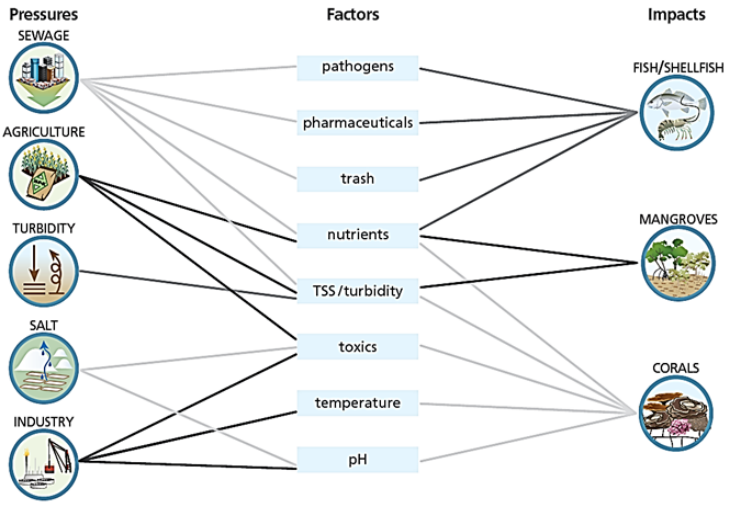
Sector 8 was characterised as having moderate pressure from agricultural runoff, turbidity, salt pan discharge and industrial development.

SECTOR 9 – NORTHWESTERN GULF OF KACHCHH

Sector 9 was characterised as having low pressure from all activities.



As estimated by Workshop participants, qualitative pressure assessment results by region and pressure category. Green indicates low pressure relative to red, which indicates high pressure.



Identification of the conceptual linkages between pressures in the region and the potential impacts on important environmental features allows selection of important parameters for the monitoring programme.

Challenges & Opportunities

A wide range of marine activities dominate the maritime zone of India thereby increasing the marine and coastal pollution. Along the Indian coast, within the narrow landward stretch of 25 km, there is high density of large and medium scale industries, thus generating ~ 1.35 million m^3/d of liquid effluent and ~ 34,500 t/d of solid waste. The quantity of the waste entering into the coastal and marine ecosystems, are often untreated and unaccounted. Quantification of the wastes (including marine litter and identification of associated issues is essential for the sustainability of the coastal and marine ecosystems

Benefits and Outcome

The source and abundance characteristics of litter and solid waste generation in the marine environment and transport pathways along the Indian coastline remain poorly understood with sparse information available. Considering the significance and need of the continuous monitoring of the waste generation, dispersal and its ecological impact, the following issues will be emphasized as a part of National Coastal Mission.

- Inventorization of major industries and Pollution hot spot all along the Indian coast
- Assessment of the existing environmental status of the coastal ecosystems through periodic State of coast reporting
- Quantification of anthropogenic waste generated (Solid and Liquid) along the Indian coast

- Proportion and quantification of marine litter (including Microplastic) production along the Indian coast
- Delineate various zones in terms of pollution, and identify the pollution hotspots
- Assessment of the Carrying capacity of coastal waters on a regional scale

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. Physical activities include strategic establishment of STPs for municipal sewage and regulatory interventions for industrial effluents. Additionally proper conservation and protection of the coastal & marine resources (e.g. wetlands) will safeguard the biodiversity, fisheries, livelihood against anthropogenic stressors.

Coral and mangrove resources of Gujarat

6 Livelihood Management Plan

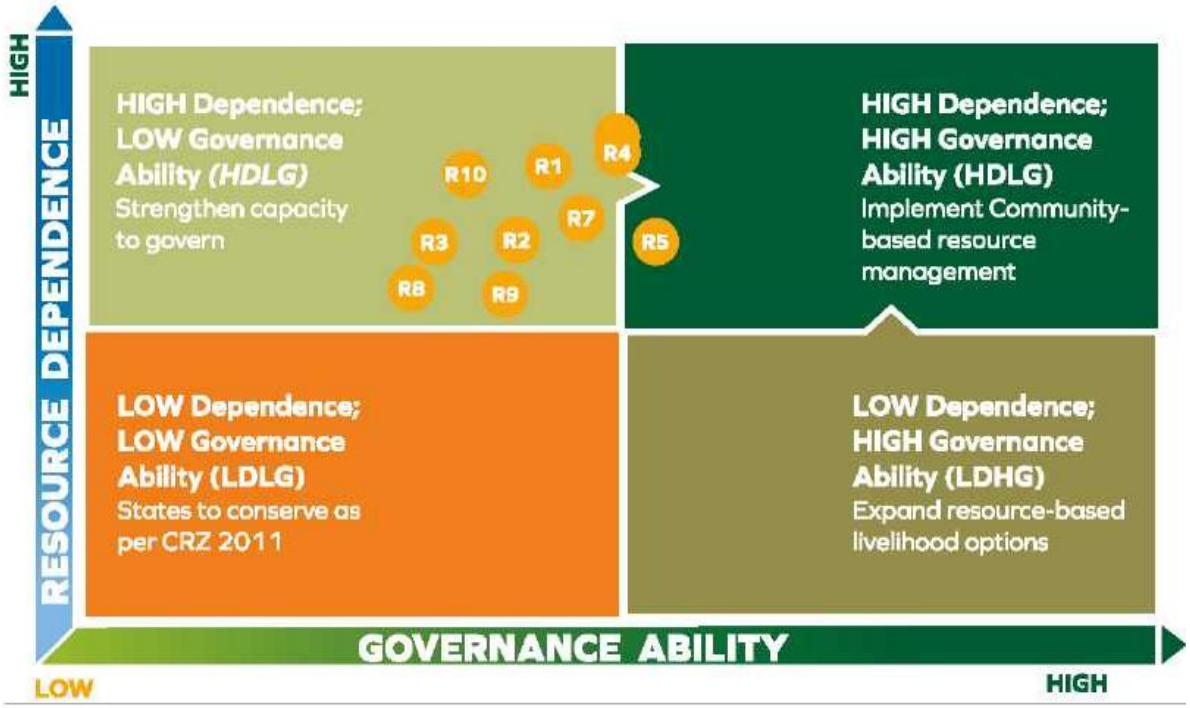
(a) Critically Vulnerable Coastal Areas (CVCA)

Globally, the involvement of communities in environmental conservation and management gained momentum especially following the Agenda 21 of Rio Conference.

- India has formulated enabling policies and enacted legislations for demarcation of community-managed areas to aid in conservation and sustainable resource use.
- The National Environmental Policy, 2006 advocates development and implementation of conservation management plans involving the community.
- Participatory approaches encourage shared decision-making, cooperation, collaboration, mutual respect, confidence building and empowerment.
- CRZ, 2011 notification has identified 12 sites along the coast of India as CVCAs for conservation ecologically sensitive areas involving the community.

Key Findings

- A detailed framework has been developed for determining the CVCA thresholds for all resource areas (contiguous patches)
- CVCA Threshold for a given resource area is the summation of dependence index and governance index values, both of which when plotted against each other in the CVCA Decision Matrix aid in planning location-specific interventions



Recommendations

- Demarcate the areas to be managed by community in the state
- Develop Integrated Management Plans for CVCAs
- Build capacity and strengthen institutional structure for co - management of coastal ecosystems
- Expand the extent of community managed coastal ESAs in the coastal states/ UTs

6 Livelihood Management Plan

(b) Mapping of Fishing Space

Activity–1: Preparation of a guideline and resource manual for decentralized micro planning exercises in fishing villages

The National Environmental Policy, 2006 has emphasized to secure livelihoods and well-being of people dependent on natural resources. Principle X of NEP 2006 has endorsed that "Decentralisation involves ceding or transfer of power from Central Authority to State and Local authorities, in order to empower public authorities having jurisdiction at the spatial level at which particular environmental issues are salient, to address these issues". (NEP 2006). In line of National Environment Policy, CRZ 2011 Notification guided the coastal States to prepare detailed plans for long term housing needs of coastal fisher communities in view of expansion and other needs, provisions of basic services including sanitation, safety, and disaster preparedness. To support the coastal States and the local Governments to prepare decentralized plans in fishing villages, a resource manual on mapping of fishing village is prepared by ISE division of NCSCM (Activity – 1). The manual also shall support preparation of decentralized plans in villages as required for implementation of Panchayat Raj institutions.

In continuation of the above activity under the mapping of fishing space project, the project has been up scaled to support achieve the objectives of CRZ 2011 Notification to protect life and livelihoods of coastal communities including fishermen community. Accordingly, a “research study to assess livelihood assets and vulnerability of fishermen communities” has been undertaken (Activity - 2). In this study, livelihood assets of fishermen community have been classified as natural, social, human, physical and financial capitals and the interaction between them have been studied to select suitable policy interventions for poverty alleviation and sustainable livelihood of fishermen community.

The objectives of the decentralized micro level decentralized planning in fishing villages are to:

a) develop plans at the grass root level
b) tackle the specific problems at the micro region
c) identify and utilize local resources and development of infrastructures
d) emphasize and use local culture, traditions, history, values and practices
e) encourage bottom-up planning
f) develop fishing villages as an independent and sustainable habitat for fishers by co-management and decentralized planning to achieve village swaraj

Contents of the guideline and resource manual

The guideline covers the followings, (i) Create a planning environment in fishing village (ii) Developing an enabling mechanism to prepare a fishing village plan and map (iii) Socio-economic development planning (iv) Land-use planning process (v) Preparation of local level disaster management plan of the fishing village (vi) Critical factors deserved to focus in fishing village planning (vii) Report preparation and (viii) plan implementation. The guideline and resource manual contents shall support preparation of decentralised fishing village planning as required for CRZ and Panchayat Raj institutional mechanisms.

Key Results

Outcome of the application of the guideline for decentralised micro level decentralised fishing village planning are as follows:

(a) eliminate poverty in fishermen villages
(b) increase of living standard of fishermen communities

(c) empowerment of rural youths, children and fishing women of the fishing village
(d) empowerment of human resource of fishermen areas in terms of their psychology, skill, knowledge, attitude and other abilities
(e) Increase of infrastructure and facilities to the fishing villages
(f) obtain drinking water, education, transport, electricity, communication and other essential facilities for the livelihood development of fishermen
(g) Decentralization of powers in panchayats, cooperatives, post, banking, credit etc.
(h) Identify the financial resources for fishermen development
(i) develop fishing related industries through the development of handicrafts, small scaled industries, village industries, rural crafts, cottage industries and other related economic operations in the rural sector
(j) develop entertainment and recreational facility for fishing communities
(k) develop leadership quality of the fishing communities
(l) improve marketing facility of the fishing products
(m) minimize gap between the urban and rural in terms of facilities availed to fishermen on land
(n) improve fishermen participation in the development of State and Nation as whole
(o) increase scopes for employment of fishing communities
(p) solve the specific problems faced by the fishing communities for their development
(q) apply various schemes implemented by Government departments for the welfare and infrastructure development of fishermen community

Activity – 2: Assess livelihood assets and vulnerability of fishermen communities

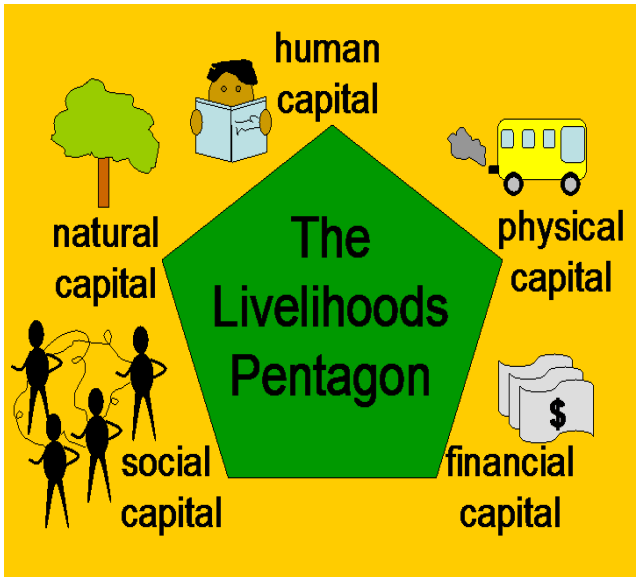
M.S. Swaminathan Committee (2009), on Policy and legal framework for Integrated Coastal Zone Management, has emphasized that the fishing communities are in double danger as well – ironically, from conservation and from development. On one hand, these communities are marginalized

and even alienated from their lands because of the need for conservation in marine parks or forested islands and on the other, they are in jeopardy because of large developments which displace them and take over their lands and livelihoods. The CRZ 2011 notification objective has also emphasized to protect the life and livelihood of coastal communities. The primary objectives of the study include:

i. Protecting and promoting livelihood capitals of coastal communities by studying interactions between them and to develop a framework for sustainable livelihood
ii. Suggesting policies and programs for the protection of livelihood of fishermen

Key Results

Coastal lands of fishermen are very significant to fishermen livelihood analysis since that area have traditionally been used by them for boat landing, fish drying, boat repairing, net mending, net drying, processing, housing, marketing etc. Under the mapping of fishing space project, NCSCM is studying "Studies on livelihood capitals of fishing communities".



In this study, livelihoods assets of fishermen are classified as natural, physical, human, social and financial capital and the interactions between them have been analysed. To analyse the fishermen livelihood capitals, remote sensing datasets (for land use), secondary data sources, and open source information are being collected and analysed to promote sustainable livelihoods. This study shall provide details of various assets and livelihoods of coastal fishing communities and villages by to improve / strengthen the livelihood assets and capitals.

6 Livelihood Management Plan

(c) 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 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

In the first part of the study, sampling was carried out in five coastal states through a structured questionnaire to obtain information on various aspects of the lives of women in the fishing sector. The sustainable livelihood framework was used to understand the vulnerability context and livelihood strategies of the women. This part of the study was carried out by the MS Swaminathan Research Foundation. In the second part of the study, data from the Marine Fisheries Census conducted by CMFRI in 2010 was analysed out to provide additional support to the earlier findings. The results from the first part of the study were used to see if they matched with the overall trends and provide generalizations that could be used to mainstream appropriate interventions in ICZM programmes throughout the coastal states of India.

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. The table below provides the varied livelihood activities of the women across the different states.

Table 1: Livelihood categories of women across the coastal states

Pre-harvest	Harvest	Post-harvest	Non-fisheries
Net making	Prawn, shrimp	Sorting	Salt pan labour
Net mending	Prawn, shrimp seed collection	Cleaning	Agricultural labour
	Fish (mainly backwaters)	Fresh fish vending	Petty shops
	Clams & mussels	Dry fish processing (salting, drying)	Tailoring
	seaweed	Dry fish vending	Handicrafts – shell making, palm leaf products
		Value added production (e.g. pickles)	poultry
		Poultry feed	
		Small scale trading	livestock
		Auctioneering	
		Labour: shore seine	
		Headload transport	

Five different groups of assets (capitals) according to the SLA framework, for women in the study are given in the table below.

Table 2: Livelihood Assets (Capitals)

NATURAL	PHYSICAL	HUMAN	SOCIAL	FINANCIAL
Open Sea	Fish landing centre	Population, sex ratio	Fisherwomen's organizations	Credit sources
Nearshore waters	Harbour	Productive and reproductive activities.	Self-help groups	Money lenders
Coral reefs	Auction hall	Literacy and education	community organizations	Banks
seaweed beds	Drying areas	Food security and nutrition	collectives	SHG microfinance
backwaters	Ice	access to health care	producer groups	Savings
estuaries	Ice box	Trading skills	gram panchayat	insurance
Open areas	Road network	Skill with respect to fish selection, cleaning etc	political organisations	Assets – house ownership
Beach space	transportation	Skills for dry fish preparation		Assets – jewellery
Pond (freshwater)	housing	Entrepreneurial skills		Assets - land
local bushy/ forested areas		Decision making ability		

*These assets are subject to **vulnerability contexts** such as:*

Trends: With respect to women in fisheries, two trends are seen to affect them directly: Access to sea and resources is getting reduced because of port construction, erosion, and pollution and Loss of beach space has meant that fish are landed at fewer centres, women have to travel distances to collect/ buy fish. Technological interventions such as motorization/ mechanization have resulted in capitalization of fisheries and lesser cashless transactions and increase in women having to buy fish at open auctions. Provision of ice and ice boxes have increased storage life of fresh fish and a consequent reduction in the need to dry fish. Reduced beach and other open space have also resulted in reduced areas for drying fish. Availability of nylon nets has reduced the demand for net-making, once a thriving activity by women.

Shocks: These include seasonal hazards such as cyclones and floods that may strike the area and damage fishing implements. Other shocks could be health epidemics (e.g. malaria), accidents at sea resulting in the disability or even death of the earning male member apart from damage/loss of fishing equipment; and disability due to impact of occupational hazards. Specifically, in the context of women, it must be mentioned that the study enumerated a number of occupational hazards faced by women especially because of their constant contact with salt water. These hazards include fever, body pain, stomach ache, breathing and skin ailments and injuries from fish/crab bites as well as fish thorns/spikes.

Table 3: Assets Threats and Possible Interventions through ICZM

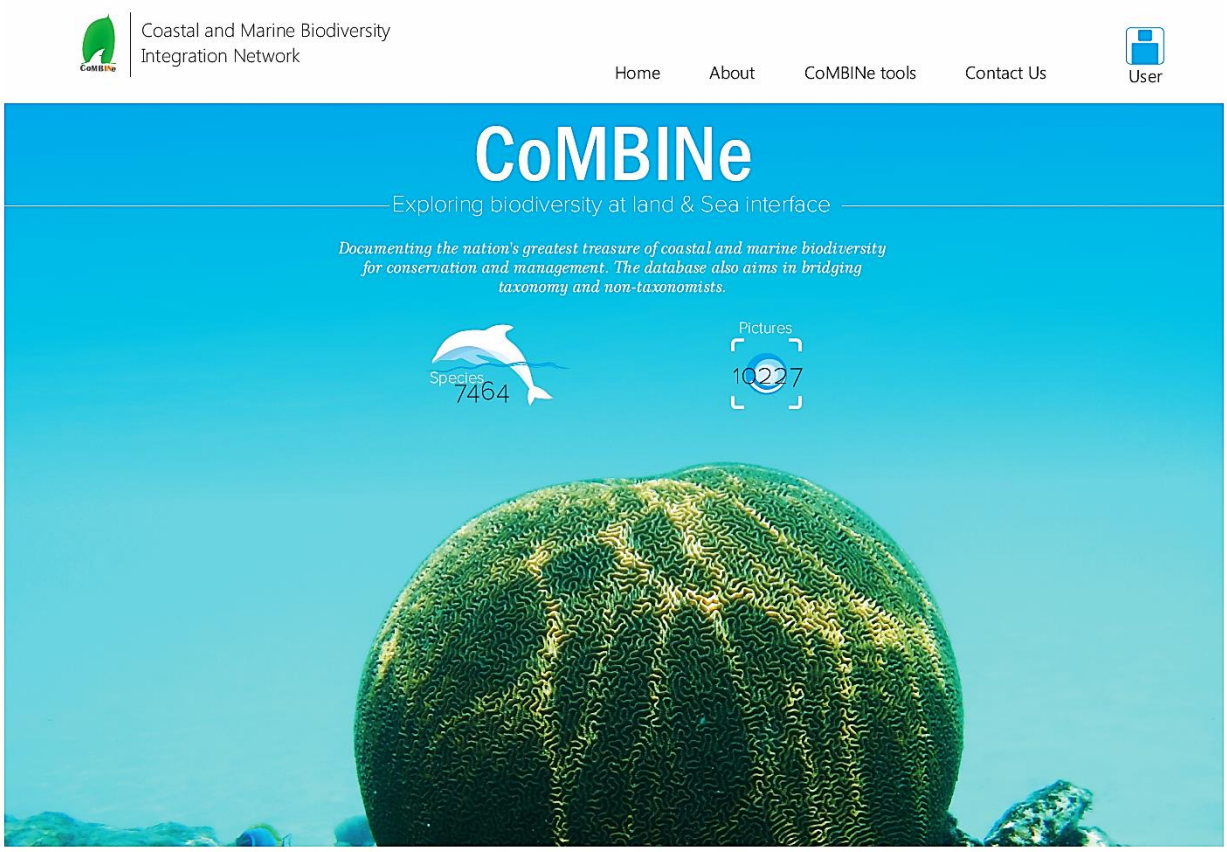
	Asset	Threats	Possible intervention
Natural	Sea, backwaters, estuary, mangrove areas	Pollution, restricted access to resources, habitat degradation	Implementation of Pollution Management Plan for the area Mangrove plantation
	Beach/ open space	Loss of beach space – for drying fish – e.g. due to erosion	Fish drying platforms, solar dryers
	Pond and other water resources	Pollution, reclamation, salinization	Fix problem at source, supply of potable water
	Local forest/ bush area – used for firewood collection, defecation	Degradation, conversion into real estate	Alternate fuel – LPG, biogas, solar etc Sanitation facilities in community/ house

Seasonality: While some fishing may be carried throughout the year, a lot of fishing is subject to seasonal fluctuation in availability. During the monsoon season, fishers often cannot go fishing in the sea due to rough seas. Consequently, women also do not have employment. Unemployment in lean season is countered by taking on alternate employment (e.g. as wage labour), migration, apart from state-support through compulsory savings via fisher cooperatives.

From an ICZM perspective, the transforming processes and structures need to be identified to mainstream appropriate interventions to ensure sustainable livelihood outcomes for women. An example with reference to Natural Capitals is given below.

7 Resources Management Plan

(a) Coastal & Marine Biodiversity Integration Network (CoMBINe)

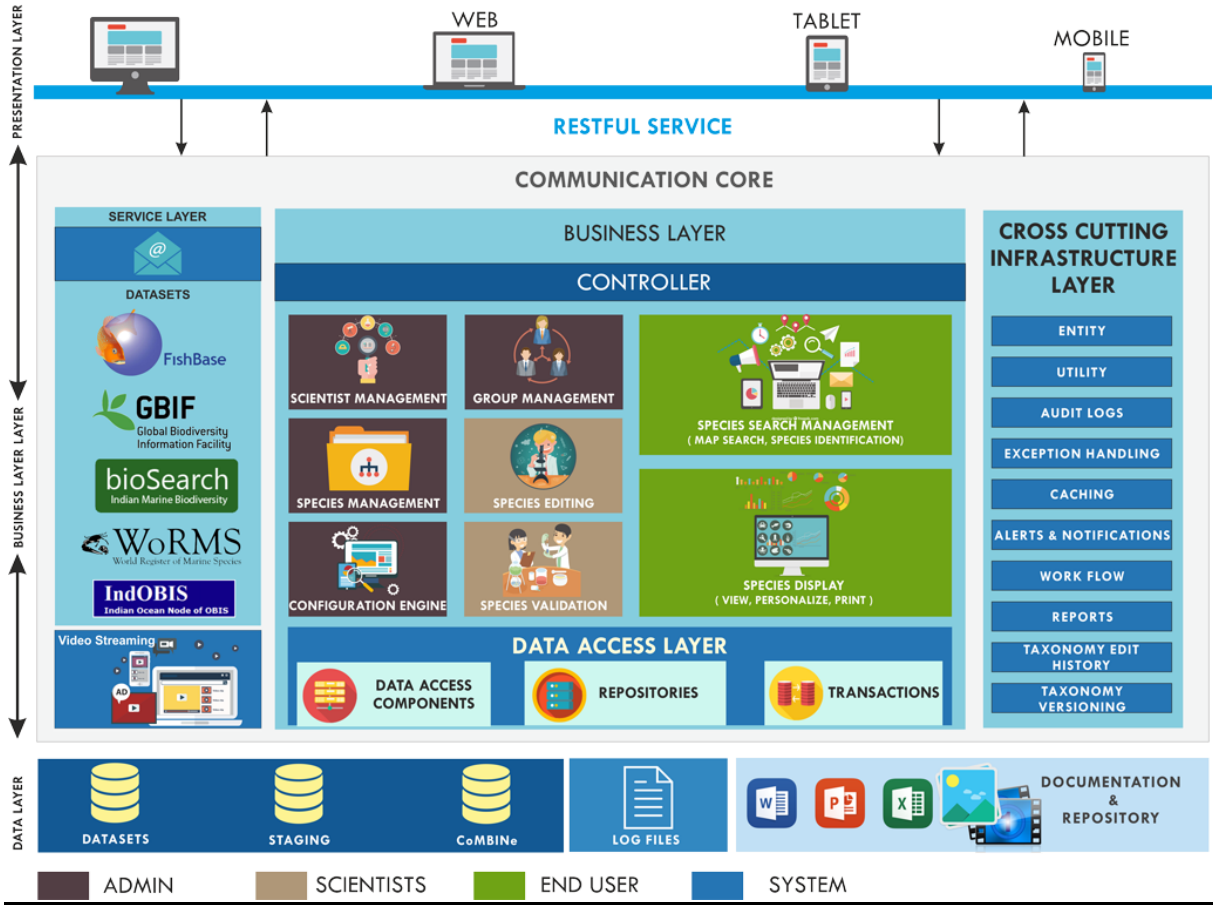


The Coastal and Marine Biodiversity Integration Network (CoMBINe) Database is built to function as an online national digital repository accommodating information pertaining to the coastal and marine flora & fauna recorded in the CRZ areas of India (500m from HTL on the landward side to 12nm offshore). CoMBINe aims to integrate biological, spatial and genetic information of organisms inhabiting sensitive ecosystems and provide advanced tools for querying, analyzing, modelling and visualizing species distribution. It envisages broadening interdisciplinary linkages of primary biodiversity data whereby, the initiatives in the fields of biology, climate change or impact assessment can be integrated to support scientific enquiry.

CoMBINe Realm

The biogeographic region of CoMBINe realm includes

- Water and bed areas between Low Tide Line (LTL) and 12 nautical miles
- Area from High Tide Line (HTL) to 500m on the landward side
- Intertidal area between HTL and LTL



CoMBINe Architecture

Key Results

- First Indian Biodiversity Database to be built on Darwin 2.0 core metadata standard for data sharing
- Updated species checklists for major coastal and marine taxa reported from the Indian coast
- Fact Sheets for more than 9000 species with 62 fields of general and scientific importance

- Interactive species identification tool (Unique Species Identifier – USI) with characters and attributes that allows end users to identify a species of interest
- Barcodes for marine species of commercial and conservation significance
- CoMBINe Mobile Application that allows end users to refer/ identify a species using hand held devices
- Integration of leading taxonomists of India and abroad for identification and scientific discussion

Major Ecosystem Species Covered

Taxa	Number of Species
Seaweeds	779
Seagrass	14
Mangroves & Associates	140
Sponges	471
Polyclads	41
Cnidaria (Corals, Sea anemones, Sea pens, Jellyfish)	662
Polychaetes	453
Crustacea (Crabs, Lobsters, Shrimps, Stomatopods)	856
Molluscs	2465
Echinoderms	687
Fishes	2577
Reptiles (Turtles, Sea snakes, Crocodile)	32
Birds	135
Mammals	33
Total	**9345**

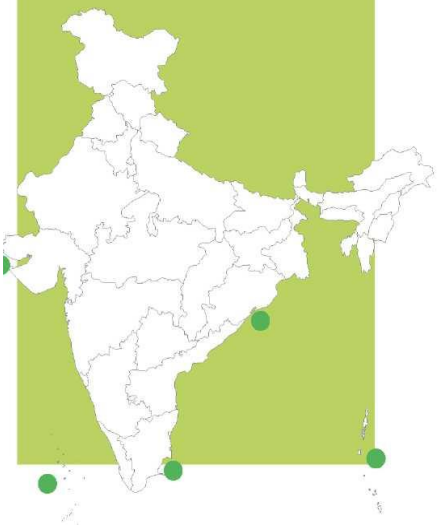
CoMBINe has collated the scattered biodiversity information spread across the country and disseminate in a structured format, targeting scientific and non-scientific end user communities.

7 Resources Management Plan

(b) Seagrass resources of India and assessment of status

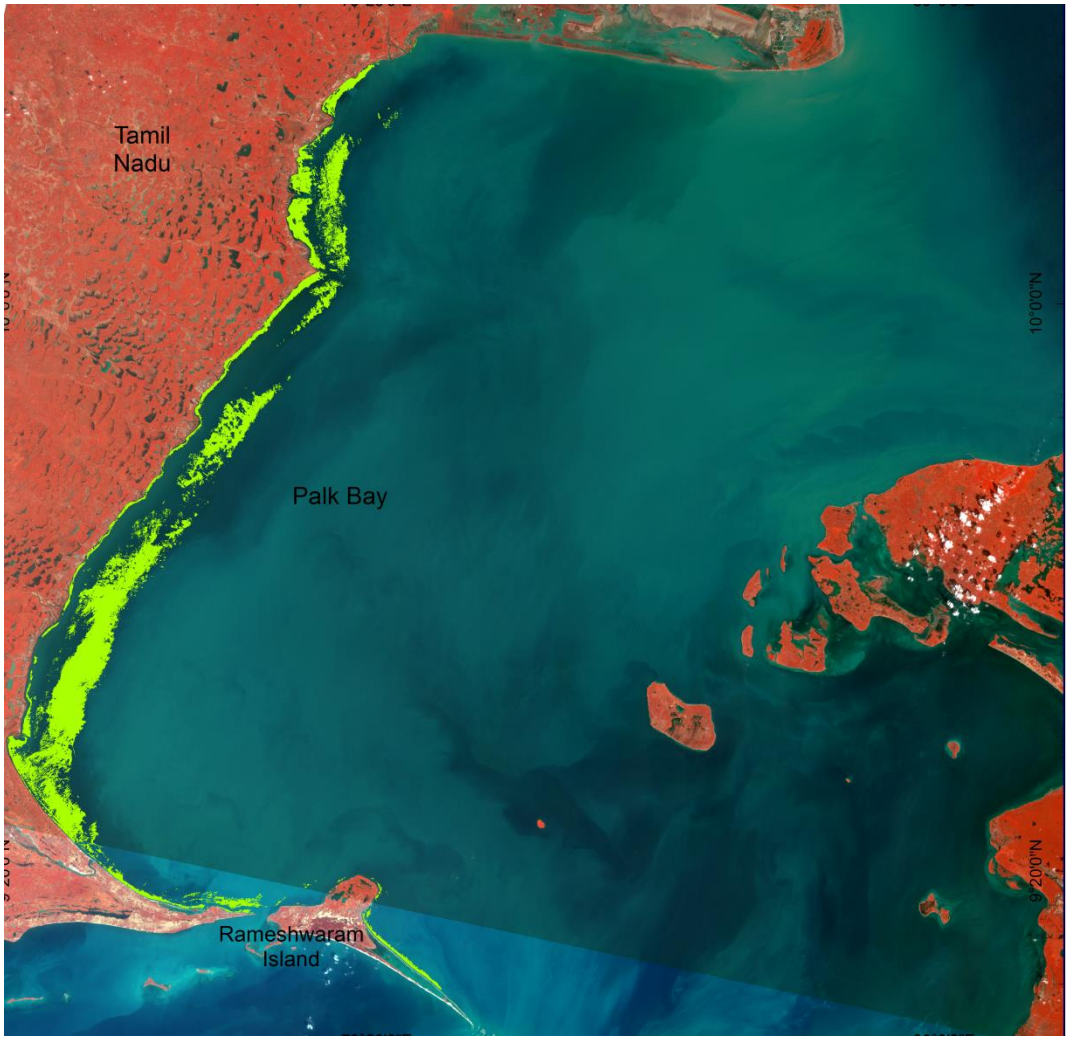
Spatial distribution of Seagrass meadows in India (in sq.km)

1. Gujarat | 16.99
2. Lakshadweep | 0.72
3. Tamil Nadu | 398.81
4. Odisha | 85.47
5. A & N Islands | 14.6

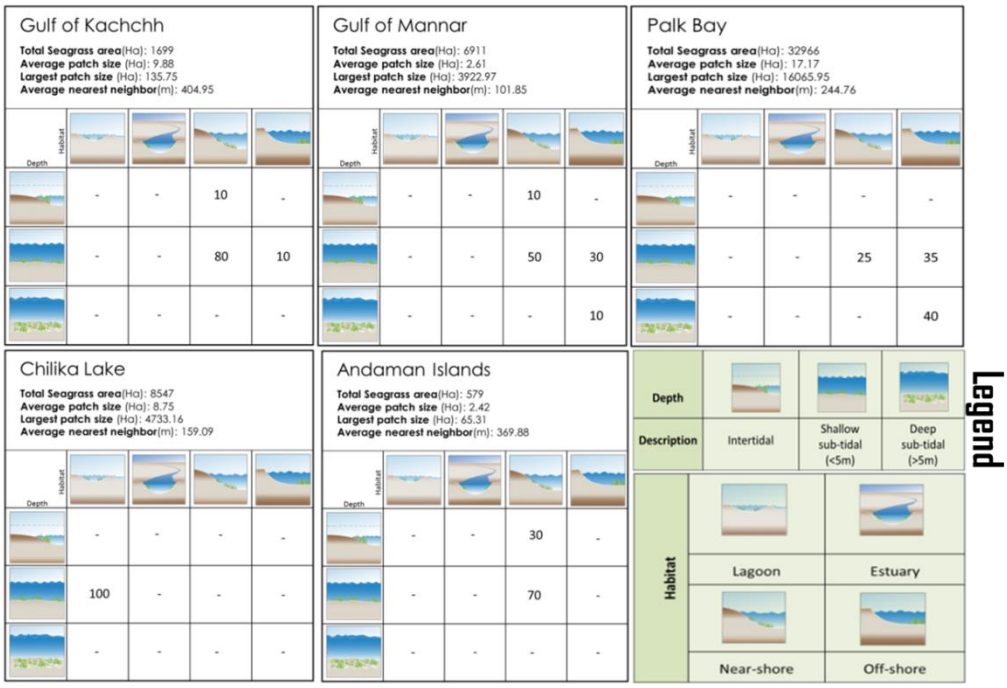


Seagrasses are firmly anchored marine flowering plants that achieve growth and complete vegetative and reproductive cycles in submerged conditions.

- Play a significant role in nutrient recycling, controlling coastal erosion and pollution, enhancing sediment accumulation and stabilization.
- 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.



Seagrass distribution along Palk Bay Coast

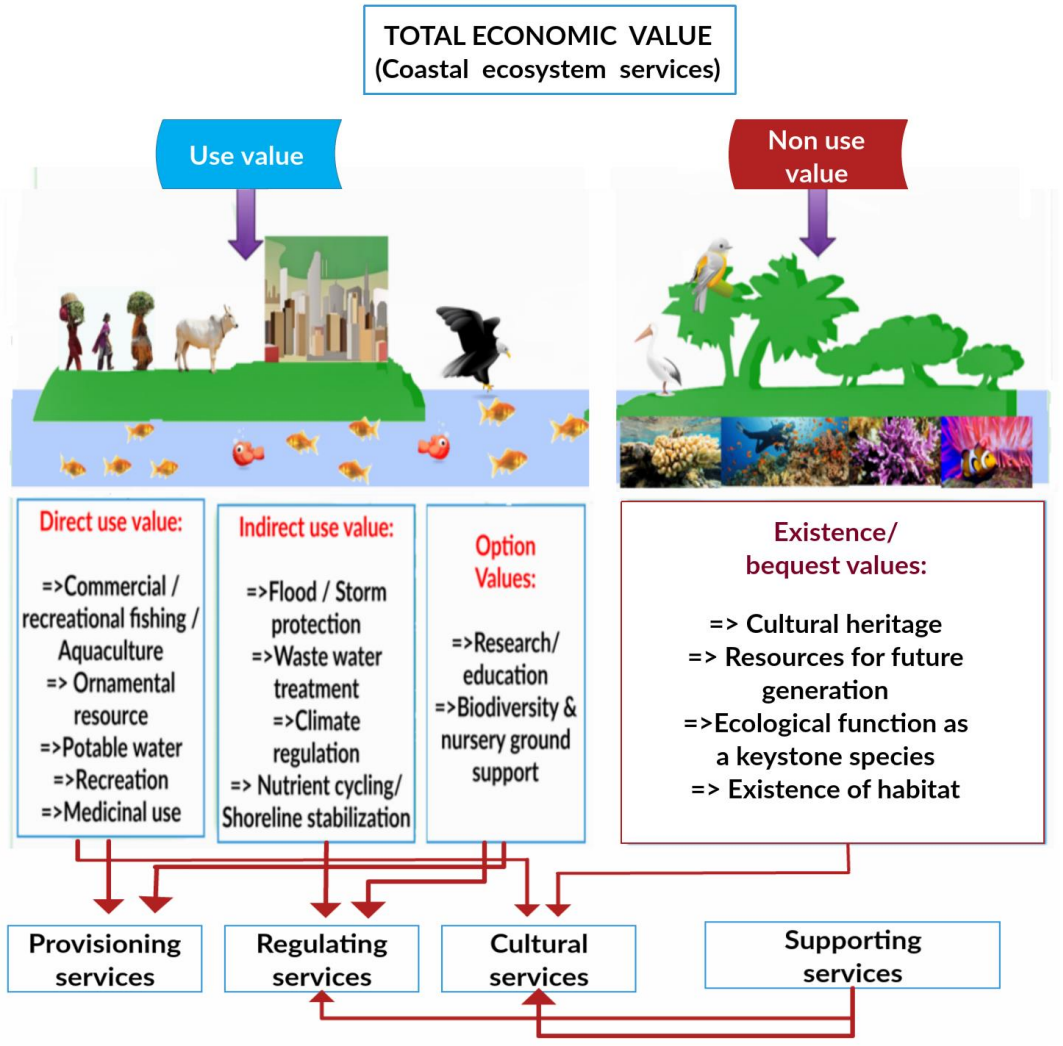


Habitat matrix of major seagrass ecosystems of India

7 Resources Management Plan

(c) Coastal & Marine Ecosystem Goods & Services

Coastal ecosystems are supplying 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.



Coastal ecosystems / habitats valued under this study

The ecosystems indicated in the Coastal Regulation Zone 2011 (CRZ, 2011) under Environment Protection Act (EPA, 1986) are being studied. The indicated coastal ecosystems / habitats are; mangroves, corals and coral reefs; sand dunes; mudflats; salt marshes; turtle nesting grounds; horse shoe crabs habitats; sea grass beds; nesting grounds of birds.

Key Results

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. After completion of the meta-analysis and application of BT method to value the coastal ecosystems, other suitable methods such as market pricing, hedonic pricing, travel cost approach, restoration cost (RSC), replacement cost and damage costs avoided etc. will applied to all the coastal ecosystem patches to compare the values obtained through various methods to recommend and use policy decisions.

The study estimated Total Economic Values (TEV) of coastal ecosystems of India and provides patch wise economic value of the coastal ecosystems which can be linked with the benefits of CRZ I areas of India. The study also estimated the economic loss due to externalities (impacts) of the coastal ecosystems and proposed indicative value for recovery cost following polluter pay principle. The estimate can be used for risk assessment and cost benefit analysis to take policy decisions on developmental activities in the coastal areas. The study has identified various underutilized coastal resources and demonstrated the potentials.

Challenges and opportunities

Justification and institutional mechanisms to link current value of environmental services (or goods) consumed by people to the National (green) accounts would be a great challenge. However, the environmental values shall offer an indicative market price to understand its importance and its economic significance in international green accounting and wealth

economics. The values can be used to create awareness about the benefits of coastal ecosystems goods and services.

Coastal and marine areas offer a relative abundance of diverse resource that creates many opportunities for exploitation. Market for coastal and marine resources are under exploited in various sectors. Since, markets play a critical role in the products generated from coastal and marine resources, development of market linkages and enterprises shall beneficial to livelihood of coastal communities. Marine living resources are not infinite. Overexploitation is a pervasive problem in fishery the world over. Landings of major fisheries resources in the Indian Ocean region have declined significantly.

Benefits and Outcome

Coastal community shall be improved in their skills and capacity to enhance income as additional income generation activities. Capacity of local governments shall be improved to facilitate pro-poor local economic development. Fisherfolk belonging to 4069 coastal villages will be benefitted from integrated development of coastal villages. On an average 25% of coastal agricultural productivity is increased leading to an additional annual return of Rs 16,000 crores per year for 40,000 sq km of salinized land. Further additional revenue can be generated from pisciculture. This promotes improved post-harvest technology of fisheries (fisheries 3.5 lakh tonnes) and agriculture products including cold chain and market linkage in line with Sagarmala Project.

Promotion of entrepreneurship through community will be undertaken which provide additional income to local communities. Increased awareness among coastal communities on business related information (laws, policies, regulations, rights, best practices, service providers) and sharing experience between communities shall provide alternative employment opportunities to the coastal communities. Socio-economic vulnerability assessment in coastal areas shall be undertaken as a process of identifying, quantifying and prioritizing socio-economic vulnerabilities along the coast. Reliable and systematic climatic data integrated with socioeconomic conditions thus helps in determining vulnerability. The socio-economic vulnerability assessment shall support in adopting suitable policy decisions and in making priority actions to mitigate climate related risks.

7 Resources Management Plan

(d) Offshore Wind Energy Potential Resource for India

Wind, a major renewable energy resource, is a promising alternative to fast depleting fossil fuels

- Offshore wind energy plays a crucial role in fulfilling the energy needs of the society and likewise in reducing adverse environmental effects.
- An attempt has been made to identify the offshore wind energy potential resource along the Indian coast using the following framework.

Framework: 5-Step Process

Step 1: Mesoscale modeling with a resolution of 15 km and 31 vertical levels along the Indian coast

Step 2: Development of wind energy blocks based on the eight categories of wind speed

Step 3: Assessment of environmental impact on exclusive zones due to offshore wind potentials
- Environmentally sensitive areas
- Bird migratory routes

Step 4: Cumulative potential area and configuration of wind farm in potential site

Step 5: Estimation of cumulative electrical power and energy per year
- Development of wind energy blocks in available area of potential sites
- Calculation of electrical power and energy per hour

Key Results

- Offshore wind speed varies between 8 to 11 m/s from the MSL to 140 m height along the Indian coast
- Cumulative potential areas are located on the west coast than the east coast of India.
- Tamil Nadu coast has the highest potential for offshore wind energy followed by Gujarat and Maharashtra
- Maximum gross electrical power predicted at 50 m hub height is ~1,500 GW during southwest monsoon and varied between 250 and 800 GW in other seasons along the Indian coast
- Total annual gross offshore electrical power is about 5,442 GW at depths between 30 and 200m.
- Available annual offshore wind energy power within the 12 NM is 74GW
- In the depth range of 30-50m, 50-100m, and 100-200m) the potential is estimated to be 421GW with the exclusion of marine protected areas, marine ecosystems, archaeological sites, bird migration, ship routes and cyclone prone areas
- Total annual offshore wind power based on exclusion zones is estimated to be ~495 GW.

Potential Sites within 12NM and 30–20m Depth along Indian Coast

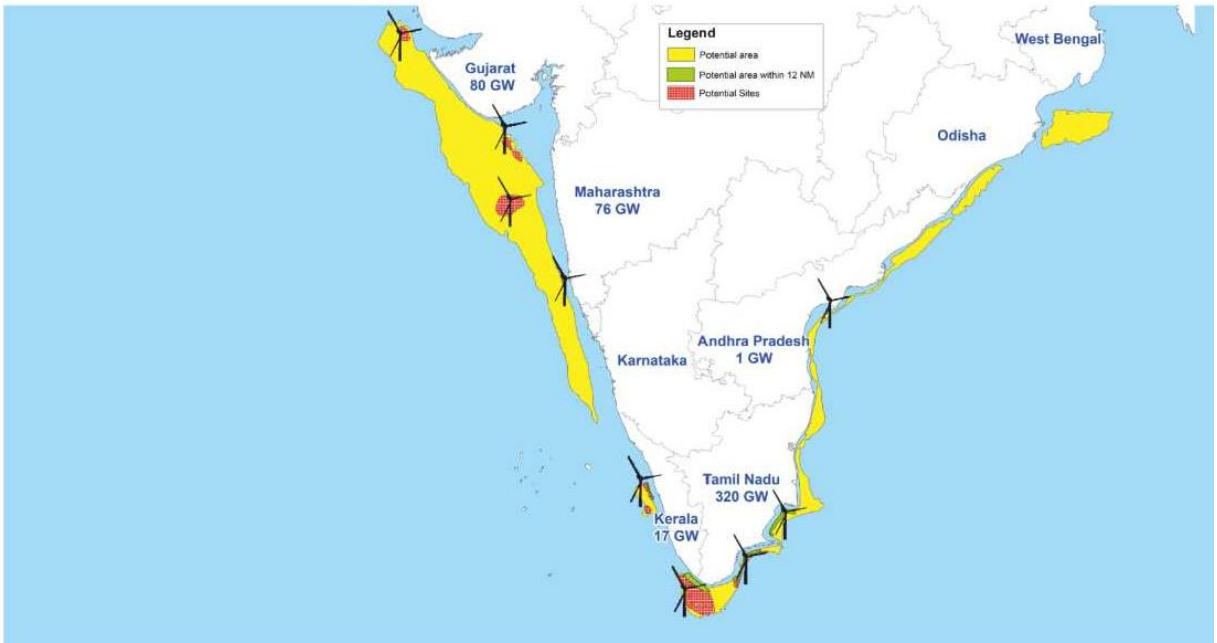


Table 1: Annual Offshore Wind Electrical Power (GW) at 50m Hub-height along the coastal States of India

Coastal State	*Electrical Power (GW)*
Gujarat	80.1
Maharashtra	76.4
Kerala	17.0
Tamil Nadu	320.4
Andhra Pradesh	1.0

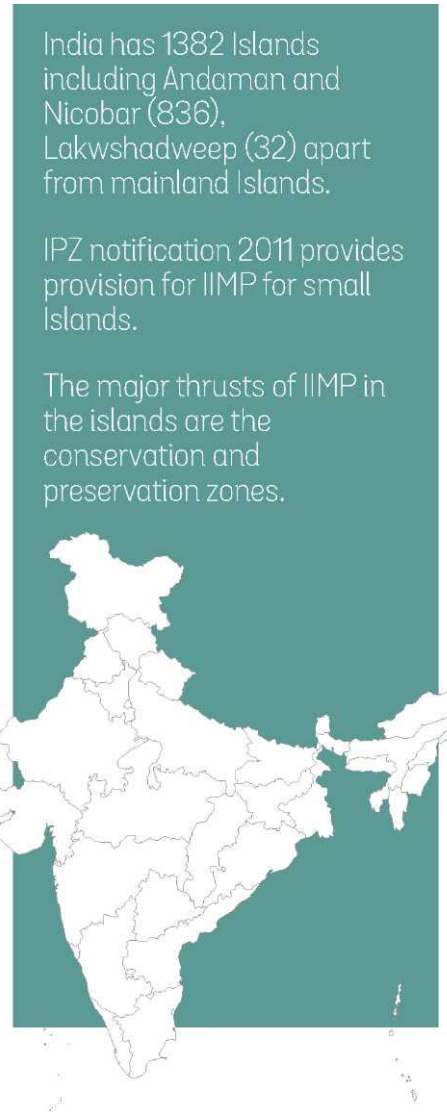
Recommendations

- Installation of wind farms may help in tapping ~60% of available offshore wind power from potential sites to meet the growing power demand.
- Maximum electrical power demand of India is about 207 GW during 2016-2017 and 294 GW during 2021 - 2022
- Installation of offshore wind energy farms would significantly reduce carbon emissions and provide green energy
- Promotes Research and Development and Skilled Manpower in the Offshore Wind Energy Sector

8 Island Management

(a) Integrated Island Management Plan (IIMP)

Preparation of Integrated Island Management Plan (IIMP) was in accordance with the guidelines provided in the Island Protection Zone (IPZ) Notification, 2011. The IIMP consist of guidelines for hazard preparedness and evolve climate change adaptation and mitigation strategies for the Islands. The major thrusts of IIMP in the islands are the conservation and preservation zones which are basically the major coastal habitats of the island ecosystems. The preparation of IIMP was in accordance with the guidelines provided in the Island Protection Zone (IPZ) Notification, 2011.



The IIMP encompasses the existing and proposed developments, conservation and preservation zones, dwelling units including the infrastructure projects such as schools, markets, hospitals, public facilities, etc., The IIMP consists of a detailed spatial plan for all the development activities covering the following:

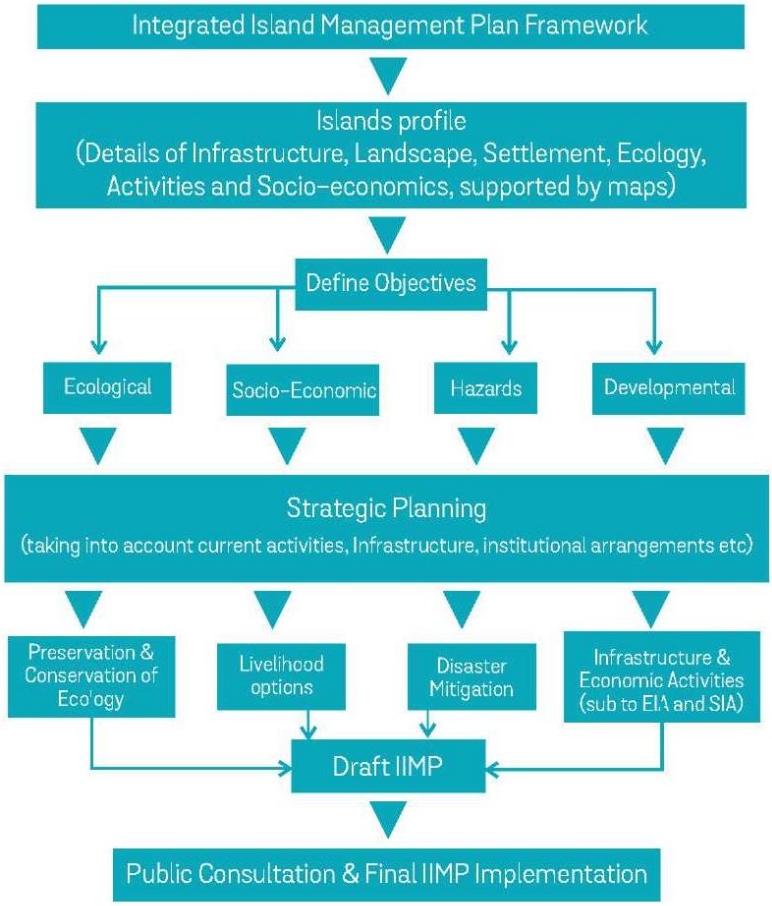
- Entire island and associated ESA areas
- Area from HTL to 12 NM seaward
- A Strip of land from HTL to landward and denoted as No Development Zone based on elevation

Integrated Island Management Plan (IIMP)

To ensure the future socio-ecological sustainability of the Indian small islands, Andaman & Nicobar and Lakshadweep by preparing an Integrated Island Management Plan. IIMP clearly demarcates conservation, preservation and No Development Zone
(NDZ).

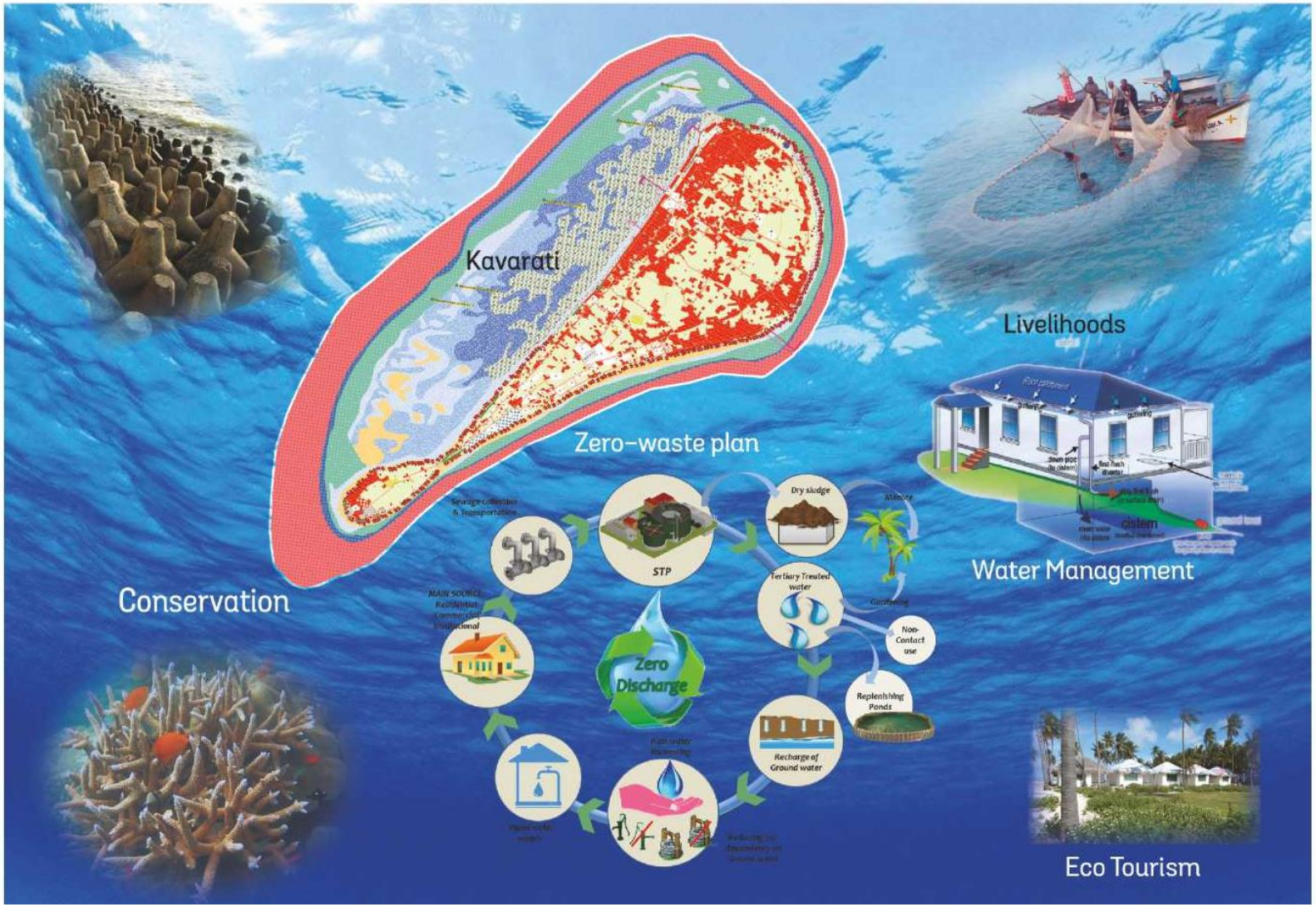
Components of IIMP

- High Tide Line
- Low Tide Line
- Ecological Sensitive Areas
- Cadastral maps
- Landuse
- Coastal process
- Eco-tourism
- Elevation and Geomorphology
- Pollution Management
- Livelihood Management



IIMP has been prepared for 10 inhabited islands of Lakshadweep and 4 islands in Andaman and Nicobar. The Lakshadweep Islands are subjected to various ecological and social vulnerabilities. IIMP is an essential tool for tracking the different issues and managing the resources in a sustainable way.

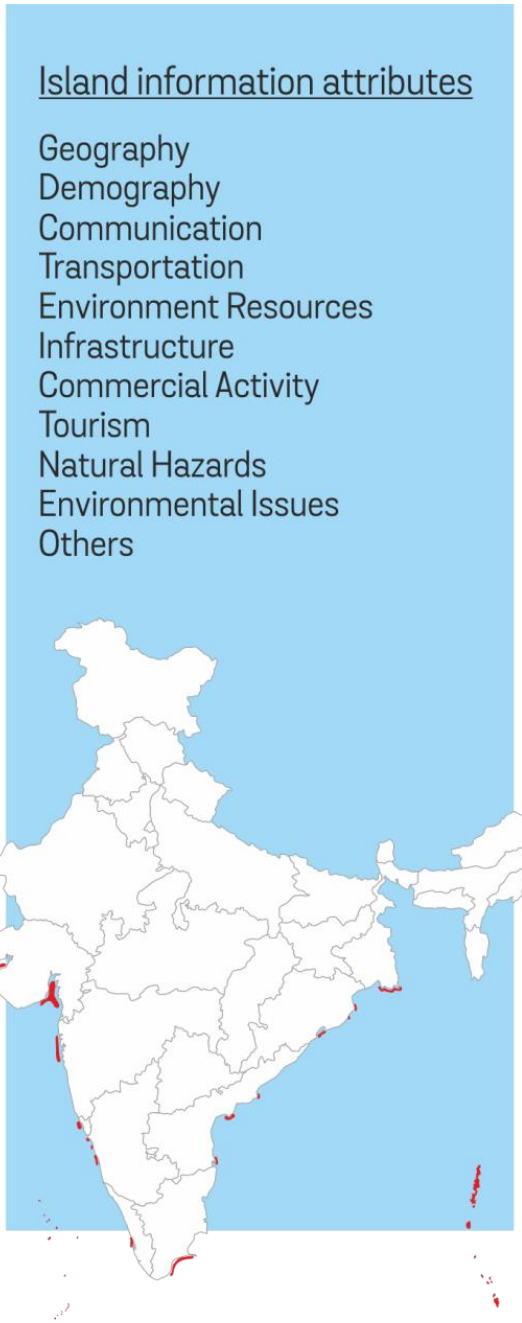
IIMP for Kavaratti Island, Lakashadweep



8 Island Management

(b) Data Web on Island Environment & Protection (DWIEP)

- India has a total of 1382 islands, comprising 514 Islands along the mainland coast and 868 Islands in the island territories (Andaman & Nicobar and Lakshadweep).
- Based on the geographical location, these islands are further classified as
  - oceanic islands and islands along the mainland
  - The mainland islands can be further classified as
    - offshore islands located in the open sea and
    - inland islands (e.g. riverine, estuarine and backwater islands).
- A few of these islands are declared as protected areas under the provisions of Wildlife (Protection) Act, 1972.
- The two oceanic island groups, the Andaman & Nicobar and the Lakshadweep receive special attention to the country's biodiversity, besides islands of mainland India.
- Data Web on Island Environment and Protection (DWIEP) is an initiative by the National Centre for Sustainable Coastal Management (NCSCM), provides a database that would



assist the policy makers in promoting holistic, inclusive and ecologically sustainable development of the Islands, while preserving and maintaining natural ecosystem and rich biodiversity of these islands

Key Results

- The "Data Web on Island Environment and Protection (DWIEP)" is a database of primary and secondary sources of data and information relevant to island systems that support development and conservation of the islands.
- 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.
- Broad activities that are permitted in the coast include:
  - Activities requiring foreshore infrastructure (e.g. Ports and Harbours)
  - Eco-tourism
  - Agriculture, horticulture, fisheries and allied activities
  - Activities of strategic importance (e.g. Defence, atomic power plants, etc.)
  - Creation of specific amenities for the local communities

Recommendations

- DWIEP will serve as a decision support system with useful database for planners, policy makers, academicians and all those interested in becoming familiar with the islands of our county.

9 Integrated Coastal Zone Management

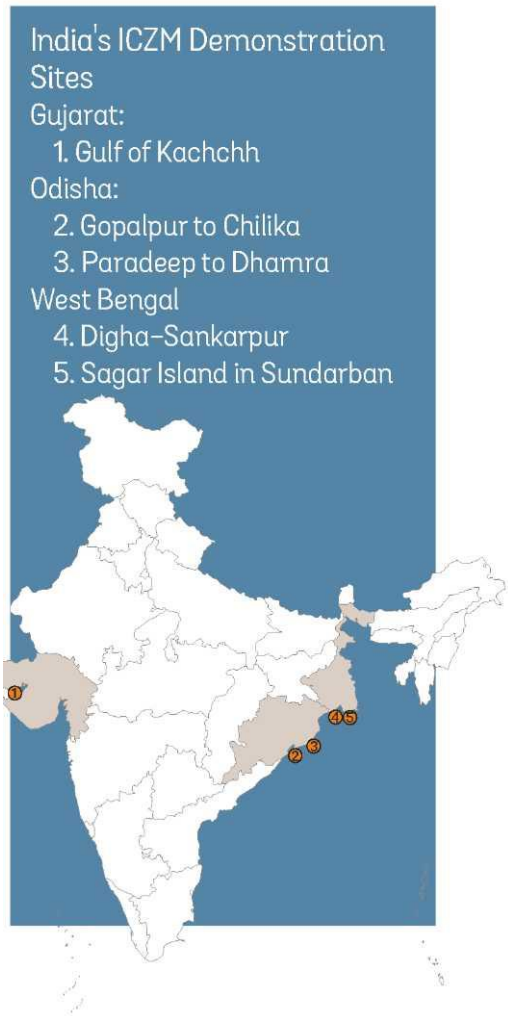
(a) ICZM Guideline

The coast is a highly vulnerable zone

- Affected by climate change and sea level rise
- Conflict for space and resources
- Development pressure on sensitive coastal ecosystems

Integrated Coastal Zone Management

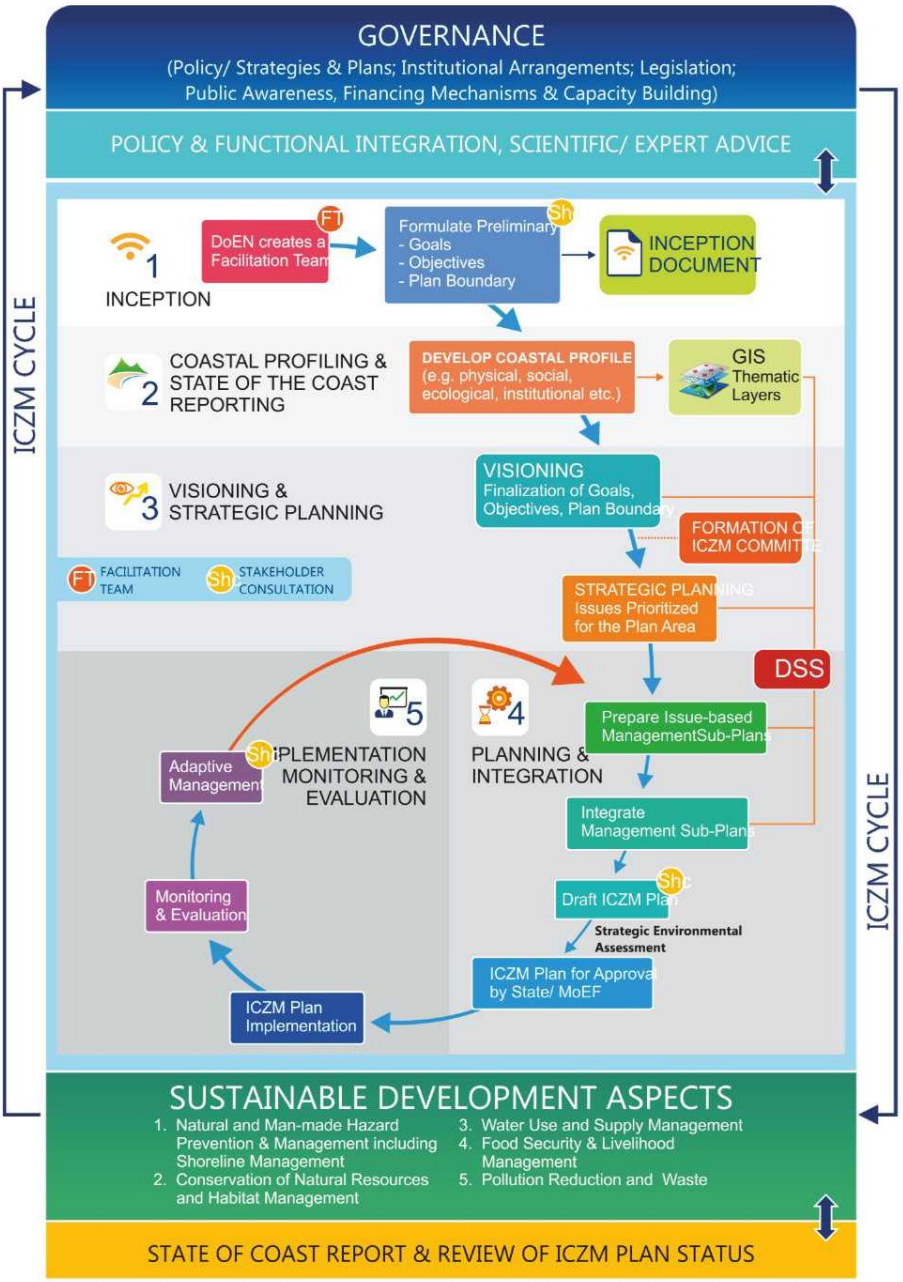
- Acknowledges interrelationships among coastal and ocean uses and the environment they potentially affect
- Overcomes fragmentation in single sector management approach, jurisdictional splits in the land-water interface
- Works within the constraints of limited space for competing resources and provides a mechanism and tools that
  - Allows development activities underscored by the precautionary principle
  - Ensure rational resource allocation and conservation of ecosystems
  - Incorporate environmental and social concerns in the developmental activities

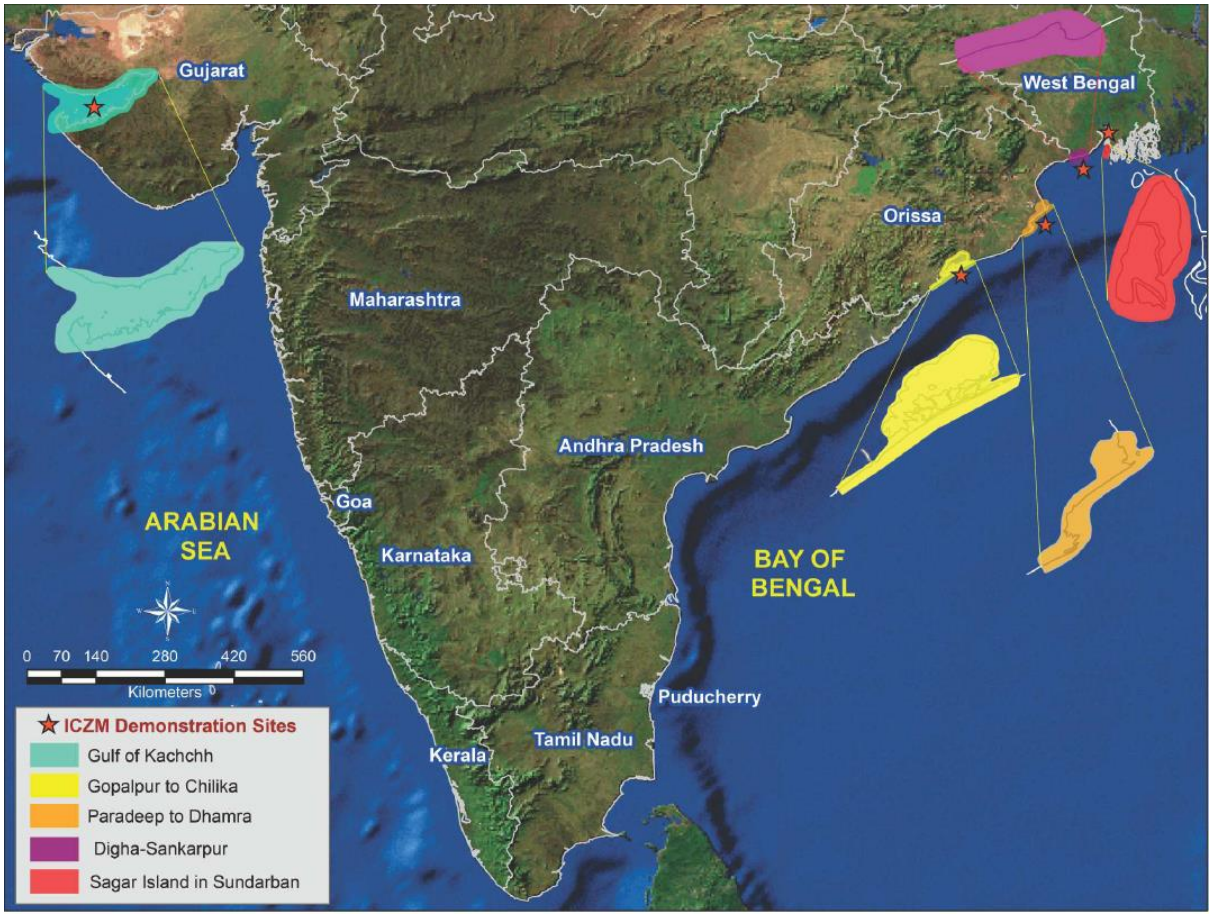


Preparing an ICZM Plan is a ***five-step process***

1) Inception Phase
2) Coastal Profiling & State of the Coast Reporting
3) Visioning & Strategic Planning
4) Planning and Integration
5) Implementation, Monitoring & Evaluation

- The framework covers a complete cycle of information collection, decision-making and preparing an integrated plan of action followed by implementation and adaptive management.
- Issues are identified and prioritized; issue based sub-management plans are developed. These are integrated to ensure no gaps or overlaps.
- The whole process is grounded in sustainable development concepts





The ICZM plan is currently being prepared for the coastal states of Gujarat, Odisha and West Bengal in five ICZM Demonstration sites, using this guideline Upscaling of ICZM plan for the other coastal states / UTs is currently underway as Phase II of the project.

Piloting Solutions & Best Management Practices for Replication

10 Tourism Management

(a) Tourism Carrying Capacity of Lakshadweep Islands

Tourism Carrying Capacity is "the maximum number of people that may visit a tourist destination at the same time, without causing destruction of the physical, economic, socio-cultural environment and an unacceptable decrease in the quality of visitors' satisfaction"

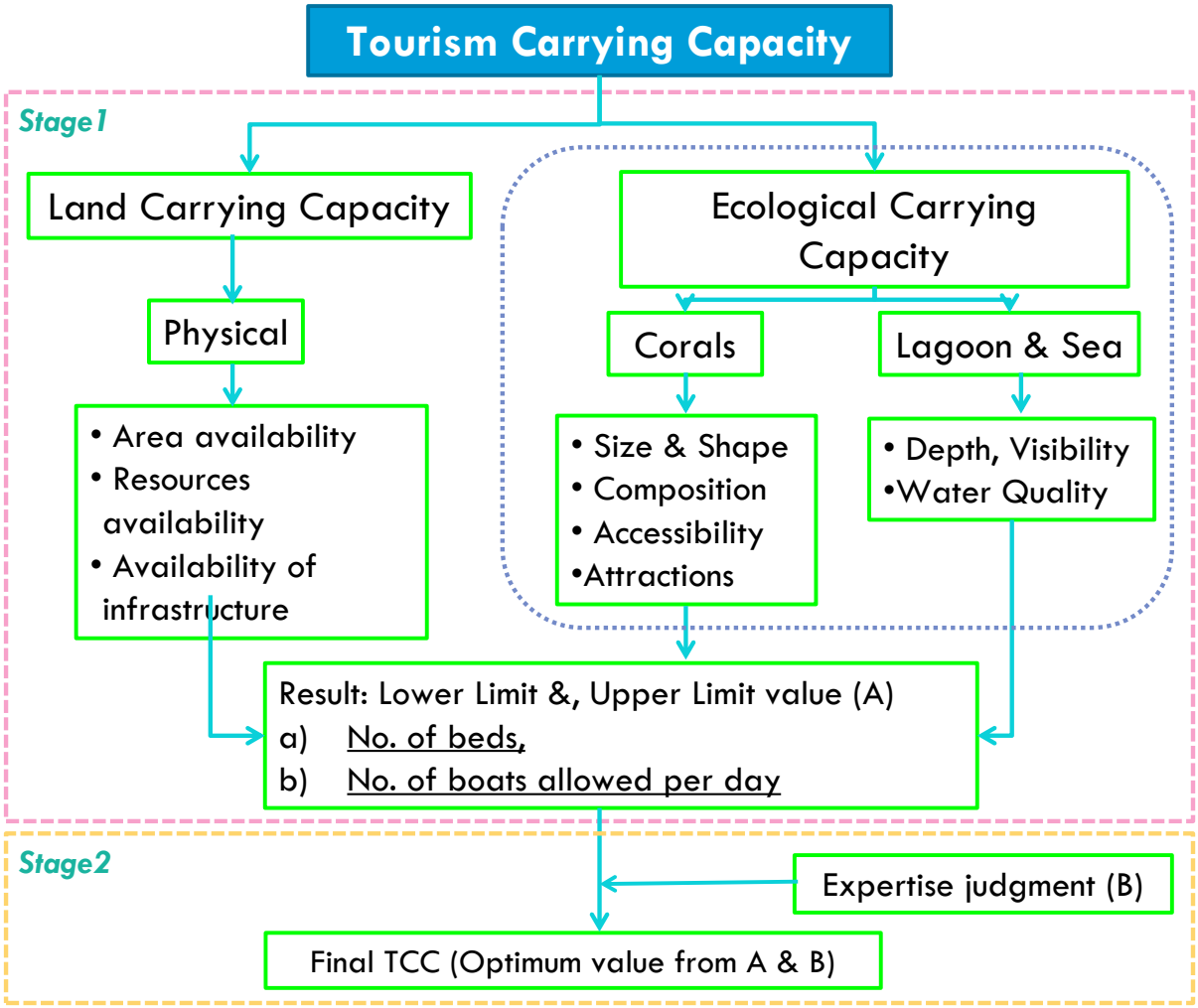
The total number of beds that can be accommodated in the island and the total number of boats that can play in the lagoon were estimated.

- One of the Largest Coral Reef Islands in India.
- Located in the Arabian sea, west of Kerala coast, Lakshadweep consists of 10 inhabited & 26 uninhabited islands
- Tourism can play a vital role in generating income, employment and over all development of islands.

Land area	2.6 sq.km
Lagoon area	17.50 sq.km
Population 2011 Census	7560

Objective functions

I. Develop scenarios for number of beds for Agatti Island
   a. By demarcating different zones
      - No Development Zone (NDZ)
      - existing development
      - Buffer areas etc.
   b. By considering limits imposed by availability and future development of:
      - Facilities/ infrastructure (e.g. water, transport, sewage treatment, solid waste disposal etc.)
      - Ecological and environmental aspects (e.g. sand dunes, corals, sandy beaches, etc.)
      - Coastal erosion &
      - Social consideration to strengthen local economy
   c. Develop a sustainable tourism carrying capacity model for the island.



Methodology

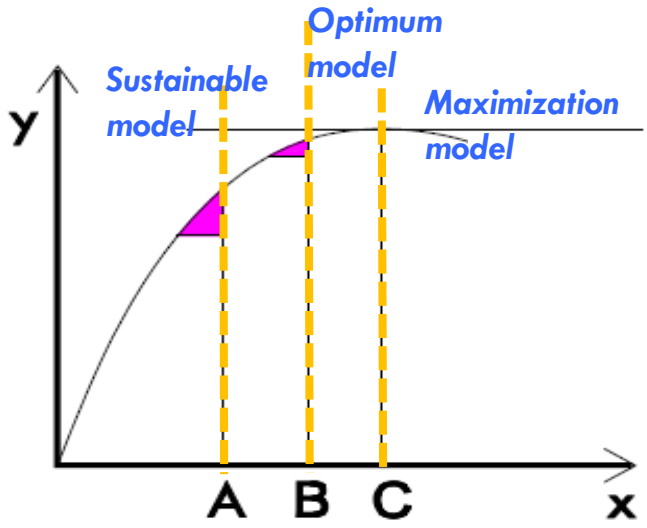
1. Identify permissible development zones/areas
2. Identify potential areas that takes into account the scale of economies
3. Determine the number of beds based on international & national standard
4. Model developed
5. Development of Scenarios for TCC (Sustainable/ Optimum & Maximum)

Criteria for developing Scenarios

1. **Island Level:** Urban Development Plans Formulation & Implementation (UDPFI) Guidelines
2. **Plot level:** Floor Area Ratio (FAR) as recommended by Justice Raveendran Committee
3. **Unit level:** Architects Data (National Building Code (NBC) & Architects Handbook by Ernst and Peter Neufert)

Scenarios Developed

Three scenarios were derived the number of beds possible under the broad rubric of Tourism Carrying Capacity.



1. Sustainable model - **Scenario A**
2. Optimal model - To identify potential areas that could be economically and environmentally sustainable - **Scenario B**
3. Maximum model - Placing the maximum number of beds that each vacant plot can hold - **Scenario C**

Recommendation

The estimated bed capacities for the scenarios

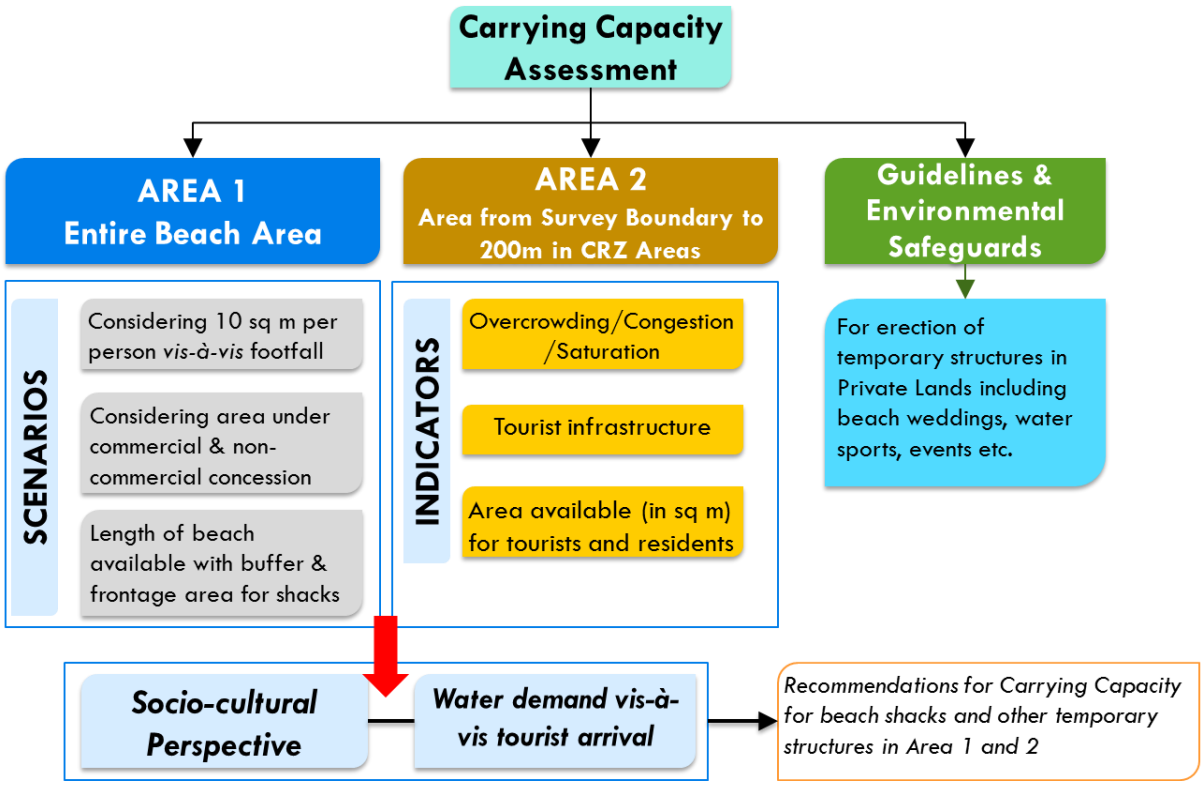
Scenario A:	**631 beds**
Scenario B:	**2254 beds**
Scenario C:	**3653 beds**

- Scenario A appears to be the most sustainable as well as opportunity for future growth and development
- Takes care of the local community's livelihood

10 Tourism Management

(b) Carrying Capacity of Beaches for Shacks and Other Temporary structures of Goa

Apart from beaches Goa is blessed with ecological features like turtle nesting, sand dunes, river, creeks and mangroves. These ecological sensitive areas have their own significance and have to be protected from any developmental activities. While determining the carrying capacity of the coastal area, the following factors have been considered:

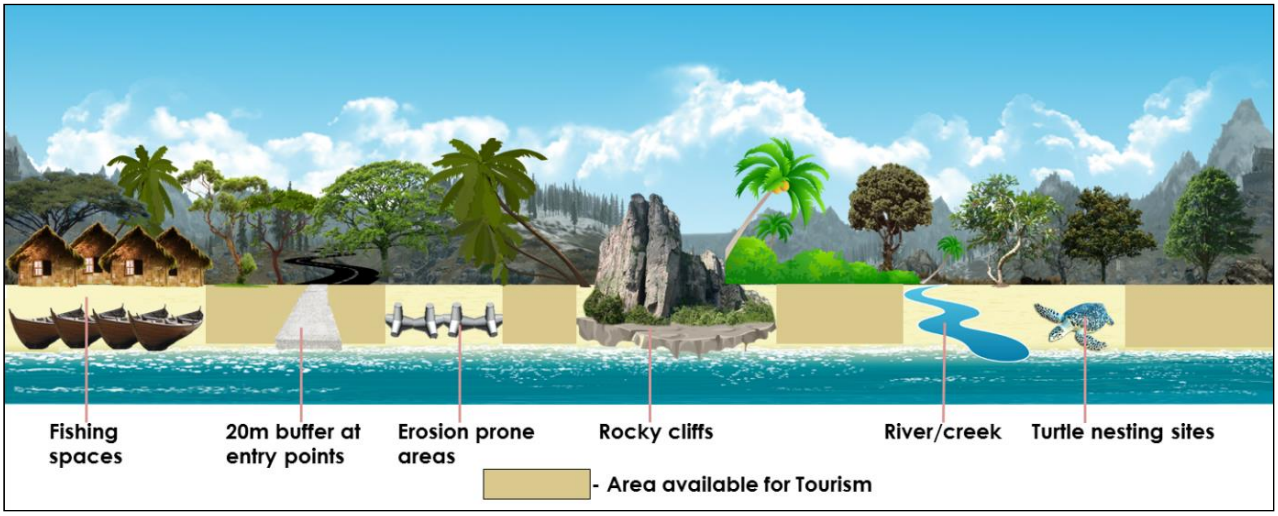


♣ Carrying capacity assessment: Area 1 (Beaches of Goa)

a. Carrying capacity w.r.t number of tourist that can visit a particular beach stretch

- The carrying capacity of different beaches is assessed considering the entire beach area available and the average footfalls based on accepted internationally norms.

- All Ecologically Sensitive Areas (ESAs), erosion prone areas, river mouths/creeks, fishing spaces are deducted from the available beach areas and the final available space for shacks is determined.



The assessment was approached in the following ways:

Scenario		*Approach*
Scenario1:	Considering 10 sq m. per person vis-a-vis footfalls	Considering the potential beach area available, the carrying capacity was calculated by dividing the beach area available by 10 (area required per person).
Scenario2:	Considering Area under commercial concession and non-commercial concession	The carrying capacity of the beach was calculated by dividing the beach area under shacks by 7.5 (commercial concession) and the remaining beach area by 15 (non-commercial concession)
Scenario3:	Length of the beach available with buffers between shacks and frontage areas	Considering potential beach length available for shacks (after deducting ESAs and other factors), the number of shacks that can be erected was determined

b. In order to determine the carrying capacity with regard to potential areas for shacks, only the beach areas which fall beyond the High Tide Line (HTL) to survey boundary has been considered.

- **Area 2 (area between survey boundary and 200m in CRZ)**

  In order to determine the carrying capacity of shacks and other temporary structures in private areas, a set of three indicators were developed based

Indicator	Approach
Indicator 1:	Overcrowding/congestion/ saturation – Number of beds per hectare (e.g. up to 50 beds/ ha for rural areas and up to 100 beds/ ha for urban areas)
Indicator 2:	Tourist infrastructure (No. of beds to population) (Rural: up to 0.5 and Urban: up to 1)
Indicator 3:	Area available (in sq m) for tourists and residents (e.g. 50 sq m per person for rural and 25 sq m per person for urban areas)

Guiding Principles for Shacks/ Huts/ Other Temporary Structures in Private Land

1. **Planning Principles**: the concept of 33% developable area and 67% open spaces for recreational, safety and other activities have been considered in beach stretches as well as for each private plot within 200m in CRZ areas. 4% of the total developable area (excluding ESAs) was considered available for temporary structures in areas within 200m in CRZ.
2. **Ecological safeguards:** ESAs such as turtle nesting sites on the beach stretch and sand dunes within 200m in CRZ are No-Go areas.
3. **Environmental safeguards:** considered include clean potable water, safe disposal of solid wastes, safe disposal of sewage, no extraction of groundwater, promoting use of renewable energy and fire safety
4. **Social considerations:** Beach areas adjacent to fishing villages shall be avoided for erection of private shacks and huts/ cottages/ tents and diversification of coastal livelihood is encouraged. Ratio of local to tourist population has also been used as an indicator for assessing the social carrying capacity.

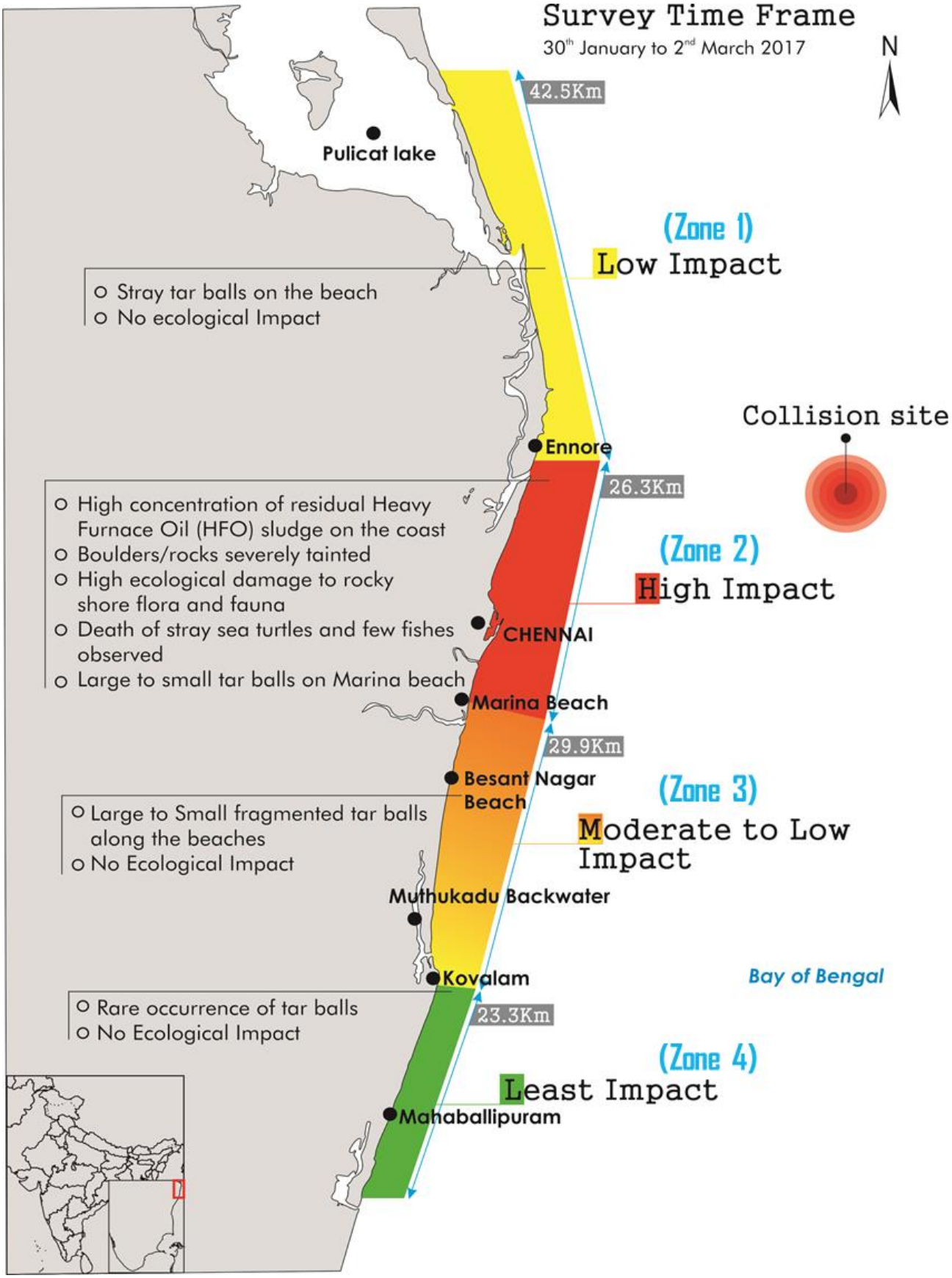
11 Disaster Management

(a) Oil Spill along Chennai Coast: Environmental and Ecological Impacts

On Saturday January 28, 2017 two vessels namely *BW Maple* (UK), an LPG tanker, collided with oil tanker *Dawn Kanchipuram* (India) carrying Residual Fuel Oil (RFO) (bunker furnace oil) at 17 kmph (nine knots), 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. Due to the prevailing winds and tidal currents the oil slick carrying 195 tons drifted close to the coast near Ramakrishna Nagar Kuppam area in spite of placing booms by KPL around the damaged vessel *MT Dawn Kanchipuram*. Total extent of spill was ~ 37 km (13 km north and 24 km south respectively from the collision site). A comprehensive study was carried out by NCSCM covering various aspects such as physical, environmental, ecological, trajectory modeling, remote sensing and socio-economics so as to understand the impacts.

Based on the extent and location-specific impact of the oil spill, the Chennai coast was divided into four zones

Zone	Nature of Impact	Location
Zone 1:	Low impact zone	Pulicat to Ennore
Zone 2:	High impact zone	Ennore to Marina Beach
Zone 3:	Moderate to Low impact zone	South of Marina to Kovalam
Zone 4:	Least impact zone	Kovalam to Mahaballipuram



Zonation based on spread of oil spill

Findings

- The spread of spill was studied by remote sensing analysis and was estimated to be about180 km^2 on 31 January 2017
- Oil spill trajectory modelling indicated that without any clean-up operations, the spill would have migrated to the south spreading along the coast of Tamil Nadu
- TPH concentrations in seawater increased to nearly three times the pre-spill concentration, especially around the collision site ranging from 6.83 to 12.15 mg l^{-1}, with an average of 9.58 mg l^{-1} immediately after spill (on 30 and 31 Jan 2017)
- In the case of rocky shores, 100% mortality was observed in barnacles; Mollusc species like Green Mussels (*Perna viridis*) and Rock Oysters (*Saccostrea cucullata*) were found to be clogged with oil with 90% mortality; Macroalgae *Chaetomorpha* sp. and *Enteromorpha* sp. were completely bleached
- Along the sandy beach coast extending from Adyar estuary to Cooum estuary, Chocolate mousse and tar balls varying in size were deposited all along the intertidal and high tide areas
- Post spill, 16 Olive Ridley turtles (*Lepidochelys olivacea*) were found dead from Mahabalipuram coast up to Ennore and could not be directly attributed to the impact of oil
- No coastal birds appeared to be affected from the spill

- The tar balls in the intertidal zone affected the movement of ghost crabs (*Ocypode* sp.)
- A total of 136 star gazer fishes belonging to the family Unranoscopidae were found dead all along the stretch of Marina beach
- No visible impacts were seen in the mangroves along the coast (especially in the estuaries and creeks under study)
- Presence of tar balls in the beach areas had affected the fishing space, crafts and gears were left a taint of oil on them
- Fear of oil in fishes caught had reduced the market price for commercially important fin and shell fishes resulting in livelihood loss of local fishing community
- Beach tourism (footfalls) was affected since the public did not venture in to the tar ball zones because of their sticky nature
- Ecological impact of oil spill on inter-tidal flora and fauna in different zones is given below

Clean-up operations

- The sea based clean-up was undertaken entirely by the Indian Coast Guard Pollution Monitoring vessel – SAMUDRA PAHEREDAR 202 and the land-based clean-up was carried out by various stakeholders duly supported by local administration
- Oil Spill Dispersants (OSD) were sprayed by the ICG through helicpoters
- Oil collected from the shore were sent for bioremediation by Indian Oil Corporation at Kamarajar Port, Ennore
- Tar balls deposited on the sandy shores were removed by teams formed by ICG in association with local bodies and fisher folk

Summary of clean-up operations and bioremediation undertaken in the Chennai Oil Spill

12 Coastal Pollution Mitigation

(a) Reduction in GHG emissions post-construction of STP at Jamnagar, Gujarat

An Underground Sewerage System has been developed for the area under Jamnagar Municipal Corporation (Jamnagar City including Jamnagar urban Development Authority) under ICZM plan.

Under the ICZM Project, an efficient Sewerage Treatment Plant to minimize the impact of untreated sewage disposal on the coastal and marine environment has been established. Our studies has shown that a significant reduction in pollution and fluxes of greenhouse gases has occurred leading to the conservation of coastal biodiversity such as corals and mangroves.

Water quality of the Rangmati River, Jamangar was significantly deteriorated due to the sewage outfall causing degradation of health of coastal and marine biodiversity in the Jamnagar region.

A pilot study to assess the water quality (in business as usual scenario) as well as environmental condition after the establishment of Jamnagar STP was undertaken by NCSCM.

Observations

Significant improvement on water quality in the treated water, which fulfil the criteria to be used in irrigation purposes, was recorded from Jamnagar STP.

Water quality at various steps during the treatment process

Sample ID	pH	DO (%)	Chl a (µg/L)	SPM (mg/L)	DIN uM/L	DIP uM/L	CO_2 Flux (mmol m^2 d^{-1})	CH_4 Flux (mmol m^2 d^{-1})
1. Raw sewage water	7.03	0	11	678	9263	109	2697	3961
2. After screening	7.03	14	10	333	328	576	3130	840
3. Before treatment	7.15	34	3	214	336	718	2146	235
4. River (STP outflow)	7.86	71	2	83	53	68	952	0.05

Considerable improvement in water quality has been observed after implementation of the STP at Jamnagar. The results below indicate the percent improvement in vital parameters from the treatment facility & the surrounding waters.

	Dissolved O_2 ↑	N Load↓	P Load↓	DOC↓	pCO^2↓	CH_4 ↓
% improvement in water quality after STP	535	98%	79%	30%	66%	100 %

This treated water can significantly reduce contamination of the ground and surface water. It can also support the aquatic biodiversity by improving the overall water quality.

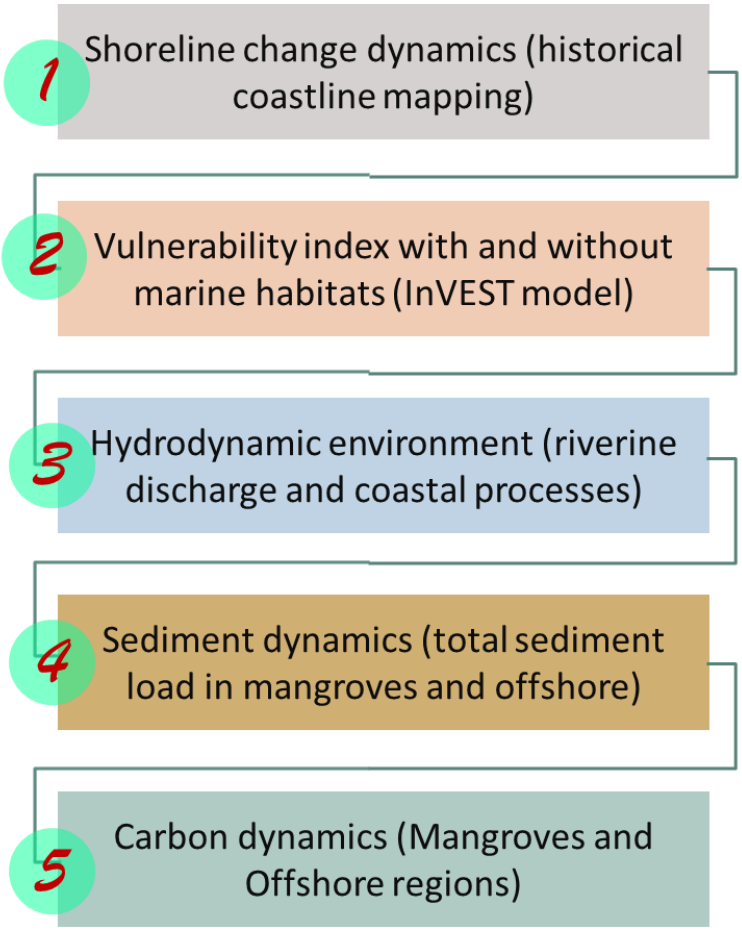
13 Shoreline Management

(a) *Sediment Budget & Coastal Stabilization in Godavari Delta*

Coastal waters of India receive a large amount of sediments from the various upstream sources. This sediment load is deposited along the coast as well as is transported to the open ocean. Any shift in equilibrium in coastal sediment budget due to the natural calamities and anthropogenic activities; substantially influences the coastal stability and associated coastal carbon budget.

Framework

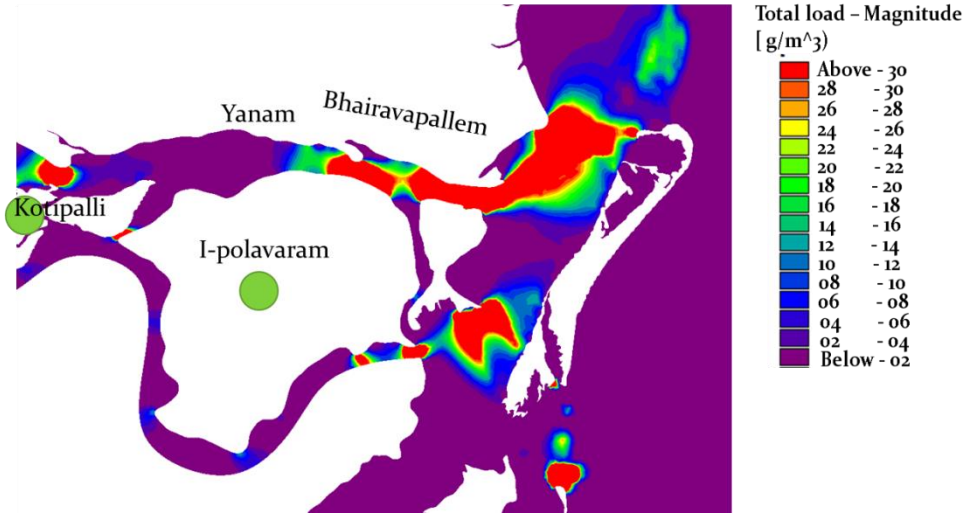
Numerical estimation of partitioning of the distribution of particulate organic carbon in Indian coastal waters using hydrodynamic, spectral wave and sediment transport models indicates the scenarios of sediment accumulation/erosion and Carbon gain /loss along the coast. The numerical model is aided with inputs of shoreline change dynamics.



Results were coupled with InVEST Coastal Vulnerability model to provide a qualitative index of coastal exposure to erosion and inundation thus highlights the relative role of natural habitat at reducing exposure and showing the areas where coastal populations are threatened.

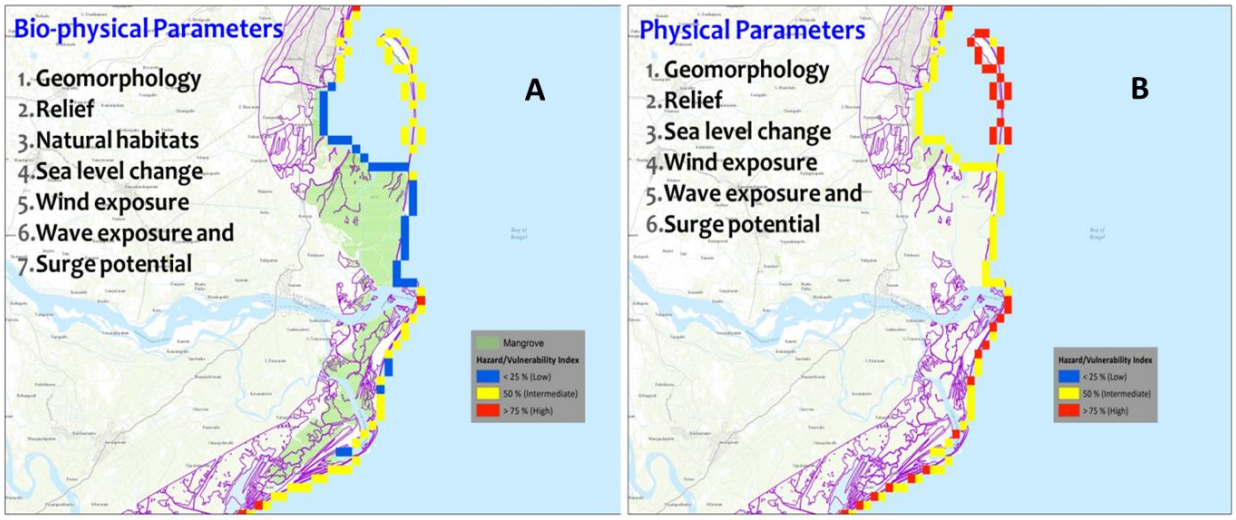
Godavari Delta

Coupled modelling (hydrodynamic, spectral wave and sediment transport) to simulate the sediment dynamics under various scenarios was undertaken for Godavari Delta. The sediment model predicted high sediment load in the in the estuarine region (30 g m^{-3}); moderate sediment load in near-shore region (<30 g m^{-3}) and low sediment load in the offshore region.



Sediment budget of Godavari estuary

Coastal vulnerability (including the carbon losses) was estimated through the exposure Index in the presence and absence of natural habitats. The model predicted that the areas with natural habitats (mangroves) cover along the coast have higher exposure index and high vulnerability.



Coastal vulnerability index in Godavari delta (a) presence and (b) absence of natural habitats

Restoration of such habitats as high priority ESA's along the coast sill shift the exposure index to lower scale thus reducing reduce coastal vulnerability.

13 Shoreline Management

(b) *Shoreline dynamics along Pentha Coast, Odisha and Sagar Island, West Bengal*

Shoreline erosion is a chronic problem along the Pentha region of the Odisha coast. The principal purpose of this report was to map shorelines and analyze shoreline change rates i.e., possible erosion rates based on statistical computation analysis. In order to determine shoreline change, multi-spectral and multi-temporal satellite images were used to map short-term shoreline positions. Multiple shorelines extracted from satellite images were used to calculate shoreline change rates using Digital Shoreline Analysis System (DSAS) model developed by United States Geological Survey (USGS) in an ArcGIS environment at 20 m spacing interval along the entire coast.

In this study, Linear Regression Rate (LRR) and End Point Rate (EPR) were used for expressing the rate of change since it includes all the available time-series shorelines. These shoreline change rates have been categorized into eight classes for Pentha as erosion (high, medium and low erosion) and accretion (high, medium and low accretion), stable and artificial coast as shown in **Table 1.**

Table 1: Classification of Shoreline Change Rates

Categories	Rate of Erosion/Accretion (m/yr)
High Erosion	>= -5
Medium Erosion	-2 to -5
Low Erosion	-0.5 to -2
Stable Coast	0.5 to -0.5
Low Accretion	0.5 to 2
Medium Accretion	2 to 5
High Accretion	>= 5
Artificial coast	*Presence of shore protection structures along the coast*

Key findings for South of Hansua River to Spit of Bhitarkanika Reserve Forest

Long-term data sets spanning the last 38 years and short-term data sets from 2011 to 2016 (6 years) were compared to identify the magnitude of the shoreline change rates before and after construction of seawall.

Long-term change analysis from 1972-2010

The statistical results obtained for this period shows that the coast has dominating erosion pattern with an average erosion rate of about -2.5 m/yr. Maximum erosion rate of about -12.96 m/yr was observed at north of Pentha region from LRR rates. Maximum accretion rate of about 10.43 m/yr is observed at mangrove swamp region. The coast exhibits continuous erosion for about 19 km from Pentha to Kanhupur.

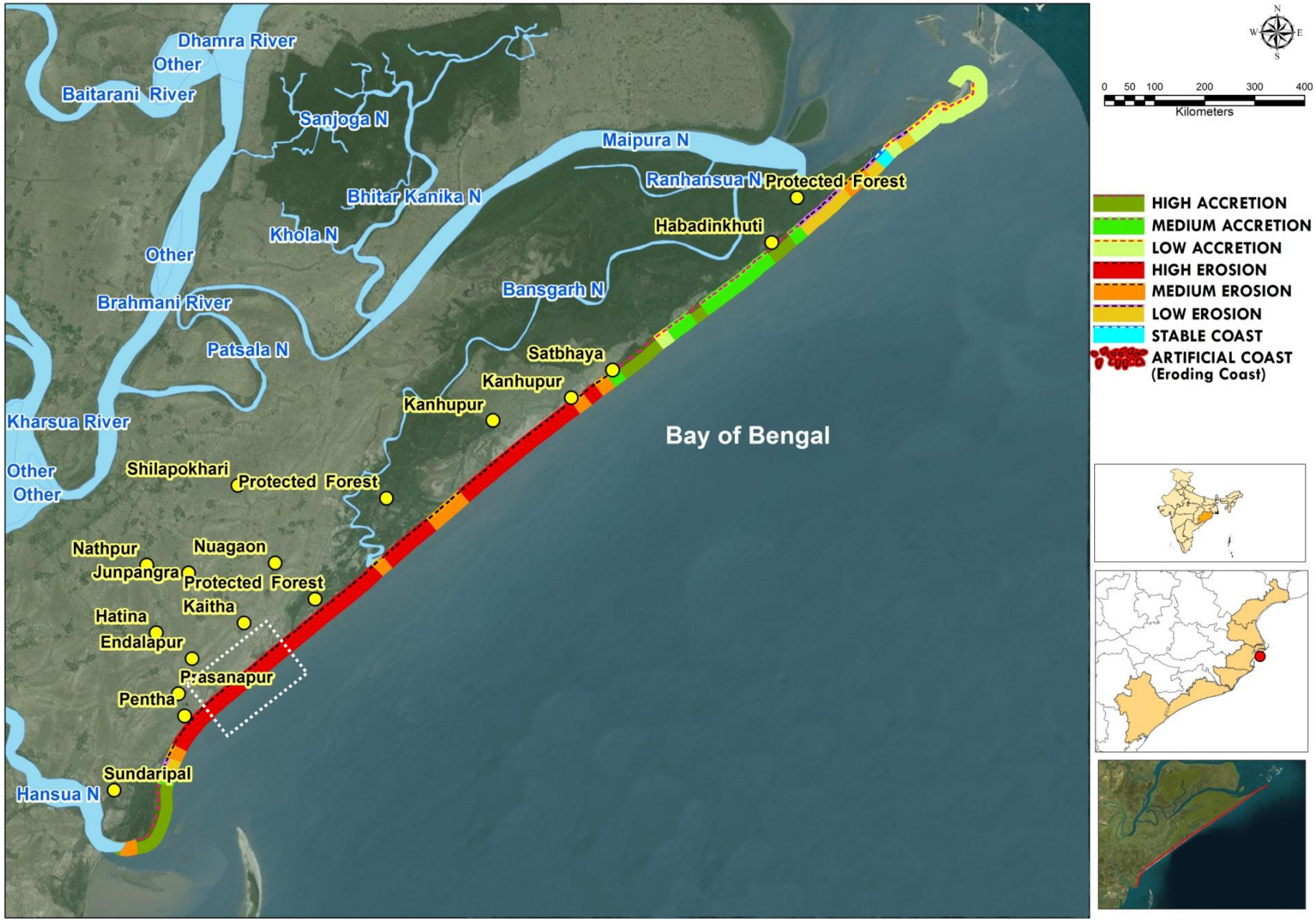
Short-term change analysis from 2011 - 2016

Short-term shoreline change from South of Hansua River to Spit of Bhitarkanika reserve forest (Subcell 23d) shows an average erosion rate of about -6 m/yr. The total length of shoreline erosion for this period was found to be 37.06 m. The coast of Pentha is protected by seawall for a length of about 505 metres with an average erosion rate of about 7 m/yr.

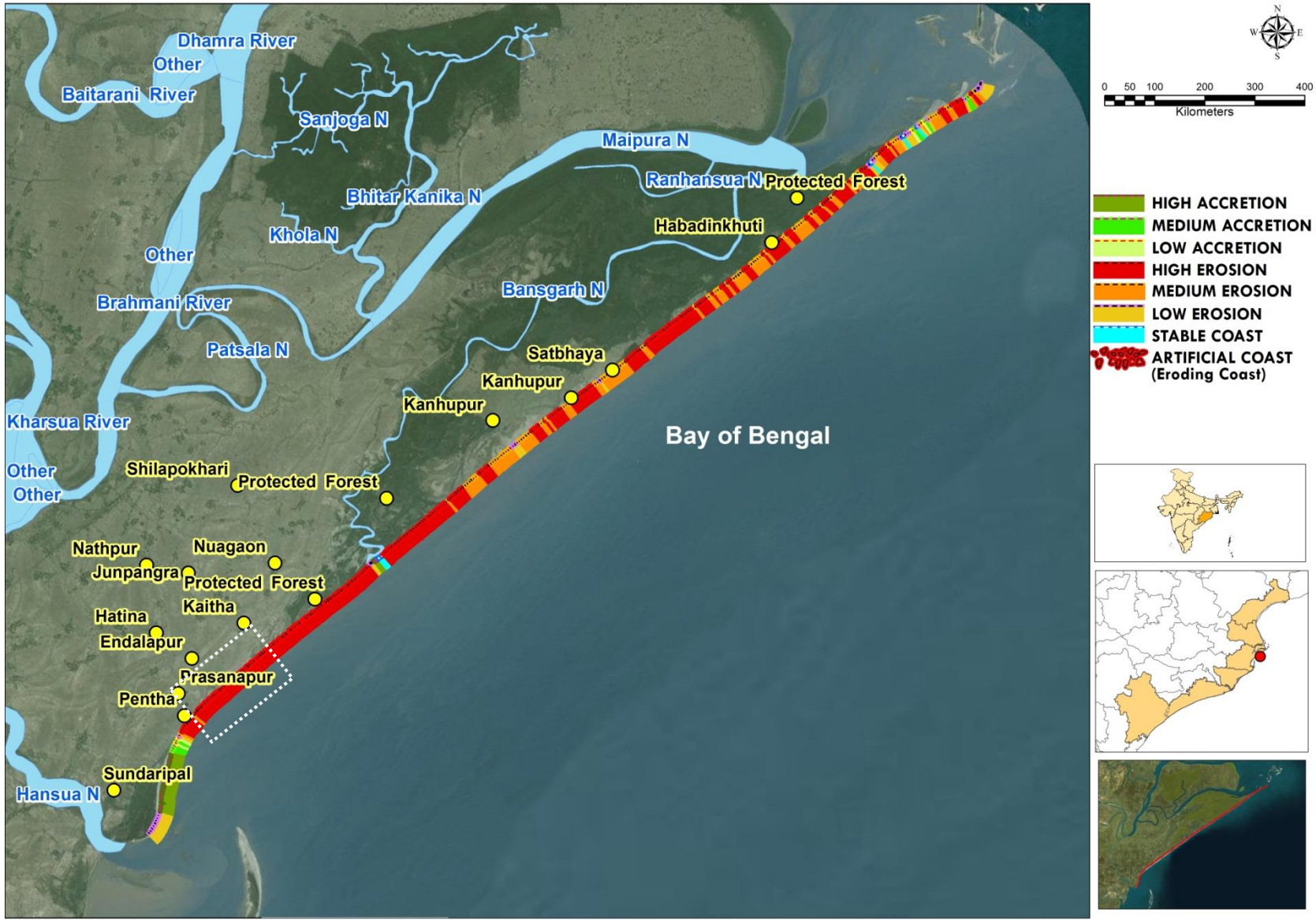
Key findings for Pentha coast: Before and After installation of Geotubes

- The average EPR rate during 2011-13 for the Pentha coast was found to be -13 m/yr, indicating an erosional trend. While for the period 2013-2016 i.e after construction of seawall the rate of erosion has been decreased to 4 m/yr.
- The shoreline change rate varies from medium erosion (-3.3 m/yr) at Transect No.1 and high erosion (-20.4 m/yr) at Transect No.27 respectively for the period 2011-2013.
- While after construction of seawall shoreline change rate has been reversed from high erosion (-12.4 m/yr) at Transect No.2 to low accretion (0.57 m/yr) at Transect No.16.

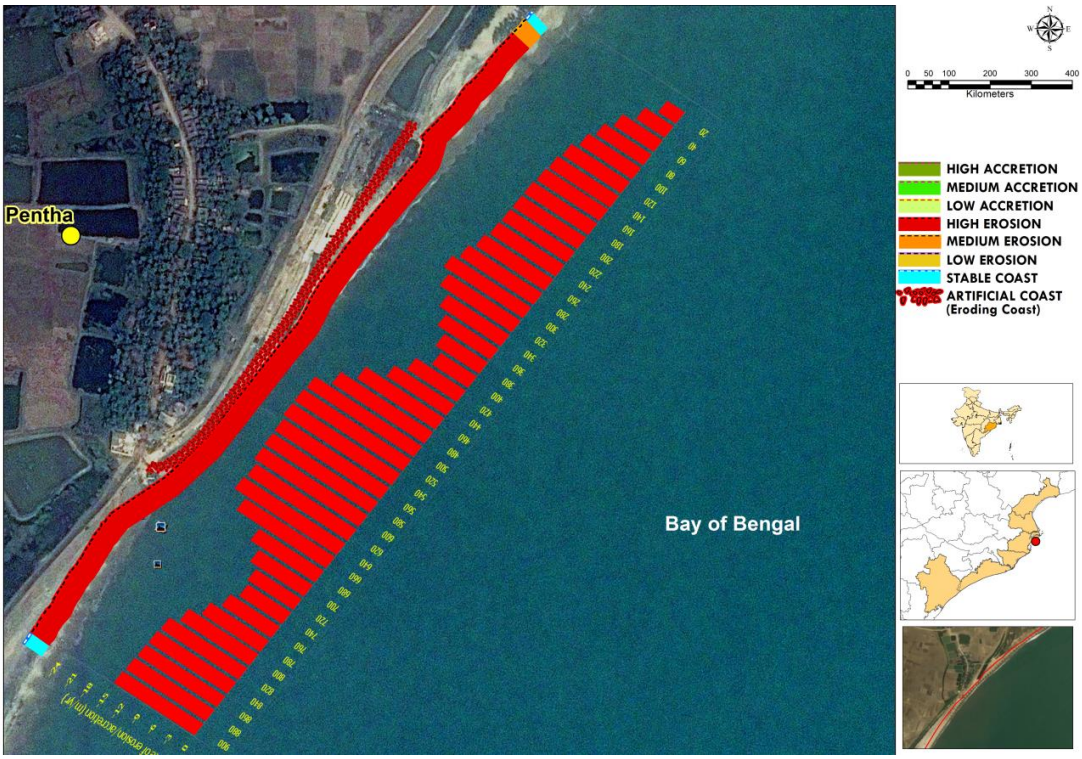
This clearly highlights that the magnitude of erosion along the Pentha coast has reduced significantly particularly after the installation of the geotubes.



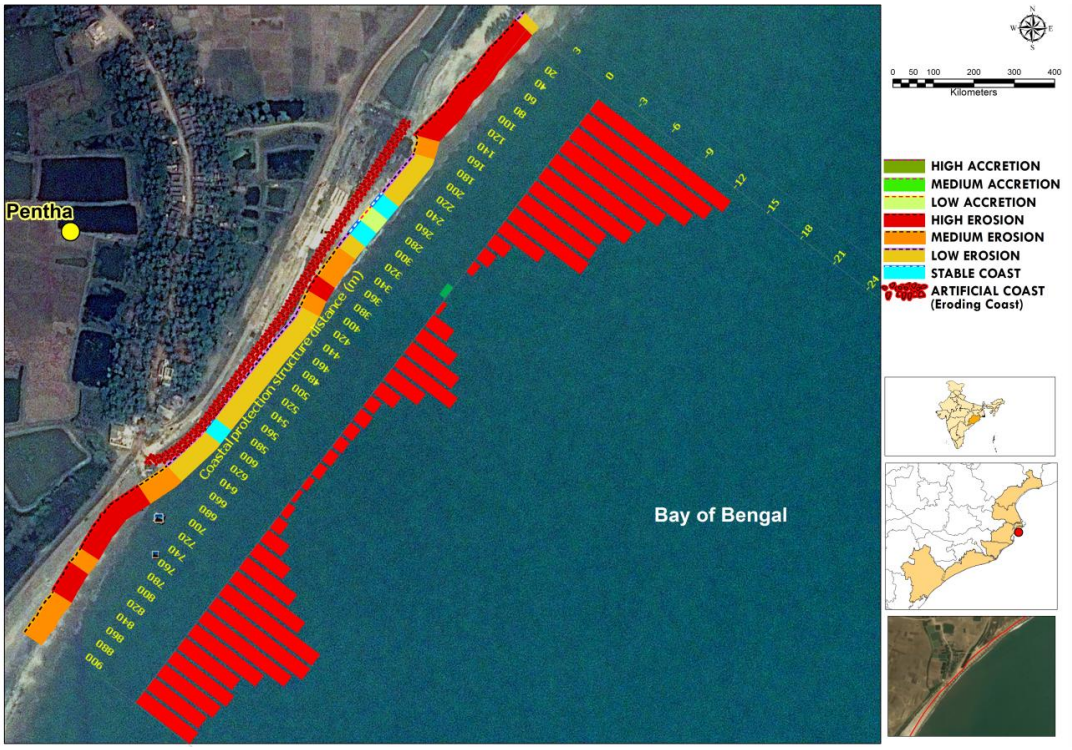
Long-term Shoreline change status from South of Hansua River to Spit of Bhitarkanika Reserve Forest



Short-term Shoreline change status from South of Hansua River to Spit of Bhitarkanika reserve forest



Shoreline change status of Pentha coast for 2011-2013



Shoreline change status of Pentha coast for 2013-2016

Key findings for Sagar Island

- Sagar Island for long-term and short-term shows general trend of erosion along the southernmost and northern part of the island.

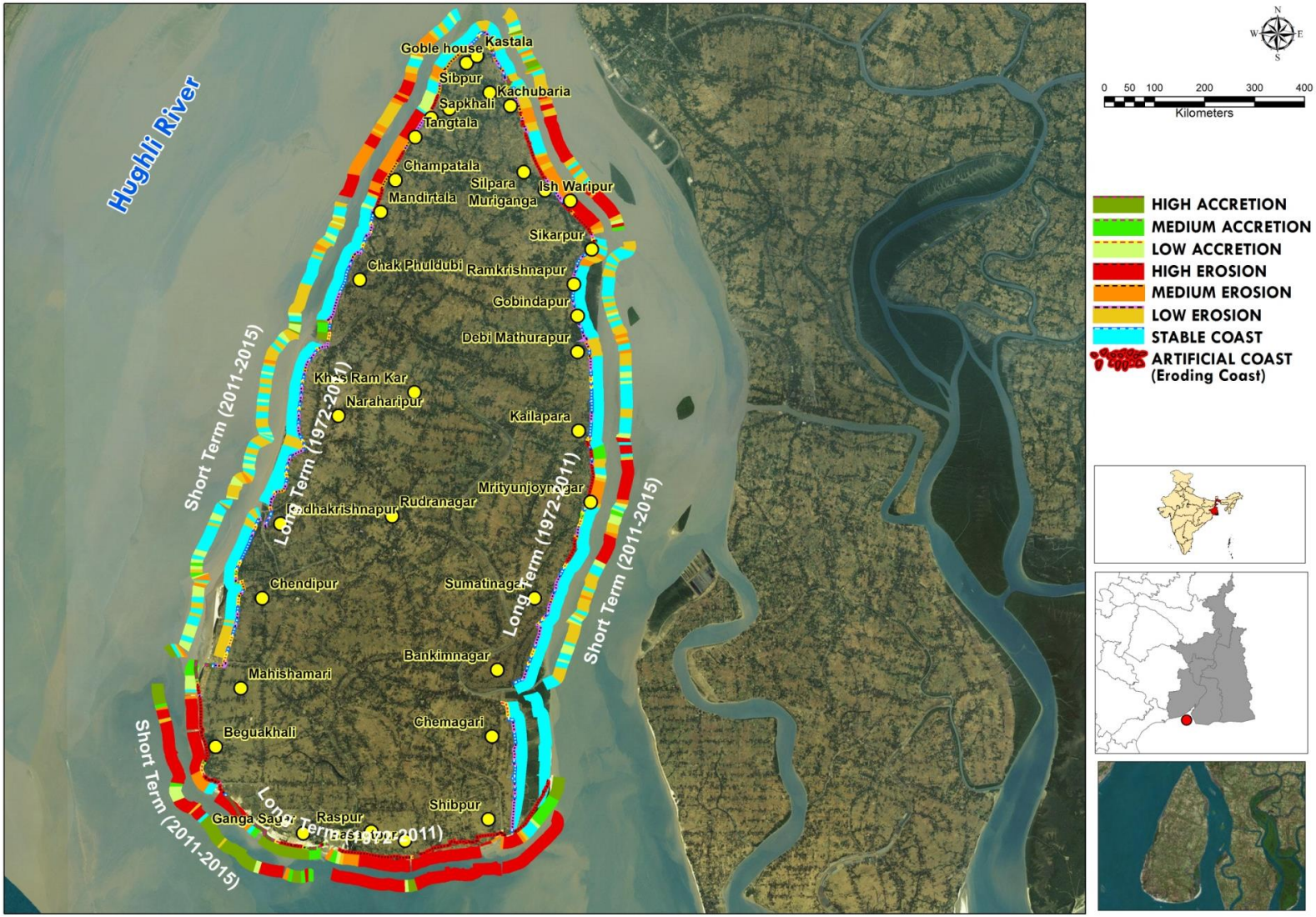
- Average erosion rate for long-term shoreline change rate was found to be 2.24 m/r and short-term shoreline change rate of about 4.54 m/yr.
- During the long-term analysis period, about 25 km or 35 % of the total extent of Sagar Island was lost to erosion. Nearly 60% of the short-term change rates are erosional.
- In the Long and Short-term Southern side experiences continuous erosion from Southeast of Beguakhali to Gangasagar and Basantpur to SouthWest of Shibpur. Northern side experiences erosion from Mandirtala to Sibpur and from Kanchubaria to Sikarpur
- Southern side experiences maximum long-term erosion rate of -29.91 m/yr at SouthWest of Basantpur, while maximum short-term erosion rate of -75.23 m/yr at SouthWest of Shipur.
- Northern side experiences maximum long-term erosion rate of -31.12 m/yr at Sikarpur. Maximum short-term erosion rate of -10.06 m/yr is found at IshWaripur.
- Recent shoreline changes on Sagar Island shows that erosion rates have now intensified at the south and north parts of the island.

Long-term classification of Shoreline Change Rates for Sagar Island

Shoreline Classification Long-Term	*Length (km)*	*% of Erosion and Accretion*	*Cumulative Erosion and Accretion (%)*
Length of Coastline (km)	**71.13**		
High Erosion Zone	11.67	16.40	
Medium Erosion Zone	7.57	10.65	
Low Erosion Zone	5.78	8.12	35.17
Stable Coast	38.90	54.68	54.68
High Accretion Zone	2.63	3.70	
Medium Accretion Zone	2.77	3.89	
Low Accretion Zone	1.82	2.56	6.45

Short-term classification of Shoreline Change Rates for Sagar Island

Shoreline Classification for Short-Term	*Length (km)*	*% of Erosion and Accretion*	*Cumulative % of Erosion and Accretion*
Length of Coastline (km)	**73.33**		
High Erosion Zone	20.52	27.98	
Medium Erosion Zone	5.25	7.17	
Low Erosion Zone	18.53	25.27	60.42
Stable Coast	16.01	21.83	21.83
High Accretion Zone	4.30	5.86	
Medium Accretion Zone	1.42	1.93	
Low Accretion Zone	7.30	9.96	11.89



Long-term and Short-term shoreline change for Sagar Island

14 Regulation

(a) *Coastal Zone Management Plan for Goa*

The State of Goa

Goa covers a total area of 3701 sq km bordering the western Indian coastline, ~105 km long and 65 km wide. The state shares its border with Maharashtra, Karnataka and Arabian Sea in the north, south and west respectively. The state of Goa is divided into two districts: i) North Goa and ii) South Goa and further subdivided into 11 talukas and 360 villages. Of the 105 km long coast, more than 70 km comprise of linear and wide sandy beaches, interrupted by rocky shores and headlands and backed by high dunes; sandy pockets and secluded coves backed by rocky cliffs.

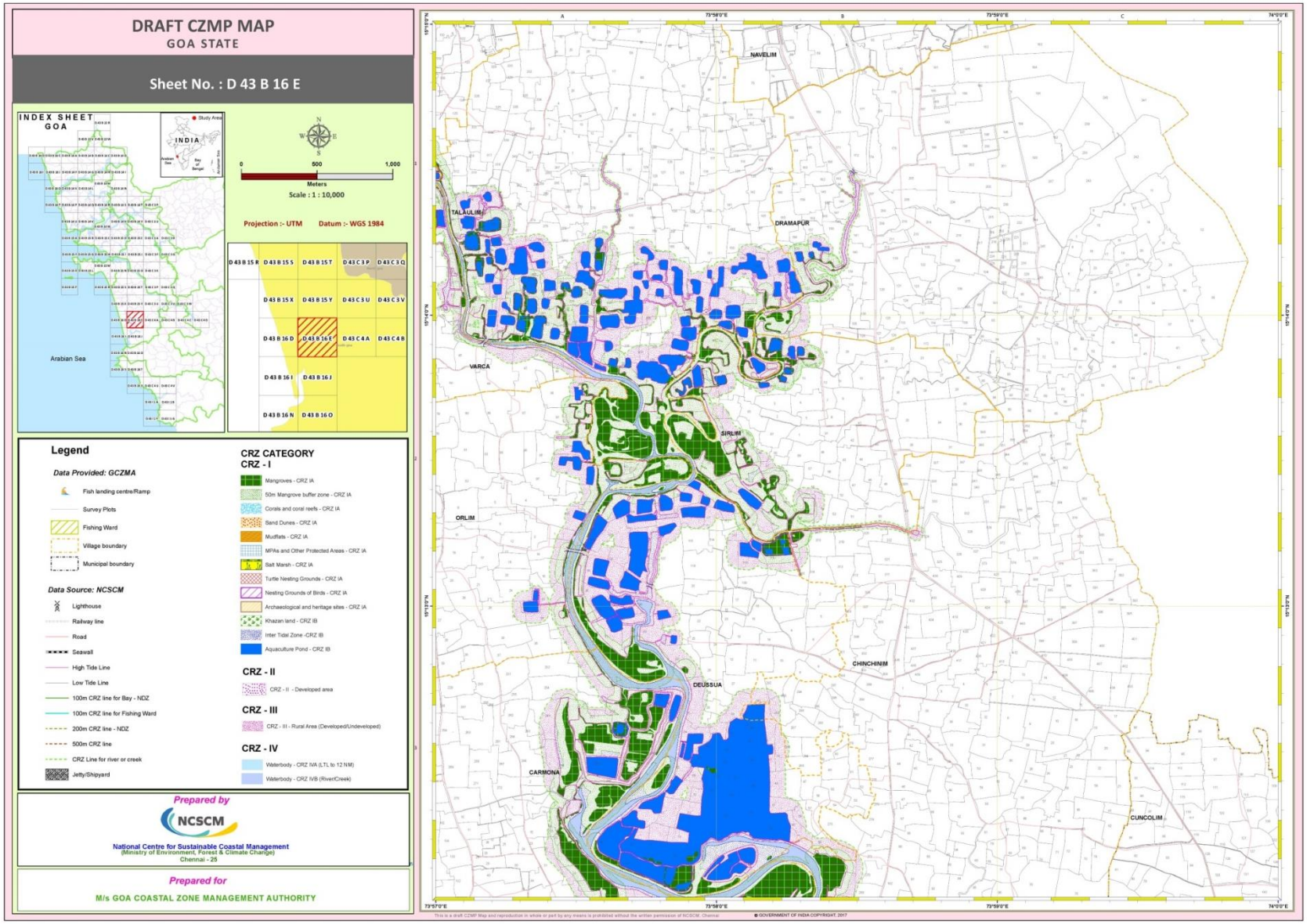
Purpose & Scope of CZMPs

The primary purpose of a CZMP is to describe proposed actions to be implemented by administrative or other public authorities and potentially by the private sector to address priority management issues in the coastal zone over a defined implementation period. These issues include:

1. ensuring livelihood security to the fisher communities and other local communities, living in the coastal areas
2. conserving and protecting coastal stretches, its unique environment and its marine area and
3. promoting sustainable development

Statistics of CRZ categories of Goa

District	*Taluka*	*CRZ I area (sq km)*	*CRZ II area (sq km)*	*CRZ III area (sq km)*
South Goa	Canacona	4.46	2.8	17.1
	Quepem	1.51	1.1	2.4
	Sanguem	0.35	0.6	0.8
	Salcette	27.85	0.1	21.7
	Mormugao	7.48	4.6	8.3
Total South Goa		***41.66***	***9.2***	***50.3***
North Goa	Tiswadi	53.34	2.4	16.7
	Ponda	17.33	0.0	11.1
	Bardez	19.78	0.4	24.1
	Pernem	9.39	0.6	14.4
	Bicholim	6.86	0.2	8.6
Total North Goa		***106.67***	***3.6***	***74.9***
Grand Total for Goa		***148.33***	***12.8***	***125.2***


DRAFT CZMP MAP
GOA STATE
Sheet No. : D 43 B 16 E
INDEX SHEET
GOA
INDIA
Study Area
Arabian Sea
Bay of Bengal
Indian Ocean
Arabian Sea
N
W
E
S
0
500
1,000
Meters
Scale : 1 : 10,000
Projection :- UTM
Datum :- WGS 1984
D43 B 15 R
D43 B 15 S
D43 B 15 T
D43 C 3 P
D43 C 3 Q
D43 B 15 X
D43 B 15 Y
D43 C 3 U
D43 C 3 V
D43 B 16 D
D43 B 16 E
D43 C 4 A
D43 C 4 B
D43 B 16 I
D43 B 16 J
D43 B 16 N
D43 B 16 O
Legend
Data Provided: GCZMA
Fish landing centre/Ramp
Survey Plots
Fishing Ward
Village boundary
Municipal boundary
Data Source: NCSCM
Lighthouse
Railway line
Road
Seawall
High Tide Line
Low Tide Line
100m CRZ line for Bay - NDZ
100m CRZ line for Fishing Ward
200m CRZ line - NDZ
500m CRZ line
CRZ Line for river or creek
Jetty/Shipyard
CRZ CATEGORY
CRZ - I
Mangroves - CRZ IA
50m Mangrove buffer zone - CRZ IA
Corals and coral reefs - CRZ IA
Sand Dunes - CRZ IA
Mudflats - CRZ IA
MPAs and Other Protected Areas - CRZ IA
Salt Marsh - CRZ IA
Turtle Nesting Grounds - CRZ IA
Nesting Grounds of Birds - CRZ IA
Archaeological and heritage sites - CRZ IA
Khazan land - CRZ IB
Inter Tidal Zone -CRZ IB
Aquaculture Pond - CRZ IB
CRZ - II
CRZ - II - Developed area
CRZ - III
CRZ - III - Rural Area (Developed/Undeveloped)
CRZ - IV
Waterbody - CRZ IVA (LTL to 12 NM)
Waterbody - CRZ IVB (River/Creek)
Prepared by
NCSCM
National Centre for Sustainable Coastal Management
(Ministry of Environment, Forest & Climate Change)
Chennai - 25
Prepared for
M/s GOA COASTAL ZONE MANAGEMENT AUTHORITY
NAVELIM
TALAULIM
DRAMAPUR
VARCA
SIRLIM
ORLIM
CHINCHINIM
DEUSSUA
CARMONA
CUNCOLIM
73°57'0"E
73°58'0"E
73°59'0"E
74°0'0"E
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15 Products Developed at NCSCM

(a) Publications in Peer Reviewed Journals

Year 2017

1. Travnikov, O., Dastoor, A., De Simone, F... *R. Ramesh., et al (2017) Multi-model study of mercury dispersion in the atmosphere: Atmospheric processes and model evaluation Atmospheric Chemistry and Physics 17, 5271-5295*

Abstract

Current understanding of mercury (Hg) behavior in the atmosphere contains significant gaps. Some key characteristics of Hg processes, including anthropogenic and geogenic emissions, atmospheric chemistry, and air–surface exchange, are still poorly known. This study provides a complex analysis of processes governing Hg fate in the atmosphere involving both measured data from ground-based sites and simulation results from chemical transport models. A variety of long-term measurements of gaseous elemental Hg (GEM) and reactive Hg (RM) concentration as well as Hg wet deposition flux have been compiled from different global and regional monitoring networks. Four contemporary global-scale transport models for Hg were used, both in their state-of-the-art configurations and for a number of numerical experiments to evaluate particular processes. Results of the model simulations were evaluated against measurements. As follows from the analysis, the interhemispheric GEM gradient is largely formed by the prevailing spatial distribution of anthropogenic emissions in the Northern Hemisphere. The contributions of natural and secondary emissions

enhance the south-to-north gradient, but their effect is less significant. Atmospheric chemistry has a limited effect on the spatial distribution and temporal variation of GEM concentration in surface air. In contrast, RM air concentration and wet deposition are largely defined by oxidation chemistry. The Br oxidation mechanism can reproduce successfully the observed seasonal variation of the RM=GEM ratio in the near-surface layer, but it predicts a wet deposition maximum in spring instead of in summer as observed at monitoring sites in North America and Europe. Model runs with OH chemistry correctly simulate both the periods of maximum and minimum values and the amplitude of observed seasonal variation but shift the maximum RM=GEM ratios from spring to summer. O3 chemistry does not predict significant seasonal variation of Hg oxidation. Hence, the performance of the Hg oxidation mechanisms under study differs in the extent to which they can reproduce the various observed parameters. This variation implies possibility of more complex chemistry and multiple Hg oxidation pathways occurring concurrently in various parts of the atmosphere.

2. Karthik, R., Paneerselvam, A., Ganguly, D., Hariharan, G., Srinivasalu, S., Purvaja, R., & Ramesh, R. (2017). Temporal variability of atmospheric Total Gaseous Mercury and its correlation with meteorological parameters at a high-altitude station of the South India. *Atmospheric Pollution Research*, *8*(1), 164-173

Abstract

Diurnal and seasonal variations of atmospheric Total Gaseous Mercury (TGM) were studied for the first time in a high altitude station, Kodaikanal, India. To achieve this, an automated continuous mercury vapour analyzer was used in the study area between November, 2012 and September, 2013. In this pilot study the annual mean atmospheric TGM concentration was found to be 1.53 ng/m3, with a range from 0.83 to 3.25 ng/m3 and with a lognormal frequency distribution pattern. The mean seasonal concentration of TGM was found to be in the following order: summer > winter > northeast monsoon > southwest monsoon. Significant temporal differences in the TGM concentrations indicated strong environmental control regulated by seasonal changes in this high altitude rural area. The study further revealed that the day time TGM concentration was strongly

modified by solar radiation, evaporation and rainfall. Moreover, this is the first study in the Indian subcontinent with continuous monitoring of the temporal changes of TGM and its relation to other micrometeorological factors.

3. Ganguly, D., Singh, G., Ramachandran, P., Selvam, A. P., Banerjee, K., and Ramachandran, R. (2017). Seagrass metabolism and carbon dynamics in a tropical coastal embayment. *Ambio*, 1-13.

Abstract

Net ecosystem metabolism and subsequent changes in environmental variables were studied seasonally in the seagrass-dominated Palk Bay, located along the southeast coast of India. The results showed that although the water column was typically net heterotrophic, the ecosystem as a whole displayed autotrophic characteristics. The mean net community production from the seagrass meadows was 99.31 ± 45.13 mM C m-2 d-1, while the P/R ratio varied between 1.49 and 1.56. Oxygen produced through in situ photosynthesis, exhibited higher dependence over dissolved CO2 and available light. Apportionment of carbon stores in biomass indicated that nearly three-fourths were available belowground compared to aboveground. However, the sediment horizon accumulated nearly 40 times more carbon than live biomass. The carbon storage capacities of the sediments and seagrass biomass were comparable with the global mean for seagrass meadows. The results of this study highlight the major role of seagrass meadows in modification of seawater chemistry. Though the seagrass meadows of Palk Bay are increasingly subject to human impacts, with coupled regulatory and management efforts focused on improved water quality and habitat conservation, these key coastal ecosystems will continue to be valuable for climate change mitigation, considering their vital role in C dynamics and interactions with the overlying water column.

Year 2016

4. Bonthu, S., Ganguly, D., Ramachandran, P., Ramachandran, R., Pattnaik, A. K., and Wolanski, E. (2016). Both riverine detritus and dissolved nutrients drive lagoon fisheries. *Estuarine, Coastal and Shelf Science*, *183*, 360-369.

Abstract

The net ecosystem metabolism in lagoons has often been estimated from the net budget of dissolved nutrients. Such is the case of the LOICZ estuarine biogeochemistry nutrient budget model that considers riverine dissolved nutrients, but not riverine detritus. However the neglect of detritus can lead to inconsistencies; for instance, it results in an estimate of 5–10 times more seaward export of nutrients than there is import from rivers in Chilika Lagoon, India. To resolve that discrepancy the UNESCO estuarine ecohydrology model, that considers both dissolved nutrients and detritus, was used and, for Chilika Lagoon, it reproduced successfully the spatial distribution of salinity, dissolved nutrients, phytoplankton and zooplankton as well as the fish yield data. Thus the model suggests that the riverine input of both detritus and dissolved nutrients supports the pelagic food web. The model also reproduces well the observation of decreased fish yield when the mouth of the lagoon was choked in the 1990s, demonstrating the importance of the physics that determine the flushing rate of waterborne matter. Thus, both farming in the watershed by driving the nutrient and detritus inputs to the lagoon, and dredging and engineering management of the mouth by controlling the flushing rate of the lagoon, have a major influence on fish stocks in the lagoon.

5. Day, J. W., Agboola, J., Chen, Z., D'Elia, C., Forbes, D. L., Giosan, L.,and Syvitski, J. (2016). Approaches to defining deltaic sustainability in the 21st century. *Estuarine, Coastal and Shelf Science*, *183*, 275-291.

Abstract

Deltas are among the most productive and economically important of global ecosystems but unfortunately they are also among the most threatened by human activities. Here we discuss deltas and human impact,

several approaches to defining deltaic sustainability and present a ranking of sustainability. Delta sustainability must be considered within the context of global biophysical and socioeconomic constraints that include thermodynamic limitations, scale and embeddedness, and constraints at the level of the biosphere/geosphere. The development, functioning, and sustainability of deltas are the result of external and internal inputs of energy and materials, such as sediments and nutrients, that include delta lobe development, channel switching, crevasse formation, river floods, storms and associated waves and storm surges, and tides and other ocean currents. Modern deltas developed over the past several thousand years with relatively stable global mean sea level, predictable material inputs from drainage basins and the sea, and as extremely open systems. Human activity has changed these conditions to make deltas less sustainable, in that they are unable to persist through time structurally or functionally. Deltaic sustainability can be considered from geomorphic, ecological, and economic perspectives, with functional processes at these three levels being highly interactive. Changes in this functioning can lead to either enhanced or diminished sustainability, but most changes have been detrimental. There is a growing understanding that the trajectories of global environmental change and cost of energy will make achieving delta sustainability more challenging and limit options for management. Several delta types are identified in terms of sustainability including those in arid regions, those with high and low energyintensive management systems, deltas below sea level, tropical deltas, and Arctic deltas. Representative deltas are ranked on a sustainability range. Success in sustainable delta ma

6. Hariharan, G., Purvaja, R., Robin, R. S., & Ramesh, R. (2016). Evaluation of the multiple biomarkers on identification of the vulnerable coastal pollution hotspots. *Environmental Science and Pollution Research*, *23*(22), 23281-23290.

Abstract

This paper presents multiple biomarkers on metal accumulation and its impacts along the Chennai to Puducherry, southeast coast of India using bivalves as bioindicators. In this regard, water samples and Perna viridis were collected from three stations and the accumulation of metals and its biological impacts were assessed. Among the three sampling stations, the

maximum accumulation was noticed in Ennore (S1) than the Puducherry (S3) followed by Kovalam (S2). Mean accumulation pattern of metals in Perna viridis was found to be in the following order Zn > Cu > Ni > Cr > Pb > Cd, which were in close match with the metal concentration in seawater at respective site. The ambient metal concentration and behavior of multiple biomarkers were positively correlated indicating that the uptake of metals might induce biological changes, particularly in the internal organs, thus significantly affecting health of the aquatic organisms. P. viridis provides reliable information concerning the adverse effects and reflects the integrated effects of all contaminants. Thus, study confirmed that Ennore (S1) coast is highly vulnerable for significant pollution, in terms of metal toxicity in the study area. Overall investigation revealed that metal enrichment was observed close to the major urban areas in the S1 and S2 which were associated with industrialized areas. The assessment of multiple biomarkers on metal accumulation was the first step in determining the trophic transfer factors on marine foot web, which can be evaluated in the future based on this study.

7. Marimuthu, N., Ramachandran, P., Robin, R. S., Tudu, D., 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.

Abstract

This study was conducted to assess the health of the coastal ecosystem based on bio-physical assessment of the coral reef ecosystem at Palk Bay. A total of 11 sites along the coast from the eastern part of Rameswaram Island to Mandapam were chosen for this study. Good live coral cover (acroporid and non-acroporid corals) of 30.08 ± 6.72% was recorded in the eastern part of Rameswaram Island. Principal component analysis demonstrated that the contribution of live coral cover was closer to the selected study sites of the eastern part of Rameswaram Island. Metric multi-dimensional scaling analysis showed three major clusters with 75% similarity based on life-form categories observed in the reef ecosystem. In this study, there was a significant segregation of study sites of the eastern part of Rameswaram Island in two clusters with 80% similarity because of their richness of live coral cover. Multi-dimensional scaling based on coral

species diversity showed three major clusters with 50% similarity. Principal component analysis showed that the major contribution and abundance of coral species were closer to the northern part of Rameswaram Island. Moreover, Shannon–Wiener species diversity index of this region was in the range of 1.592–1.856, which was higher than the other sites. Hence, it was observed that there is no relationship between mean live coral cover and coral species diversity index of the reef ecosystem. The impact of biological indicators such as Halimeda algae and Palythoa sp. (Zoanthids) on the reef ecosystem was also analyzed. About 31 species of live corals belonging to 9 families and 18 genera were recorded during the study period. The outcome of this study helped in the understanding of the health of the ecosystem based on the intensity of mean live coral cover and coral species diversity. It also made it easier to understand the longitudinal variations and distribution pattern of coral reef community categories.

8. Banerjee, K., Selvam, P. A., Purvaja, R., and Ramesh, R. (2016). Heavy Metal Distribution and Pollution Assessment Using Environmental Indices in The Surface Sediments of Sundarbans Delta, India. *Journal of Applied Geochemistry*, *18*(4), 369.

Abstract

An attempt was made to identify the sources and distribution of heavy metals in Sundarbans Delta. The estuarine regions of Hooghly River and mangrove areas of Sundarbans were sampled (n=60) and analyzed for heavy metal content (Fe, Mn, Zn, Cu, Ni, Cr, Co and Pb). Different environmental indices (Enrichment Factors, Contamination Factors, Pollution Load Index and Geoaccumulation Index) were calculated based on both global shale value and local background values to assess the degree of contamination. Considering global shale values, low values were observed for all the indices against local background values, though the sediments were moderately polluted with Cu, Mn, Ni and Zn. This indicated that, later one is more suited for assessing contamination levels. In both the areas, Fe-Mn oxy-hydroxides were observed to be the major controlling factor for heavy metal accumulation along with mud and organic carbon content. These systems are under moderate stress of anthropogenic activities and effluent discharges.

9. Rocktim R. Das, G. Kantharajan, S. Goutham, V. Deepak Samuel, P. Krishnan, R. Rajkumar, R. Purvaja. 2017. First report of *Antigona somwangi* M. Huber, 2010 (Mollusca: Bivalvia: Veneridae) from India. Journal of Conchology. Vol.No. 42(5): 379-380.

Abstract

First Report of *Antigona Somwangi* Huber, 2010 (MOLLUSCA: BIVALVIA: VENERIDAE) from India *Antigona somwangi* Huber, 2010, is newly reported from Indian waters. This extends the distributional range for this species to the west coast of the Bay of Bengal, previously it had been known only from Andaman Sea.

10. Sprovieri, F., Pirrone, N., Bencardino, M., D'Amore, F., Carbone, F., Cinnirella, S., and Brunke, E. G. (2016). Atmospheric mercury concentrations observed at ground-based monitoring sites globally distributed in the framework of the GMOS network. *Atmospheric Chemistry and Physics*, *16*(18), 11915-11935.

Abstract

Long-term monitoring of data of ambient mercury (Hg) on a global scale to assess its emission, transport, atmospheric chemistry, and deposition processes is vital to understanding the impact of Hg pollution on the environment. The Global Mercury Observation System (GMOS) project was funded by the European Commission (http://www.gmos.eu) and started in November 2010 with the overall goal to develop a coordinated global observing system to monitor Hg on a global scale, including a large network of ground-based monitoring stations, ad hoc periodic oceanographic cruises and measurement flights in the lower and upper troposphere as well as in the lower stratosphere. To date, more than 40 ground-based monitoring sites constitute the global network covering many regions where little to no observational data were available before GMOS. This work presents atmospheric Hg concentrations recorded worldwide in the framework of the GMOS project (2010–2015), analyzing Hg measurement results in terms of temporal trends, seasonality and comparability within the network. Major findings highlighted in this paper include a clear gradient of Hg concentrations between the Northern and Southern hemispheres, confirming that the gradient observed is mostly driven by local and regional sources, which can be anthropogenic, natural or a combination of both.

11. Parasuram, P., Narayanan, P., Pelling, M., Solecki, W., Ramachandran, P., and Ramachandran, R(2016). Climate Change Adaptation Pathways in Kolkata. *Journal of Extreme Events*, *3*(03), 1650021.

Abstract

Disaster risk management and wider processes of adaptation are too often understood in isolation from development. Kolkata faces increasing heatwaves, flood hazard and everyday waterlogging as a result of climate change but the social and spatial distribution of impacts will likely be mediated by historic and contemporary development decisions. The paper reports on a study that has combined a scenario workshop method and expert interviews to surface the views of risk and resilience planners, academics and urban professionals on the adaptation–development nexus. Kolkata is experiencing rapid and fundamental transition in its governance regimes and economic structures as state-led development gives way to stronger market forces. Planners welcome an opening of urban governance but are worried by the speed of change. Transition in risk governance is observed in a predicted shift from a contemporary orientation where capacity is limited but focused on protecting development gains, to one which also embraces the flexibility of resilence.

12. Samuel, V. K. D., Sreeraj, C. R., Krishnan, P., Parthiban, C., Sekar, V., Chamundeeswari, K., ... and Ramesh, R. (2016). An updated checklist of shrimps on the Indian coast. *Journal of Threatened Taxa*, *8*(7), 8977-8988.

Abstract

This study reports an updated checklist of marine shrimps found along the Indian coast, including the Lakshadweep and the Andaman & Nicobar Islands. A total of 364 species classified under 128 genera belonging to the order Decapoda is reported, thus adding 27 species to the existing checklist of 337 species. Marine shrimps are classified under two suborders of the order Decapoda, viz., Dendrobranchiata and Pleocyemata, and the two suborders account for 155 (42.6 %) and 209

species (57.4 %) of these 364 species, respectively. Pleocyemata is represented by three infraorders, viz., Axiidea, Caridea and Stenopodidea, while Caridea has a maximum of 199 reported species. Among the 12 superfamilies, Penaeoidea contributed to 38.13% (135 species) followed by Paleaemonidea with 18.07% (64 species). All other superfamilies were found to contribute less than 12%. Superfamilies, Bresilloidea and Psalidopodoidea had only single species representatives (0.28% each). The final list was compiled after reviewing all existing literature including monographs, catalogues, checklists, websites and fishery reports. The scientific names were validated with the World Register of Marine Species (WoRMS) database. A total of 25 issues were identified from the previous checklist out of which 19 species have been updated with the correct, accepted names and six species have been removed from the previous list.

13. Sridhar, R., Sachithanandam, V., Mageswaran, T., Purvaja, R., Ramesh, R., Senthil Vel, A., and Thirunavukkarasu, E. (2016). A Political, Economic, Social, Technological, Legal and Environmental (PESTLE) approach for assessment of coastal zone management practice in India. *International Review of Public Administration*, *21*(3), 216-232.

Abstract

This article presents a comprehensive analysis of coastal zone management practice through a political, economic, social, technological, legal and environmental (PESTLE) approach and by reviewing relevant literature. Various geo-morphological features and coastal resources of India and major threats on coastal areas were highlighted. The article also highlights the transition of coastal zone management policies of India and their impacts on the coastal areas and ecosystems. Attempting to cite examples for the efforts taken for environmental protection from historical past to the recent developing era, the article also describes the present framework and addresses the strengths and challenges and concludes with some suggestions for an effective coastal zone management in India.

14. Nirmala, K., Ramesh, R., Ambujam, N. K., Arumugam, K and Srinivasalu, S. (2016). Geochemistry of surface sediments of a tropical brackish water lake in South Asia. *Environmental Earth Sciences*, *75*(3), 1-11.

Abstract

This article presents the result of the geochemical analysis of sediment from Pulicat lake, India. The analysis consists of textural composition, CaCO3, organic carbon, total phosphorus, metals such as Cr, Ni, Cu, Pb, Zn, Cd, Fe and Mn of the sediments collected. Multivariate analysis is performed on the dataset and the interpretations are used as pointers to the origin of the composition of sediment components. Analysis shows a strong inter metal relationship, with lesser correlation with sand or mud which indicates that the metals have a common origin and they were already agglomerated before reaching the lake. Contamination Factor and Geo-accumulation Index demonstrated that the sediments were moderately contaminated with Cd. The Pollution Load Index for the C d, Cr, Cu and Pb were greater than 1, whereby a Pollution Load Index greater than 1 indicates that the system under study is undergoing progressive deterioration representing Cd >Cu>Pb>Cr >Ni>Mn>Zn. Hierarchy of EF for metals in sediments is Cd >Cu>Pb>Cr >Ni>Mn>Zn with average of 3.6> 2.1>1.8>1.4>1.0>0.8>0.7, respectively. Cd concentration varies from a minimum of 0.01–1.5 mg kg-1 with a mean of 0.77 mg kg-1. Cu concentration ranges from 25 mg kg-1 and maximum of 81 mg kg-1 with a mean of 50 mg kg-1. Most of the metals are concentrated in the stations near the eastern part, which lie parallel to the sea and these regions act as hot spots for metal accumulation.

Year 2015 & 2014

15. Banerjee, K., Ganguly, D., Selvam, P. A., Ramachandran, P and Ramesh, R. (2014). Source-sink inventory of greenhouse gases from Indian mangroves: a review.

Abstract

Present study inventorises quantitative evaluation of greenhouse gas (GHG) emissions from various mangrove ecosystems distributed along the Indian coast. Inconsistency in terms of methodological aspects of GHG flux estimations from Indian mangrove ecosystems along with the variation in space and time, has been tried to be pointed out in this present paper. Inventorization of existing resources available from mangrove ecosystems along the east and west coast of India, would be useful for estimating the future potential ecosystem capacities for fluxes of CO2, CH4 and N2O. This review further confirms the potential role of Indian mangrove waters and sediments as perinial source for GHGs, whereas the canopy (vegetation) particularly acts as a CO2 sink.

16. Mary divya suganya G, Purvaja Ramachandran and Ramesh R , (2015) Modelling the Spatial Dynamics of landscape ecology near suburbs of Visakhapatnam and Gangavaram port, Andhra Pradesh, International Journal of Earth Sciences and Engineering, 8(2):680-689

Abstract

Scenario analysis of understanding the change in Land use/Land cover trajectories for a period of 37 years has become crucial guidance for rational land expansion in the suburbs of two ports Visakhapatnam and Gangavaram, Andhra Pradesh. The integrated Land use change model combines, a logistic regression model, Markov chain, and Multi-Layer Perceptron (MLP) neural network. Results reveal that multi-temporal change detection has the highest urban growth rates, from 19% to 28.5%, industrial expansion from 0.1% to 9.4% and port expansion from 0.02% to 3.57% occurred between 1973 and 2010. The areas most affected by this degradation were agricultural land and land without scrub. This model was calibrated with data, from 1973 to 2010 and was validated against

reference map from 2010. The true-positive proportion and standard Kappa variations had an acceptable accuracy of Kno, Klocation and Kstandard were of 86%, 82% and 80% respectively which proves to have strong consideration for predicting the model. Predictions for 2020 estimates that agricultural, land with scrub and sandy area has the probability of changing to settlement as 0.55, 0.43, and 0.31 respectively. Also land without scrub and wetlands has the probability of changing to industrial area as 0.31 and 0.27 respectively. Furthermore urban settlements are expected to emerge in the eastern areas, and these developments are expected to increase urban pressure. Thus the integrated method of, spatial dynamic assessment helps us to understand the driving mechanism of urban expansion, hence for the implications of urban planning and management in and around the ports of Andhra Pradesh.

17. Ramesh, R., Chen, Z., Cummins, V., Day, J., D'Elia, C., Dennison, B and Kremer, H. (2015). Land–ocean interactions in the coastal zone: past, present & future. *Anthropocene*, *12*, 85-98.

Abstract

The Land–ocean Interactions in the Coastal Zone (LOICZ) project was established in 1993 as a core project of the International Geosphere–Biosphere Programme (IGBP) to provide the science knowledge to answer "How will changes in land use, sea level and climate alter coastal systems, and what are the wider consequences?" In its first phase of operation (1993–2003) LOICZ began a fundamental investigation focused on biophysical dimensions, including seminal assessments of coastal seas as net sources or sinks of atmospheric CO2, river discharge to the oceans, and biogeochemical modelling. In the second generation of LOICZ (2004–2014), increased attention was paid to the human dimensions of the coast, involving the inclusion of cross-cutting themes such as coastal governance, social-ecological systems, ecological economics and activities around capacity building and the promotion of early career scientists. This paper provides a synthesis of this work and looks forward to the future challenges for the project. With the transition to Future Earth, there is a paradigm shift emerging. The new vision is to support transformation to a sustainable and resilient future for society and nature on the coast, by facilitating

innovative, integrated and solutions-oriented science. Realising this vision takes LOICZ into a third generation: to be at the forefront of co-designing, co-producing and co-implementing knowledge for coastal resilience and sustainability. LOICZ as Future Earth Coasts will continue to address 'hotspots' of coastal vulnerability, focusing on themes of dynamic coasts, human development and the coast, and pathways to global coastal sustainability and constraints thereof.

18. Purvaja, R., Ramesh, R., Glavovic, B., Ittekkot, V and Samseth, J. (2015). Regional initiatives for interlinking global coastal scientific research projects. *Environmental Development*, *14*, 66-68.

Abstract

LOICZ (Land Ocean Interactions in the Coastal Zone) (see http://www.loicz.org/) is a core research project of International Geosphere Biosphere Program (IGBP) (and previously also the International Human Dimensions Program (IHDP) involving scientists from across the globe investigating biogeochemical as well as social, economic and governance related coastal zone research. Since 2003, its focus on human dimensions allows better informing the scientific community, policymakers, managers and other stakeholders on the relevance of global environmental change in the coastal zone. LOICZ has six existing regional nodes: in South Asia (Chennai, India), Southeast Asia (Singapore), East Asia (Yantai, China), Latin America (Rio de Janeiro) and North America (Louisiana, USA). The four upcoming nodes include Arctic (Canada), West Africa (Nigeria), Caribbean (Trinidad & Tobago) and China (Taiwan). Each regional node coordinates and promotes global change research at the regional and local level as well as facilitates links and exchanges between international, national and local science and policy.

19. Ramesh, R., Robin, R. S and Purvaja, R. (2015). An inventory on the phosphorus flux of major Indian rivers. *Current Science*, *108*, 1294-1299.

Abstract

The biogeochemical cycles of phosphorus in rivers are intimately linked to the processes that occur in terrestrial ecosystems. Riverine networks hold a

crucial role in the transfer of nutrients from the land and atmosphere to the coastal oceans and often act as pool for numerous inorganic and organic compounds. Biogeochemical transformation of elements in river network is extensively influenced by catchment alteration and anthropogenic inputs. By means of the rising consciousness of human impact on the excellence of rivers, emphasis is given on rivers, as an ecosystem by itself and also on the river-coast continuum. In this study, the major forcing functions that affect the riverine composition of phosphorus have been examined, in Indian context. An attempt has been made to study and inventorize phosphorus flux from major Indian rivers. Relatively high concentrations of dissolved PO_3^{4-} (dissolved inorganic phosphorus – DIP) are observed in few of the Indian rivers, which may be due to modifications in river catchment. The flow of DIP and particulate inorganic phosphorus to the coastal ocean from Indian rivers is estimated to be about 190 x 10^3 tonnes year–1 and 1367 x 10^3 tonnes year–1 respectively. Suspended load is significant in Indian rivers and its cumulative flux is in the order of 1450 x 10^6 tonnes year–1. The DIP concentration in the Indian rivers is more than twice the concentration observed for the other rivers in the world. Such increased nutrient input into the riverine system reflects the imbalances and alterations in terrestrial sources. Thus, the quantity and quality of nutrient input to the rivers need to be monitored to cope with the existing and future climatic and environmental changes.

20. Ashokan, M., Latha, G and Ramesh, R. (2015). Analysis of shallow water ambient noise due to rain and derivation of rain parameters. *Applied Acoustics*, *88*, 114-122.

Abstract

Ocean ambient noise time series data were measured in shallow waters off the East coast of India from 09/12/2011 to 20/01/2012 and off the West coast of India from 16/05/2012 to 03/07/2012 at around 30 m ocean depth using hydrophones placed at 15 m depth in the mid water column. The measurements of wind and rain were recorded by an anemometer and precipitation type rain gauge mounted on a buoy. The objective of this work is to analyse the ambient noise caused by rain and determining the rain parameters such as rain drop size, rain fall rate,

terminal velocity, impact angle, etc. This is the first time such open sea measurements of noise have been made in Indian seas along with environmental parameters and influence of rain on ambient noise field is studied.

21. Swaney, D. P., Hong, B., Selvam, A. P., Howarth, R. W., Ramesh, R and Purvaja, R. (2015). Net anthropogenic nitrogen inputs and nitrogen fluxes from Indian watersheds: An initial assessment. *Journal of Marine Systems*, *141*, 45-58.

Abstract

In this paper, we apply an established methodology for estimating Net Anthropogenic Nitrogen Inputs (NANI) to India and its major watersheds. Our primary goal here is to provide initial estimates of major nitrogen inputs of NANI for India, at the country level and for major Indian watersheds, including data sources and parameter estimates,making some assumptions as needed in areas of limited data availability. Despite data limitations, we believe that it is clear that the main anthropogenic N source is agricultural fertilizer, which is being produced and applied at a growing rate, followed by N fixation associated with rice, leguminous crops, and sugar cane. While India appears to be a net exporter of N in food/feed as reported elsewhere (Lassaletta et al., 2013b), the balance of N associated with exports and imports of protein in food and feedstuffs is sensitive to protein content and somewhat uncertain. While correlating watershed N inputs with riverine N fluxes is problematic due in part to limited available riverine data,we have assembled somedata for comparative purposes.We also suggest possible improvements in methods for future studies, and the potential for estimating riverine N fluxes to coastalwaters.

22. Sachithanandam, V., Mageswaran, T., Sridhar, R., Arumugam, T and Ramesh, R. (2015). Marine turtle mortalities along the Tamil Nadu coast of India and the need for turtle-friendly fisheries. *Biodiversity*, *16*(1), 8-14.

Abstract

In the past two decades, sea turtle mortality has increased due to a variety of anthropogenic activities along the Nagapattinam and Chennai

coast region in Tamil Nadu, South India. Weekly field surveys were conducted over an eight-month period from December 2013 to July 2014 to monitor the mortality of turtles in these coastal areas, revealing a notable disruption in the nesting activity of the turtles during January–March; the worst affected were mature individuals. Anthropogenic activities like boat strikes and fishing activity were recorded as the major causes of turtle death within this region. This paper highlights the need for better turtle monitoring systems within this part of South India, particularly for endangered species like the olive ridley turtle (Lepidochelys olivacea), whilst also suggesting suitable conservation measures to protect them.

23. Patro, S., Krishnan, P., Gopi, M., Raja, S., Sreeraj, C.R., Purvaja, R. and Ramesh, R. (2015) Snowflake coral, Carijoa riisei from Grand Island, Goa: a case of invasion of an alien species or re-establishment of a native species?. Current Science, 109(6): 1028-1030.

Abstract

Invasion is an ecological phenomenon of introduction of organisms to areas outside their native ranges. It concerns all aspects relating to their transport, establishment and spread in a new region. An invasive species causes imbalance to the ecosystem by monopolizing food and spatial resources and consequently disrupting the native community. Biological invasion is presently one of the major sources of stress to the coral reef habitats, which harbour 25% of total marine biodiversity and contribute to 10% of total fishery production.

24. Mageswaran, T., Sachithanandam, V., Sridhar, R., Thirunavukarasu, E and Ramesh, R. (2015). Mapping and monitoring of land use/land cover changes in Neil Island (South Andaman) using geospatial approaches.

Abstract

Present study examines the dynamics of land use/ land cover changes to Neil Island, South Andaman using Remote Sensing and GIS for a period

of 13 years. Geocoded satellite imageries of Landsat TM (2000) and Landsat ETM 8 (2013) were used to identify the changes between 2000 and 2013. Visual interpretation technique was carried out to identify the features from the satellite imagery along with ground truth verifications. Land use categories such as forest area, mangroves, coral reefs, sandy beach, water body and built-up land have been identified and mapped. The present status (2013) of these resources is as follows: forest area 735.17 ha (40.17%), built-up land covers 601.15 ha (32.85%), coral reef covers an area of 441.00 ha (24.10%), mangroves covers 34.03 ha (1.86%) and sandy beach covers 16.15 ha (0.88%). Forest area was the largest component of land use feature which shows a significant change from 2000 to 2013. Aerial extent of coral reef and mangroves was decreased to 9.21 ha and 2.32 ha respectively.

25. Ashokan, M., Latha, G., Ramesh, R. and Thirunavukkarasu, A. (2015). Analysis of underwater rain noise from shallow water ambient noise measurements in Indian seas.

Abstract

Ocean ambient noise data were collected in shallow waters of Indian seas. The surface parameters like wind speed, wind direction and rainfall rate were measured by a buoy mounted anemometer and precipitation type rain gauge. On retrieving and analysing the ambient noise data sets, heavy rainfall noise was observed in the power spectral density over a frequency band from 2-7 kHz. Ambient noise intensity in the acoustic data correlate well with the rainfall rates recovered from the rain gauge. This paper presents the work carried out on the sea surface noise coherence and vertical directionality pertaining to rain in shallow waters of Bay of Bengal and Arabian Sea. In Indian seas so far no research work has been carried out on analysing the rainfall noise coherence and directionality and this is the first such study which will be useful further for deriving rain parameters such as rain drop size, number of drops, etc.

26. Rengarajan, S., Veeraragavan, S., Thangaraj, M and Ramachandran, R. (2014). Geographical analysis of tourism sites in Andaman Archipelago (India) and ecotourism development for Smith Island of North Andaman. *International Journal of Sustainable Development & World Ecology*, *21*(5), 449-455.

Abstract

This paper applies the nearest-neighbour analysis to analyse the clustering of tourist attractions in Andaman region and suggests ecotourism development for Smith Island of North Andaman using remote sensing techniques. The results indicated that present tourism sites are distributed in clusters in three regions (Port Blair, Mayabunder and Diglipur). To avoid concentration of tourism sites and population pressure in one particular area, there is a need to promote tourism to other locations as well. The study provided suggestions for ecotourism development in Smith Island after analysing its various ecological features to support the Andaman Administration's vision to promote ecotourism.

27. Ramachandran, R., Ramachandran, P., Lowry, K., Kremer, H. and Lange, M. (2014). Improving science and policy in managing land-based sources of pollution. *Environmental Development*, *11*, 4-18.

Abstract

Detailed scientific information about degraded systems and impacts of land-based sources of pollution [LBSP] including information about accelerating costs caused by degradation are readily available. Conveying and bringing this information to decision-makers and the public requires both efficient transmission of findings and institutional support for decision-making. In 2010 the Global Environment Facility [GEF] developed a medium-sized project on 'Enhancing the use of science in International Waters projects to improve projects results' to examine the role of science and technical analysis in trans boundary water projects. This article follows up an analysis of the LBSP working group. The emphasis was on examining the science-policy interface in over forty projects dealing with LBSP. The analytical framework combined descriptive [scientific component-incorporation into project design and implementation], evaluative [extent of use of analytical tools] and prescriptive elements. Best practices for

management of LBSP were identified. The prescriptive analysis discussed the importance of enhancing communication among scientists and policy makers. The authors conclude that a common framework [here the DPSIR, further developed as DPSWR approach] should be applied across projects to enable collective framing of the key environmental issues and working towards informal adaptive management.

28. Sachithanandam, V., Mageswaran, T., Sridhar, R., Purvaja, R. and Ramesh, R. (2014). Assessment of Cyclone Lehar's impact on seagrass meadows in Ross and Smith Islands, North Andaman. *Natural hazards*, *72*(2), 1253-1258.

Abstract

Cyclonic storms are large-scale disturbances which cause extensive damage in coastal ecosystems. On 25 November 2013, Cyclone Lehar made a significant impact on the coastal areas of Andaman and Nicobar Islands. We observed the pre- and post-Lehar cyclonic effects on the seagrass meadows at Ross and Smith Island, North Andaman. The study indicates that the seagrass meadows are composed of Halodule uninervis, Halophila ovalis, Halodule pinnifolia and Thalassia hemperichii species. Seagrass beds of approximately 1.96 ha (approx. 63 %) were destroyed in the cyclone.

29. Hariharan, G., Purvaja, R. and Ramesh, R. (2014). Toxic effects of lead on biochemical and histological alterations in green mussel (Perna viridis) induced by environmentally relevant concentrations. *Journal of Toxicology and Environmental Health, Part A*, *77*(5), 246-260.

Abstract

Acute and chronic toxicity tests were conducted on green mussel (*Perna viridis*) to determine the adverse effects of lead (Pb). Exposure of organisms to acute toxicity test for 96 h and lethal concentration (LC_{50}) was the endpoint of the test. Acute toxicity for 96-h LC_{50} and 95% confidence intervals of *P. viridis* was 2.62 ± 0.12 (2.62–3.24) mg/L Pb. Chronic toxicity tests revealed that survival of exposed organisms decreased with elevated exposure concentrations. No-observed-effect

concentration (NOEC) and lowest-observed-effect concentration (LOEC) were calculated based on survival of test organisms. Results of this study demonstrated an increase in toxicity in test organisms with rise in exposure time and concentration. In this study, histology and biochemical enzymes, namely, catalase, reduced glutathione, glutathione *S*-transferase, and lipid peroxides, were correlated with chronic value and survival endpoints of *P. viridis* after chronic exposure to Pb. Biochemical and histological responses to different concentrations of Pb were assessed and significant differences were observed between control and increasing exposure concentrations. Biomarker studies in internal organs confirmed that the observed changes are due to adverse effects of Pb. This assessment of toxicity was the first step to determining the seawater quality criteria for marine organisms.

30. Kumarasamy, P., James, R. A., Dahms, H. U., Byeon, C. W and Ramesh, R. (2014). Multivariate water quality assessment from the Tamiraparani river basin, Southern India. *Environmental earth sciences*, *71*(5), 2441-2451.

Abstract

The hydrochemistry of a perennial river has been investigated with multivariate cluster analysis (CA) and principal component analysis/factor analysis (PCA/FA). The aim was to investigate parameters responsible for spatial and temporal variations of river water quality. Water quality was monitored along the river basin at 20 different sites over a period of 1 year from July, 2008 to June, 2009. Multivariate statistics revealed that Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, HCO_3^{-}, Cl^{-}, H_4SiO_4, SO_4^{2-}, NO_2^{-}, and PO_4^{3-} were influenced by seasonal and spatial variations and that water quality was in the first place determined more by natural weathering processes than by anthropogenic activities. We could prove by (a) Box and Whisker plot, (b) matrix scatter score mean plot, (c) ternary plot, and (d) Gibbs plot that the chemistry of river water is controlled by lithogenic weathering processes. The higher concentration of dissolved silica during summer and the pre-monsoon season is explained by natural and tropical climatic conditions of the environment.

31. Linto, N., Barnes, J., Ramachandran, R., Divia, J., Ramachandran, P., and Upstill-Goddard, R. C. (2014). Carbon dioxide and methane emissions from mangrove-associated waters of the Andaman Islands, Bay of Bengal. *Estuaries and coasts*, *37*(2), 381-398.

Abstract

We estimated CO_2 and CH_4 emissions from mangrove-associated waters of the Andaman Islands by sampling hourly over 24 h in two tidal mangrove creeks (Wright Myo; Kalighat) and during transects in contiguous shallow inshore waters, immediately following the northeast monsoons (dry season) and during the peak of the southwest monsoons (wet season) of 2005 and 2006. Tidal height correlated positively with dissolved O_2 and negatively with pCO_2, CH_4, total alkalinity (TAlk) and dissolved inorganic carbon (DIC), and pCO_2 and CH_4 were always highly supersaturated (330–1,627 % CO_2; 339–26,930 % CH_4). These data are consistent with a tidal pumping response to hydrostatic pressure change. There were no seasonal trends in dissolved CH_4 but pCO_2 was around twice as high during the 2005 wet season than at other times, in both the tidal surveys and the inshore transects. Fourfold higher turbidity during the wet season is consistent with elevated net benthic and/or water column heterotrophy via enhanced organic matter inputs from adjacent mangrove forest and/or the flushing of CO_2-enriched soil waters, which may explain these CO_2 data. TAlk/DIC relationships in the tidally pumped waters were most consistent with a diagenetic origin of CO_2 primarily via sulphate reduction, with additional inputs via aerobic respiration. A decrease with salinity for pCO_2, CH_4, TAlk and DIC during the inshore transects reflected offshore transport of tidally pumped waters. Estimated mean tidal creek emissions were ~23–173 mmol m^{-2} day^{-1} CO_2 and ~0.11–0.47 mmol m^{-2} day^{-1} CH_4. The CO_2 emissions are typical of mangrove-associated waters globally, while the CH_4 emissions fall at the low end of the published range. Scaling to the creek open water area (2,700 km^2) gave total annual creek water emissions ~$3.6–9.2 \times 10^{10}$ mol $CO_2$and $3.7–34 \times 10^7$ mol CH_4. We estimated emissions from contiguous inshore waters at ~1.5×10^{11} mol CO_2 $year^{-1}$ and 2.6×10^8 mol CH_4 $year^{-1}$, giving total emissions of ~1.9×10^{11} mol CO_2 $year^{-1}$ and ~3.0×10^8 mol CH_4 $year^{-1}$ from a total area of mangrove-influenced water of ~3×10^4 km^2. Evaluating such emissions in a range of mangrove environments is important to resolving the greenhouse gas balance

of mangrove ecosystems globally. Future such studies should be integral to wider quantitative process studies of the mangrove carbon balance.

32. Sachithanandam, V., Mageswaran, T., Ragavan, P., Mahapatra, M., Sridhar, R., Ramesh R.and Mohan, P. M. (2014). Mangrove regeneration in tsunami affected area of north and south Andaman using insitu and remote sensing techniques. nisciar-csir,43(06),1061-1067

Abstract

Present study assessed the area of mangroves regeneration and rejuvenation status at North and South Andaman, 5 years later to Tsunami occured in 2004. Trees, Saplings and Seedlings were identified and collected during the traverse in this transect and enumerated all species of mangrove. GARMIN GPS was used to record sampling location and data collection points. Regeneration of mangrove trees after the devastation of tsunami has also been identified using Remote Sensing techniques and field observations. Submergence and degradation takes place in the seaward mangroves and the landward or riverine mangroves subsequently. Present study infers that the tsunami affected Island environment requires minimum five years for the regeneration of the dead mangroves after the catastrophic event.

33. Renaud, F. G., Syvitski, J. P., Sebesvari, Z., Werners, S. E., Kremer, H., Kuenzer, C., ... & Friedrich, J. (2013). Tipping from the Holocene to the Anthropocene: How threatened are major world deltas?. Current Opinion in Environmental Sustainability, 5(6), 644-654.

Abstract

Coastal deltas are landforms that typically offer a wide variety of benefits to society including highly fertile soils for agricultural development, freshwater resources, and rich biodiversity. For these reasons, many deltas are densely populated, are important economic hubs, and have been transformed by human interventions such as agricultural intensification, modification of water and sediment fluxes, as well as urbanization and industrialization. Additionally, deltas are increasingly affected by the consequences of climate change including sea level rise, and by other natural hazards such as cyclones and storm surges. Five examples of major

deltas (Rhine-Meuse, Ganges, Indus, Mekong, and Danube) illustrate the force of human interventions in shaping and transforming deltas and in inducing shifts between four different social-ecological system (SES) states: Holocene, modified Holocene, Anthropocene and 'collapsed'. The three Asian deltas are rapidly changing but whereas SES in the Ganges and Indus deltas are in danger of tipping into a 'collapsed' state, SES in the Mekong delta, which is at the crossroads of various development pathways, could increase in resilience in the future. The Rhine-Meuse and Danube delta examples show that highly managed states may allow, under specific conditions, for interventions leading to increasingly resilient systems. However, little is known about the long-term effects of rapid human interventions in deltas. It is therefore critical to increase the knowledge-base related to SES dynamics and to better characterize social tipping points or turning points in order to avoid unacceptable changes.

34. Singh, G., Ganguly, D., Paneer Selvam, A., Kakolee, K., Purvaja, R.and Ramesh, R. (2015). Seagrass Ecosystem and Climate Change: An Indian Perspective. *Journal of Climate Change*, *1*(1, 2), 67-74.

Abstract

The significance of the seagrass ecosystem as global carbon sinks has been well studied worldwide; however, studies in India are sparse. Most research in India focuses on the distribution and ecology of seagrass and biogeochemistry has often been less studied. This paper describes the potential carbon sequestration, particularly carbon burial and uptake by seagrass ecosystems of India. The results reported the higher dissolved carbon uptake rates by seagrass ecosystem followed by high net ecosystem productivity. Below ground biomass dominated in the seagrass ecosystem which is a storehouse of buried carbon. High storage capacity of seagrass ecosystem is described through a case study of Chilika lagoon where the carbon pool in the biomass and sediments were observed to range from 2.3 to 2.5 Gg C and 4.5 to 5.7 Gg C respectively. The study emphasized on the need of focused research, particularly, on the role of carbon in seagrass ecosystems in India.

(b) Chapters in Books

1. Patro, S., Krishnan, P., Samuel, V. D., Purvaja, R and Ramesh, R. (2017). Seagrass and Salt Marsh Ecosystems in South Asia: An Overview of Diversity, Distribution, Threats and Conservation Status. In *Wetland Science* (pp. 87-104). Springer India.

Abstract

India, Pakistan, Bangladesh, Sri Lanka and the Maldives have extensive coastal and marine ecosystems. Seagrass beds and salt marshes are coastal ecosystems restricted to the subtidal and intertidal zone ranging from shallow water in the case of seagrass to the high upland of intertidal zone in case of salt marsh. The chapter provides an overview of the salt marsh and seagrass ecosystems in India and other South Asian countries. Despite their significant ecological importance, seagrass and salt marsh ecosystems are relatively under-explored or unexplored, particularly in the South Asian countries. Fifteen species of seagrass are reported from South Asian region, all of which are found in India. They are distributed along the coastal states/union territories except Maharashtra, Daman and Diu, Puducherry and West Bengal. The salt marsh species diversity in India and the Maldives is not reported. The chapter provides checklist of salt marshes of India, represented by 14 species, which are distributed along Gujarat, Daman and Diu, Maharashtra, Tamil Nadu, Puducherry, Andhra Pradesh and Andaman and Nicobar Islands.

2. Ramesh, R., Abhilash, K. R., Purohit, M., Krishnan, P., Lakshmi, A., Purvaja, R.and Kingsley, P. W. (2017). Involvement of Community in Managing Coastal Wetlands in South Asia: Status, Issues and Challenges. In *Wetland Science* (pp. 545-562). Springer India.

Abstract

The development and population pressures on the coastal states of South Asia have significant impact on their coastal resources. As a large number of coastal communities are highly dependent on the coastal resources, the decline in resources affects their livelihoods. To manage the coastal

resources effectively from further damage, a community-oriented mode of resource management is highly recommended, as it imparts the sense of stewardship and accountability in extraction and use of the resources. The community participation in ecosystem conservation and management has been implemented in South Asia through various enabling policies, regulatory frameworks and community practices. Conservation through involvement of people has not only yielded benefits to coastal environment and resources but also helped people to gain food security and income through tourism. This chapter discusses about various international and national policies and legal frameworks, which provide support for community-based resource management and empower the people of the local community in designing and implementing coastal resource conservation and management plans.

3. Pasupalati, N., Nath, M., Sharan, A., Narayanan, P., Bhatta, R., Ramachandran, R and Ramachandran, P. (2017). Economic Valuation of Wetland Ecosystem Goods and Services. In *Wetland Science* (pp. 259-284). Springer India.

Abstract

The degradation of wetland resources including waterbodies, marshy coastal cropland, mangroves and salt marshes due to a variety of human activities within and outside the wetlands is a major environmental concern in India. Despite their importance, these ecosystems are under severe threat of degradation due to both natural and anthropogenic factors primarily due to the lack of awareness of the link between human support systems and natural ecosystems. Unless our natural capital is systematically accounted for, coupled with the knowledge of its total economic value, the probability of unsustainable exploitation leading to loss of human well-being would be significantly high. This necessitates a thorough understanding on the tools and techniques used in economic valuation and the ecosystem goods and services of a wetland ecosystem. The present chapter provides comprehensive information on the typology of various tools used in economic valuation of wetland resources. A synthesis of available information from published literature is also

included, which provides a snapshot of monetary values of this natural resource.

4. R. Ramesh, Paneer Selvam, A., Robin, R.S., Ganguly, D., Singh, G and Purvaja, R Nitrogen Assessment in Indian Coastal Systems in The Indian Nitrogen Assessment: Sources of Reactive Nitrogen, Environmental and Climate Effects, Management Options, and Policies, 1st Edition (Eds. YP Abrol TK Adhya Viney P. Aneja Nandula Raghuram Himanshu Pathak Umesh Kulshrestha Chhemendra Sharma Bijay Singh) ELSEVIER ISBN 9780128118368

Abstract

Productive coastal zones have been a backbone of human development since ages. Coastal zones occupy ~8% of the world's surface area, but provide 25% of global productivity, 90–95% of the world's marine fish catch, 80% of global carbonate production, 50% of global denitrification, and 90% of global sedimentary mineralization (UNEP, 1992). Human interventions have significantly altered global N budget, which was in balance during the preindustrial era. Concurrently, input rates from synthetic N fertilizer production, legume crops, and combustion of fossil fuels have superseded the losses. Consequently, the inputs of newly fixed N_2 in the terrestrial systems (formation of bioavailable N from atmospheric N_2) have increased by 100% due to human interventions (Galloway et al., 2004). A considerable fraction of this newly fixed/chemical nitrogen is transported to the coastal waters through rivers where it modifies the coastal ecosystem function (Rabalais, 2002; Gilbert et al., 2005). Changes in phytoplankton species composition, alteration and loss of sea grass habitats, and increases in carbon fixation, extent and duration of anoxic and hypoxic waters, harmful algal blooms, and coral reef degradation are some of the effects associated with the excess N inputs to coastal systems (Sutton et al., 2011). The coastal and marine nitrogen cycle occupies a complex, central role within the biogeochemical cycles (Purvaja et al., 2008a).

5. Ramesh, R., Purvaja, R., Krishnan, P., Lakshmi, A., Abhilash, K. R.and Kingsley, P. W. (2017). Conservation of Coastal Wetlands: An Appraisal of the Policy and Legal Framework in South Asian Nations. In *Wetland Science* (pp. 515-544). Springer India.

Abstract

The development and population pressures on the coastal states of South Asia have significant impact on their coastal resources. As a large number of coastal communities are highly dependent on the coastal resources, the decline in resources affects their livelihoods. To manage the coastal resources effectively from further damage, a community-oriented mode of resource management is highly recommended, as it imparts the sense of stewardship and accountability in extraction and use of the resources. The community participation in ecosystem conservation and management has been implemented in South Asia through various enabling policies, regulatory frameworks and community practices. Conservation through involvement of people has not only yielded benefits to coastal environment and resources but also helped people to gain food security and income through tourism. This chapter discusses about various international and national policies and legal frameworks, which provide support for community-based resource management and empower the people of the local community in designing and implementing coastal resource conservation and management plans.

6. Naren Pasupalati, Megha Nath, Abhijit Sharan, Priya Narayanan, Ramachandra Bhatta, Ramesh Ramachandran, and Purvaja Ramachandran. 2017. Economic Valuation of WetlandEcosystem Goods and Services. In: Prusty, B. Anjan Kumar, Chandra, Rachna, Azeez, P. A. Wetland Science: Perspectives from South Asia, Springer. Pp. 259 – 284. ISBN 978-81-322-3715-0

Abstract

The degradation of wetland resources including waterbodies, marshy coastal cropland, mangroves and salt marshes due to a variety of human activities within and outside the wetlands is a major environmental concern in India. Despite their importance, these ecosystems are under severe threat of degradation due to both natural and anthropogenic factors primarily due to the lack of awareness of the link between human support systems

and natural ecosystems. Unless our natural capital is systematically accounted for, coupled with the knowledge of its total economic value, the probability of unsustainable exploitation leading to loss of human well-being would be significantly high. This necessitates a thorough understanding on the tools and techniques used in economic valuation and the ecosystem goods and services of a wetland ecosystem. The present chapter provides comprehensive information on the typology of various tools used in economic valuation of wetland resources. A synthesis of available information from published literature is also included, which provides a snapshot of monetary values of this natural resource.

7. Krishnan, P., Samuel, V. D., Sreeraj, C. R., Abhilash, K. R., Patro, S., Sankar, R and Ramesh, R. (2017). Digital Repositories for Coastal Wetland Biodiversity in South Asia: A Conceptual Framework from India. In *Wetland Science* (pp. 51-65). Springer India.

Abstract

Wetlands support a variety of life forms, which are inextricably linked with the goods and services provided by them. Documentation of the biological resources of wetlands is essential in order to aid in their conservation. Digital repositories ensure wide and easy access to such complex biodiversity information and are gaining significance in conservation planning. However, such digital repositories are few at the regional level, especially in South Asia, an area of high coastal and marine biodiversity. This chapter provides an overview of digital repositories in general and the design and architecture of Coastal and Marine Biodiversity Integration Network (CoMBINe), a national Web portal on coastal biodiversity of India, designed to be scalable vertically to include data with respect to other taxonomic groups and horizontally to cover other countries.

8. S. Dam Roy, P. Krishnan, Shesdev Patro, Grinson George, A. Velmurugan, R. Kiruba Sankar, and Purvaja Ramachandran. 2017. Wetlands of Small Island Nations in South Asia vis-à-vis the Mainland and Island Groups in India: Status and Conservation Strategies In: Prusty, B. Anjan Kumar, Chandra, Rachna, Azeez, P. A. Wetland Science: Perspectives from South Asia, Springer. Pp. 31 – 48.

Abstract

The wetlands of small island nations in South Asia such as Sri Lanka and the Maldives are compared with that of India with respect to their status, biodiversity, threats and conservation measures. Sri Lanka has diverse coastal habitats, which are known to support fishes (1800 species), marine turtles (5 species), marine mammals (38 species), corals (183 species), mangroves (40 species), birds (100 species), reptiles (33 species) and seagrasses (10 species). The Maldives boasts one of the world's richest marine biodiversity comprising 250 species of corals, over 1200 of reef fishes, 200 species of sponges, over 1000 species of crustaceans and over 100 species of echinoderms. Marine biodiversity of India comprises 12,913 species, of which more than 5800 species are reported from Andaman and Nicobar Islands. Marine biodiversity of Lakshadweep islands is represented by corals (172 species), fishes (396), sponges (95), molluscs (260), echinoderms (84), crustaceans (80), turtles (04), birds (142), marine mammals (6), seagrasses (07) and mangroves (03). The major threats to these wetlands of South Asian countries are climate change, extreme events like tsunami, coastal erosion, population pressure, habitat destruction and over-exploitation. The chapter emphasises the need for adopting frontier tools for biodiversity documentation and innovative strategies for their conservation.

9. Sridhar, R., Yuvaraj, E., Sachithanandam, V., Mageswaran, T., Purvaja, R and Ramesh, R. (2016). Tourism Carrying Capacity for Beaches of South Andaman Island, India. *TOURISM-FROM EMPIRICAL RESEARCH TOWARDS PRACTICAL APPLICATION*, 61

Abstract

The Andaman and Nicobar Islands (ANI) is one of the largest tourist areas in India attracting both the international and domestic tourists each year. The Island Administration has a vision to develop the islands as an upmarket island destination for ecotourism. Among the island group, the South Andaman region is the most visited tourist destination and beaches of these islands have great potential for tourism attractions. The present work is an attempt to understand the potential of these beaches by assessing the carrying capacity in terms of number of visitors that can be allowed over a period of time, which will further help with better tourism management. The methodology used to estimate the tourism carrying capacity (TCC) is based

on the physical and ecological conditions of each site and the existing infrastructure. The total effective carrying capacity (ECC) estimated for the beaches of Port Blair area (126,301 visitors/day) reveals that the current tourism activity is in lower level compared to its carrying capacity. Such carrying capacity assessments can be used as an input into the regular planning process. Preliminary estimates suggest that A&N Islands can be promoted for high value-low volume, eco-friendly, and environmentally sustainable tourism.

10. Devaraj Asir Ramesh, Priya Narayanan, Karthi,N., P, Priya., Arumugam Senthil Vel S.V. Reddy, and Ramesh Ramachandran., 2016. Education and skill development for coastal fishing community for sustainable livelihood. published in (book) "Sustainable development through education" (Ed.) Dr. Sujit Kumar Paul, Visva Bharati, Published by - APRAN Publication, New Delhi. ISBN 978-93-82135-95-1.

Abstract

Education plays a significant role in development of individual fishermen, families as well as fishing community and society. Education is one of the essential livelihood asset and capital for coastal fishing community development. In the 7,516.6 km long coastline of India, a total of 3,432 coastal fishing villages with a total population of 39,99,214 are present. Out of the total population in the coastal fishing villages of India, nearly 57 % of the population are literate, which is below the National average of 65%. Higher education of fishermen is poor (2%) while comparing National average of 11%. The low level of education is closely related to poverty. Poverty makes the poor unable to continue their education to higher level which will affect their ability and skill level required for sustainable fishing. It is well-established that education is an important catalyst for achieving all development goals. Literacy level has been used as an primary indicator to measure Human Development Index (HDI). Among the coastal fishermen population, literates are 61.57 % (crude literacy rate) which is very lower than National average of 74 % that indicates the difference of fishermen population in literacy also the requirement of attention for socio-economic development. Infrastructures for education development such as schools and related infrastructures shall

be improved in the coastal fishing villages to increase the literacy rate. The reason to increase infrastructure for education is evident while correlation between nThumber of primary school available for 1000 fishermen population with the number of literates population. Not only the specific infrastructures of education also other welfare and infrastructures for fishing to achieve socio-economic development shall improve the status of fishermen to obtain education. A study was conducted by Integrated Social and Economics Division of National Centre for Sustainable Coastal Management (NCSCM) to understand the relationship between literacy rate and livelihood assets of fishermen to guide policy interventions to promote fishermen capacity building activities. This study summarises the relationship between literacy rate, livelihood assets of fishing communities and provides recommendations for policy interventions in fishermen education.

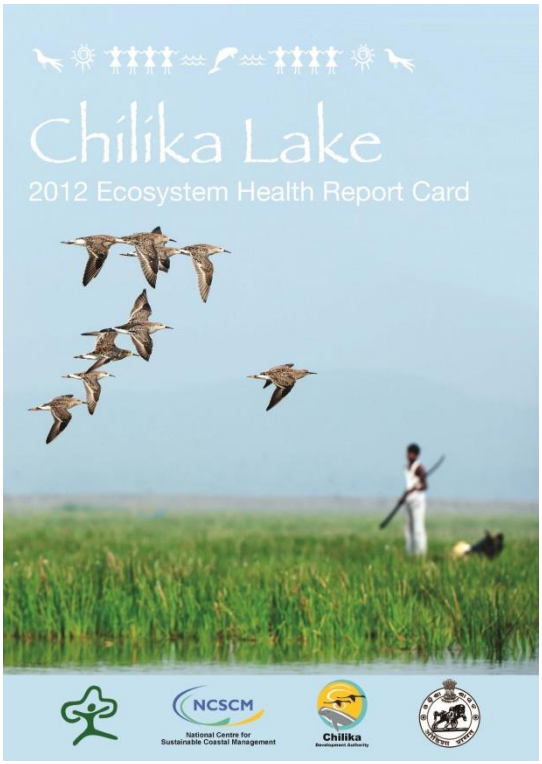
(c) Publications & Report Cards

NCSCM Brouchure

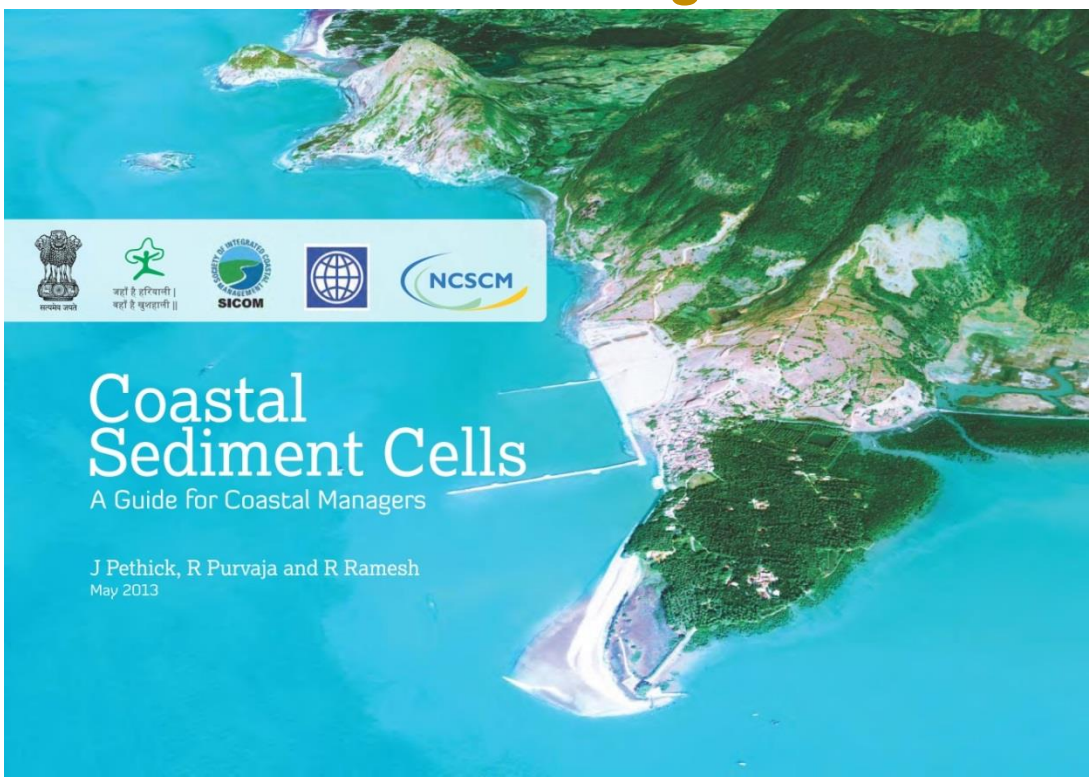
National Assessment of Shoreline Change Odisha Coast – Y 2011

National Assessment of Shoreline Change Kerala Coast – Y 2011

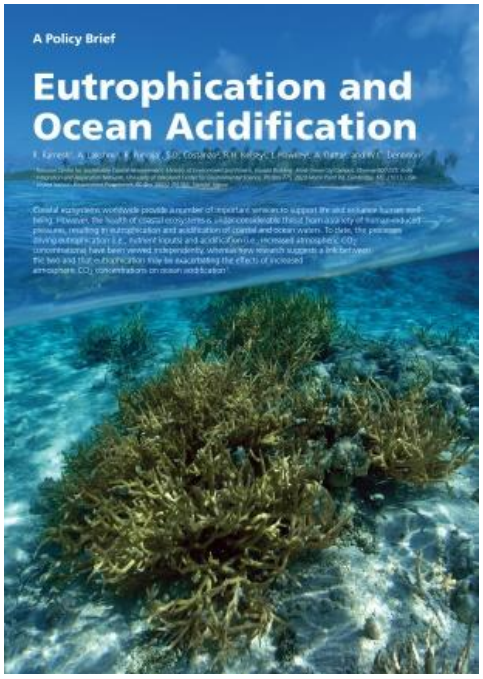
Ecosystem Health Report Card
Chilika Lake – Year 2012



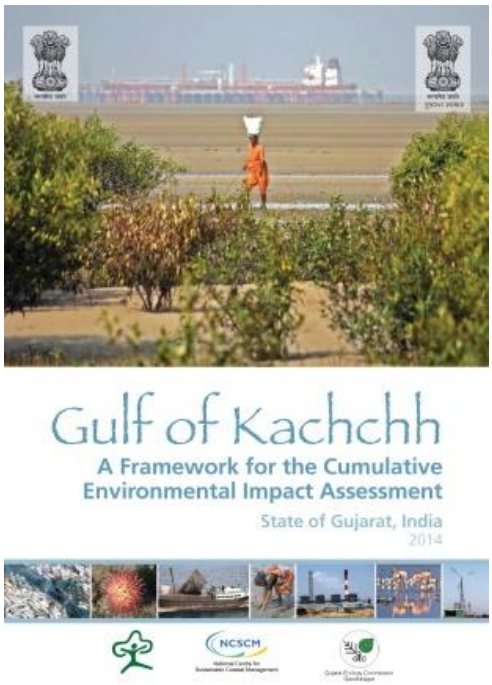
Coastal Sediment Cells
A Guide for Coastal Managers – Year 2013



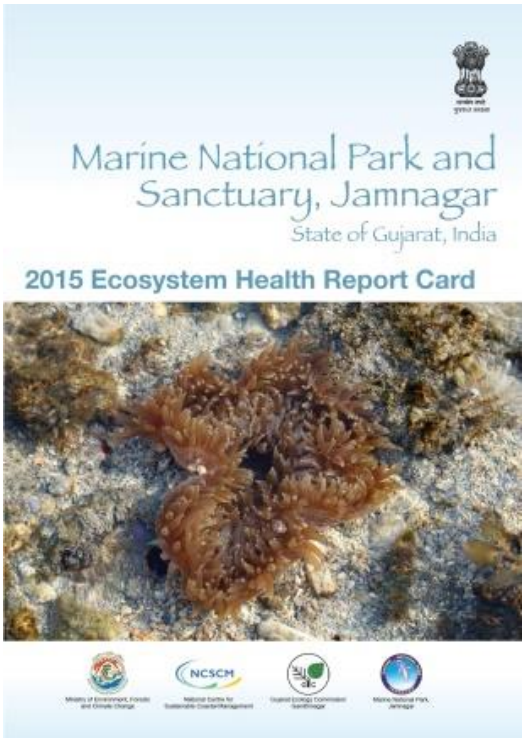
Policy brief Eutrophication and Ocean Acidification -



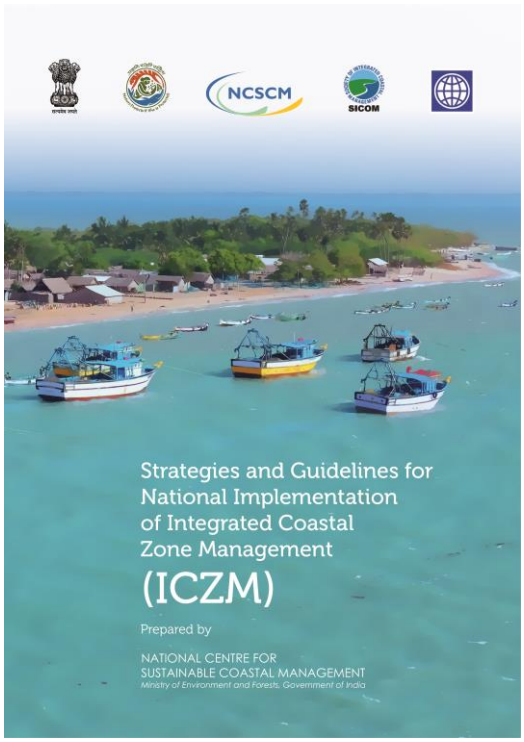
A framework for the Cumulative Environmental Impact Assessment for the Gulf of Kachchh, State of Gujarat,



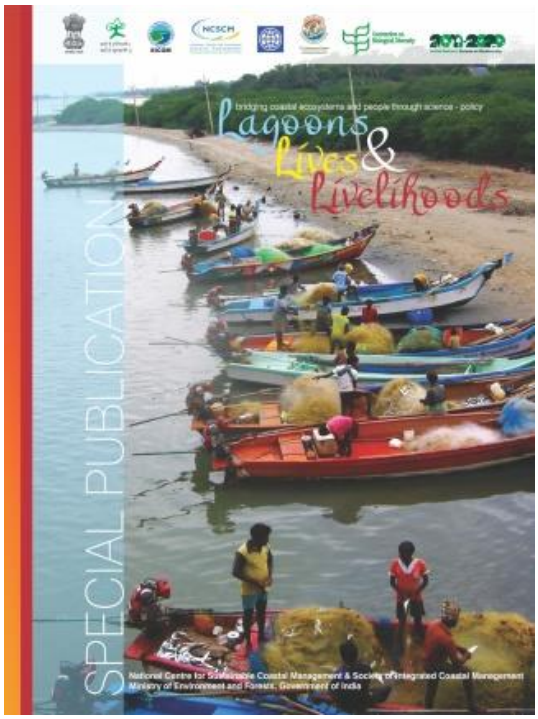
Ecosystem Health Report Card - Marine National Park and Sanctuary, Jamnagar, State of Gujarat, India – Y 2014



Strategies and Guidelines for National Implementation of Integrated Coastal Zone Management (ICZM) – Y2014



Lagoons, Lives and Livelihood - Special Publication (CBD COP 11) - Y 2012



NCSCM Annual Report Y 2013

(d) Fact sheets

India @ COP21: Y 2015

India @ COP22 Y 2016

INDIA@COP22

Ministry of Environment, Forest and Climate Change Government of India

NCSCM

NATIONAL CENTRE FOR SUSTAINABLE COASTAL MANAGEMENT

National Centre for Sustainable Coastal Management is established by the Ministry of Environment, Forest and Climate Change, Government of India in 2011, with an aim to become a world class institution for coastal and marine area management.

The National Centre for Sustainable Coastal Management (NCSCM), Ministry of Environment, Forest and Climate Change, has the following vision and mission that would aid in the better protection, conservation, rehabilitation, management and policy design of the coast. It would promote integrated and sustainable management of coastal and marine areas in India and advise the Union and States/ Union Territory Governments and other associated stakeholders on policy, and scientific matters relating to Integrated Coastal Management (ICZM)

Vision

Promote sustainable coasts through increased partnerships, conservation practices, scientific research and knowledge management for the benefit and well being of current and future generations.

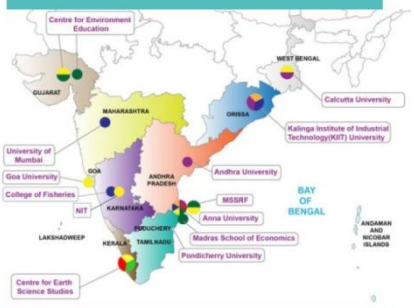
Mission

Support integrated management of coastal and marine environment for livelihood security, sustainable development and hazard risk management by enhancing

- Knowledge
- Research and advisory support
- Partnerships and network
- Coastal community interface

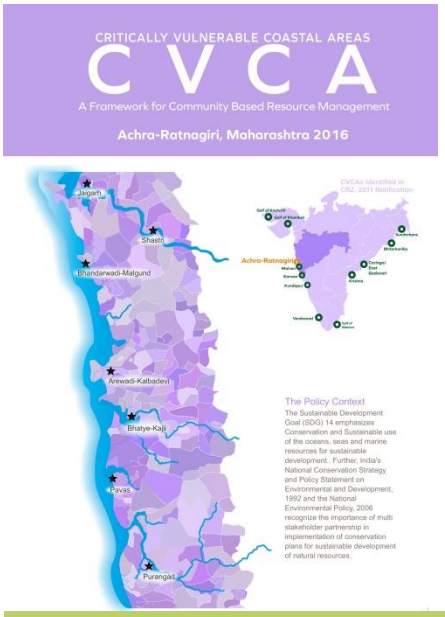
Consortium Partner Institutions

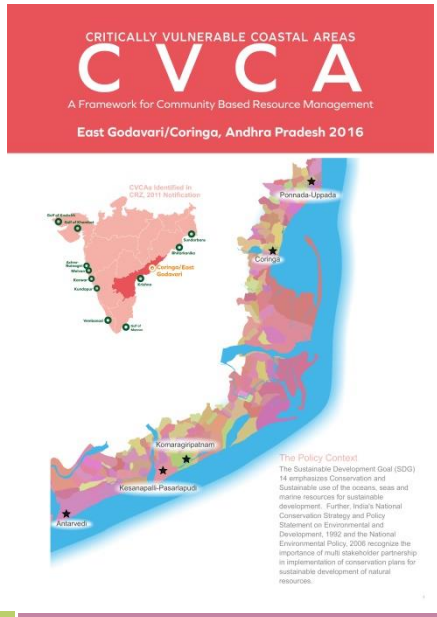
Fourteen institutions from coastal states have formed a consortium with NCSCM and signed the Anna University Declaration on 21st June 2010

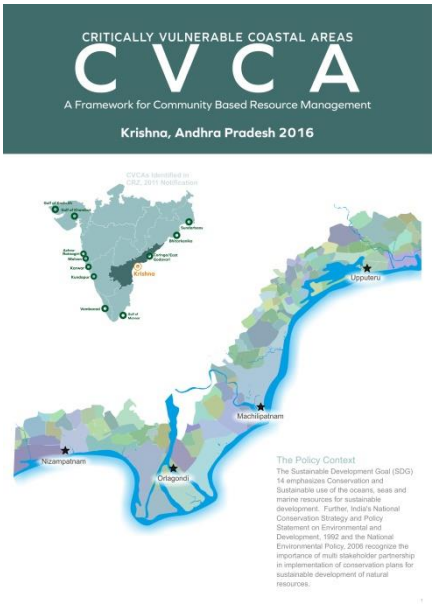


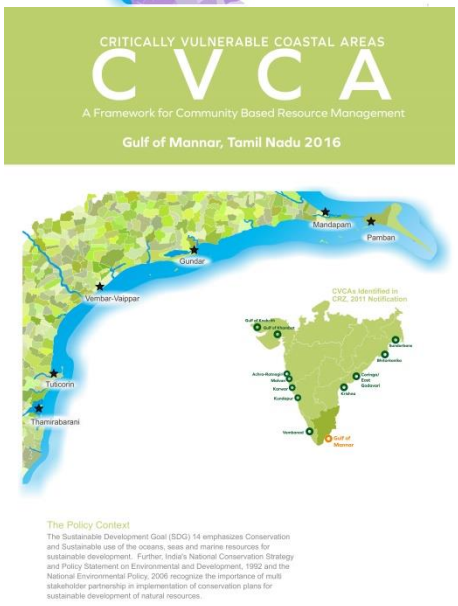
NCSCM HAS AN ADVANCED AND MULTI-DISCIPLINARY RESEARCH AGENDA TO ADDRESS SUSTAINABLE COASTAL MANAGEMENT

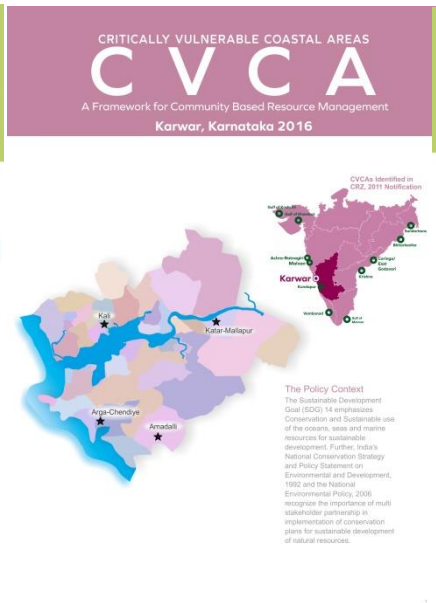
CVCA Report Cards 2016-2017

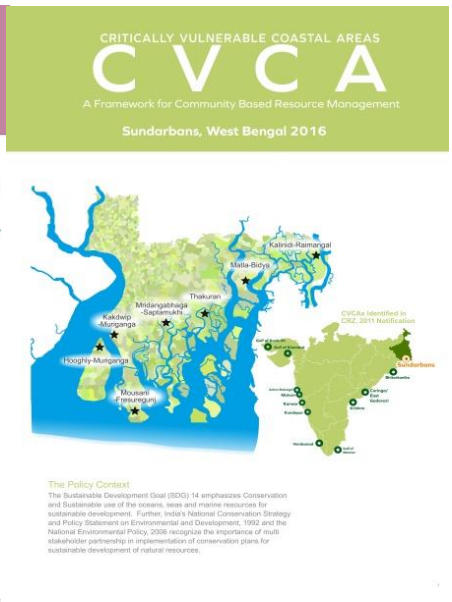


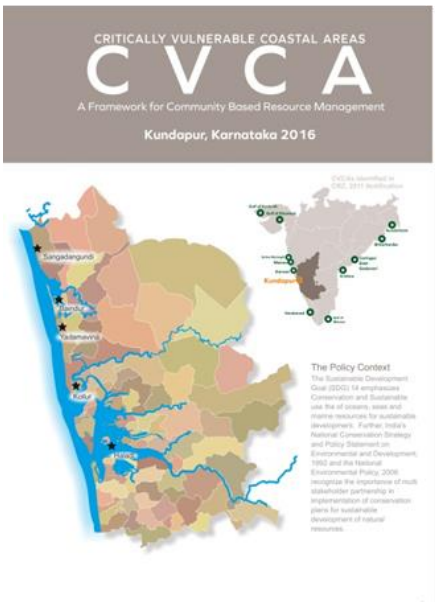


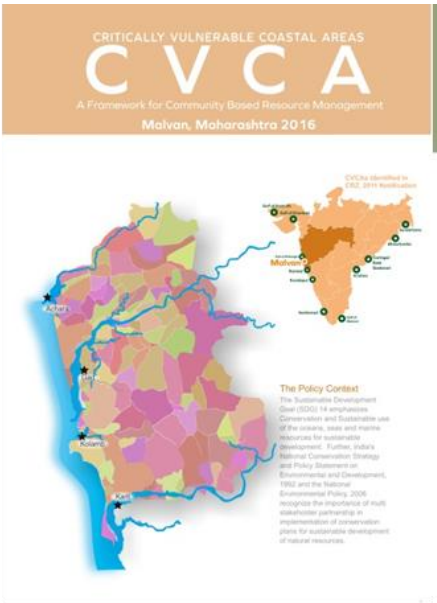


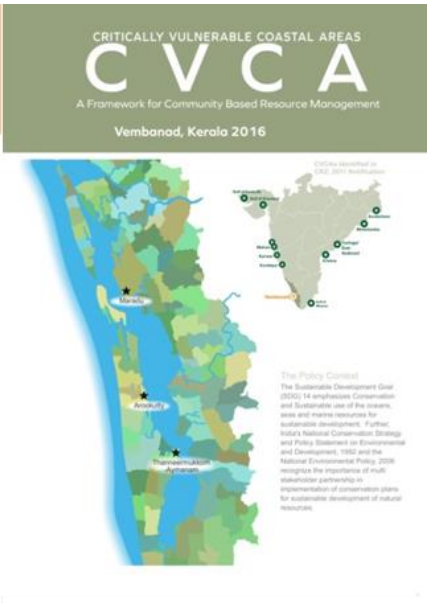












(e) Reports & Manuals

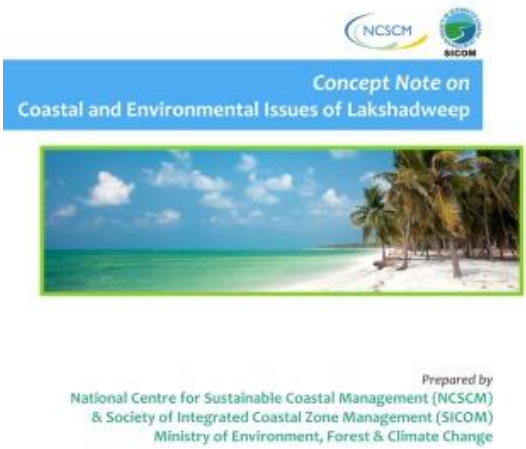
National Strategy for Coastal Protection

Vulnerability Assessment of Munroe island report

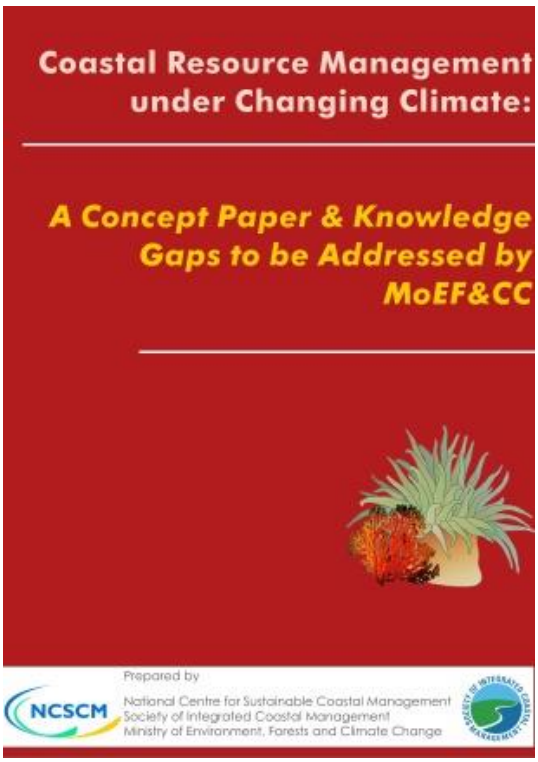
Vulnerability Assessment of Island Polavaram, Andhra Pradesh

Exploring wellbeing in fishing communities Methods Handbook

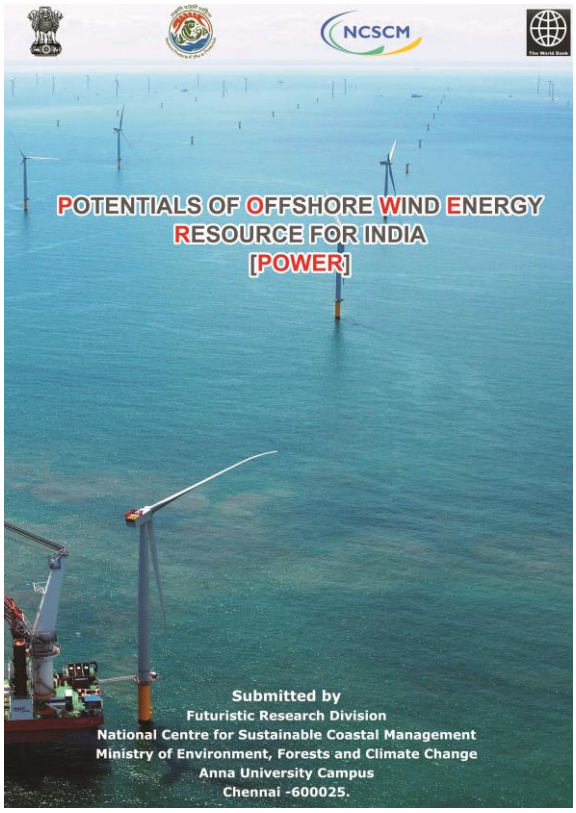
Concept Note on Coastal and Environmental Issues of Lakshadweep

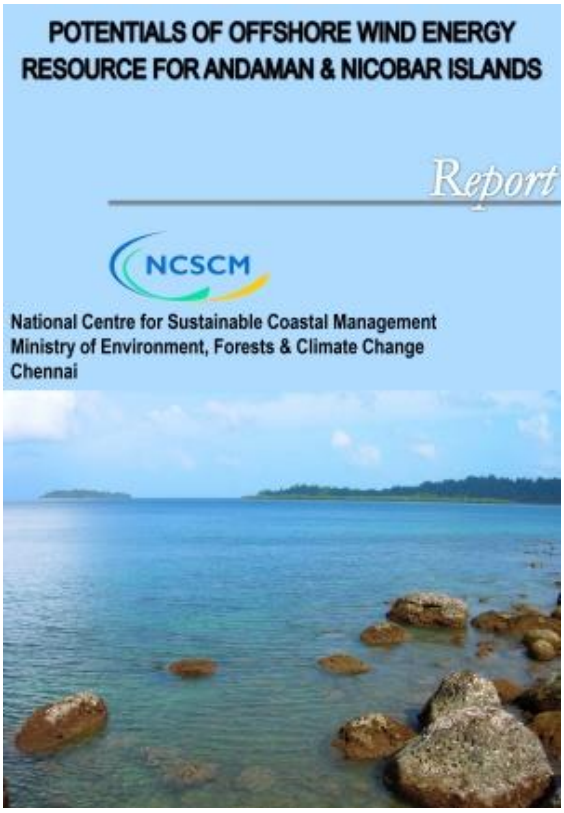


Coastal Resource Management under Climate Change



Potential Offshore Wind Energy Report – Mainland & A&N Island





Addressing the gaps identified in the IIM Plan for Lakshadweep Island

Addressing the Gaps identified in the
Integrated Island Management Plan for
Agatti Island, Lakshadweep

Prepared by

National Centre for Sustainable Coastal Management (NCSCM)
Ministry of Environment, Forest & Climate Change (MoEF&CC) &
Union Territory of Lakshadweep (UTL)

IIMP & ICRZ Reports for A & N Islands

Island Coastal Regulation Zone (ICRZ) Plans for
Andaman and Nicobar Islands

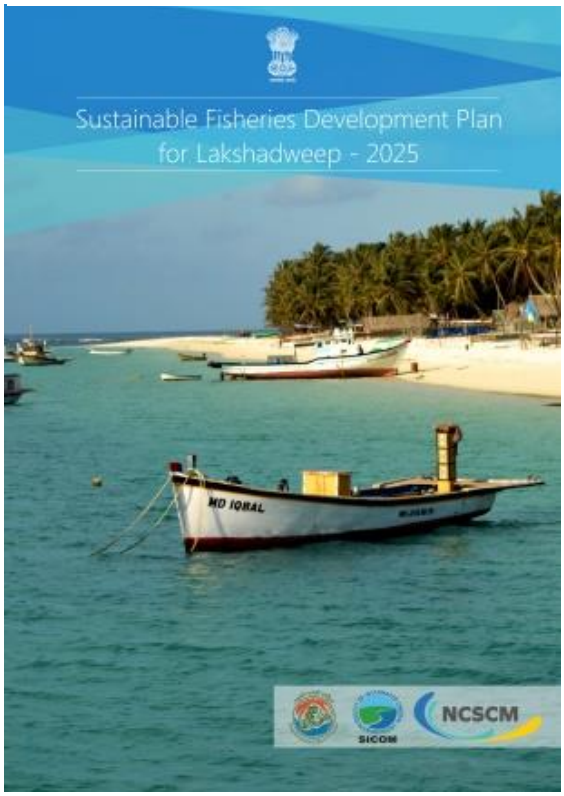
ICRZ PLAN FOR HAVELOCK ISLAND
(SOUTH ANDAMAN DISTRICT)

NCSCM

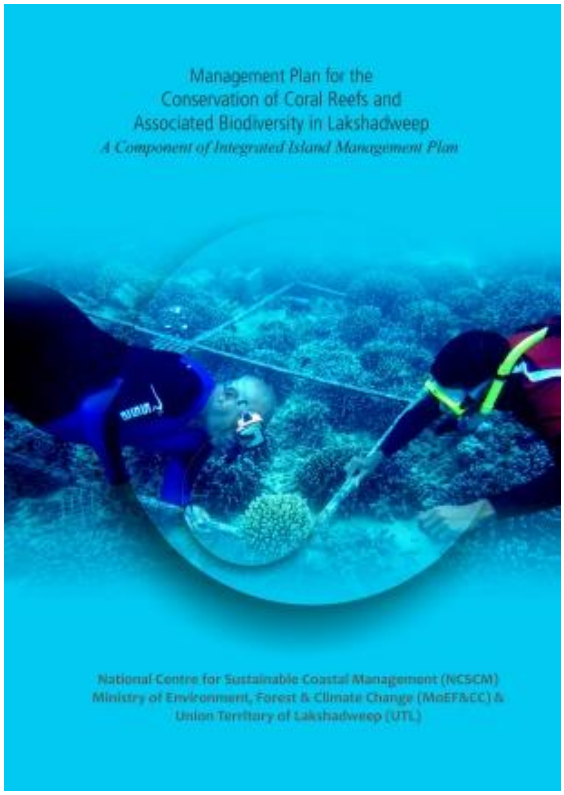
National Centre for Sustainable Coastal Management
Ministry of Environment, Forest & Climate Change
Koodal Building, Anna University Campus
Chennai - 600025

January 2017

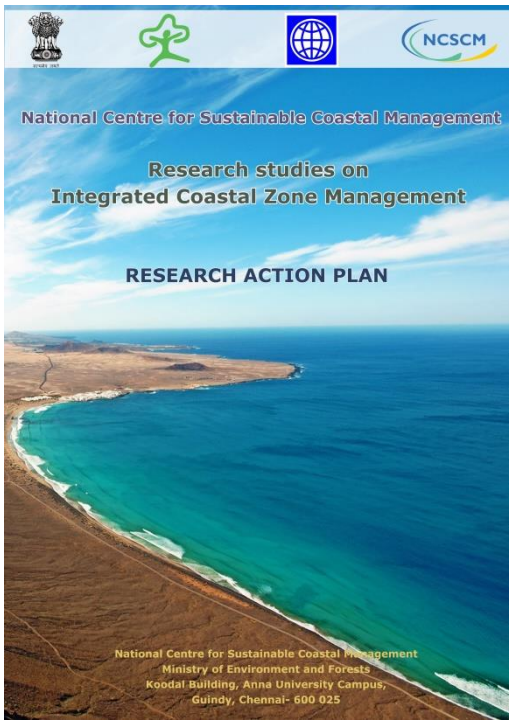
Sustainable Fisheries development plan for Lakshadweep

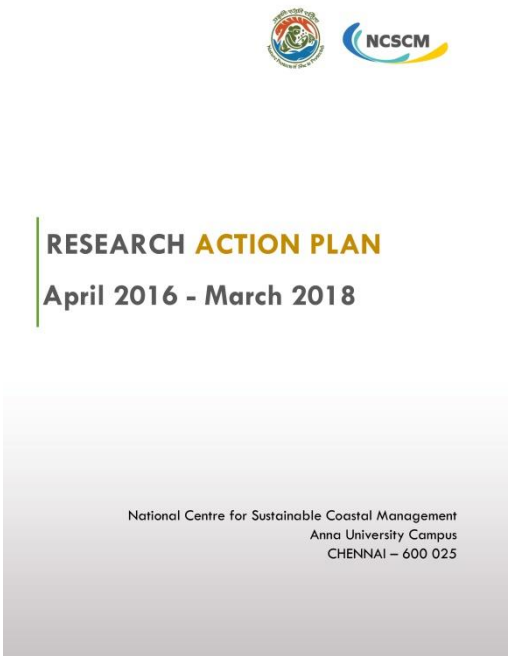


Conservation Management Plan for Lakshadweep

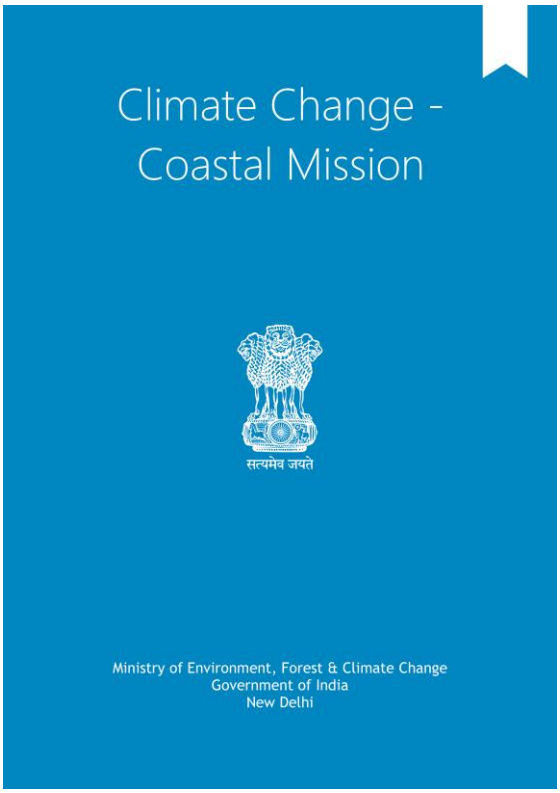


NCSCM - Research Action Plan

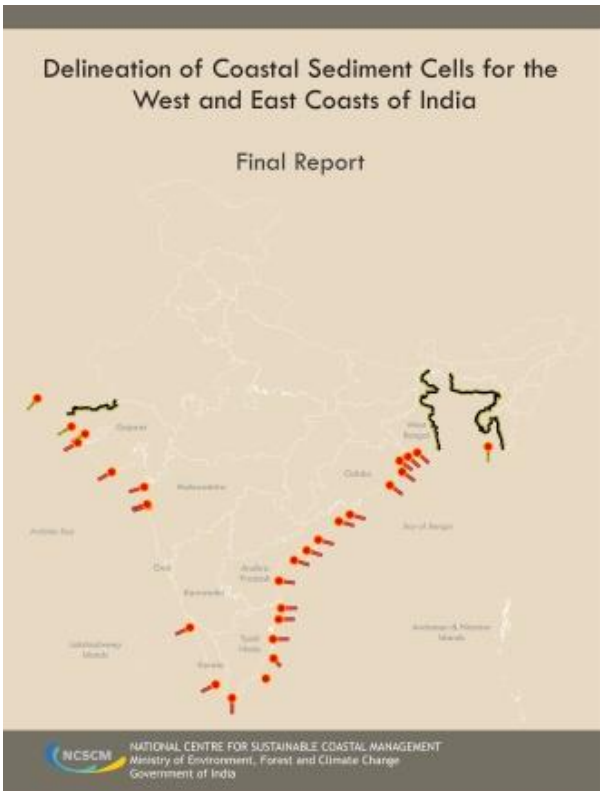




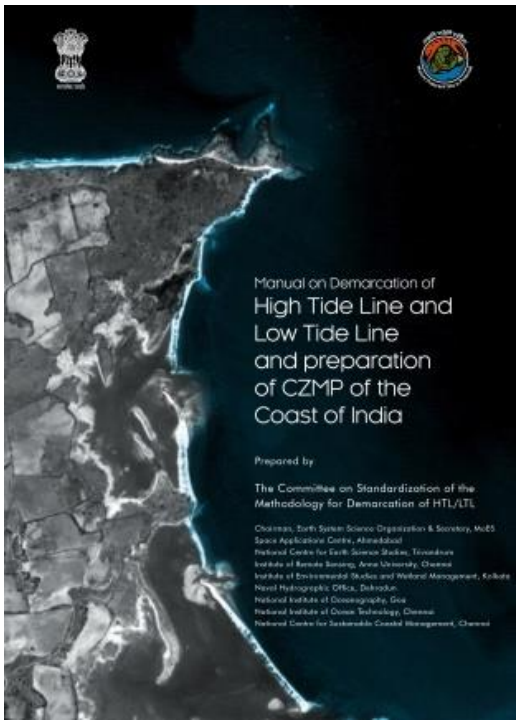
National Mission on Coast

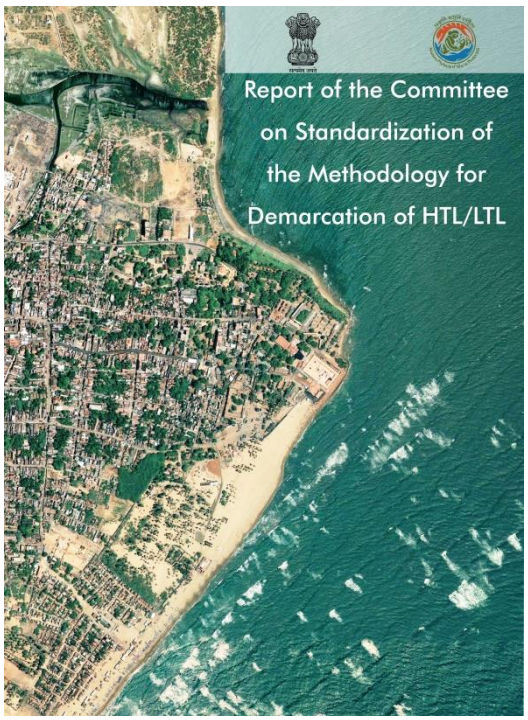


Sediment Cell Final Report

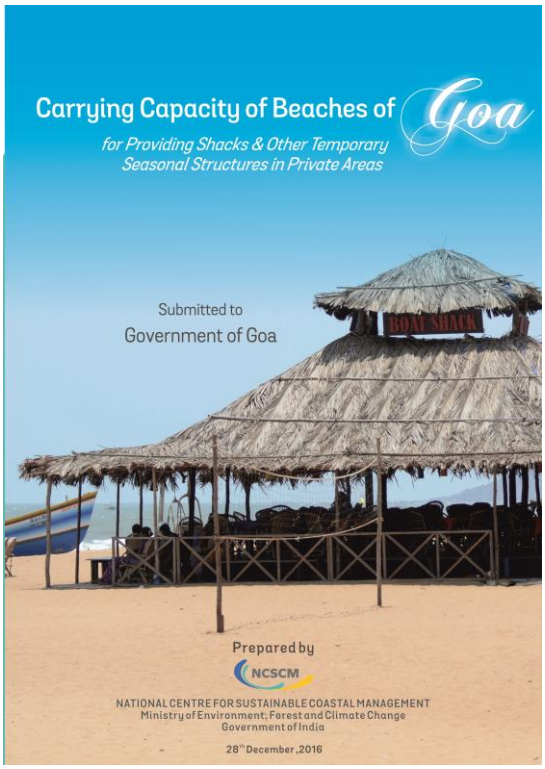


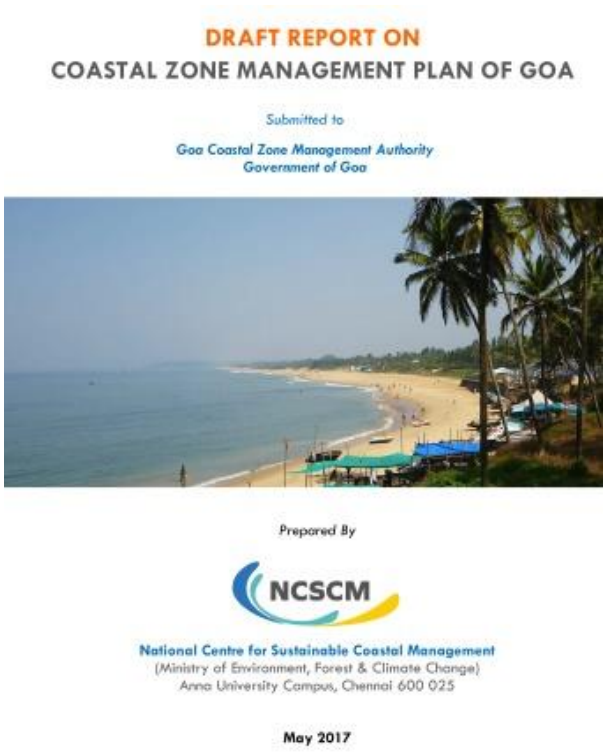
Manual on HTL & Report of the Committee on Standardization of the Methodology for Demarcation of HTL/LTL





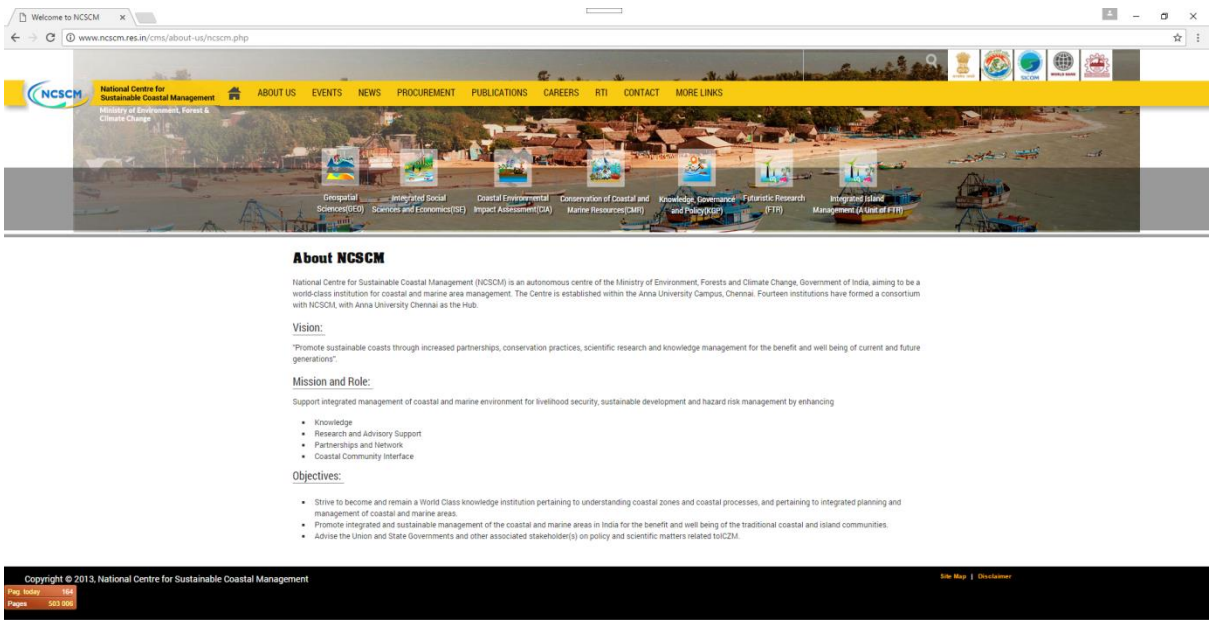
Carrying Capacity of Beaches of Goa for Providing Shacks & Other Temporary Seasonal Structures in Private Areas_Y 2016 & CZMP Report of Goa



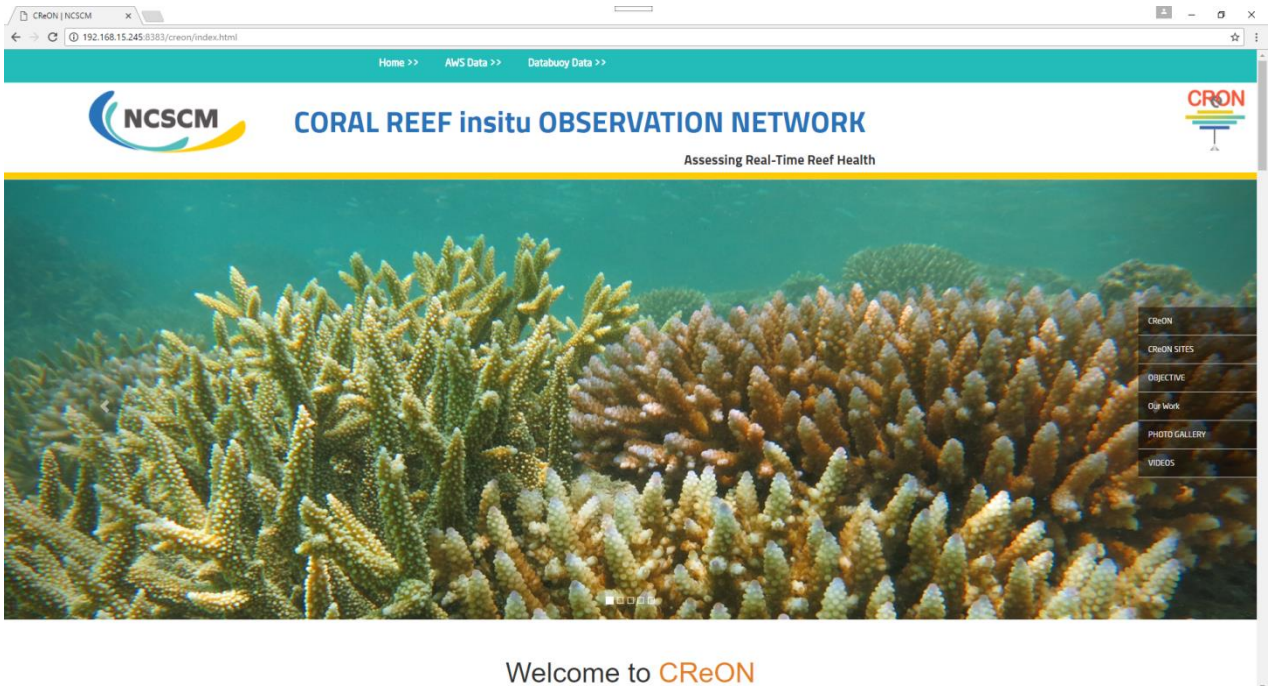


Environmental Management and Monitoring Plan (EMMP) and Oil Spill Report for Kamarajar Port (KPL) - Y 2017

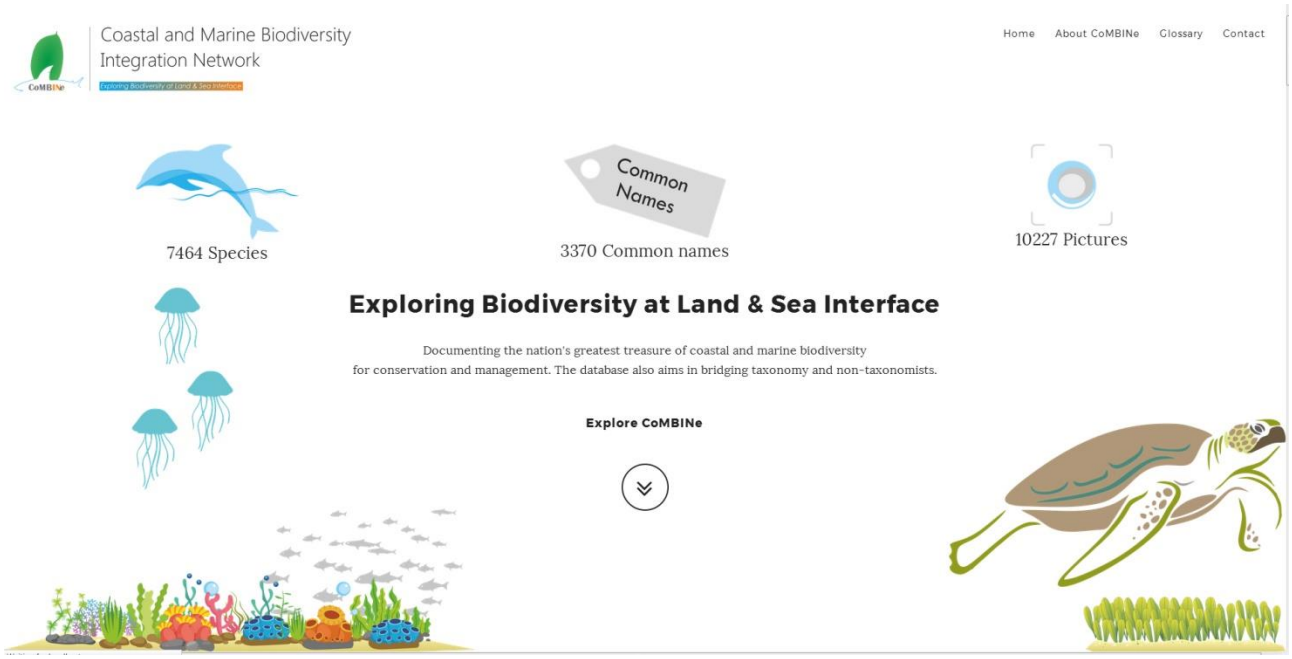
NCSCM Website



CReON Website



CoMBINe Website



(f) Atlas

National Assessment of Shoreline Change: Tamil Nadu

National Assessment of Shoreline Change: Kerala

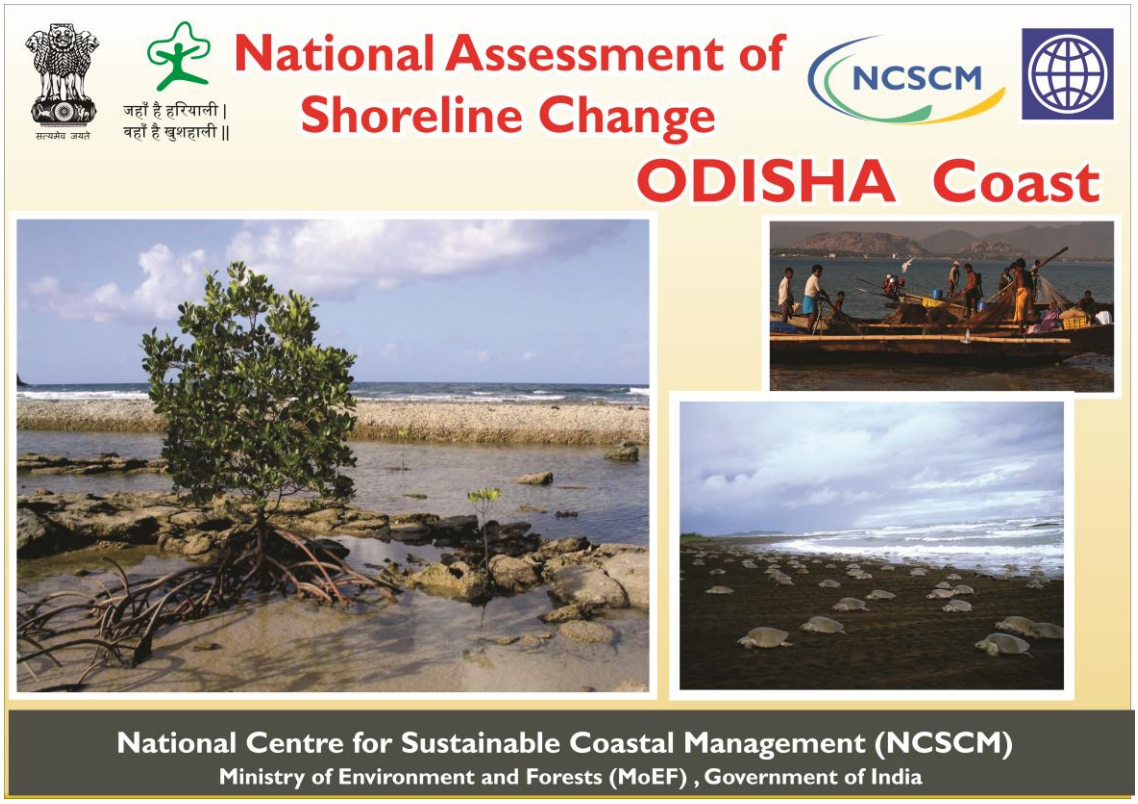
National Assessment of Shoreline Change_Karnataka

National Assessment of Shoreline Change: West Bengal

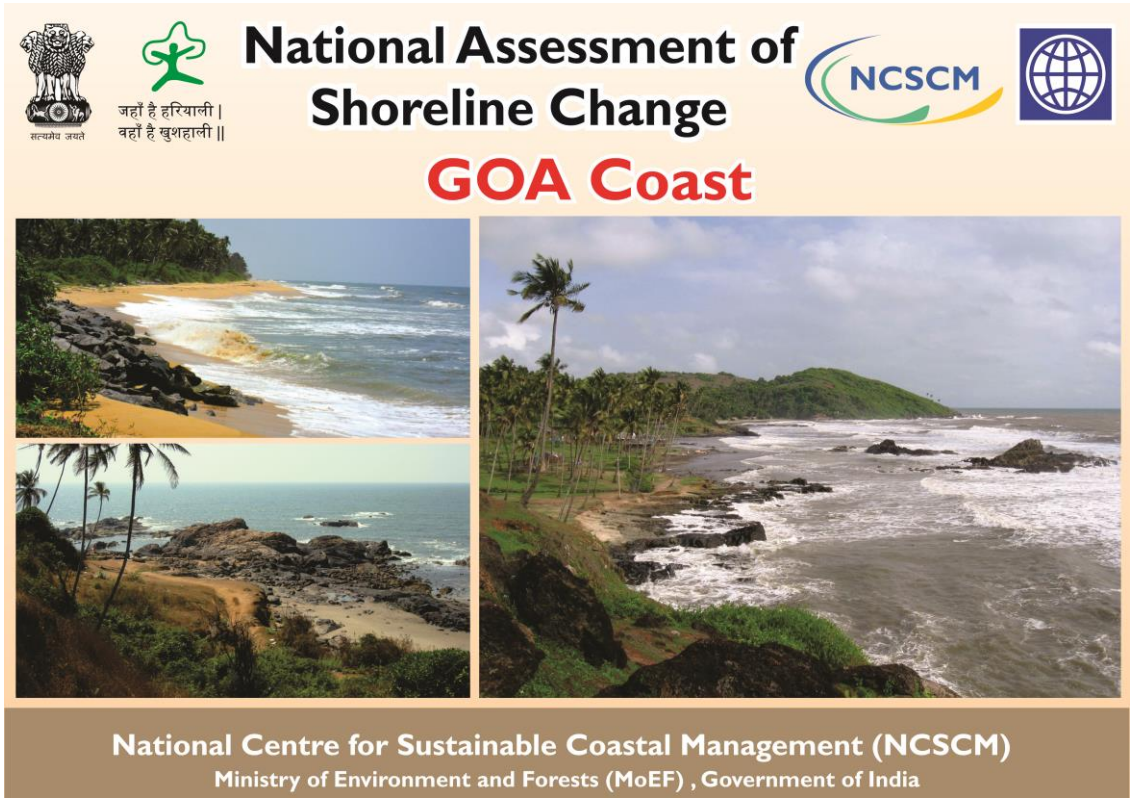
National Assessment of Shoreline Change: Andhra Prasesh

National Assessment of Shoreline Change: Gujarat

National Assessment of Shoreline Change: Odisha

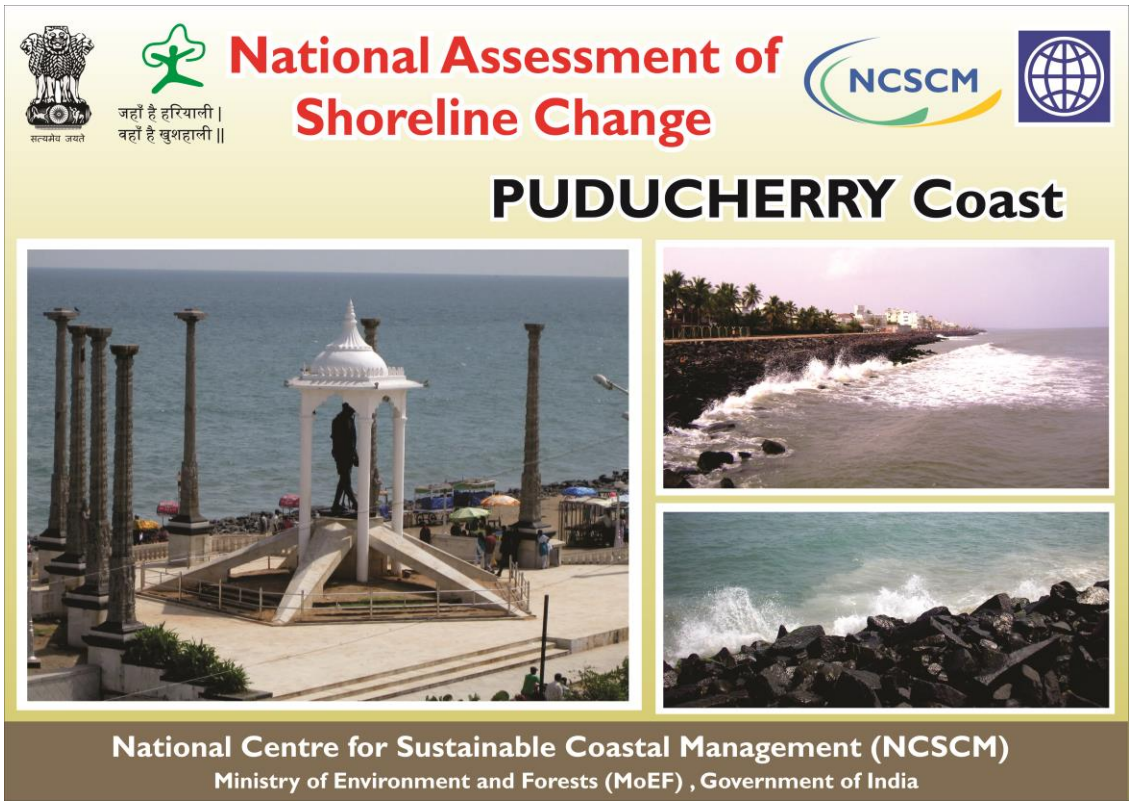


National Assessment of Shoreline Change: Goa

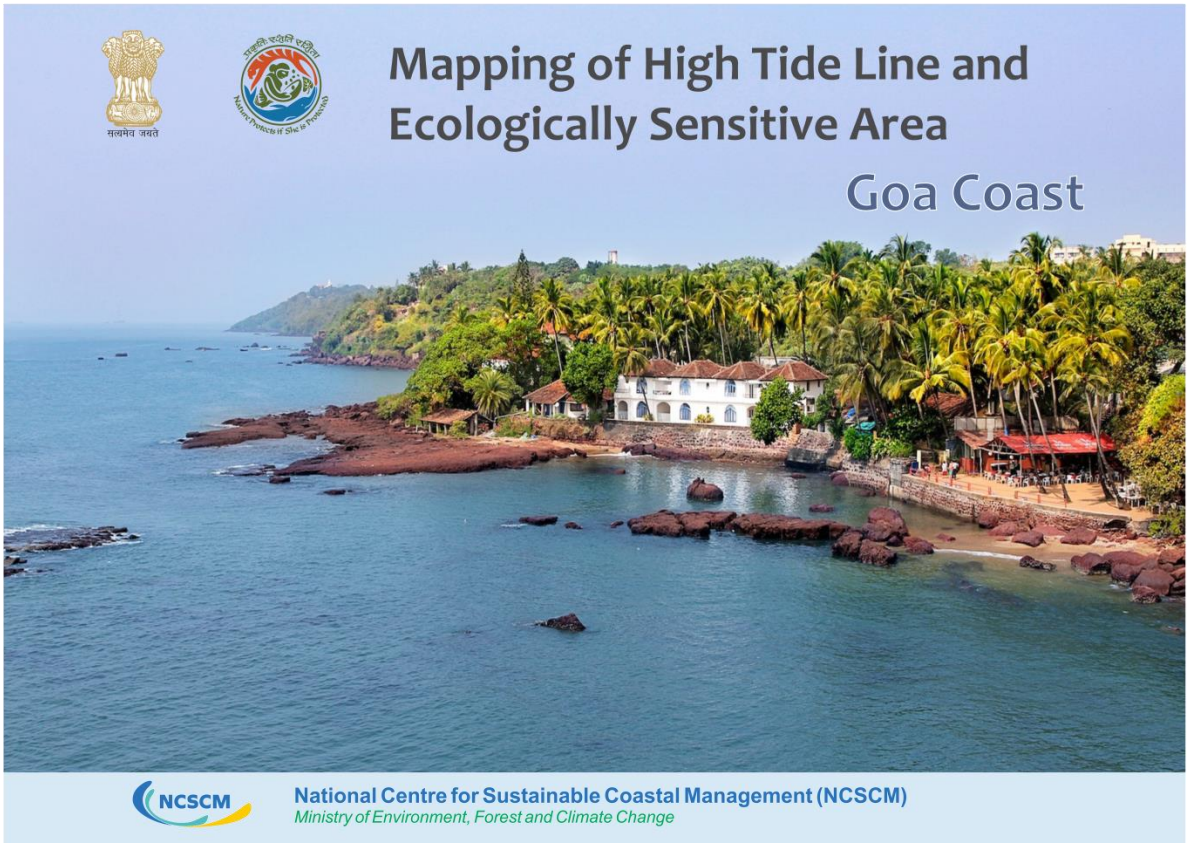


National Assessment of Shoreline Change: Maharashtra

National Assessment of Shoreline Change: Puducherry

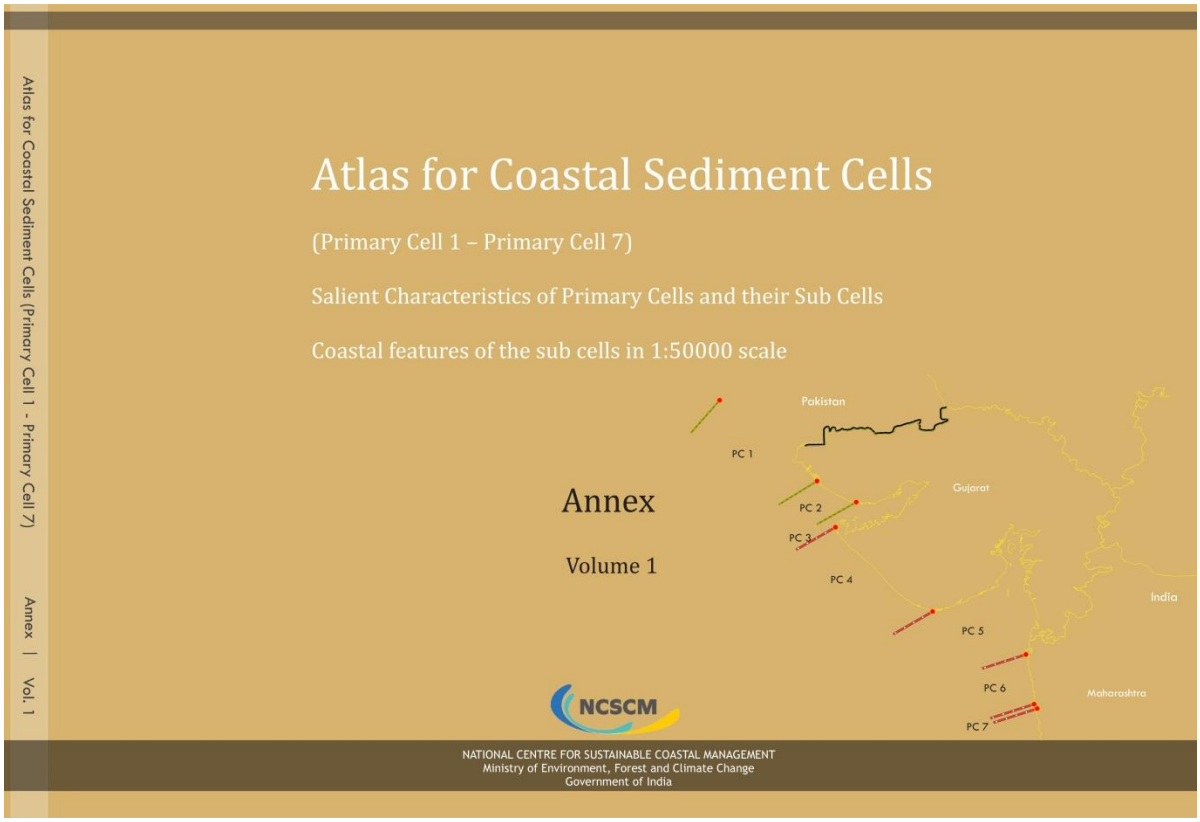


Mapping of High Tide Line & ESA: Goa

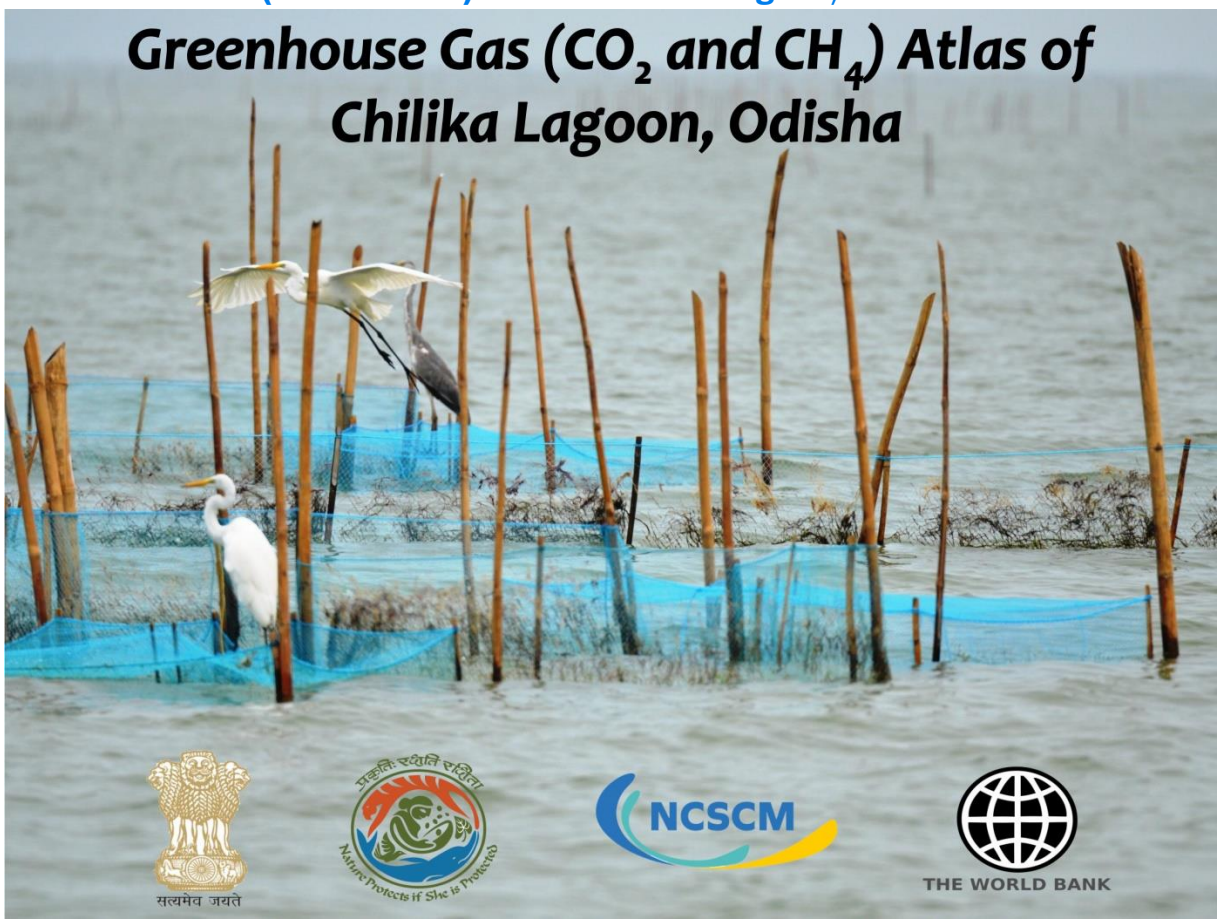


Potentials of Offshore Wind Energy for the coast of Tamil Nadu

Sediment Cell



Greenhouse Gas (CO_2 and CH_4) Atlas of Chilika Lagoon, Odisha



Coastal Zone Management Plan of Goa

Assessment of High Resolution Shoreline Change of Goa

16 ICZM Phase II

Under the proposed Coastal Mission project of the Ministry of Environment, Forest and Climate Change, the following key studies are proposed.

a) Scientifically map the cumulative vulnerability of coastal environment to climate change and consequent threats to ecology, lives and livelihoods
b) Develop vulnerability- based environment & adaptive management plans for key sectors
    - Mainstream climate sensitivity and readiness into all coastal developmental projects
    - Promote development taking into account the threats due to natural hazards in the coastal areas and SLR
c) Build resilience of coastal communities (e.g. fishers, agriculture etc.), infrastructure and settlements (urban and rural)
d) Conserve and protect coastal stretches, its unique environment and its marine area by enhancing mitigation (e.g. Blue carbon)
e) Build institutional capacity (sector-wise & community)

Under the scenario of coastal vulnerability and climate change the following issues need immediate attention:

(a) Stringent restrictions on infrastructure development

As per 2011 census, there are 403 census towns with population of more than 45 million people all along the 78 coastal districts of India (includes state & UT's). Growth of these towns lead to unrestricting growth on infrastructure development includes housing, transport etc. The growth in the coastal region need to be rationalized holistically, by implementing scientific methods, adopting socio-economic indices and involving the

community to understand the existing problems. After accurate study of these properties, an amendment of legal provisions has to be implemented.

Benefits and Outcome: With increased pressure in coastal region, geospatial planning will ensure that the various sectoral activities are managed in an integrated manner so that they promote sustainable development. The amendment is to protect the society by providing safe housing for more than 5 crore population; improve transportation (includes Roads, Railways) with connectivity of major harbours and ports; and development of integrated water transport systems. To accomplish these criteria minimum 3 to 5 years' timeline is needed.

(b) Promoting tourism

Coastal areas play a vital role in serving both as rich and highly fragile ecosystem (consisting a wide range of biodiversity ranging from corals to mangroves and the marine life) and are engines promoting growth (developmental activities, tourism and population situated on the coast). Tourism in coastal areas has been increasing and is a major contributor to the economy of these areas. However, in most of the places, the coastal ecosystem is at a risk due to massive influx of tourists, related activities coupled with poor infrastructure. Damage to the marine environment could be minimized by promoting sustainable means of growth, though carrying capacity studies, promoting localised area planning promoting eco-tourism (consisting of appropriate measures for construction & developmental activities, sewage and solid waste disposal), proposing guidelines for management of activities in the coastal areas.

Benefits and Outcome: Promotion of tourism in the coastal areas would boost the economic growth of this service sector, thus contributing to the growth of local cottage industries, fishermen communities by involving and promoting their culture and traditional practices as a component under tourism. Sustainable use of coastal areas for tourism activities would further keep these activities sustainable and resilient keeping in view the changing climatic factors of the modern world. Some of the major outcomes which could be done in phases:

- Promoting sustainable growth in the identified beach stretches, offshore islands
- Increase in employment generation – benefitting 4 lakh people in 3-5years
- Promoting growth for improving the livelihood for local communities
- Promoting resilient and sustainable growth, thus increasing the means to adapt to the changing climatic conditions.
- Increase in revenue from tourism sector – estimated contribution of 1.48 lakh crore rupees in 5 years (by 2024).

(c) Climate change and sea level rise

Climate change and sea level rise will be dealt with by incorporating disaster management plans furnished with various adaptation and mitigation interventions. Vulnerable areas along the coastline will be identified considering the geomorphological features and various climate change scenarios.

Benefits and Outcome: Successful implementation will ensure protection of coastal communities from cyclones, storm surges, coastal floods etc. for 19.8 crore population in 78 coastal districts along the Indian Coast. Conservation and restoration of coastal wetlands (e.g. mangroves) through science based policies will support in reducing floods, slowing down erosion, defending against cyclones, providing, natural habitat and sustainable fisheries. This will safeguard the coastal developments and cause its growth more sustainable against projected climate change and sea level rise. Additionally, the study will be useful in green belt development necessary for industrial development in the coastal environment and climate change mitigation through blue carbon sequestration.

NCSCM Team

Scientists

Dr. Ramesh R
Director

Dr. Purvaja Ramachandran
Scientist G & Division Chair

Dr. Rajakumari S
Scientist E

Dr. Asir Ramesh D
Scientist E

Dr. Sridhar R
Scientist E

Dr. Gejo Anna G
Scientist D

Dr. Deepak Samuel V
Scientist D

Dr. Badarees K O
Scientist D

Dr. Gurmeet Singh
Scientist C

Dr. Robin R.S.
Scientist C

Dr. Dipnarayan Ganguly
Scientist C

Dr. Abhilash KR
Scientist C

Mr. Muruganandam R
Scientist C

Dr. Debasis Tudu
Scientist C

Ms. Yogeshwari S
Scientist C

Dr. Sachithanandam V
Scientist C

Dr. Sreeraj C R
Scientist C

Dr. Mary Diviya Suganya G
Scientist C

Dr. Sarunjith KJ
Scientist B

Dr. Paneer Selvam A
Scientist B

Ms. Madhumitha R
Scientist B

Dr. Kakolee Banerjee
Scientist B

Dr. Sankar R
Scientist B

Dr. Mageswaran T
Scientist B

Dr. Priya P
Scientist B

Dr. Deepika B
Scientist B

Mr. Manik Mahapatra
Scientist B

Administration Staff

Mr. Ananda Kumar KG
Manager(Admin/HR)

Mr. Alok Ranjan Samal
Manager(Finance/Accounts)

Ms. Nithya S
System Administrator

Ms. Mary Premila L
Stenographer

Mr. Rajesh U
Office Assistant cum Driver

Technical Staff

Mr. Sathishkumar S
Applications Engineer

Ms. Ramya Sivagnanam
Junior Application Engineer

Mr. Madhava Rao Chennupati
Junior Software Engineer

Ms. Rosy Siji AG
Data Entry Operator [D]

Ms. Jayasri Priya M
Data Entry Operator [D]

Mr. Issac Rajan J
Field Assistant

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Chartered Accountant
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Anna Nagar, Chennai - 600 040.
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Mobile : 98401 49391

To
The Director
National Centre for Sustainable Coastal Management
Anna University Campus
Guindy
Chennai-600025

Dt: 10.03.2018

Dear Sir,

Sub: Statutory Audit for FY: 2015-16 & FY: 2016-17 - Management Letter

In connection with our audit of the financial statements of the NCSCM Project for the Year ended 31st March 2016 & 2017, we have familiarized ourselves with Project documents, the internal guidelines & circulars applicable during the period under audit. We also reviewed the business of the Project and evaluated the accounting systems and related internal controls of the Project in order to plan and perform our audit.

This letter to Project Management includes observations noted during the course of our audit examination in the following areas:

- Opportunities for strengthening financial management records, systems and controls, together with recommendations for improvement :-

  i) Lack of presence of Internal Audit Department:
  The direct and ultimate responsibility for internal control always lies with management. The presence of Internal Audit Department will help in monitoring the effectiveness of the existing internal control processes and also newly introduced processes on a **regular and continuous basis** established by management which will help in **accomplishing its objectives** by bringing a systematic, disciplined approach to evaluate and improve the effectiveness of **risk management, control and governance processes**. Since NCSCM activity is growing at a very good pace, introduction an Internal Audit Department becomes essential and needful.

  ii) Advances to Partner Institutions:
  The management has promised to finalize the reports sent by KIIT after scrutinizing the expense statement sent by them. This advance is to be squared off as early as possible since it is overdue as on date.

  iii) Settlement of Staff Advances (TA/DA &Contingency):
  We would like to suggest for an introduction of a **policy** for settling of the advances made to various research and other personnel for their field trip visits. The advances given to employees is required to be settled before **a affixed deadline** (for ex: employees should submit appropriate vouchers/bills "within 7 days of completion of field visit" / "end of the financial year" whichever is earlier). This shall ensure the timely closure of the advances given by NCSCM to employees and also avoiding mishandling/misuse of organization funds in the hands of employees.

  iv) Delay in Revenue Recognitiion of Projects undertaken by NCSCM:
  Requirement of a **dedicated mechanism** for timely completion of Projects undertaken by NCSCM before the applicable deadline as decided in the first instance in the contract/agreement in order to avoid the delay for the following reasons:-
  a) The recognition of Revenue in P&L a/c is not delayed/deferred to next financial year.
  b) The creation of Corpus in Balance Sheet is not delayed/deferred.

  v) Existence of Contract extension agreement:
  During the course of audit, it has been observed that few contracts are still continued without existence of appropriate Contract extension agreement. Hence, we thereby suggest that steps to be taken to retrospectively enter into contract extension agreement for the aforesaid issue and proper measures to be placed to avoid such anomalies in the future.

K. RAMANAN & CO. K. RAMANAN M. No. 19177 AH-46, SHANTHI COLONY CHENNAI-40 Chartered Accountants

vi) Unreconciled Deposits by Staff:
The numerous cash deposits made by staff over a period of time directly into the bank a/c of NCSCM amounting to Rs. 1,25,076/- for "settlement of balances of TA/DA or Contingency advances"
is unable to be traced and adjusted to respective individual staff advance a/c due to unavailability of data (employee name, project against which remaining balance of advance sanctioned earlier is deposited)for tracing the particulars of each deposit made so far.

- Status of maintenance of Project books and records : Maintained upto date.
- Accuracy of Project financial statements : Satisfactory
- Compliance with prescribed Procurement procedures : Satisfactory
- Status of prior audit recommendations :-
  i) The proceeds relating to an Insurance claim lodged w.r.t to an asset (Wave Rider Buoy) which was lost during the field trip visit has not been received. Since the claim proceeds receivable forms a significant and material value, appropriate steps and measures should be taken at the **earliest** in order to make the claim tenable.
  ii) The requirement for maintenance of an Asset Movement Register reported earlier is now successfully fulfilled.
  iii) The detailed reconciliation of Advances to Staff for "TA/DA" / "Contingency" as required to be complied in previous audit report is now fulfilled with few exceptions. The credit balances in staff a/c has been now nullified in books by transferring to appropriate debit balances.

The matters contained in this Management Letter are intended solely for the information of The Project Management, for such timely consideration and action as Project Management may deem appropriate. They have all been considered by us in formulating the audit opinion expressed on the project financial statements in our audit report dated: 10.03.2018 and they do not alter the opinion expressed in that audit report.
We wish to take this opportunity to thank Project Management for the courtesy and cooperation extended to us in the course of audit.

Yours Faithfully

K. RAMANAN & CO. K. RAMANAN M. No. 019177 AH - 46, SHANTHI COLONY CHENNAI - 40 Chartered Accountants

CA.K.RAMANAN
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For K.Ramanan & Co
Chartered
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FRN No. 02926S

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AH - 46, Shanthi Colony
Anna Nagar, Chennai - 600 040.
E-mail : kramanan1949@gmail.com
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Office : 044-2621 5936
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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 2017, 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

K. RAMANAN & CO. K. RAMANAN AH-46, SHANTHI COLONY CHENNAI-40 Chartered Accountants

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, 2017;

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 : 10/03/2018

NATIONAL CENTRE FOR SUSTAINABLE COASTAL MANAGEMENT

Annexure to the Balance Sheet as on March 31st,2017

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

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

K. RAMANAN & CO. K. RAMANAN M. No. 019177 AH - 46, SHANTHI COLONY CHENNAI - 40 Chartered Accountants

(CA.K.Ramanan)
Proprietor
Place: Chennai
Date : 10.03.2018

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

NATIONAL CENTER FOR SUSTAINABLE COSATAL 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, 2017

(in Rs.)

RECEIPTS	AMOUNT	PAYMENTS	AMOUNT
Opening Balance		Deposits (Asset)	2,000.00
Bank Accounts	3,58,42,744.89	TDS REFUND TO KAKOLEE	7,374.00
Cash in hand	10,000.00	PF	20,000.00
		Provisions	30,942.00
GSLI	240.00	TDS PAYABLE - STAFF	49,072.00
NPS	589.00	Sundry Debtors	69,314.00
Other Grant IN AD-SP-2	1,508.00	Performance Guarantee	2,57,525.00
NPMU -SB Interest	1,727.00	EPF	3,28,831.00
Car Advance.	2,800.00	VAT TDS	5,84,472.00
GPF Advance	22,800.00	REVENUE ACTIVITY	9,00,111.00
Retention Money- Ensysy Tech	29,165.00	Bid Security	20,01,197.00
GPF	30,000.00	DEPOSIT WITH CMDA	25,92,000.00
Professional Tax	31,596.00	Sundry Creditors	68,78,789.00
Unpaid Amount	59,868.00	ADVANCE FOR ESA	1,95,15,245.00
NOTICE PAY	1,01,000.00	INVESTMENT COST	19,63,566.00
EPF - PROJECT STAFFS	1,23,308.00	Physical	34,69,22,726.20
Retention - Cold Room Eackon	1,74,213.00	Capacity Building & Projects	1,90,630.00
Retention Money - Goderj	2,43,810.00	Communication	1,59,542.00
LIQUDITITY DAMAGES	3,06,530.00	Operational Cost	9,72,85,248.12
EPF ARREAR - PROJECT STAFF	3,86,174.00	IT Equipments - B	3,78,475.00
TDS Payable - Others	5,02,358.00	IT Equipments - C	7,44,552.00
RETAINTION MONEY-ETA	12,92,953.00	Advertisement Charges	18,236.00
RETENTION MONEY (METEC DESIGN)	15,20,755.00	Other Grants in Project	11,638.00
Retention (Kewaunee)	17,78,031.00	SICOM-OVERHEAD-C-A	11,01,987.00
RETENTION MONEY-MACRO	18,50,660.00	SICOM-OVERHEAD-C-B	27,58,000.00
NCR RECOVERIES	19,18,239.00	SICOM-OVERHEAD-C-C	9,01,646.00
LABOUR CESS	21,85,740.00	Duties & Taxes	54,97,709.00
NPMU - Interest on FD	38,33,525.00	TAX CREDIT-C-A	12,90,839.00
TRUCK&DELTA	40,46,650.00	TAX CREDIT-C-B	35,70,637.00
Retention Money-Renaatus	67,60,438.00	Tax Credit-RD	8,910.00
ADVANCES	3,10,85,952.74	Truc & Delta	4,35,120.00
NPMU - Fund Received	55,35,00,000.00	Contingency Advance	18,121.00
ARREAR EPF FOR IHR -HARIHARAN G	15,960.00	Overhead Expense	19,77,362.00
Arrear EPF Recovery	23,237.00	Contingency Expenses	2,74,692.00
EPF	26,380.00	TA/DA Expenses	27,02,583.59
Fund Recived From Lakhsdweep Administration	25,43,686.00	Manpower Expenses	63,64,105.00
Wrong Deposit	27,958.00	Material Expenses	1,05,340.00
Sundry Creditors	4,41,302.00	TA ADV	2,16,210.00
Material Income	13,73,800.00	Project Management	1,55,94,847.00
Manpower Income	78,88,132.00	Advances to Institutes	18,33,059.00
TA/DA Income	32,16,596.00	Contingency Advances	48,530.00
Contingency Income	23,65,938.00	Imprest Account	35,451.00
NCSCM Overheads	22,03,745.00	FACILITIES & EQUIPMENTS-DELTA	7,47,285.00
IC Consultancy	24,01,324.00	UTILISATION OF FUND DELTA	14,65,085.00
PERFORMANCE SECURITY	3,44,000.00	UTILISATION OF FUND TRUC	6,30,157.00
NCSCM	1,09,74,982.00	DELTAS-TDS OTHERS	1,350.00
Sundry Debtors	6,62,61,352.00	TRUC-TDS OTHERS	1,350.00
Interest on Saving Bank A/c	34,65,126.33	ADVANCES	5,60,000.00
TA Advance	15,201.00	CONTINGENCY ADV	12,000.00
NPMU	1,50,68,765.00	SINDHUDURG- PROJECT-REV EXP	25,332.00
Imprest Account	20,060.00		
INTEREST ON GRANTS IN AID	33,821.00		
MOES-TRUC	509.00		
Provisions	11,205.00		
Loans & Advances (Asset)	1,70,750.00	**Closing Balance**	
TDS U/s-194C	494.00	Bank Accounts	23,89,92,505.05
Funds Received	15,44,000.00	Cash in Hand	
Total	**76,80,81,697.96**	**Total**	**76,80,81,697.96**

For National Centre for Sustainable Coastal Management

Director

Place: Chennai
Date : 10-03-2018

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
AH - 45, SHANTHI COLONY
CHENNAI - 40
Chartered Accountants

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

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, 2017

(In Rs

Particulars	Amount	Amount	Particulars	Amount	Amount
1. NCSCM		11,44,85,607.12	**1. NCSCM**		
Capacity Building & Projects	85,74,084.00		Grants in Aid	-	47,10,09,055.32
Communication	1,59,542.00				
Hazard & ESA Mapping	1,20,47,475.00				
Operational Cost	9,37,04,506.12				
2. TRUC & DELTA		21,26,292.00	**2. TRUC & DELTA**		
Utilisation of Fund Delta	14,80,610.00		Grants in Aid (DELTA)	-	22,27,895.00
Utilisation of Fund Truc	6,45,682.00		Grants in Aid (TRUC)	-	6,45,682.00
3. ESA & CVCA MAPPING			**3. ESA & CVCA MAPPING**		
Operational Cost	-	1,04,50,056.00	Grants in Aid		3,13,70,985.00
4. REVENUE ACTIVITY		60,68,827.59	**4. REVENUE ACTIVITY**		2,34,52,268.61
Advertisement Charges	18,236.00		Material Income	15,05,469.00	
TA/DA Expenses	4,23,032.59		Manpower Income	88,59,910.16	
Manpower Expenses	14,06,456.00		TA/DA Income	31,30,798.59	
Contingency Expenses	22,43,741.00		Contingency Income	26,21,898.00	
Overhead Expenses	19,77,362.00		NCSCM Overheads	14,95,673.00	
			IC Consultancy	23,26,904.53	
			IC RD	46,489.00	
			Interest on Savings A/c	34,65,126.33	
5. OTHER GRANTS IN AID		49,050.00	**5. OTHER GRANTS IN AID**		49,050.00
BANK CHARGES	63.00		Grants in Aid	49,050.00	
ADVERTISEMENT	25,269.00				
CONTINGENCY	10,492.00				
MANPOWER	13,226.00				
Excess of income over expenditure		**39,55,75,103.22**			
Total		**52,87,54,935.93**	**Total**		**52,87,54,935.93**

For National Centre for Sustainable Coastal Management

Dr. R.Ramesh
Director

Place: Chennai
Date : 10-03-2018

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

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

K. RAMANAN & CO. K. RAMANAN M. No. 019177 AH-46, SHANTHI COLONY CHENNAI-40 Chartered Accountants

K.Ramanan

(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 Balance Sheet as on 31st March 2017

(In Rs.)

Liabilities	Sch. No.	Amount	Assets	Sch. No.	Amount
Capital Account:-			**Fixed Assets:-**		
Corpus Fund	1	90,49,77,508.44	Investment Cost	-	5,01,17,012.00
			Physical	-	79,04,29,784.47
Current Liabilities:-			Project Management (ESA)	-	3,67,30,019.00
Provisions	-	14,888.00	Equipment (DELTA)	-	9,37,864.00
NCR Recoveries	-	28,65,857.00	Equipment (TRUC)	-	1,37,528.00
Perfomance Guarantee	2	10,53,365.00	IT Equipments (Revenue Activity)	-	11,23,027.00
Bid Security	-	2,73,803.00			
Income Recognition Deferred	3	9,30,70,232.60	**Investment:-**		
Duties & Taxes (Revenue)	-	77,50,237.62	Fixed Deposit (UBI)	-	3,80,375.00
Labour Cess	-	27,53,889.00			
MS Cholamandalam Tax Credit	-	44,920.00	**Current Assets:-**		
Notional Recoveries from Salary	4	5,84,926.00	Bank Accounts	13	23,89,92,505.05
Notice Pay	5	59,000.00	Tax Credit (Revenue Activity)	14	59,83,642.00
NPMU - Fund Received	6	14,70,72,865.85	Expense Recognition Deferred	15	82,71,052.50
Interest on MOES Funds (T&D)	-	2,81,243.00	SICOM New Delhi	-	6,073.00
Professional Tax	7	1,01,563.00	Sundry Debtors	16	3,10,67,961.00
Retention Money	-	2,36,55,521.00	Advances	17	3,19,26,917.26
SICOM Overhead	8	42,10,540.88	Deposit (NCSCM)	-	25,94,000.00
Sundry Creditors	9	19,04,693.00			
TDS Payable - Others	10	8,21,185.89			
TDS Payable - Staff	11	83,146.00			
Unreconciled Deposits from Staff	12	1,35,884.00			
VAT TDS	-	18,76,595.00			
MOES- DELTA	-	31,92,875.00			
MOES- TRUC	-	1,16,752.00			
Sindhudurg - Funds received	-	14,94,950.00			
Revenue Expenses Payable	-	2,60,000.00			
TDS Refund	-	41,319.00			
TOTAL		**1,19,86,97,760.28**	**TOTAL**		**1,19,86,97,760.28**

For National Centre for Sustainable Coastal Management

Director

Place: Chennai
Date : 10-03-2018

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

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

K. RAMANAN & CO
K. RAMANAN
M. No. 019177
AH - 46, SHANTHI COLONY
CHENNAI - 40
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

Schedules forming part of the accounts for the Year ended 31st March, 2017

Schedule-1 : Corpus Fund

Particulars	Amount
NCSCM	84,07,27,117.47
ESA & CVCA	3,67,30,019.00
TRUCK & DELTA	10,75,392.00
REVENUE ACTIVITY	2,64,44,979.97
OTHER GRANTS IN AID	-
TOTAL	**90,49,77,508.44**

Schedule-2 : Performance Guarantee/Security

Particulars	Amount
NCSCM	**7,09,365.00**
REVENUE ACTIVITY	3,44,000.00
TOTAL	**10,53,365.00**

Schedule-3 : Income Recognition Deferred (Revenue Activity)

Particulars	Amount
Material Income Deferred	73,81,398.96
Manpower Income Deferred	2,70,84,407.97
TA/DA Income Deferred	1,09,30,658.19
Contingency Income Deferred	2,27,98,982.96
NCSCM Overheads Deferred	1,22,01,041.00
IC Consultancy Deferred	1,26,73,743.52
TOTAL	**9,30,70,232.60**

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

Schedule-4 : Notional Recoveries from Salary

Particulars	Amount
NCSCM	5,06,556.00
REVENUE ACTIVITY	65,577.00
TRUC & DELTA	11,205.00
OTHER GRANTS IN AID	1,588.00
TOTAL	**5,84,926.00**

Schedule-5: Notice Pay

Particulars	Amount
NCSCM	18,000.00
REVENUE ACTIVITY	25,000.00
ESA	16,000.00
TOTAL	**59,000.00**

Schedule-6 : NPMU Fund Received

Particulars	Amount
NCSCM	16,01,62,631.37
ESA & CVCA	-1,30,89,765.52
TOTAL	**14,70,72,865.85**

Schedule-7 : Professional Tax

Particulars	Amount
NCSCM	93,473.00
TRUCK & DELTA	98.00
ESA & CVCA	7,992.00
TOTAL	**1,01,563.00**

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

Schedule-8 : SICOM Overheads

Particulars	Amount
SICOM-OVERHEAD-CTG-A	38,10,711.88
SICOM-OVERHEAD-CTG-B	2,01,600.00
SICOM-OVERHEAD-CTG-C	48,787.00
SICOM-OVERHEAD-RD	1,49,442.00
TOTAL	**42,10,540.88**

Schedule-9 : Sundry Creditors

Particulars	Amount
NCSCM	18,98,511.00
REVENUE ACTIVITY	1,419.00
TRUC & DELTA	4,763.00
TOTAL	**19,04,693.00**

Schedule-10 : TDS Payable - Others

Particulars	Current A/c Advance
NCSCM	8,27,882.89
ESA & CVCA	31,423.00
TRUC & DELTA	-3,153.00
OTHER GRANTS IN AID	494.00
REVENUE ACTIVITY	-35,461.00
TOTAL	**8,21,185.89**

Schedule-11 : TDS Payable - Staff

Particulars	Current A/c Advance
NCSCM	83,572.00
ESA & CVCA	434.00
REVENUE ACTIVITY	-860.00
TOTAL	**83,146.00**

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

Schedule-12 : Unreconciled Deposits from Staff

Particulars	Amount
NCSCM	1,07,926.00
REVENUE ACTIVITY	27,958.00
TOTAL	**1,35,884.00**

Schedule-13 : Bank Accounts

Particulars	Amount
NCSCM	14,97,23,936.00
ESA & CVCA	31,87,585.48
REVENUE ACTIVITY	8,51,15,381.57
TRUC & DELTA	18,440.00
OTHER GRANTS IN AID	9,47,162.00
TOTAL	**23,89,92,505.05**

Schedule-14 : Tax Credit (Revenue Activity)

Particulars	Amount
TAX CREDIT CLAIMED	7,50,796.00
TAX CREDIT DEFERRED	52,32,846.00
TOTAL	**59,83,642.00**

Schedule-15 : Expense Recognition Deferred (Revenue Activity)

Particulars	Amount
TA/DA Expense Deferred	29,65,044.50
Contingency Expense Deferred	7,84,568.00
Manpower Expense Deferred	44,16,100.00
Material Expense Deferred	1,05,340.00
TOTAL	**82,71,052.50**

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

Schedule-16 : Sundry Debtors

Particulars	Amount
NCSCM	73,211.00
REVENUE ACTIVITY	3,09,94,750.00
TOTAL	**3,10,67,961.00**

Schedule-17 : Advances

Particulars	Amount
NCSCM	2,78,90,515.26
ESA & CVCA	32,26,293.00
REVENUE ACTIVITY	2,50,110.00
TRUC & DELTA	-1.00
OTHER GRANTS IN AID	5,60,000.00
TOTAL	**3,19,26,917.26**

Note:- The Balance Sheet is prepared without considering the balances of Inter Project Receivables & Payables.

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

NATIONAL CENTER FOR SUSTAINABLE COSATAL MANAGEMENT

ANNA UNIVERSITY CAMPUS

GUINDY

CHENNAI - 600025

Receipts and Payments Account for the year ended on March 31st, 2017

(In Rs.)

RECEIPTS	AMOUNT	PAYMENTS	AMOUNT
Opening Balance			
Bank Accounts	1,25,49,343.58	Deposits (Asset)	2,000.00
		TDS REFUND TO KAKOLEE	7,374.00
GSLI	240.00	PF	20,000.00
NPS	589.00	Provisions	21,213.00
Other Grant IN AD-SP-2	1,508.00	TDS PAYABLE - STAFF	49,072.00
NPMU -SB Interest	1,727.00	Sundry Debtors	69,314.00
Car Advance	2,800.00	Performance Guarantee	2,57,525.00
GPF Advance	22,800.00	EPF	3,28,831.00
Retention Money- Ensysy Tech	29,165.00	VAT TDS	5,84,472.00
GPF	30,000.00	REVENUE ACTIVITY	9,00,111.00
Professional Tax	31,596.00	Bid Security	20,01,197.00
Unpaid Amount	59,868.00	DEPOSIT WITH CMDA	25,92,000.00
NOTICE PAY	76,000.00	Sundry Creditors	68,78,789.00
EPF - PROJECT STAFFS	1,23,308.00	ADVANCE FOR ESA	1,95,15,245.00
Retention - Cold Room Eackon	1,74,213.00	Imprest Account	35,451.00
Retention Money - Goderj	2,43,810.00	INVESTMENT COST	19,63,566.00
LIQUDITITY DAMAGES	3,06,530.00	Physical	34,69,22,726.20
EPF ARREAR - PROJECT STAFF	3,86,174.00	Capacity Building & Projects	1,90,630.00
TDS Payable - Others	5,02,358.00	Communication	1,59,542.00
RETAINTION MONEY-ETA	12,92,953.00	Operational Cost	9,21,12,039.12
RETENTION MONEY (METEC DESIGN)	15,20,755.00		
Retention (Kewaunee)	17,78,031.00		
RETENTION MONEY-MACRO	18,50,660.00		
NCR RECOVERIES	19,18,239.00		
LABOUR CESS	21,85,740.00		
NPMU - Interest on FD	38,33,525.00		
Imprest Account	20,060.00		
TRUCK&DELTA	40,46,650.00		
Retention Money-Renaatus	67,60,438.00		
ADVANCES	3,10,85,952.74	**Closing Balance**	
NPMU - Fund Received	55,35,00,000.00	Bank Accounts	14,97,23,936.00
Total	**62,43,35,033.32**	**Total**	**62,43,35,033.32**

For National Centre for Sustainable Coastal Management

Director

Place: Chennai
Date : 10-03-2018

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

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

K. RAMANAN & CO. K. RAMANAN M. No. 019177 AH-46, SHANTHI COLONY CHENNAI 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

Income and Expenditure Statement for the year ended 31st March,2017

(In Rs.

Particulars	Amount	Amount	Particulars	Amount	Amount
Indirect Expenses		**11,44,85,607.12**	**Indirect Incomes**		**47,10,09,055.32**
Capacity Building & Projects	85,74,084.00				
Communication	1,59,542.00		Grants in Aid	**47,10,09,055.32**	
Hazard & ESA Mapping	1,20,47,475.00				
Operational Cost	9,37,04,506.12				
Excess of income over expenditure		**35,65,23,448.20**			
Total		**47,10,09,055.32**	**Total**		**47,10,09,055.32**

For National Centre for Sustainable Coastal Management

Director

Place: Chennai
Date : 10-03-2018

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

K. RAMANAN & CO.
K. RAMANAN
M. No. 019177
AH - 46, SHANTHI COLONY
CHENNAI - 40
Chartered Accountants

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

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

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, 2017

(In Rs.)

Liabilities	Sch. No.	Amount	Assets	Sch. No.	Amount
Capital Account:-			**Fixed Assets:-**		
Corpus Fund	1	84,07,27,117.47	Investment Cost	4	5,01,17,012.00
			Physical	5	79,04,29,784.47
Current Liabilities:-					
Sundry Creditors	-	18,98,511.00	**Investments:-**		
NCR Recoveries	2	28,65,857.00	Fixed Deposit - UBI	-	3,80,375.00
Performance Guarantee	3	7,09,365.00			
Bid Security	-	2,73,803.00	**Current Assets:-**		
Labour Cess	-	27,53,889.00	Advances	6	2,78,90,515.26
Notional Recovery from Salary	8	5,06,556.00	Bank Accounts	7	14,97,23,936.00
Notice Pay	-	18,000.00	SICOM New Delhi	-	6,073.00
NPMU - Fund Received	9	16,01,62,631.37	Deposit	-	25,94,000.00
Other Grants in Aid	-	1,508.00	Sundry Debtors	-	73,211.00
Professional Tax	-	93,473.00	Advance to ESA	-	1,94,47,795.00
Retention Money	10	2,36,55,521.00			
Revenue Activity	-	38,711.00			
TDS Payable - Others	-	8,27,882.89			
TDS PAYABLE - STAFF	-	83,572.00			
TDS Refund	-	41,319.00			
TRUC & DELTA	-	40,20,464.00			
Unreconcilied Deposits From Staff	-	1,07,926.00			
VAT TDS	-	18,76,595.00			
TOTAL		**1,04,06,62,701.73**	**TOTAL**		**1,04,06,62,701.73**

For National Centre for Sustainable Coastal Management

Director

Place: Chennai
Date : 10-03-2018

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

K. RAMANAN & CO. K. RAMANAN M. No. 019177 AH - 46, SHANTHI COLONY CHENNAI - 40 Chartered Accountants

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

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

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, 2017

Schedule-1 : Corpus Fund

Particulars	Amount
Opening Balance	48,42,03,669.27
Add: Excess of Income over Expenditure	35,65,23,448.20
Closing Balance	**84,07,27,117.47**

Schedule-2 : NCR Recoveries

Particulars	Amount
CIVIL Works	12,58,926.00
HVAC Works	6,48,926.00
Macro	9,58,005.00
TOTAL	**28,65,857.00**

Schedule-3 : 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
SWAN ENVIRONMENT PVT LTD	41,632.00
Universal Technologies	36,774.00
TOTAL	**7,09,365.00**

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

Schedule-4 : Investment Cost

Particulars	Amount
COMPUTERS & SYSTEMS	3,32,22,497.00
EQUIPMENTS & FACILITIES	44,25,695.00
CIVIL WORKS	1,00,79,461.00
FURNITURE & FITTINGS	14,79,653.00
VEHICLE	9,09,706.00
TOTAL	**5,01,17,012.00**

Schedule-5 : Physical

Particulars	Amount
CONSTRUCTION OF NEW BUILDING & FACILITIES	42,13,05,233.00
GOODS & EQUIPMENTS (SCIENTIFIC)	35,15,61,622.47
OFFICE& IT EQUIPMENTS	1,75,62,929.00
TOTAL	**79,04,29,784.47**

Schedule-6 : Advances

Particulars	Amount
ADVANCE TO CONTRACTOR	28,74,699.26
ADVANCE TO OTHER INSTITUTIONS	19,20,915.00
ADVANCE TO PARTNER INSTITUTIONS	16,63,386.00
CONTINGENCY ADVANCE	6,26,491.00
TA ADVANCE	4,46,178.00
Advances to Staff Others	-73,583.00
Advances to Staff TA	4,534.00
ADVANCE TO NRSC, HYDERABAD	2,03,36,909.00
DEPOSIT BY HARIHARAN G	6,000.00
Dr.Sarunjith Kj	7,500.00
GAYATRI AUTO SERVICE	37,035.00
Ramnathpuran Dist Central Co Bank	5,000.00
Imprest Account Employee	35,451.00
TOTAL	**2,78,90,515.26**

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

Schedule-7 : Bank Accounts

Particulars	Amount
UBI CURRENT A/C	-22,62,665.14
UBI SEDIMENT CELL SAVING A/C	22,403.94
STATE BANK OF INDIA	-4,12,802.80
FLEXI BALANCE	14,35,00,000.00
LC MARGIN	88,77,000.00
TOTAL	**14,97,23,936.00**

Schedule-8 : Notional Recovery from Salary

Particulars	Amount
EPF	4,63,437.00
GPF Advance	41,400.00
GSLI	120.00
NPS	5,199.00
PF	-5,000.00
Car Advance	1,400.00
TOTAL	**5,06,556.00**

Schedule-9 : NPMU Fund Received

Particulars	Amount
Opening Balance	7,37,81,816.69
Add: Fund received	55,35,00,000.00
Add: Interest on funds received during the year	38,33,525.00
Add: Savings Bank Interest	56,345.00
Less: Funds transferred as Grants in Aid	47,10,09,055.32
TOTAL	**16,01,62,631.37**

Schedule-10 : Retention Money

Particulars	Amount
ETA	18,21,546.00
Cold Room Eackon	1,74,213.00
Kewaunee	17,78,031.00
Ensysy Technologies	91,025.00
Godrej	2,43,810.00
Macro	18,50,660.00
Metec Design	15,20,755.00
Retention Money	1,61,75,481.00
TOTAL	**2,36,55,521.00**

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

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, 2017

(in Rs.)

RECEIPTS	AMOUNT	PAYMENTS	AMOUNT
Opening Balance			
Bank Accounts	6,28,132.48	Project Management	1,55,94,847.00
Cash-in-hand	10,000.00	Advances to Institutes	18,33,059.00
		Contingency Advances	48,530.00
NCSCM	1,01,24,861.00	Operational Cost	51,73,209.00
TA Advance	15,201.00	Provisions	9,729.00
NPMU	1,50,68,765.00		
		Closing Balance	
		Bank Accounts	31,87,585.48
Total	**2,58,46,959.48**	**Total**	**2,58,46,959.48**

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 : 10.03.2018

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

K. RAMANAN & CO.
K. RAMANAN
M. No. 019177
AH - 46, SHANTHI COLONY
CHENNAI - 40
Chartered Accountants

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

ESA&CVCA MAPPING

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

Income and Expenditure Statement for the year ended 31st March, 2017

(In Rs.)

Particulars	Schedule	Amount	Particulars	Schedule	Amount
Indirect Expenses			**Indirect Incomes**		
Operational Cost	6	3,240.00	Grants in Aid	-	1,50,00,000.00
Excess of income over expenditure		**1,49,96,760.00**			
Total		**1,50,00,000.00**	**Total**		**1,50,00,000.00**

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 : 10.03.2018

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

K. RAMANAN & CO.
K. RAMANAN
M. No. 019177
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CHENNAI - 40
Chartered Accountants

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

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, 2017

(In Rs.)

Liabilities	Sch. No.	Amount	Assets	Sch. No.	Amount
Capital Account:-			**Fixed Assets:-**		
Corpus Fund	1	3,08,05,850.00	Project Management	3	3,67,30,019.00
Current Liabilities:-			**Current Assets:-**		
Professional Tax	-	7,992.00	Advances to Institutes	4	31,78,160.00
NPMU Funds	2	-1,30,89,765.52	TA Advance	-	22,833.00
NCSCM	-	1,94,47,795.00	Contingency Advance	-	25,300.00
Notice Pay	-	16,000.00	Bank Accounts	5	31,87,585.48
TDS Others	-	31,423.00			
TDS Salary	-	434.00			
TOTAL		**3,72,19,728.48**	**TOTAL**		**4,31,43,897.48**

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 : 10.03.2018

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

K. RAMANAN & CO.
K. RAMANAN
M. No. 019177
AH - 46, SHANTHI COLONY
CHENNAI - 40
Chartered Accountants

(CA. K.Ramanan)
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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, 2017

Schedule-1 : Corpus Fund

Particulars	Amount
Opening Balance	1,58,09,090.00
Add: Excess of Income over Expenditure	1,49,96,760.00
TOTAL	**3,08,05,850.00**

Schedule-2 : NPMU Funds

Particulars	Amount
Opening Balance	32,09,156.48
Add: Funs received from SICOM	1,50,00,000.00
Add: Interest received from NPMU funds	72,063.00
Less: Expenses incurred during the year	3,13,70,985.00
TOTAL	**-1,30,89,765.52**

Schedule-3 : Project Management

Particulars	Amount
3G DONGLE	13,000.00
AIR CONDITIONERS	2,59,900.00
AUDIO CONFERENCING SYSTEM	30,500.00
CEPTOMETER	3,97,110.00
CIVIL WORKS	14,63,378.00
CORELDRAW GRAPHICS	1,29,000.00
DESKTOP COMPUTER	38,45,849.00
HP COLOUR LASER JET	22,03,724.00
HR SOFTWARE	13,48,320.00
JAVASCRIPT CHART SOFTWARE	17,558.00
LG 84 INCH DISPLAY	31,29,180.00
LPS IMAGE STATION	1,14,20,550.00
NAS STORAGE BOX	85,000.00
OTHER FACILITIES & EQUIPMENTS	1,51,580.00
PRIMER 7-SOFTWARE	1,12,998.00
SCANNER & PRINTER	13,067.00
SOFTWARES INCLUDING CUSTOMISATION	6,74,160.00
TABLETS	20,83,360.00
UNDER WATER CAMERA	32,000.00
UPS	98,685.00
WORK STATION COMPUTER	92,21,100.00
TOTAL	**3,67,30,019.00**

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

Schedule-4 : Advance to Institutes

Particulars	Amount
CEE AHEMADABAD	27,17,000.00
CMFRI KOCHI	3,17,162.00
IOM AU	1,00,000.00
KVFSU-BIDAR	1,27,429.00
WBUAFS KOLKATA	3,378.00
REGISTRAR IIS BANGALURE	-99,000.00
SACON-MAPPING KEY NESTING SITE	12,191.00
TOTAL	**31,78,160.00**

Schedule-5 : Bank Accounts

Particulars	Amount
FLEXI BALANCE	65,85,000.00
STATE BANK OF INDIA	-59,715.00
UNION BANK OF INDIA	-33,37,699.52
TOTAL	**31,87,585.48**

Schedule-6 : Operational Cost

Particulars	Amount
CONSUMABLES	14,08,425.00
PROJECT STAFF SALARY	27,04,298.00
TRAVEL BOARDING	12,09,484.00
CONSULTANCIES/STUDIES	33,69,899.00
IIMP LAKSHADWEEP	1,98,000.00
LAB CONSUMABLES	37,450.00
MEETING EXPENSES	10,205.00
OTHER OFFICE COST	54,748.00
PRINTING & STATIONERY	2,72,158.00
PROJECT CONSULTANT	-76,000.00
REPAIR & MAINTENANCE	3,240.00
Travel,Boarding & Accommodation	3,07,123.00
WATCH AND WARD & SECURITIES	9,48,826.00
WORKSHOPS/CONSULTANCIES	2,200.00
TOTAL	**1,04,50,056.00**

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

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, 2017

(in Rs.)

RECEIPTS	AMOUNT	PAYMENTS	AMOUNT
Opening Balance		IT Equipments - B	3,78,475.00
Bank Accounts	2,05,12,769.83	IT Equipments - C	7,44,552.00
		Advertisement Charges	18,236.00
ARREAR EPF FOR IHR -HARIHARAN G	15,960.00	Other Grants in Project	11,638.00
Arrear EPF Recovery	23,237.00	SICOM-OVERHEAD-C-A	11,01,987.00
EPF	26,380.00	SICOM-OVERHEAD-C-B	27,58,000.00
Fund Recived From Lakhsdweep Administration	25,43,686.00	SICOM-OVERHEAD-C-C	9,01,646.00
Notice Pay	25,000.00	Duties & Taxes	54,97,709.00
Wrong Deposit	27,958.00	TAX CREDIT-C-A	*12,90,839.00*
Sundry Creditors	1,419.00	TAX CREDIT-C-B	*35,70,637.00*
Material Income	13,73,800.00	Tax Credit-RD	*8,910.00*
Manpower Income	78,88,132.00	Truc & Delta	*4,35,120.00*
TA/DA Income	32,16,596.00	Contingency Advance	*18,121.00*
Contingency Income	23,65,938.00	Overhead Expense	*19,77,362.00*
NCSCM Overheads	22,03,745.00	Contingency Expenses	*2,74,692.00*
IC Consultancy	24,01,324.00	TA/DA Expenses	*27,02,583.59*
PERFORMANCE SECURITY	3,44,000.00	Manpower Expenses	*63,64,105.00*
NCSCM	7,95,121.00	Material Expenses	*1,05,340.00*
Sundry Debtors	6,62,61,352.00	TA ADV	*2,16,210.00*
Interest on Saving Bank A/c	34,65,126.33		
		Closing Balance	
		Bank Accounts	8,51,15,381.57
Total	**11,34,91,544.16**	**Total**	**11,34,91,544.16**

For National Centre for Sustainable Coastal Management

Director

Place: Chennai
Date : 10-03-2018

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

K. RAMANAN & CO. K. RAMANAN M. No. 019177 AH-46, SHANTHI COLONY CHENNAI-10 Chartered Accountants

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

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

NCSCM REVENUE ACTIVITY

NATIONAL CENTER FOR SUSTAINABLE COSATAL MANAGEMENT

MINISTRY OF ENVIRONMENT, FOREST & CLIMATE CHANGE

ANNA UNIVERSITY CAMPUS

GUINDY

CHENNAI-600025

Income and Expenditure Statement for the year ended 31st March, 2017

Particulars	Amount	Particulars	Amount
Advertisement Charges	18,236.00	Material Income	15,05,469.00
TA/DA Expenses	4,23,032.59	Manpower Income	88,59,910.16
Manpower Expenses	14,06,456.00	TA/DA Income	31,30,798.59
Contingency Expenses	22,43,741.00	Contingency Income	26,21,898.00
Overhead Expenses	19,77,362.00	NCSCM Overheads	14,95,673.00
		IC Consultancy	23,26,904.53
		IC RD	46,489.00
Excess of income over expenditure	**1,73,83,441.02**	Interest on Savings A/c	34,65,126.33
Total	**2,34,52,268.61**	**Total**	**2,34,52,268.61**

For National Centre for Sustainable Coastal Management

Director

Place: Chennai
Date : 10-03-2018

As per the Audit Report of even date attached
For K.Rama
Chartered Accou

K. RAMANAN & CO.
K. RAMANAN
M. No. 019177
AH - 46, SHANTHI COLONY
CHENNAI - 40
Chartered Accountants

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

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

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, 2017

(In Rs.)

Liabilities	Sch. No.	Amount	Assets	Sch. No.	Amount
Capital Account			**Fixed Assets**		
Corpus Fund	1	2,64,44,979.97	IT equipments	10	11,23,027.00
Current Liabilities			**Current Assets**		
Duties & Taxes	2	77,50,237.62	Sundry Debtors	11	3,09,94,750.00
Provisions	-	14,888.00	Bank Accounts	12	8,51,15,381.57
Sundry Creditors	-	1,419.00	Contingency Advance	13	1,30,460.00
Material Income Deferred	3	73,81,398.96	TA/DA Expense Deferred	14	29,65,044.50
Manpower Income Deferred	4	2,70,84,407.97	Contingency Expense Deferred	15	7,84,568.00
TA/DA Income Deferred	5	1,09,30,658.19	Manpower Expense Deferred	16	44,16,100.00
Contingency Income Deferred	6	2,27,98,982.96	Material Expense Deferred	17	1,05,340.00
NCSCM Overheads Deferred	7	1,22,01,041.00	TA Advance	18	1,19,650.00
IC Consultancy Deferred	8	1,26,73,743.52	Tax Credit - CTG-A	19	16,14,386.00
Performance Security	-	3,44,000.00	Tax Credit - CTG-B (Deferred)	-	38,02,957.00
EPF	-	65,577.00	Tax Credit - CTG-C	20	5,57,389.00
Tax Credit : MS Cholamandalam	-	44,920.00	Tax Credit - CTG- RD	-	8,910.00
Notice Pay	-	25,000.00	NCSCM	-	38,711.00
Other Grants in Aid	-	2,48,362.00	Truc & Delta	-	4,35,120.00
SICOM Overhead - CTG-A	-	38,10,711.88			
SICOM-Overhead - CTG-B	-	2,01,600.00			
SICOM-Overhead - CTG-C	-	48,787.00			
SICOM-Overhead - RD	-	1,49,442.00			
Wrong Deposit	-	27,958.00			
TDS	9	-36,321.00			
Total		**13,22,11,794.07**	**Total**		**13,22,11,794.07**

For National Centre for Sustainable Coastal Management

Director

Place: Chennai
Date : 10-03-2018

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

K. RAMANAN & CO. K. RAMANAN M. No. 019177 AH - 46, SHANTHI COLONY CHENNAI - 40 Chartered Accountants

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

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

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, 2017

Schedule- 1: Corpus Fund

Particulars	Amount
Cash Corpus	11,23,027.00
Capital Corpus	2,53,21,952.97
TOTAL	**2,64,44,979.97**

Schedule-2 : Duties & Taxes

Particulars	Amount
PROFESSIONAL TAX	12,890.00
KKC PAYABLE	2,21,077.96
SERVICE TAX PAYABLE	72,46,299.34
SWATCH BHARAT CESS PAYABLE	2,69,970.32
TOTAL	**77,50,237.62**

Schedule-3 : Material Income Deferred

Particulars	Amount
CONSULTANCY : CTG- A	49,74,665.96
CONSULTANCY : CTG- B	19,20,000.00
CONSULTANCY : CTG- C	4,86,733.00
TOTAL	**73,81,398.96**

Schedule-4 : Manpower Income Deferred

Particulars	Amount
CONSULTANCY : CTG- A	1,83,91,592.73
CONSULTANCY : CTG- B	45,94,000.00
CONSULTANCY : CTG- C	40,98,815.24
TOTAL	**2,70,84,407.97**

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

Schedule-5 : TA/DA Income Deferred

Particulars	Amount
CONSULTANCY : CTG- A	61,57,725.19
CONSULTANCY : CTG- B	25,84,000.00
CONSULTANCY : CTG- C	21,88,933.00
TOTAL	**1,09,30,658.19**

Schedule-6 : Contingency Income Deferred

Particulars	Amount
CONSULTANCY : CTG- A	32,60,297.96
CONSULTANCY : CTG- B	1,70,90,000.00
CONSULTANCY : CTG- C	24,48,685.00
TOTAL	**2,27,98,982.96**

Schedule-7 : NCSCM-Overhead Income Deferred

Particulars	Amount
CONSULTANCY : CTG- A	59,97,475.00
CONSULTANCY : CTG- B	51,21,600.00
CONSULTANCY : CTG- C	10,81,966.00
TOTAL	**1,22,01,041.00**

Schedule-8 : IC Consultancy Income Deferred

Particulars	Amount
CONSULTANCY : CTG- A	59,57,526.52
CONSULTANCY : CTG- B	53,81,389.00
CONSULTANCY : CTG- C	13,34,828.00
TOTAL	**1,26,73,743.52**

Schedule-9 : TDS

Particulars	Amount
TDS : Others	-35,461.00
TDS : Salary	-860.00
TOTAL	**-36,321.00**

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

Schedule-10 : IT Equipments

Particulars	Category - B	Category - C
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
TOTAL	**3,78,475.00**	**7,44,552.00**

Schedule-11 : Sundry Debtors

Particulars	Amount
DEPT OF ENVIRONMENT, GOVT OF TAMIL NADU	2,29,58,600.00
DIRECTOR, DEST-GOA-CARRYING CAPACITY	10,00,000.00
DIRECTOR , DEST-GOA-CZMP	30,00,000.00
DIRECTOR, DEST- GOA-MAPPING	10,00,000.00
HINDUJA INDIA LTD-SOLAR FEASIBILITY STUDY	1,85,438.00
Krishnapatanam Port Co Ltd.	18,66,312.00
Nodal Officer SindhuDurg	9,84,400.00
TOTAL	**3,09,94,750.00**

Schedule-12 : Bank Accounts

Particulars	Amount
YES Bank	8,42,54,843.57
State Bank Of India	8,60,538.00
TOTAL	**8,51,15,381.57**

Schedule-13: Contingency Advances

Particulars	Amount
ABHILASH	50,000.00
Dipnarayn Ganguly	35,000.00
Prabhakaran	45,000.00
Sachithanandanam	460.00
TOTAL	**1,30,460.00**

Director
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Chennai - 600 025, India

Schedule-14 :TA/DA Expense Deferred

Particulars	Amount
CONSULTANCY : CTG- A	3,32,010.00
CONSULTANCY : CTG- B	5,42,132.00
CONSULTANCY : CTG- C	20,90,902.50
TOTAL	**29,65,044.50**

Schedule-15 : Contingency Expense Deferred

Particulars	Amount
CONSULTANCY : CTG- A	-
CONSULTANCY : CTG- B	1,29,146.00
CONSULTANCY : CTG- C	6,55,422.00
TOTAL	**7,84,568.00**

Schedule-16 : Manpower Expense Deferred

Particulars	Amount
CONSULTANCY : CTG- A	-
CONSULTANCY : CTG- B	12,44,643.00
CONSULTANCY : CTG- C	31,71,457.00
TOTAL	**44,16,100.00**

Schedule-17 : Material Expense Deferred

Particulars	Amount
CONSULTANCY : CTG- A	-
CONSULTANCY : CTG- B	1,05,340.00
CONSULTANCY : CTG- C	-
TOTAL	**1,05,340.00**

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

Schedule-18 : TA Advances

Particulars	Amount
DEBASIS T	150.00
Dipnarayn Ganguly	6,750.00
Gurmeet Singh	6,750.00
Prasanta Moharaj	18,500.00
Rajesh Kumar Sahu	18,500.00
ROBIN RS	6,750.00
Tenjing Singh Y	18,500.00
Viswanathan C	18,500.00
YOGESWARI S	6,750.00
Yudhistir Reddy	18,500.00
TOTAL	**1,19,650.00**

Schedule-19 : Tax Credit : CTG-A

Particulars	Amount
TAX CREDIT CLAIMED	4,16,886.00
TAX CREDIT DEFERRED	11,97,500.00
TOTAL	**16,14,386.00**

Schedule-20 : TAX CREDIT: CTG-C

Particulars	Amount
TAX CREDIT CLAIMED	3,25,000.00
TAX CREDIT DEFERRED	2,32,389.00
TOTAL	**5,57,389.00**

Director
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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, 2017

(in Rs.)

RECEIPTS	AMOUNT	PAYMENTS	AMOUNT
Opening Balance			
Bank Accounts	-	ADVANCES	5,60,000.00
		CONTINGENCY ADV	12,000.00
TDS U/s-194C	494.00	SINDHUDURG- PROJECT-REV EXP	25,332.00
Funds Received	15,44,000.00		
		Closing Balance	
		Bank Accounts	9,47,162.00
Total	**15,44,494.00**	**Total**	**15,44,494.00**

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 : 10-03-2018

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

K. RAMANAN & Co
K. RAMANAN
M. No. 019177
AH - 46, SHANTHI COLONY
CHENNAI - 40
Chartered Accountants

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

Other Grants In Aid

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

Income and Expenditure Statement for the year ended 31st March, 2017

(In Rs.)

Particulars	Schedule	Amount	Particulars	Schedule	Amount
Indirect Expenses			**Indirect Incomes**		
Bank Charges	-	63.00	Grants In Aid	-	49,050.00
Advertisement Expense	-	25,269.00			
Manpower Expense	-	13,226.00			
Contingency Expense	-	10,492.00			
Excess of income over expenditure	-	-			
Total		**49,050.00**	**Total**		**49,050.00**

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
Director Chennai - 600 025, India

Place: Chennai
Date : 10-03-2018

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

K. RAMANAN & CO.
K. RAMANAN
M. No. 019177
AH - 46, SHANTHI COLONY
CHENNAI - 40
Chartered Accountants

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

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 2017

(In Rs.)

Liabilities	Sch.No	AMOUNT	Assets	Sch.No	AMOUNT
Capital Account:-			**Fixed Assets:-**		
Corpus Fund	-	-	Facilities & Equipments	-	-
Current Liabilities:-			**Current Assets:-**		
Fund Received	-	14,94,950.00	Bank Accounts	-	9,47,162.00
EPF	-	1,588.00	Advance to Institutes	-	5,60,000.00
Revenue Expenses Payable	-	2,60,000.00	Revenue Activity	-	2,48,362.00
TDS Others (194-C)	-	494.00	NCSCM	-	1,508.00
Total		**17,57,032.00**			**17,57,032.00**

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 : 10-03-2018

As per the Audit Report of even date attached
For K.Ramanan & Co
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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, 2017

(in Rs.)

RECEIPTS	AMOUNT	PAYMENTS	AMOUNT
Opening Balance			
Bank Accounts	21,52,499.00	FACILITIES & EQUIPMENTS-DELTA	7,47,285.00
		UTILISATION OF FUND DELTA	14,65,085.00
INTEREST ON GRANTS IN AID	33,821.00	UTILISATION OF FUND TRUC	6,30,157.00
MOES-TRUC	509.00	DELTAS-TDS OTHERS	1,350.00
Provisions	11,205.00	TRUC-TDS OTHERS	1,350.00
Sundry Creditors	4,39,883.00		
Loans & Advances (Asset)	1,70,750.00	**Closing Balance**	
NCSCM	55,000.00	Bank Accounts	18,440.00
Total	**28,63,667.00**	**Total**	**28,63,667.00**

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 : 10-03-2018

As per the Audit Report of even date attached
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MINISTRY OF ENVIRONMENT, FOREST & CLIMATE CHANGE

ANNA UNIVERSITY CAMPUS

CHENNAI-600025

Income and Expenditure Statement for the year ended 31st March, 2017

(In Rs.)

Particulars	Schedule	Amount	Particulars	Schedule	Amount
Indirect Expenses			**Indirect Incomes**		
Utilisation Of Fund - DELTA	5	14,80,610.00	Grants In Aid TRUC	-	22,27,895.00
Utilisation Of Fund - TRUC	6	6,45,682.00	Grants In Aid DELTA	-	6,45,682.00
Excess of income over expenditure	-	**7,47,285.00**			
Total		**28,73,577.00**	**Total**		**28,73,577.00**

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 : 10-03-2018

As per the Audit Report of even date attached
For K.Ramanan&Co
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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 2017

(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:-					
Professional Tax - DELTA	-	98.00	**Current Assets:-**		
Interest on MOES Funds	-	2,81,243.00	Bank Accounts	4	18,440.00
MOES - DELTA	-	31,92,875.00	NCSCM	-	40,20,464.00
MOES - TRUC	-	1,16,752.00	TA-Advance (Excess Refund)	-	-1.00
Sundry Creditors	-	4,763.00			
EPF	-	11,205.00			
Revenue Activity	-	4,35,120.00			
TRUC- TDS Others	-	-3,153.00			
Total		**51,14,295.00**	**Total**		**51,14,295.00**

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 : 10-03-2018

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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, 2017

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	-2,700.00
UNION BANK OF INDIA	21,140.00
TOTAL	**18,440.00**

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

Schedule-5 : Utilisation Of Fund - DELTA

Partculers	Amount
Consumables	13,13,174.00
Travel	2,178.00
Project Staff Salaries	1,65,258.00
TOTAL	**14,80,610.00**

Schedule-6 : Utilisation Of Fund - TRUC

Partculers	Amount
Consumables	77,724.00
Travel	2,36,306.00
Project Staff Salaries	3,31,652.00
TOTAL	**6,45,682.00**

Director
National Centre for Sustainable Coastal Management
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