NATIONAL CENTRE FOR
SUSTAINABLE COASTAL MANAGEMENT

Ministry of Environment, Forest and Climate Change
Government of India

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NATIONAL CENTRE FOR SUSTAINABLE COASTAL MANAGEMENT

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HPSC

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- *Prof. M. Sekar, Dean, College of Engineering Guindy, Anna University, Cherinai [Expert Member]*
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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

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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.

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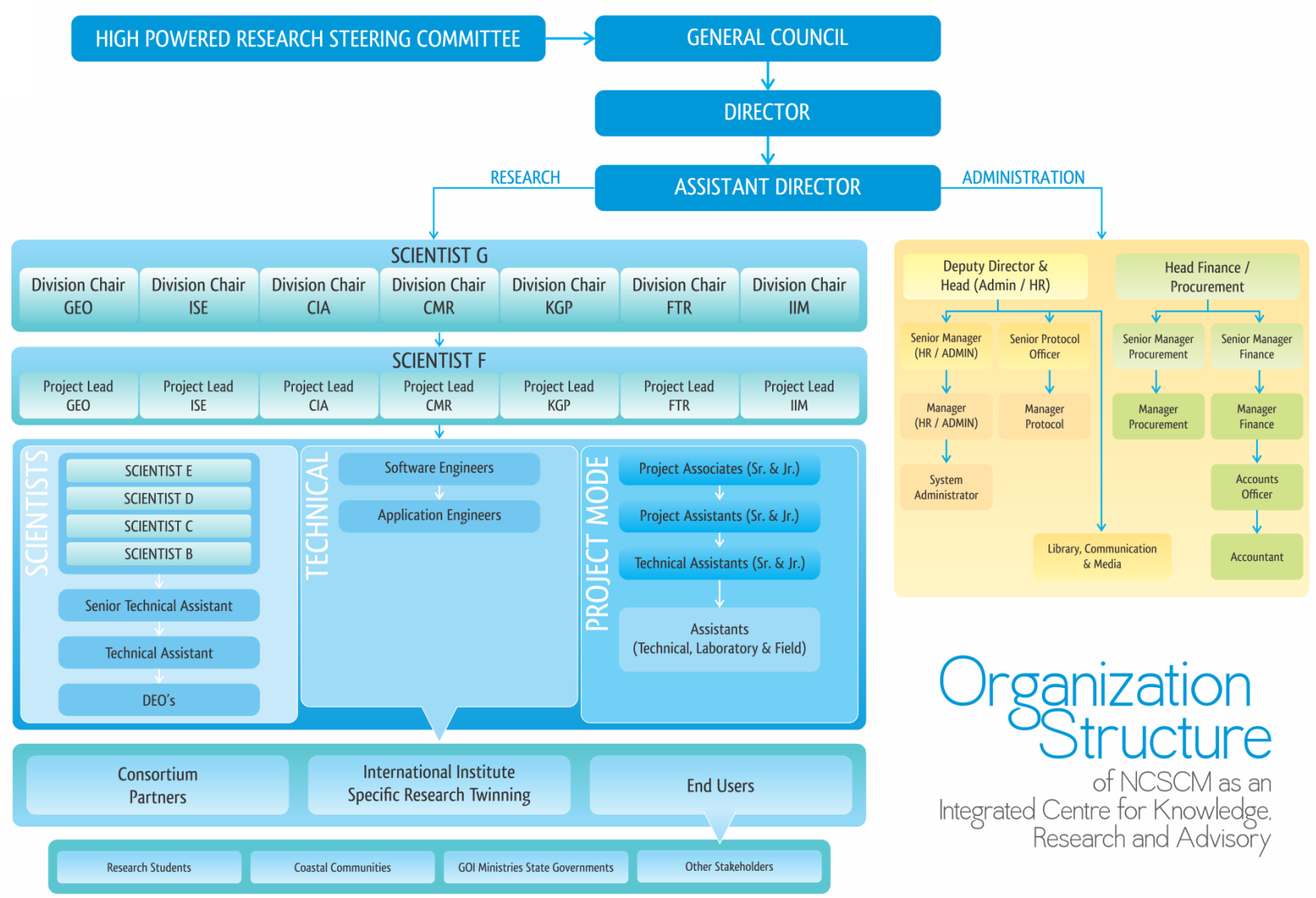

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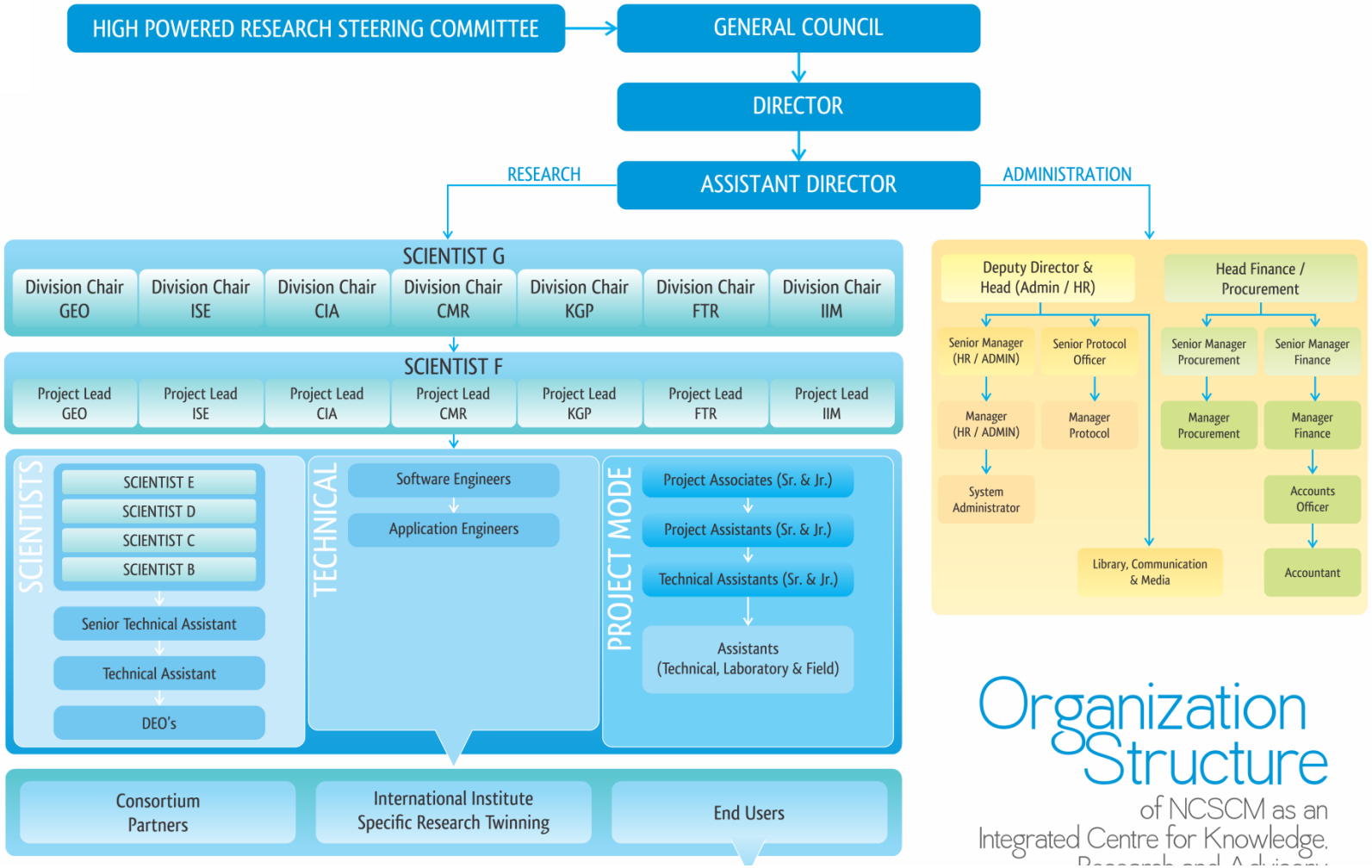


Organization Structure

of NCSCM as an Integrated Centre for Knowledge,

Research Divisions of NCSCM

The Geospatial Sciences Division (GEO)

The objectives of the GEO are to provide scientifically-based decision support system to a wide variety of users, to promote environmentally sound use of coastal resources by employing the state of-the-art technology in geographic information systems (GIS) modeling, and field surveys. The major groups under the GEO are: (i) the Land Survey, (ii) the Hydrographic Survey, (iii) the Cartography, (iv) the Digital Photogrammetry, Digital Image Processing and ALTM Laboratory, and (y) the GIS Work Centre and Data Warehousing.

Integrated Social Sciences and Economics Division (ISE)

The ISE would focus on coastal communities and their livelihoods. In particular, the would focus on community based approach to coastal vulnerability and coastal management with collaboration with other divisions of the NCSCM. Research interests of 15E would include social aspects of the coastal management, traditional wisdom, and the regional and national level solutions for livelihood security and improved community level resilience against coastal hazards. The major group under the ISE are: (i) the Coastal Livelihood and Demography, (ii) the Traditional Knowledge, (iii) the Employment and Education, (iv) the Coastal Community, Culture and Heritage, (y) the Regional Planning, (vi) the Coastal Conflicts Study, and (vii) the Coastal Ecosystem Economics.

Coastal Impact Assessment Division (CIA)

This division would provide input and advice on all components of coastal environment impact assessment. The division would study all relevant aspects to establish baseline environmental conditions of specific coastal areas. It would study the cumulative environmental, economic and social effects of regional development prospects on coastal and marine resources and environment

This Division would suitably advice management measures for Ecologically Sensitive Areas in the coastal and marine areas. The major groups under the division are: (i) the Coastal and Marine Sciences, (ii) the Coastal and Marine Engineering and Infrastructure, (iii) the Cumulative Coastal Environmental Impact Assessment, (iv) the Social Assessment and Gender, and (y) the Coastal Tourism and Heritage.

Conservation of Coastal and Marine Resources Division (CMR)

The primary mandate of CMR would be to guide the use of the living and non—living natural resources for diverse and often conflicting sectoral activities, so that the continued viability of all aspects of resource usage and ecosystem health can besecured. The CMR will investigate the interactions between natural coastal resources and the coastal communities, with a view to establish the level of sustainable utilization, and thereafter the adoption of conservation ideas in the integrated coastal zone management plans in the country. The major groups under the division are: (i) the Coastal and Marine Living Resources Group, (ii) the Coastal and Marine Non-Living Resources Group, (iii) the Coastal Energy Group, and, (iv) the Marine Protected Areas Group.

Knowledge Governance and Policy Division (KGP)

This division will work as a central repository for the dispersed information on the Indian coast. Coastal management requires all the stakeholders to be interconnected at different scales in order to share information, knowledge and data to solve problems and conflicts facing the coastal area and livelihood of the coastal communities. The knowledge management system of the centre would assist those interested in coastal governance to access the most relevant information of coastal issues. This division would also provide advisory to the government on coastal governance and policy issues. The major groups under the division are: (i) the Information Bank, (ii) the Communication and Dissemination Group, (iii) the Capacity Building Group, (iv) the Coastal Law and Policy Group, and, (y) the Partnership and Networks Group.

Futuristic Research Division (FTR)

FTR would conduct advanced research on climate change and sea level rise issues including paleo-climatic issues; offshore energy; future development potential ofthe coastal and marine areas and the islands; long-term adaptation plans aimed to achieve increased resilience to coastal hazards. In additional, the division would undertake research to enhance the resilience of the island communities; will help in building regional capacity in risk management, and prepare long-term guidelines for integrated coastal management plans. The major groups under the division are: (i) the Climate Change and Sea Level Rise Group, (ii) the Coastal Hazards and Mitigation Group, (iii) the Nano-Science and Ocean technology Group, and, (iv) the Island Ecology and Communities Group.

Integrated Island Management Division

The Integrated Island Management Division ((IIM) would prepare a model framework for integrated island management plan. The goal of the IIM is to help ensure the future socio-ecological sustainability of the Indian islands, Andaman and Nicobar and the Lakshadweep by preparing an Integrated Island Management Plan. The IIM would undertake scientific approaches, coupled with indigenous knowledge for the better management of the islands and its resources. The IIM would consider the indigenous governance structures and knowledge - particularly in tribal dominated islands. The islands being pristine areas, this division would undertake long-term historical analysis including monitoring of the oscillations of crucial environmental variables.

The IIM would develop guidelines for hazard preparedness and evolve climate change adaptation and mitigation strategies for the Islands. Some of the major goals are to develop integrated island management / green island economy concept and to explore, in conjunction with island populations, ecotourism development as a particular option. The IIM would provide tools for mainstreaming Disaster Risk Management based on experiences from selected island countries worldwide. The IIM division would undertake specific research to enhance the resilience of the island communities; will help in building regional capacity in risk management, and prepare long-term guidelines for integrated coastal management plans.

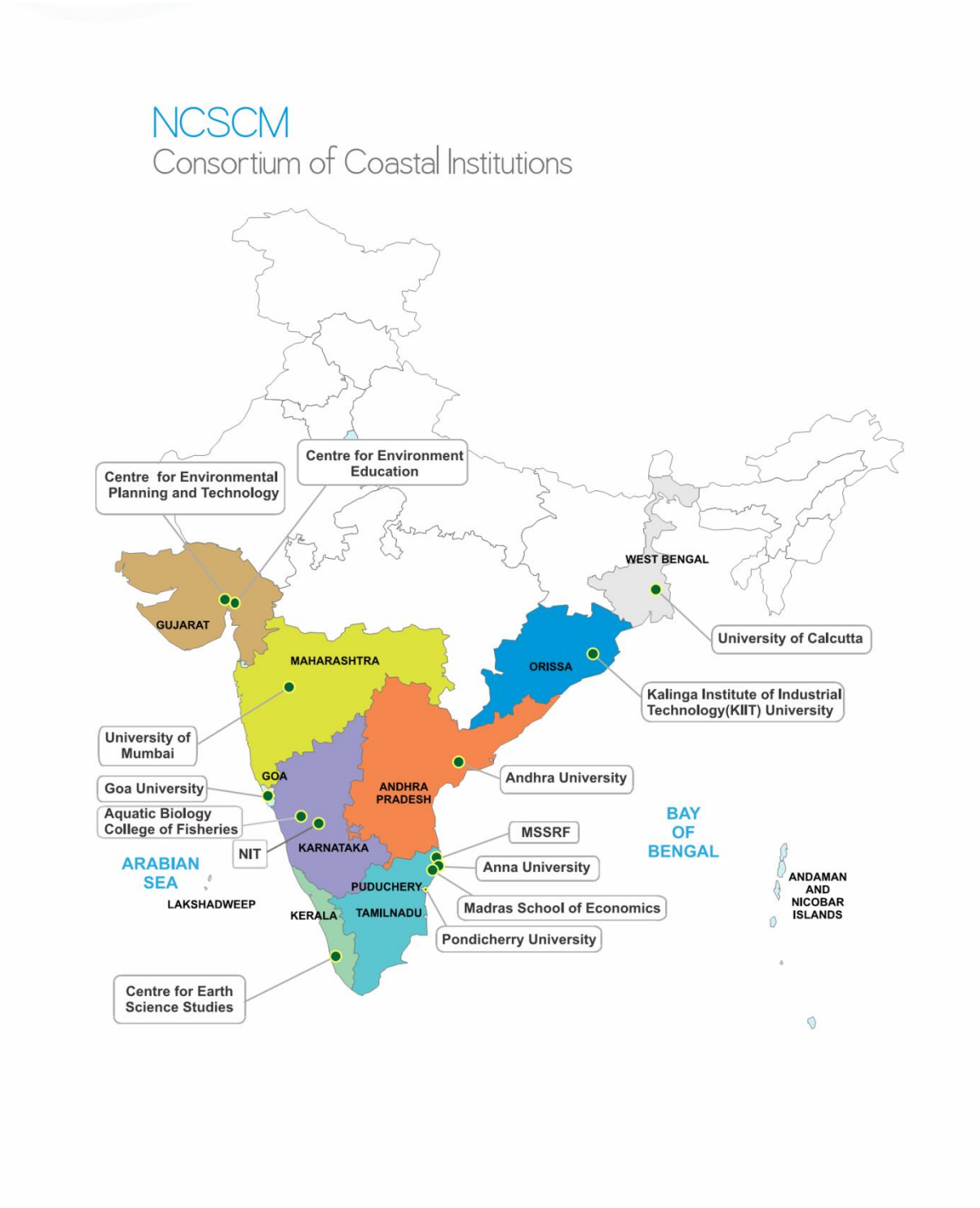
Consortium Partner

Institutions

The Ministry of Environment and Forests recognized that the issues related to the coast are too diverse and complex to be addressed by one research organization and hence there is a need to strengthen the capacity of regional universities and research units along the coast so as to be the research consortium partners of NCSCM, Chennai. The idea is novel and NCSCM is the first central research consortium organization to have such a focussed collaboration with regional universities. Fourteen institutions have formed a consortium with the National Centre for Sustainable Coastal Management, Anna University Chennai and signed the Anna University declaration on 21st June 2010 to that effect. The salient features of the Declaration are:

1. *Preparing immediate preventive and remedial action, wherever possible, using existing knowledge, resources, plans and processes for conservation and protection ofthe coastal environment and safeguarding the livelihood of local communities who depend upon the resources from the coastal and marine areas.*
2. *Promoting access and undertaking high quality targeted research in the area of coastal and marine area management and facilitating transfer of technology and information*
3. *Collecting compiling and disseminating information in the area of coastal and marine environment management through networking among States/ Institutions.*
4. *Encouraging cooperative and collaborative action and partnerships, among governmental institutions and organizations, communities, the private sector and non-governmental organizations which have relevant responsibilities and/or experience;*
5. *Assisting institutional strengthening and human resources development for capacity building in ICZM. NCSCM has put in place a road map for strengthening and expanding the existing NCSCM consortium, stakeholder network and prioritize the community interface. NCSCM supports its partner consortium institutes by strengthening their core area of research, and build capacities on the core research mandates of the NCSCM.*

Such networks and partnerships will formalize multidisciplinary interactions in order to effectively address key coastal research problems. Research proposals are being prepared by the Cis jointly with the scientists of NCSCM in order to address the coastal issues through systematic research


NCSCM
Consortium of Coastal Institutions
Centre for Environment Education
Centre for Environmental Planning and Technology
GUJARAT
MAHARASHTRA
WEST BENGAL
University of Calcutta
ORISSA
Kalinga Institute of Industrial Technology(KIIT) University
University of Mumbai
GOA
Goa University
Aquatic Biology College of Fisheries
NIT
KARNATAKA
ANDHRA PRADESH
Andhra University
BAY OF BENGAL
MSSRF
Anna University
ARABIAN SEA
LAKSHADWEEP
PUDUCHERY
KERALA
TAMILNADU
Madras School of Economics
Pondicherry University
ANDAMAN AND NICOBAR ISLANDS
Centre for Earth Science Studies

The Ministry of Environment, Forest and Climate Change (MoEF&CC) has established the National Centre for Sustainable Coastal Management (NCSCM) with assistance from the World Bank to execute research studies on Integrated Coastal Zone Management (ICZM). The primary mandate of NCSCM is to undertake research on wide range of activities relating to the coastal zone and to support the MoEF&CC in meeting the scientific and technical requirements for implementation of the Coastal Regulation Zone (CRZ) Notification, 2011 and other environmental acts/rules. The High Power Steering Committee (HPSC) of NCSCM in its second meeting held on 25th July 2012 approved the following research activities be undertaken by NCSCM.

1. Assessment of coastal and marine ecosystem health in pollution hotspots
2. Cumulative environmental impact assessment along the coastal and marine areas including hydrodynamic modeling.
3. Establishment of sentinel sites as indicators for coastal and marine ecosystem health
4. Marine biodiversity database
5. Creation of spectral library of mangroves, seagrass and seaweeds etc
6. Impact on large scale cultivation of seaweeds on coastal environment of India
7. Blue carbon offsetting carbon emissions by conserving coastal and ocean vegetation (BLUE-C)
8. Inventorization of greenhouse gas flux emissions from coastal ecosystems – input into climate modeling (# 8 has been merged with # 7)
9. Assessment of offshore wind energy potentials – long term study
10. Integrated Island Management (IIM) Plan for Andaman & Nicobar Islands and Lakshadweep Islands.
11. Island Coastal Regulation Zone (ICRZ) Plan preparation for Andaman & Nicobar Islands, and Lakshadweep Islands
12. High resolution erosion mapping with Survey of India (SOI)
13. Shoreline management plan
14. Assessment of coastal and marine ecosystem goods and services
15. Mapping of fishing spaces

For the above activities, a detailed Research Action Plan (RAP) (2013-16) comprising consolidated programme and activity wise budgetary

requirements (Rs. 1058.10 lakhs) was prepared and subsequently approved the Governing Council of NCSCM.

Significant achievements have been made under these research projects and some of the activities under selected projects are proposed to be extended up to March 2018 with additional tasks, while few activities have been completed.

Studies Completed

1. *Im*pact of large scale cultivation of seaweeds on coastal environment of India (CMR)
2. Potentials of Offshore Wind Energy Resources (FTR)

Studies Ongoing

1. *Assessment of Cumulative Coastal Environmental Impacts (ACCES)*
2. *Assessment of coastal and marine ecosystem health in pollution hotspots - Coastal ECOsystem HEALTH Report Card (ECOHEALTH)*
3. *Establishment of Sentinel Sites for Coastal Management*
4. *Marine biodiversity database - Development of Coastal and Marine Biodiversity Integration Network*
5. *Development of spectral library of mangroves and sea-grasses*
6. *Blue Carbon: Offsetting Carbon Emissions (BLUE-C)*
7. *Preparation of Integrated Island Management for A &N islands*
8. *Preparation of ICRZ and ICZM plans for Andaman & Nicobar Islands*
9. *High Resolution Erosion Mapping*
10. *Mapping of Fishing Space – Socio-economic impact of coastal Land Use/ Land Cover Changes on Fishers Livelihood in India*
11. *Assessment of coastal and marine ecosystem goods and services- Linking Coastal Zone Management to Ecosystem Services in India*
12. *ICZM Plan Preparation Guidance Document and Training Materials*

In addition, research work is in progress for two externally funded projects with financial support from BELMONT Forum/ MoES, Government of India

No	Research Study	Divisions involved
1	*Transformation and Resilience on Urban Coasts (TRUC)*	*FTR, ISE, CIA & GEO*
2	*DELTAS: Catalyzing action towards sustainability of deltaic systems with an integrated modeling framework for risk assessment*	*CIA, FTR & GEO*

Major Achievements

Major achievements of the research activitiesundertaken by each Division during April 2013 – March 2016 aredescribed below along with additional tasks to beundertaken during April 2016 – March2018.

National Strategy for Coastal Protection

A study on High Resolution Erosion/accretion mapping for the coast of India is undertaken to identify areas of the coast with significant erosion and accretion for the period 1975 – 2010, thereby to determine the rates of erosion/ accretion and to create a national database for coastal shoreline changes with 1975 as the base year. The research study includes determination of 100 year predicted shoreline and demarcation of shoreline displacement in 0.5m elevation contour map. This predicted shoreline can be utilised to identify potential zones for suitable sector based developments. Apart from this, the study will also indicate coastal stretches prone to erosion, which is one of the noticeable stresses on the coastal and marine ecosystems. Hence this component of the study can be used to identify loss of ecosystems along the coast to asses and plan strategies for regeneration or restoration of the ecosystems which is a substantial goal of ICZM. The research study was conducted from Jan 2014 – Mar 2016 with 5 work packages enlisting various technical and field tasks. Of the proposed tasks, geo referencing of satellite images (Indian /Foreign) and extraction of shorelines are completed for stretches for which rectified ortho-photos are shared by Survey of India. The remaining locations are undertaken as and when the orthophotos are provided.

In this regard the research study is proposed to be continued for the period of

Apr 2016 – Dec 2017 ie till the extended period of the ICZM project with a proposed budget of 166 lakhs.with additional scope of i) Identification of potential development zones and ii) study on Degraded coastal and marine ecosystems (mangroves and corals) and development of strategies for their restoration in pilot sites, based on the shoreline status of the coast. Significant applications of the study includes identification of vulnerable coastal stretches, threshold limit of hazards on the coast, potential zones for future developments, Identification of erosion prone areas to be managed for protection of livelihoods and natural resources.

Major components of the study

- Erosion/Accretion status of the coast of India
- Prediction of 100 years erosion line
- Identification of Potential sites for sustainable developments
- Strategies to conserve restore and regenerate degraded coastal and marine ecosystems

India's coastal zone envisages diverse physical, ecological, economical and social utilisation in the recent years which are in no way comparable to its utilisation in the past. Due to the multifold usage of this fragile zone, the degree of stress are increased exponentially such as increased frequency of natural disasters, human interventions and urbanisation, increased developmental infrastructures, rapid depletion of natural resources and so on. Change in shoreline mirrors the status of the coastal zone as it is the dynamic outcome of the change in the sediment transport along and across the shore. Study of coastal erosion and accretion are therefore vital to manage the coast and its assest and the communities dependent on it.

Presently, approach of managing India's coastal zone is purely regulatory as per the Coastal Regulation Zone (CRZ) Notification of 1991, promulgated under the Environment (Protection) Act of 1986. Increasing development pressure leads to violations of legislations. Hence, economic sector has been simultaneously demanding for rationalizing the present regulatory measures. Perceiving the setbacks in coastal governance, the Ministry of Environment and Forests (MoEF) has constituted an Expert Committee in July 2004, under the chairmanship of Prof. Dr M.S. Swaminathan, to carry out a comprehensive review of the Coastal Regulation Zone notification, taking into account the findings and

recommendations of all previous committees, judicial pronouncements, representations from various stakeholders and suggest suitable amendments. The committee also has the mandate to take regulatory framework consistent with well-established scientific principles of coastal zone management and more flexible, depending on the local characteristics of the coastal zone stretches that needs to be protected. The expert committee has recommended for delineation of hazard line based on 1) coastal inundation levels (flood line) and 2) rate of coastal displacement (erosion line). The committee further suggested that the flood line demarcation to be undertaken by SoI based on the natural factors such as water level fluctuation, storm surges and cyclones, including episodic events such as tsunami and the erosion/ accretion line, to be demarcated by NCSCM, based on SoI toposheets and satellite imageries. The primary objectives of the study are:

i. To identify areas of the coast where significant erosion and accretion has occurred and continues on long term (1973 – 2010) and short term (2000 – 2012) time scale based on historic satellite images

ii. To quantify the rates of erosion/ accretion along the nation's coastline

iii. To create a national database for coastal erosion and accretion with 1973, as the base year

iv. Extrapolation of the shoreline changes of the coast for the year 2110 (next 100 years)

v. To demarcate the shoreline displacement in 0.5m elevation contour map

Strategy For Coastal Protection

Coastal Sediment Cells

The sediment cell is a stretch of coast between boundaries which partly or wholly contain sediment movement. 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

- Within this stretch, a main activity of the coastal system is the sourcing, transfer and deposition of sediment. In order that sediment inputs to a shoreline are balanced by outputs, the shore becomes orientated obliquely to wave crests such that the wave energy is deflected alongshore, a process known as longshore drift, resulting in longshore sediment transport:

Figure 1 Sediment Cell indicating a swash-aligned coast

- Coastal systems which receive significant sediment inputs across their boundaries become drift aligned in order that they achieve a balance between inputs and outputs. Drift alignment requires that an oblique angle is formed between the shoreline and the dominant wave crests. The longshore current, and therefore the potential for alongshore sediment transport, increases as this angle between shore and wave crest increases
- Where coastal systems receive little or no sediment inputs they become swash-aligned (Fig. 4.1). Redistribution of sediment within the system takes place and the shoreline becomes parallel to the approaching wave crests so that the angle between wave and shore approaches zero. Under these conditions no energy is deflected alongshore and little or no net sediment transport takes place, so that the coastal system is in equilibrium

This is the key to understanding coastal dynamics. If sediment input does not equal output then accretion or erosion will occur and this will change the angle between wave and shore until the necessary balance is achieved. Thus the coastal system is self-adjusting and erosion and accretion must be seen as the process to achieving equilibrium. Attempts to combat erosion therefore merely exacerbate the problem (Fig. 2)

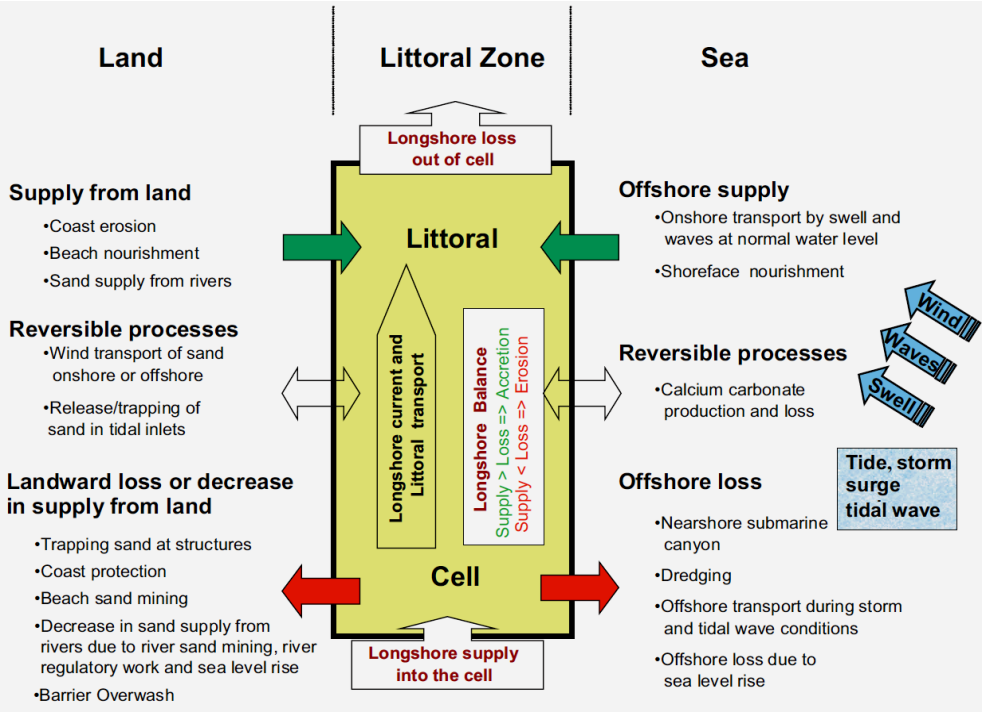


Figure 2: Overview of sediment sources and losses to the coastal area (Mangor, 2002)

Sediment cell boundaries may be "fixed", such as those determined by geographical or topographical factors such as rocky headlands or man-made structures such as breakwaters. "Free" boundaries are those where sediment movement changes direction or rate. This may be due to alteration in wave approach angle caused by bathymetric variation in the offshore. It may also be due to changes in the coastal orientation, either due to adjustment of the shoreline itself or due to geological constraints. Movement of sediment by waves and tides takes place between areas of sediment input and areas of output, a movement that can be interrupted by temporary storage of sediment. Estimates of volumes of sediment involved in these movements, normally using the annual net values, is known as the sediment budget (Figure 2).

Sediment cell theory is a key component of shoreline management plans, which determine future strategies. The choice of sediment cell as the unit of

management goes beyond political boundaries and not only focuses on erosion but also on the cumulative impacts due to multiple activities in a particular area.

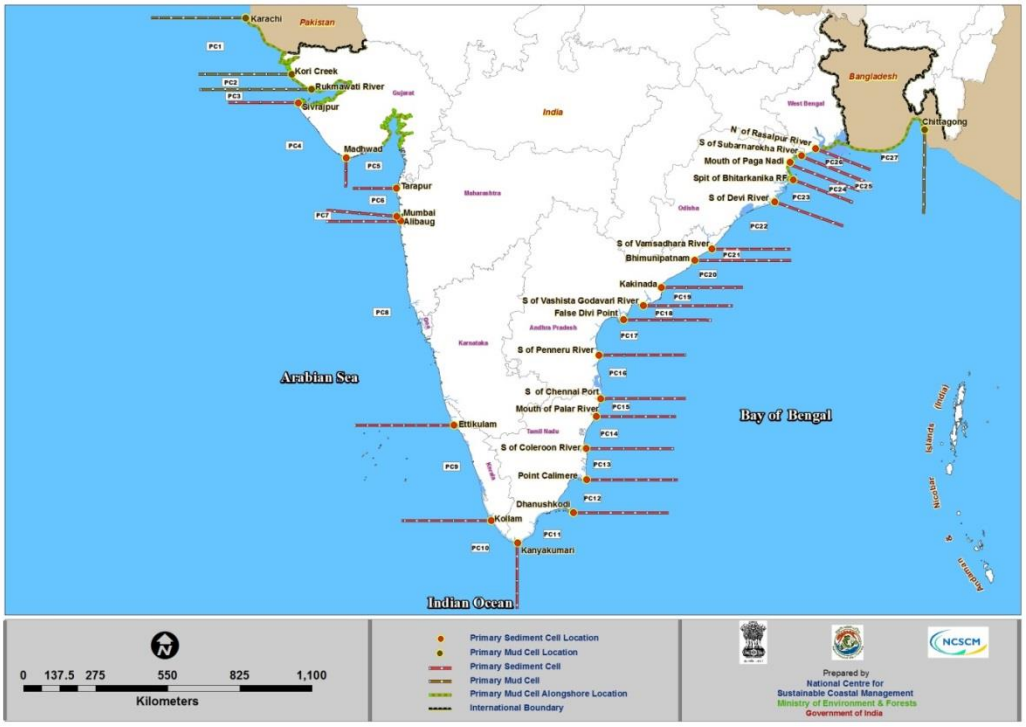


Figure 3 Demarcation of primary sediment cells along mainland coast (Source NCSCM

Based on specific criteria, primary cells are first identified along the coast. If the primary cell is very long, it may be divided into sub units called secondary cells. The primary cells are large in scale/extent and the dividing points are the headlands, around which almost no sediment can pass, or embayments that act as sediment sinks. Within these cells are subcells; some are short lengths where the coastal alignment reverses the direction of drift. In terms of shoreline management plans, the subcells are the most important units, but maintaining the natural integrity of the primary cells is a consideration, based on the principle that any interference with longshore drift can disadvantage coast – and coastal stability – downdrift. Further classification of the sub-cells into "management units" is made using the land use as major criteria. Along the Indian coast, 27 primary sediment cells have been demarcated (Figure 3).

Level 1: Coastal Sediment Cells

NCSCM has prepared the coastal sediment cell atlas for the entire coast of India. The coast of India is divided into a number of primary cells based on well-defined criteria. These sediment cells may be further divided into sub-

cells based on specific criteria (Pethick, J., Purvaja, R. and Ramesh, R, 2013).

Level 2: Preparation of CZMP Maps

CZMP maps: 500m landward from the HTL (as well as the area between the hazard line and HTL if hazard line is beyond HTL) is the CRZ. The different classes of CRZ (CRZ I, CRZ II, CRZ III and CRZ IV) are marked on the CZMP maps prepared based on criteria defined in CRZ 2011.

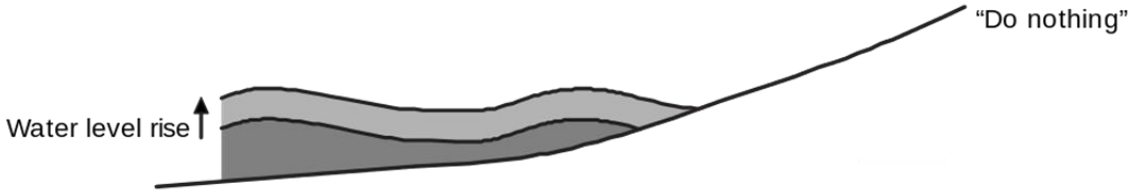
Level 3: Incorporation of Shoreline Change Maps

Shoreline Change maps: NCSCM has prepared a shoreline change assessment for the entire country classifying the coast based on erosion (high, medium and low) and accretion (high, medium and low); artificial coasts (which can be inferred to be areas high erosion) and stable coasts. The shoreline change maps have been presented to the concerned coastal states/ UTs and the finalized maps have been submitted to the States/ UTs. The shoreline change maps are incorporated into the CZMPs.

Level 4: Prioritization for Coastal Protection within CZMP

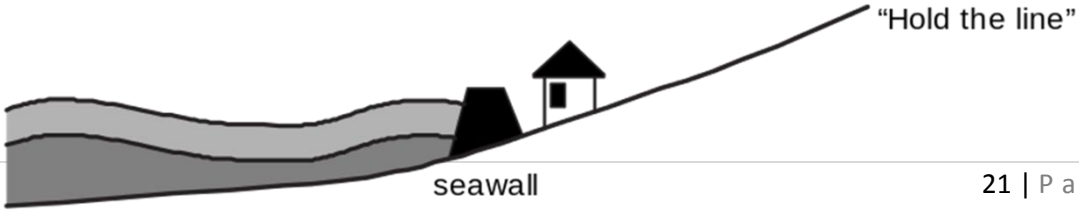
The three levels of mapping: i) delineation of coastal sediment cells; ii) mapping the CZMPs and iii) assessing the erosion/ accretion of the coastline would provide areas for prioritizing coastal protection. For example, in CRZ II areas, identifying high erosion zones (including artificial coast) would become the "Highest Importance" and a suitable method for protection could be evolved by the State/ UT with stakeholder consultation (e.g. Mumbai and Puducherry coasts). The method for protection of such areas would be decided based on the CRZ class and some of the recommendations are as follows:

a) **Do nothing/ No intervention/ Limited Intervention** is to be practiced in the case of natural systems.



b) **Highest importance:** Areas with high erosion and high economic importance the following protection measures are generally used:

i. Hold the line or Advance the line



For example, if an area comes under CRZ II (built up area) and is classified as highly eroding, or if the area comes under CRZ I or III (e.g. archaeological monuments along the shore) then highest priority should be given in terms of coastal protection. The preferred approach would be to **'hold the line' or even 'advance the line'** (moving seawards) as there may not be any possibility of moving landwards to create a buffer between the encroaching sea and the landward activities.

e exact method to be used for holding the line/ advancing the line would be to use structural methods such as seawalls. However, to decide the correct method that would enable protection would require an approach as given in Fig. 4.6

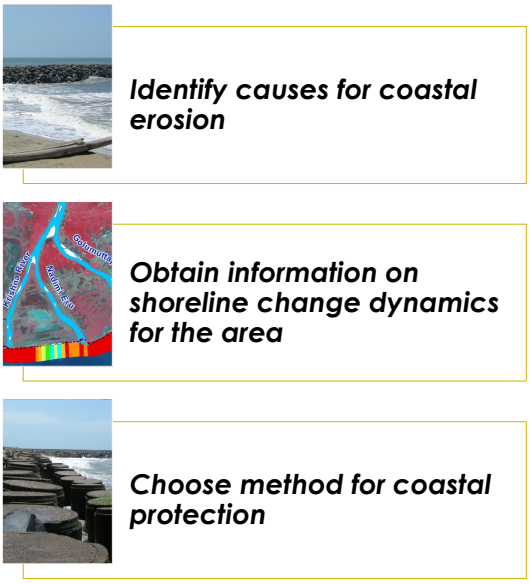


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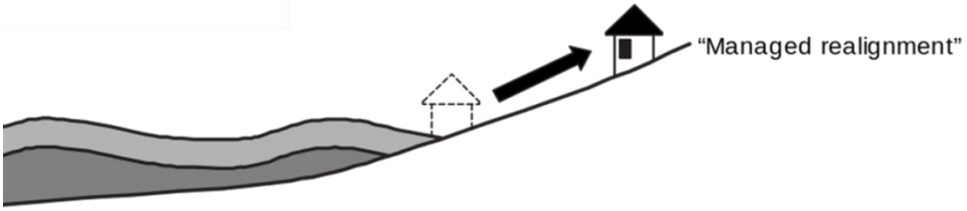
Figure 4.6: Approach to enable coastal protection (e.g. Hold the line)

ii. **Managed realignment** involves a plan for long term '**managed realignment**' to accommodate the encroaching sea must also be created. This could include retrofitting of buildings as well as a planned retreat while, over time, building a buffer through soft interventions.



c) **Medium to low importance:** In the case of CRZ I areas which are

natural ecosystems such as mangroves, the cause for erosion should be determined first. If the cause is anthropogenic, the source of the problem should be identified. However, ecosystems have natural adaptive capacities that must be allowed to stabilize on their own. In such cases, the best approach may be for '**limited / no active intervention**'.

Table 1: Matrix to assist decision making with respect to Erosion and CRZ class

CRZ Class / Erosion	Artificial Coast	High Erosion	Medium Erosion	Low Erosion
CRZ I	Only applicable in the case of archaeological monuments in the CRZ • Is the method currently used appropriate • What are the options available (example relocation of monuments)	Nature of ecosystem Cause for erosion – if anthropogenic – needs to be addressed	Check for any possible anthropogenic cause for erosion is likely to come up in the nearby area	Check of any possible anthropogenic cause for erosion is likely to come up in the nearby area
CRZ II	• Is the method currently used appropriate? • How can it be scaled up?	High need for protection	Application of CRZ (including hazard line) regulations Long term managed realignment / planned retreat	Application of CRZ (including hazard line) regulations Long term managed realignment
CRZ III	• Is the method currently used appropriate • How can it be scaled up • What alternatives are available?	Application of CRZ (including hazard line) regulations Promote soft protection measures Restoration/ conservation of protective ecosystems such as beaches/ coastal wetlands	Application of CRZ (including hazard line) regulations Limited intervention, planned retreat	Application of CRZ (including hazard line) regulations Check of any possible anthropogenic cause for erosion is likely to come up in the nearby area

A possible framework to assist in decision making is given below (Figure 7):

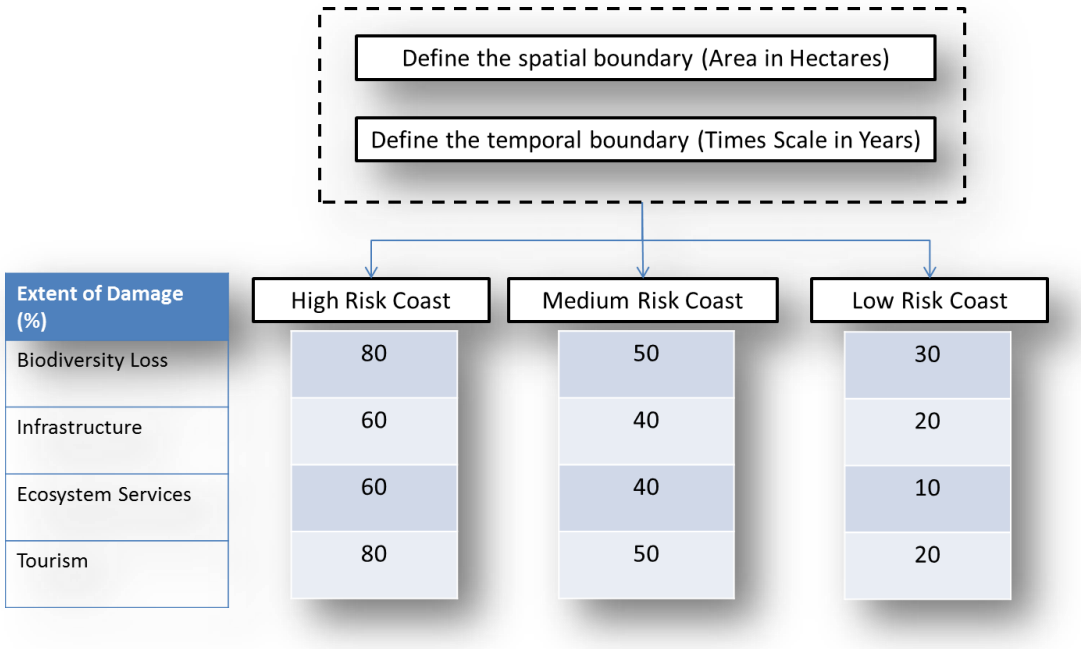


Figure 7: framework to assist in decision-making

The following aspects may be considered to aid in the decision making process:

- Determine the spatial and temporal scale of the assessment to obtain both accurate and meaningful results
- Perform a risk assessment by estimating and comparing the probability of coastal erosion impacts based on shoreline change trends
- Use various intervention scenarios to estimate the extent of land lost annually due to erosion
- Perform a cost-benefit analysis for various options
- Compute the net present value (NPV): The NPV is basically the difference between the present value of costs and the present value of the benefits. If the present value of benefits of protected property and increased value of coastal ecosystems outweigh the present value of costs of protection, coastal protection is considered efficient and feasible.

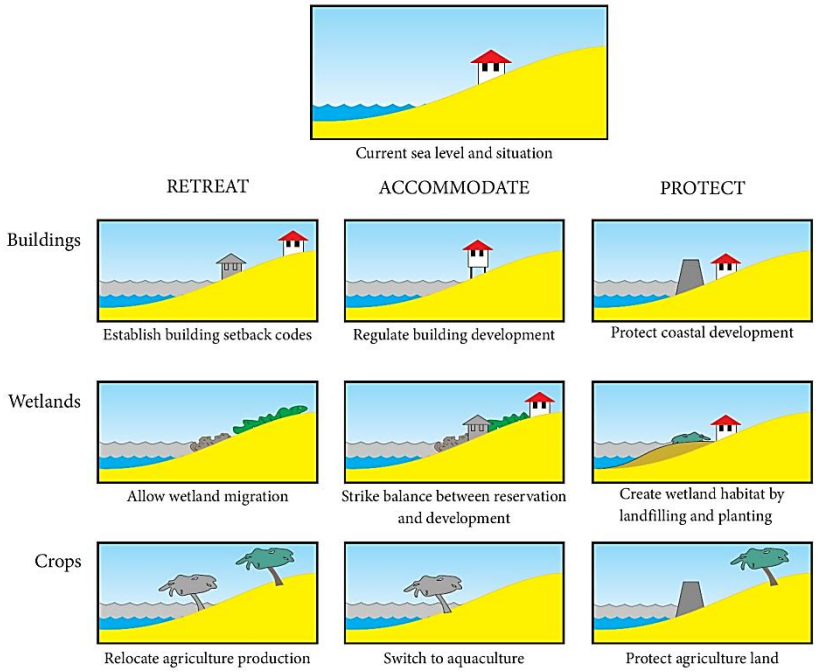
The strategy is then decided as **protect/ accommodate/ retreat**

a. **Protection** of people, property and infrastructure is a typical first response. This includes 'hard' measures such as building seawalls and other barriers, along with various measures to protect critical

infrastructure. 'Soft' protection measures are increasingly favored. These include enhancing coastal vegetation and other coastal management programs to reduce erosion and enhance the coast as a barrier to storm surges.

b. **Accommodation** is a more adaptive approach involving changes to human activities and infrastructure. These include retrofitting buildings to make them more resistant to the consequences of sea level rise, raising low-lying bridges, or increasing physical shelter capacity to handle needs caused by severe weather. Soft accommodation measures include adjustments to land use planning and insurance programs.

c. **Managed retreat** involves moving away from the coast and may be the only viable option when nothing else is possible.



Summary of three main coastal strategies for Buildings, wetlands and cropland (Dorst, 2011)

Assessment of Cumulative Coastal Environmental impactS [ACCES]

Majority of the world's population live in coastal zones- combiningterrestrial-aquatic areas and revolving around the land–sea interface. Such areas face many environmental and management challenges, due to a combination of environmental impacts that arise in both open ocean areas and those areas inherent to coastlines, such as the impacts of land based activities. The high degree of complexity in coastal zones has led to emphasis on adoption of integrated coastal zone management (ICZM) as a governance mechanism by considering various aspects of human activities and their management. Cumulative environmental impact assessment (CEIA) is an integral part of ICZM processes, considering cumulative impacts of development of the coastal/marine areas. CEIA helps to link the different scales of environmental assessment, focusing on how developmental plans are designed and the effects of a particular plan.

Framework for the Cumulative Environmental Impact Assessment for the Gulf of Kachchh, *Gujarat*

A Framework for the Cumulative Environmental Impact Assessmentfor the Gulf of Kachchh (GoK)is being prepared in a participatory mannerthroughvarious stakeholder consultations. On the basis of the information generated, a historical timeline of major events since the pre-independence era, was drawn for the GoK (Fig. 2). Events such as establishment of industries, natural disasters, and creation of the Marine National Park among other historical

events were documented in the timeline. Based on the above-said events, there were three major events classified such as Extraction, Protection and Restoration periods.

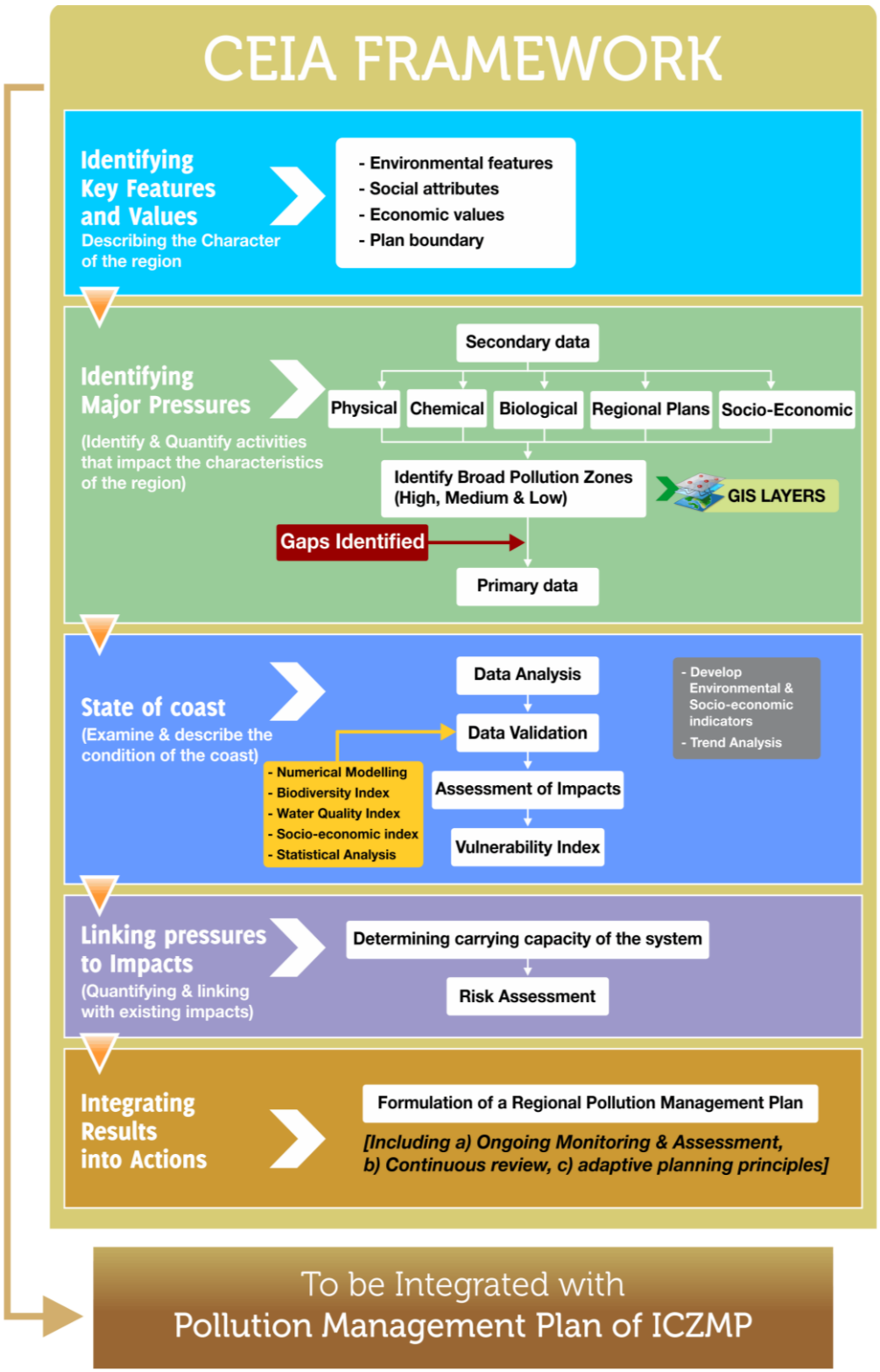
In addition, the present conditions based on the factors such as anthropogenic and natural pressures and major risk viz. ports, industries; agriculture, domestic sewage, salinity etc. were also considered. The CEIA aims to help coastal managers and policy makers, determine the status and conditions of GoK, and provide a broad perspective on the future of GoK. It addresses a few key questions:

- How will conditions in the GoKbe in the future?
- How have and will the above mentioned factors affect the GoK in due course of time?
- Most importantly, will it help us to develop strategies and response to mitigate the negative effects in the time through state machinery and comprehensive projects like the ICZMP?

This activity outlines a framework for the Cumulative Environmental Impact Assessment for the Gulf of Kachchh.This framework was generated following the Workshop on Cumulative Environmental Impact Assessment of Gulf of Kachchh, conducted in GEER Foundation, Gandhinagar, Gujarat, on 5th-6thSeptember, 2013. The Workshop incorporated local expertise – qualitative data (and not quantitative data) about the natural resources and features of the Gulf of Kachchh, the potential pressures affecting them, and current conservation efforts.

Framework conceptualisation

The assessment framework is divided into a 5-step process that will lead to improved management planning for the GoKregion. An overview of each step, followed by recommendations, including actions and information required to fulfil the Cumulative Environmental Impact Assessment is provided.



Framework Conceptualization ofCEIA

KEY FEATURES AND VALUES

The environmental characteristics of the region including the social, economic and environmental values placed upon them (Fig. 3) describe the key

features and values of the GoK region.

MAJOR PRESSURES

Identify and quantify the current and future activities in the region that are, or are likely to, impact the environmental characteristics and values.

- Urban sewage and waste
- Agricultural runoff
- Turbidity
- Salt pan discharge
- Industrial development
-

LINKING PRESSURES TO IMPACTS

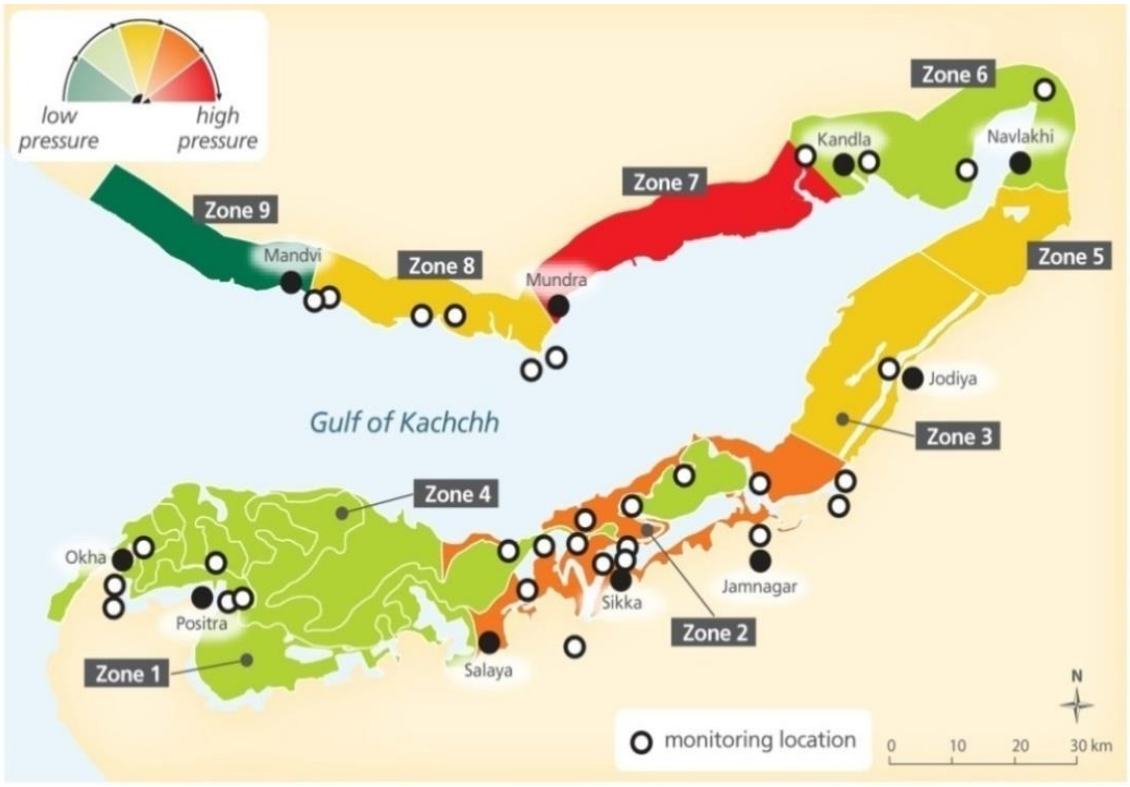
Quantify past and existing pressures and determine linkages to known impacts to enable forecasting of risks associated with future developments.

A methodology to reasonably foresee future development of the region is a critical component of the framework. This step addresses how the assessment framework will predict the likelihood and magnitude of future impacts (Fig.5) from new and/or growing activities in the Gulf, and the inevitable uncertainty entailed in doing so. This will require an understanding of what the relative contribution of new and/or growing activities will have towards the existing situation in the Gulf; what indicators and thresholds will be used to measure and assess this; and what specific government and/or company goals and management objectives exist or are proposed to address the activities' cumulative effects.

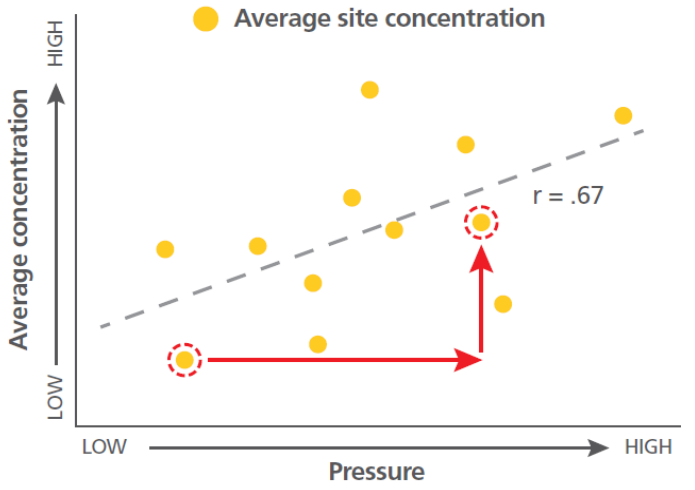
STATE OF THE ENVIRONMENT

Examine and describe the condition of the existing environment, identify vulnerable areas, and determine the carrying capacity of the system for current and expanded growth.

Status and trends: To prepare the foundation for the Cumulative Environmental Impact Assessment, a comprehensive state of the environment assessment will be required.Gulf of Kachchh zonation map, is well illustrated in figure 4.



Zonation Map of the Gulf of Kachchh



A statistical model can use a relationship of pressure to impacts to project future impacts if pressures are increased.

Linking Pressure to Impacts

iNTEGRATING RESULTS INTO ACTION

Consolidate and integrate information obtained from Steps 1 - 4 into a regional management plan that includes ongoing monitoring and assessment, continuous review, and adaptive planning.

Potential management recommendations for GoK

The types of management activities that may be required to reduce pressures on Gulf natural resources are described below.

Salt pans

• Improve efficiencies of salt production to produce less bittern.
• Recover useful chemicals from bittern.

Agriculture

• Encourage seaweed harvesting and cultivation in high nutrient influx area without affecting the core ecosystem by local communities.
• Encourage organic farming methods to minimize fertiliser and pesticide use.

Urban areas

• Improve wastewater treatment capacity and removal efficiency.
• Improve trash and solid waste collection.

Dredging

• Modernize dredging methods.
• Dispose of dredged material without plume generation, e.g., closed conveyance system.

Industry and ports

• Review industrial policies with regard to oil spill contingency plan.
• Require all ports to create Emergency Management Plans.
• Encourage zero discharge technology.

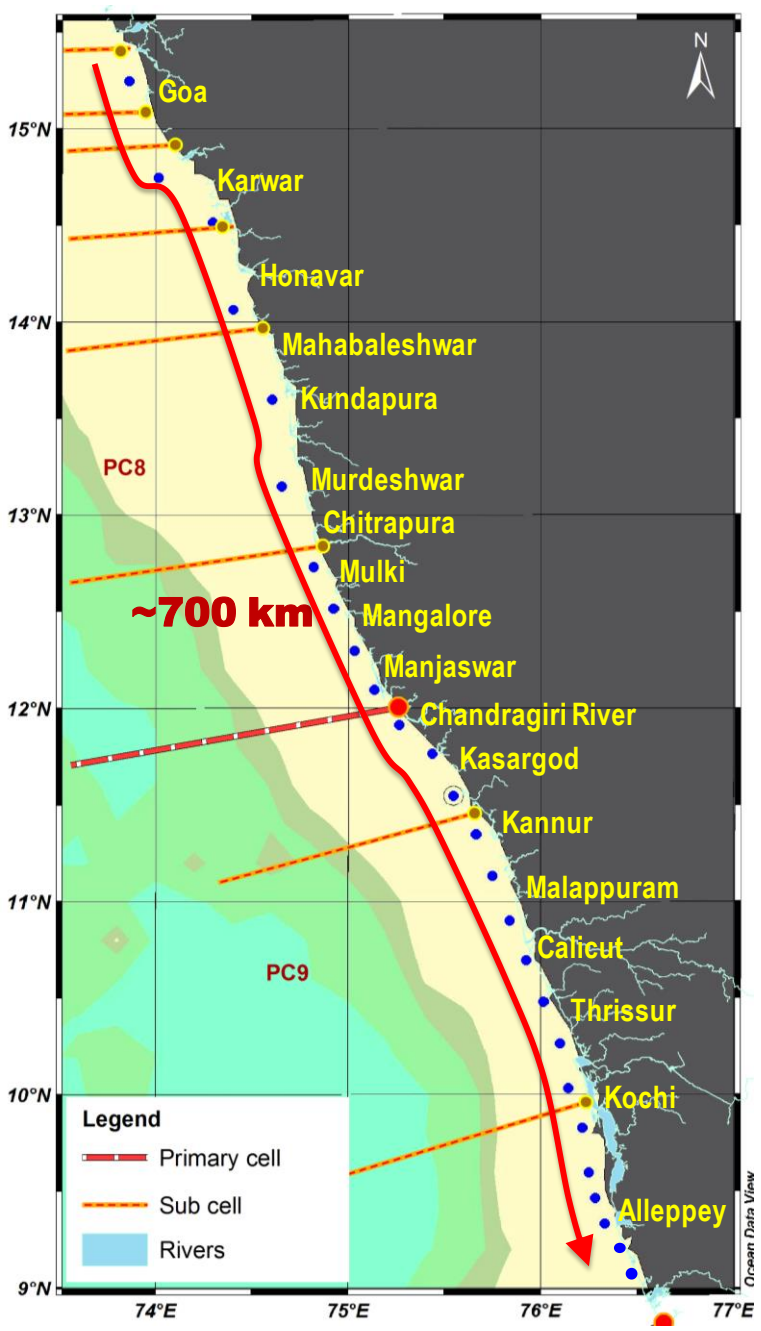
Fisheries

• Promote alternative livelihoods for local communities during monsoon season.
• Increase contiguous marine protected areas.
• Continue research on marine ecology and coral reefs.

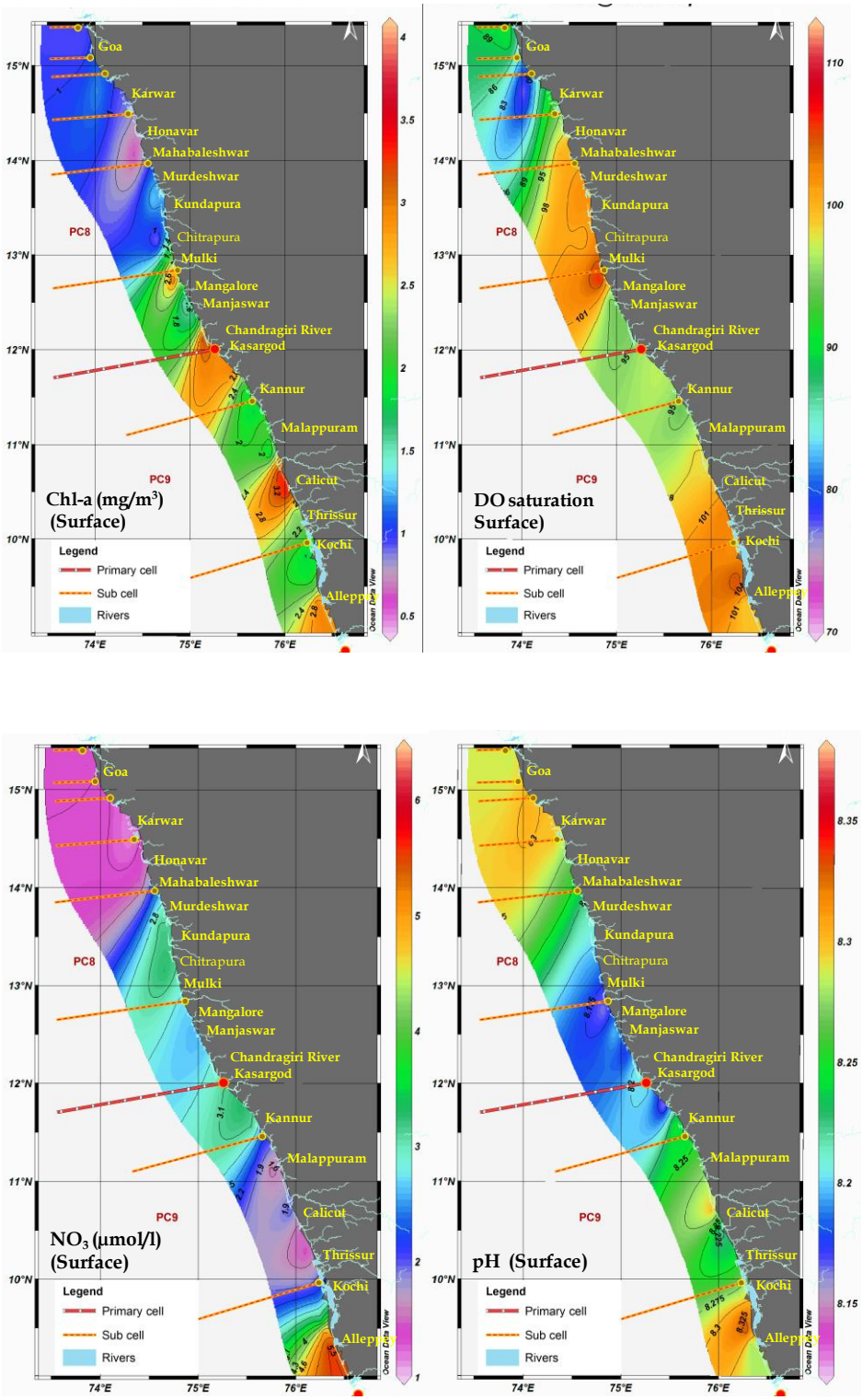
The present cumulative environmental impact assessment for the Gulf of Kachchh region is the first of its kind in India that provides a broad understanding of the key pressures and values of the region. The current assessment is based primarily on key stakeholder perceptions, and available secondary data and information. Efforts are on to conduct a detailed CEIA, based on the framework proposed in Fig. 1, with appropriate primary data and State of coast reporting.

Assessment of Cumulative Environmental Impacts along the southwest coast

As a part of the ACCES research study, environmental impacts of several cumulative coastal activities of west coast of India from Goa to Alleppey (Fig.6)was carried out. Water, sediment and biological samples were collected and analysed from various transects by undertaking a cruise on CRV*SagarPaschimi* (Coastal Research Vessel of *Ministry of Earth Sciences*) during the first week of May 2014 (Fig.7). Different transects have been segregated on the basis of sediment cell concept. Variation of physico-chemicalparameters with respect to sampling stations along the south west coast of India is shown in figure 8.

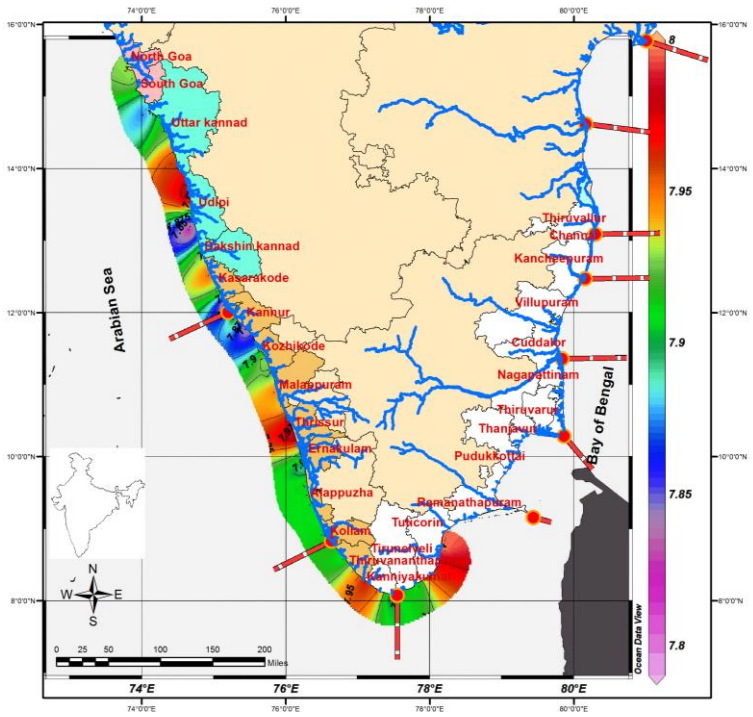


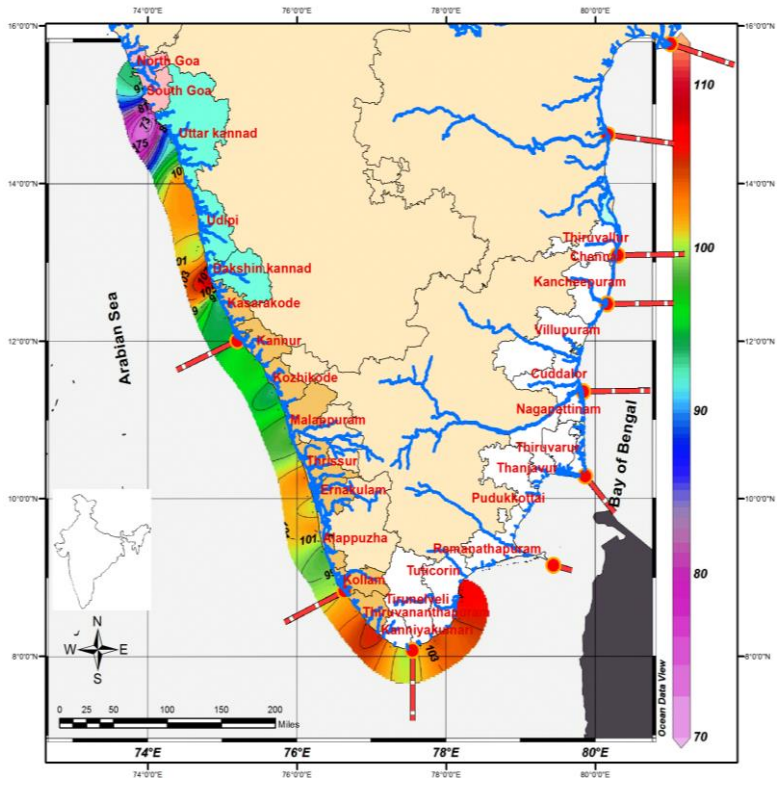
Location map of cruise programme (Goa to Alleppey)



Current status of major physico-chemical variables (surface and Bottom) along the south west coast of India

Spatial variation of pH and O_2 Saturation along the South West coast of India



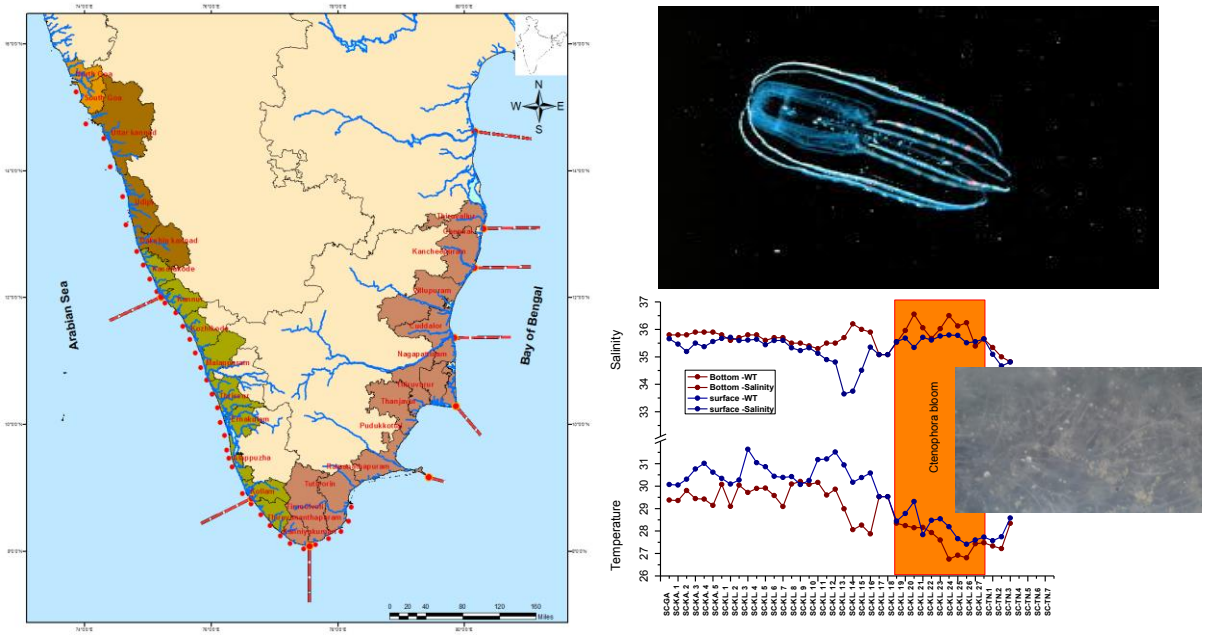


Spatial variation of Nitrite (NO_2^--N & DIP) along the South West coast of India

- NO_2^- concentration was high at the Mangalore.
- May be due to high organic load which gets re-mineralized and leached into the water column.
- Kanyakumari to Tuttukudi recorded relatively low (NO_2^--N)
- DIP concentrations recorded high at the mudbank region.
- Adsorption and desorption of phosphate and buffering action of sediment under varying environmental conditions.

The N:P atomic ratio observed during the study period showed a significant spatial and seasonal variation in the lagoon. The N/P Redfield ratio indicates surface coastal waters were N limiting.

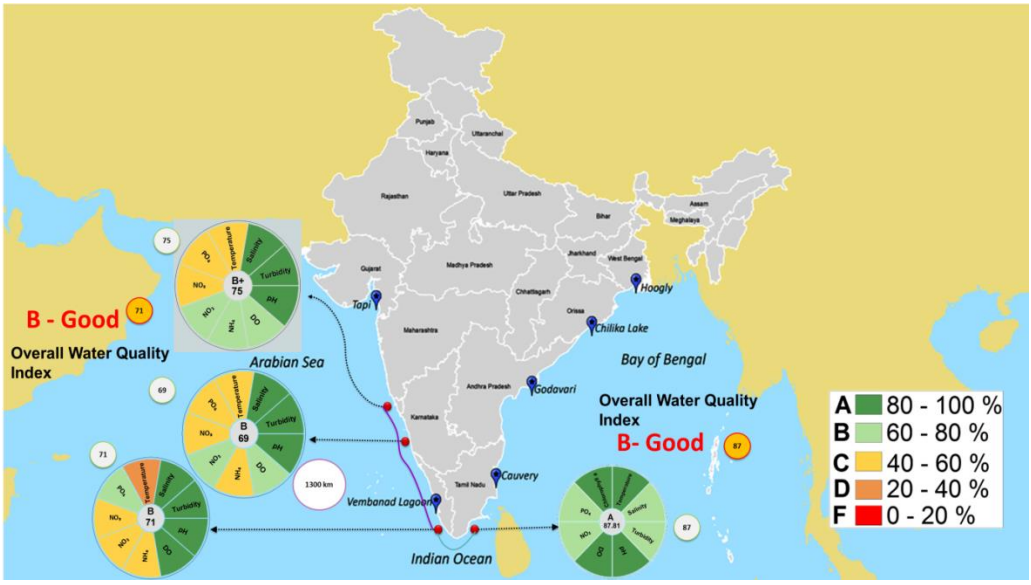
Ctenophore bloom along the southwest coast of India



Water quality index (WQI)

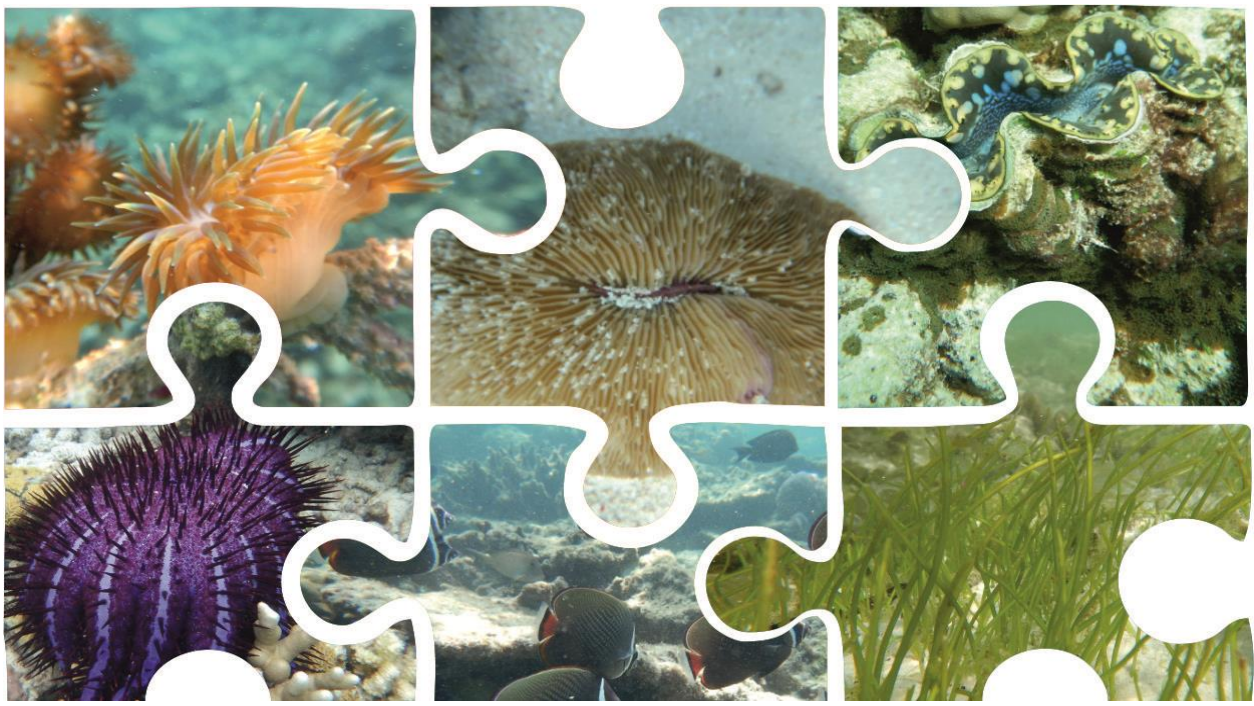
It is simple and easy to understandable for decision makers about quality and possible uses of any water body. It serves the understanding of water quality issues by integrating complex data and generating a score that describes water quality status. Water quality index is one of the most effective tools to communicate information on the quality of water to the concerned citizens and policy makers. It thus becomes an important parameter for the assessment and management of coastal and marine waters. The Water Quality Index combines the water quality threshold

scores (DO, SD, TN, TP and chlorophyll a) into a single overarching index. Good overall water quality is characterized by having high index scores and poor overall water quality is characterized by having low index scores.



Key Observations

- Dissolved Inorganic Nitrogen (DIN) and Dissolved Inorganic Phosphorus (DIP) showed linear relationship with Chlorophyll along the Southwest coast of India. High nutrient concentration is observed to influence enhanced phytoplankton primary productivity along these coastal waters
- Unusually high Dissolved Organic Carbon (DOC) concentration (5 mg l-1) is observed off Kochi due to discharge of untreated urban wastes directly into the coastal waters
- DIP concentrations were high (1.2 µmol l-1) in the mudbank region attributed to adsorption and desorption of phosphate and buffering action of sediment under varying environmental conditions
- Multivariate analysis indicates that chlorophyll and DOC are highly influential parameters along the Kerala coast
- For the coastal stretch between Goa and Tamil Nadu, cluster analysis indicates three major clusters a) Goa – Karnataka; b) Kerala c) Tamil Nadu
- The increasing dominance of deteriorating coastal water quality are as follows: Tamil Nadu > Karnataka-Goa > Kerala



Mapping of ecologically sensitive areas (esas) and critically vulnerable coastal areas (cvcas) along the coast of India

During the period from April 2015 - March 2016, major progress took place in the project under various packages such as validation of ESA maps, HTL maps, demarcation of highly sensitive areas (HSZ) among the ESAs, demarcation of CVCAs and addressing the gaps in Integrated Island Management Plan for Lakshadweep Islands. Validation of the HTL prepared by the State/UT Governments was carried out by NCSCM, by convening several meetings inviting the representatives of State/UT Governments, State Environment Departments and Coastal Zone Management authorities of all the coastal States/UTs. The draft CZMP / HTL data prepared by the State/UT Governments were overlaid and examined vis-a-vis the HTL prepared by NCSCM using the very high resolution aerial photography data covering the entire coastline and the HTL prepared by the State/UT Governments were validated online in the presence of the representatives of the State/UT Governments. During this period, technical review meetings were held upon to review the ESA maps such as horse shoe crab habitats, turtle nesting sites and coastal archaeological sites prepared with the inputs from Zoological Survey of India, Institute of Science, and Archaeological Survey of India

respectively and to review the marine protected area maps prepared by Wildlife Institute of India, Dehradun. During this period, field studies have been carried out extensively in the identified contiguous patches of mangroves, salt marsh along the Indian coast both by NCSCM and research Collaborators. Data collected from all identified contiguous patches has been submitted and data verification has been done by NCSCM for further analysis and assessment of conservation value to demarcate HSZs. During this period, primary household data were collected from the villages adjoining the CVCAs listed in CRZ 2011 notification using an android application by collaborating with different expert institutions viz., Centre for Environment Education (CEE), Ahmedabad (Gulf of Kachchh and Gulf of Kambhart in Gujarat; Coringa, Krishna and East Godavari in Andhra Pradesh; Karwar in Karnataka), College of Fisheries, West Bengal University of Fisheries and Animal Sciences (WBUFAS-COF), Kolkata (Sundarbans in West Bengal; Bitharkanika in Odisha), ICAR-Central Institute of Fisheries Education (ICAR-CIFE), Mumbai (Achra-Ratnagiri and Malvan in Maharashtra), Institute for Ocean Management (IOM), Anna University, Chennai (Gulf of Mannar in Tamil Nadu; Malvan in Maharashtra), College of Fisheries, Karnataka Veterinary, Animal Sciences and Fisheries University (KVAFSU-CoF), Mangalore (Kundapur in Karnataka) and ICAR-Central Marine Fisheries Research Institute (ICAR-CMFRI), Kochi (Vembanad Lake). Further during this period, as per the direction of the Honorable Supreme Court, several activities were undertaken and specific recommendations were drafted in the IIMPs prepared for ten inhabited islands in Union Territory of Lakshadweep by addressing the identified gaps. Delivered outputs were (i) shoreline change assessment along coast of Agatti Island, (ii) management plan for the conservation of corals and associated biodiversity in Lakshadweep, (iii) assessment on tourism carrying capacity of all islands, (iv) draft sustainable fisheries development plan for 2025 and (vi) recommendations for optimal use of alternative energy for energy security of all islands. The recommendations made by NCSCM based on the study have been notified by MoEFCC.

DEVELOPMENT OF COASTAL AND MARINE BIODIVERSITY INTEGRATION NETWORK (CoMBINe)

While significant work has been done on coastal biodiversity in India, a comprehensive national checklist of species is not readily available. The biodiversity databases in general and that of coastal and marine bio-resources in particular, are scattered among several institutes and agencies, built with incompatible data types. A capacity building initiative for the guidance and coordination of the Integrated Coastal Zone Management (ICZM) program in India, the Government of India with the aid of the World Bank, has set up the National Centre for Sustainable Coastal Management (NCSCM), based at Chennai, India. As part of its National Mission, the development of a biodiversity database for the coastal fauna and flora is/ was envisaged. The species documentation generally concentrates on the diversity of CRZ region (Coastal Regulation Zone) and extends up to the 12 nautical miles for the time being.

The database would include all macro plants (seagrass, mangroves, seaweeds) and animals (Phylum Porifera to Chordata) inhabiting the coastal regulation zone (I to IV) as defined in CRZ 2011 notification of India. Therefore, a comprehensive database and a nation wide web portal for biodiversity information are necessary in order to integrate data from diverse information resources. Thus, Coastal and Marine Biodiversity Integration Network (CoMBINe) an exclusive Digital repository for this purpose is anticipated to form the baseline database for the planning of various coastal zone management plans where, information on the coastal biodiversity is to be duly consulted. The CoMBINe is a unique coastal and marine biodiversity web portal that combines multiple databases in a single platform and allows user querying to garner a wealth of information about Indian coastal and marine flora and fauna, housed in biological repositories. The research study envisages to combine data from multiple, independent, heterogeneous datasets through novel approaches for querying, analyzing, modeling and visualizing. The CoMBINe database involves designing and developing the architecture; indexing and retrieving data housed in biological repositories; storing and disseminating biological and geo-spatial distribution information about organisms through orchestration and integration of biodiversity informatics.

CoMBINe uses the Darwin Core 2.0 metadata standard which is a standard for sharing data about biodiversity, which has a relatively long history of community development and is deployed widely. It is an extension of Darwin core and has a special customization to adopt to the taxonomy/specimen centric biodiversity practices and to the global practices of storing information of marine species covering all major areas of biodiversity. The valid coastal and marine organisms are first grouped into 20+ categories based on their broad morphological features and each such group would include different classes across phyla, key identification characters and attributes. A complete and comprehensive database is thus designed with 62 fields covering taxonomy, anatomy, biology, conservation, molecular, spatial, spectral and others. The Distributed Generic Information Retrieval (DiGIR) protocol will allow more precise data searches because it is designed to reduce information overload and extract common characteristics from all data sources in different formats. It is envisaged that the CoMBINe portal, the Indian biodiversity portal to be built as per International codes, would emerge as the national repository for coastal and marine biodiversity. Steps have been taken for developing the mobile portal of CoMBINe so as to integrate people and knowledge in real-time. Further, CoMBINe would help in identifying taxonomic and biological data gaps so as to steer focused research on coastal and marine biodiversity. The CoMBINe architecture would provide for integrating the biodiversity databases scattered among several institutes and local bodies with incompatible data types. The database architecture has been built as per international codes so as to share data between national and international sites. The primary purpose is to create a common language for sharing biodiversity data that is complementary and reuses metadata standards from other domains wherever possible. The back-end process in CoMBINe has two major components viz. (i) developing and sustaining a web portal to serve as a national repository for coastal biodiversity and (ii) developing and operationalizing an innovative schema for character-based field identification through re-engineering conventional taxonomy. CoMBINe is built on Darwin Core2.0 metadata standard along with Simple Object Access Protocol (SOAP), which is a request and response message format for communication between data provider, portal engine, and applications, by linking the metadata and the existing databases already available in different organizations. The adoption of SOAP enables data sharing between GBIF, OBIS, FishNet, MaNIS, HerpNET,

PaleoPortal and other international databases. CoMBINe utilizes Open Cloud configuration. This architecture enables the web servers to utilize the Cloud Block Storage for extra disk space. Cloud Load Balancers are also used in multiple levels of the application, balancing not only web workloads but application workloads as well. CoMBINe Application Server Architecture is a comprehensive design of the entire system, including all its sub-components and external applications interfaces. The architecture is designed in a way to access the application through a Web browser or a specialized user agent. The browser creates HTTP requests for specific URLs that map to resources on a Web server. The server renders and returns HTML pages to the client, which the browser would display. CoMBINe is designed keeping in mind the overall objective of integration, scalability and interoperability within the system, as well as with external systems. The present status of database includes more than 9000 species categorized into 26 shape based groups.

The "character/image based field identification" feature aims at taking the biodiversity information to all stakeholders as well as to create interest among them, irrespective basic understanding on taxonomy, through re-engineering conventional taxonomy, thus bridging the knowledge-divide. Based on these taxonomic characters, an interactive user friendly web interface is set up, which is updated by users after suitable validation from taxonomic grid in existence. The interactive protocol can be initiated from the geographic area of distribution and can scale up to its minute morphology which will ultimately help in distinguishing the species. It is envisaged to use appropriate tools to integrate image based identification of major groups of coastal and marine bio-resources. The data generated will aid in strengthening the knowledge-base on coastal and marine biodiversity of India, which would lead to renewed focus for conservation of marine biodiversity.

Current Status

Checklist

- Checklist completed for 23 Taxa (Preparation of checklists has helped in updating diversity)
- Checklists not available for many minor phyla – challenge!
- Manuscripts containing Taxa wise species checklists is completed for Echinoderms and Shrimps

- 6995 species of coastal/ marine flora and fauna have been uploaded with taxonomic content

Fact sheets

- 62 fields identified and a base template is followed
- Manual typing of species information from published monographs, field guides, research manuscripts, books etc. has been carried out for species with less or no information in websites/ webportals/ databases
- Standard check for collected species information
- Manual typing of species information from published monographs, field guides, research manuscripts, books etc.

Field Identification Characters

- Simple character based identification tool for end users
- Based on morphological close resemblances, 28 groups of marine flora and fauna identified
- Preparation of specific field identification characters for designated groups
- Validate in expert consultation meetings

eagrass, mangroves and salt marshes can capture two-thirds of the organic C in an oceanic environment signifying them as the most valuable carbon sinks on the earth. Carbon sequestration rate of seagrass ecosystem is 35 times faster than tropical rainforests, and their sediments never become saturated (McLeod et al. 2011).

Seagrass ecosystems are often CO_2 limited and photosynthetically less active in seawater, due to their inefficient utilization of bicarbonate (HCO^-_3 that forms the majority of dissolved inorganic carbon, for photosynthesis. Seagrass actively uses dissolved CO_2, thereby constantly increasing growth rates. With their potential to increase their productivity during the enrichment of CO_2, autotrophic seagrass has the capability to offset the ocean acidification, thus increasing the rate of calcification rates in the surrounding corals (Singh et al. 2015).

Significance of present study

In Indian scenario, there is a lacking in scientific studies on estimation of C stock in a salt marsh ecosystem, and salt marsh ecosystem has never been mapped properly. Furthermore, quantification of these greenhouse gas fluxes from the coastal wetlands under varying spatial and temporal conditions are still inconsistent in the Indian subcontinent. The East coast has been well studied and inventorized with respect to GHGs, whereas there have been very few studies from the west coast. Most of the studies have been carried out using different methodology, thus making the comparison more challenging. There is a strong need to assess the source/sink of GHGs using a universal methodology to elucidate the

actual role of these unique ecosystems towards the release of GHGs and its impact on regional/ global climate change.

The major challenges that need to be resolved include:

(i) Accurate estimation of coastal ecosystems that are considered as potential blue carbon areas

(ii) Estimation of the Carbon conversion rates (CO_2 to biomass) and Determination of individual ecosystem C stocks

(iii) Estimation of C storage time scale in these ecosystems

(iv) Source/sink assessment with respect to the greenhouse gases identification of key data uncertainties relevant to moving forward with conservation of blue carbon

The study BLUE-Cis conceptualized into three parts

- **Part A: Biogeochemical assessment of Carbon sequestration in coastal ecosystems.** This part will focus on the processes governing carbon dynamics in coastal ecosystems and will incorporate following field based and laboratory based measurements

- **Part B: Geo-Spatial assessment of Carbon sequestration in coastal ecosystems.** It will involve various work packages related to Satellite based Assessment of Carbon Sequestration

- **Part C: Prediction and projection of future trends in carbon dynamics under future climate change scenarios.** It will involve various numerical models to predict possible fate of existing C stocks with modification in coastal ecosystems (Loss/gain Assessment).

BLUE CARBON DYNAMICS

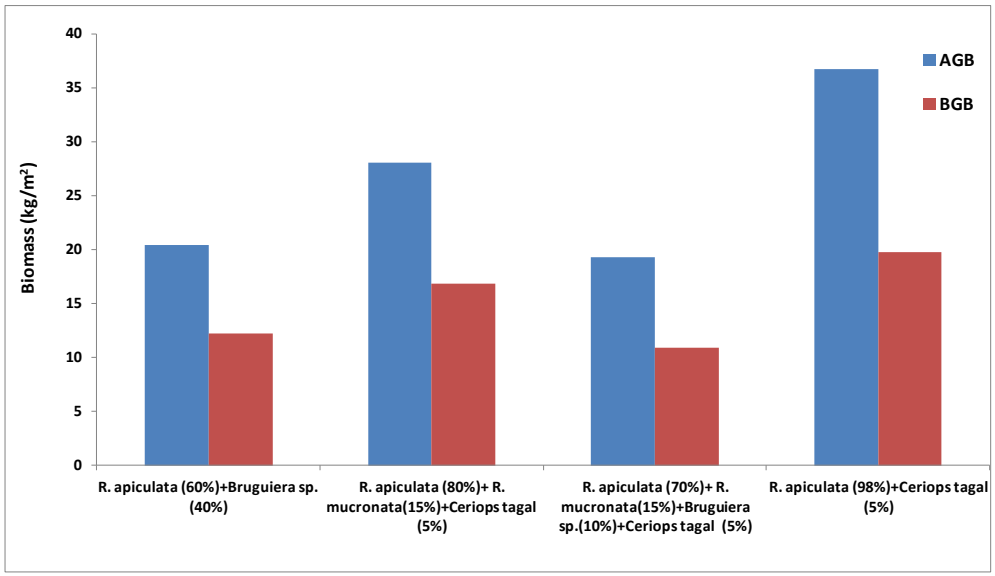
Blue Carbon Dynamics in Mangrove Ecosystems

Carbon storage capacity in the biotic and abiotic compartments of Andaman mangrove ecosystems was estimated. Live plant biomass were estimated for Kannur mangroves, Kerala. Sediment characteristics of Coringa Mangrove, AndhraPradesh, and Kannur mangroves, Kerala were also studied.

Carbon accumulation as biomasss

Kannur mangroves

Estimates of above ground biomass (AGB) were made using published equations (Zanne et al 2009). Conversion from biomass to carbon was achieved through dividing biomass by the carbon fraction of 50% (Gifford 2000). Observations on the nature and condition of the mangrove vegetation were made, along with the collection of data using a rapid field assessment methodology. A total of 41 trees were recorded in the survey plot representing an area of 70 m2. Three species were found at the site: Avicennia marina, Rhizophora apiculata, Bruguiera parviflora. The diameter at breast height of the mangroves species in the plot varied from 3.2 cm to 25.5 cm, and the height ranged between 2m and 10m.



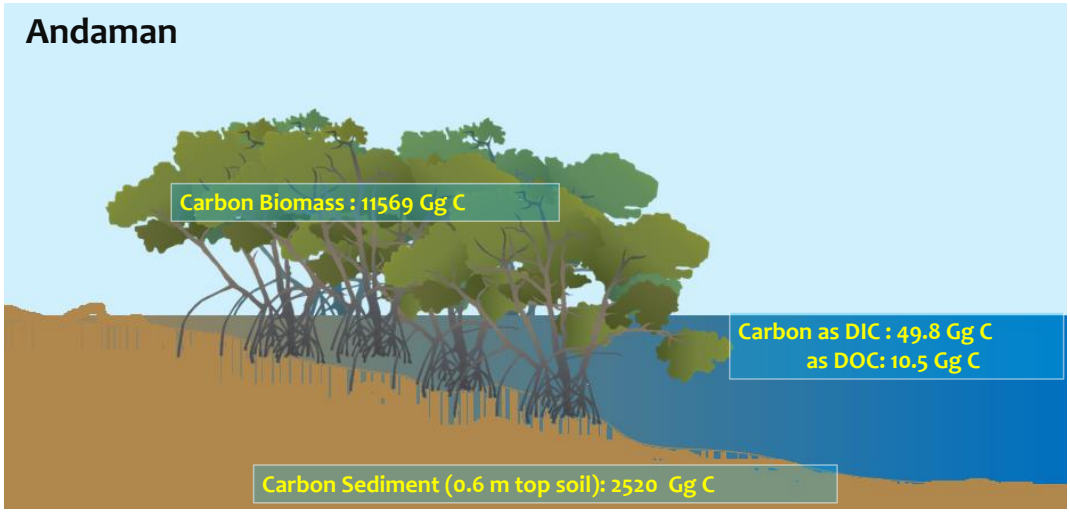
Above ground biomass (AGB) and Below ground biomass (BGB) in different mangrove patches of Andaman

Total above-ground biomass of the trees estimated based on equation in the studied plot ranged from 3.2 to 470 kg (1.3 to 190 kg dry wt.). Similarly estimated below-ground biomass of the trees in the plot ranged from 2.0 to 170 kg (0.8 to 72 kg dry wt.). Overall the total above ground biomass and below ground biomass estimated from the plot is 2141 kg (856 kg dry wt.) and 933 kg (373 kg dry wt.). Total carbon from the calculated biomass for both AG and BG from the plot was 5.26 and 2.29 kg m-2 respectively. These values are further extrapolated for the total mangrove area in (600h) Kerala region and estimated total carbon storage of 3.16 & 1.37 (x 103 tonnes) from both AG and BG mangrove biomass. Since this

sequestration only accounts for the mangroves vegetation only, further its impact in the sediment pool as sediment carbon storage studies are in progress.

Andaman mangroves

To better understand the dynamics of organic matter cycling in the mangroves; it is important to know the amount of biomass that is present in the vegetation covering at a given time. Hence, to estimate the mangrove biomass of Andaman, 4 Quadrate (10 m x 10 m) surveys were conducted. A total of 94 individual data (*Rhizophora apiculata* - 75; *Bruguiera* sp. – 8; *Ceriops tagal* – 7; *Rhizophora mucronata* – 2) were collected.



Carbon stocks in Andaman Mangroves

Organic Carbon Dynamics in Mangrove Sediments

Coringa Mangroves

The sediments were mainly dominated by silty in Coringi and Gaderu creeks. Sand, silt and clay content varies from 1.9 - 20.8; 77.7 - 96.3 and 1.5 - 1.8 (%) in Coringi creek and from 1.1 - 96.1; 2.0 - 96.7 and 0.9 - 3.3 (%) in Gaderu Creeks. As per the Folk ternary diagram (Flemming 2000) sediments showed variable textural facies mainly silty in Coringi estuary and sandy, clayey sand, sandy mud, silty in Gaderu creeks. Clayey sand is dominated in Coringi sediments and silt, sandy silt, silty sand and sand in Gaderu sediments. The uneven

admixture of sand, silt and clay fractions among the stations from the study area reflect variable transportation and accumulation patterns existing in the estuaries.

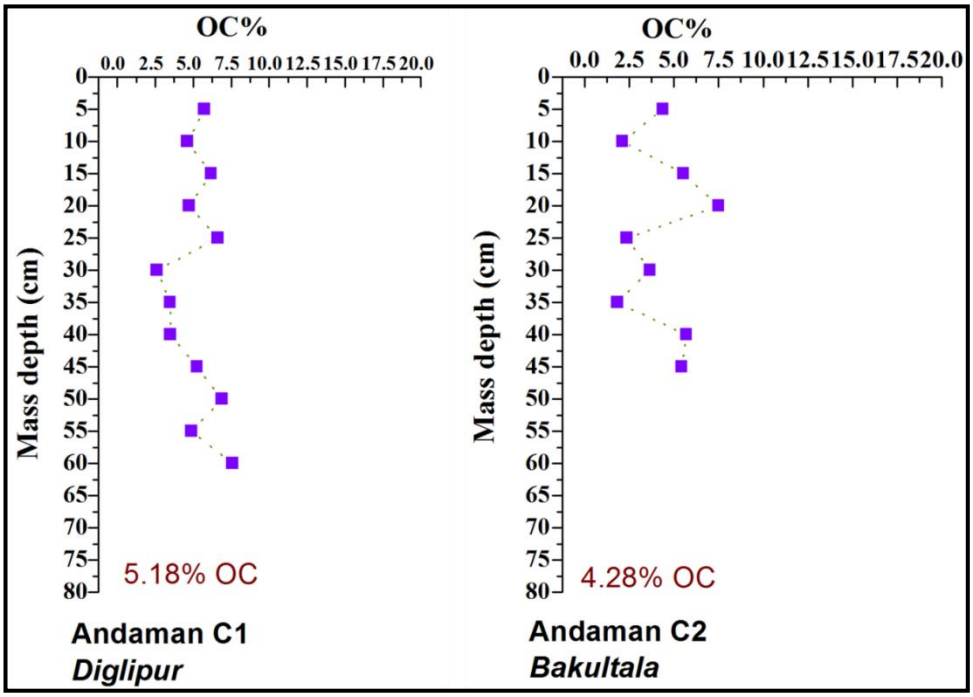
Kerala mangroves

The sediments were mainly dominated by Sandy (sand+ silt) in Valapattanam (VA) and Dharmadam (DH) except at some stations in the DH. Sand, silt and clay content vary from 1.7 - 92.6; 5.1 - 84.0 and 1.0 - 57.2 (%) in DH and from 1.7 - 92.6; 5.1 - 84.0 (%) in VA estuary. As per the Folk ternary diagram (Flemming 2000) sediments showed variable textural facies mainly sandy, clayey sand, sandy silt, muddy sand in DH estuary and sandy, clayey sand, sandy mud,silty in VA estuary. Clayey sand is dominated in DH and sandy type sediments were dominated in VA region. The admixture of sand, silt and clay fractions among the stations reflect variable transportation and accumulation patterns existing in these estuaries. Organic carbon (OC) distributions in the estuaries display a wide variation from 0.09 to 2.93 % with mean values of 0.95 ± 0.78 %. DH sediments showed slightly higher organic carbon (0.97 ± 0.65 %) fraction compared to VA estuary. The distribution of OC is mainly dependent on the sediment grain size due to the higher surface area of finer fractions (Rodriguez-Barroso et al 2010). This is observed from their positive relationship with mud (0.95) and a negative correlation with sand fraction (-0.94). Higher OC values were observed at stations, especially near the areas affected by sewage and anthropogenic activities. OC accumulated regions are evidenced with high CH_4 concentrations as reflected with the positive correlation (+0.32) with OC and CH_4.

Carbon Sequestrationin Mangrove

The organic carbon (C_{org}) stores of coastal vegetated habitats are dominated by the C stored in their organic-rich soils (Kennedy et al. 2010). The C stores of mangroves have been estimated to be 1,023 MgC ha^{-1} (Donato et al. 2011). In the present study, we quantified C storage in mangroves sediments in Andaman Islands, with the geographic core of mangrove area (604 km^2). Below-ground C storage in Andaman mangroves has been quantified from two mangrove cores (avg. height 50 cm), one from Diglipur – North

Andaman and one from Bakultala- Middle Andaman. In both the places *Rhoziphora apiculata* is a dominant (80%) species. The amount and origin of organic carbon in mangrove sediments are mainly influenced by both physical (e.g., tidal amplitude) and biological (e.g., consumption, removal, degradation) factors (Bouillon et al. 2003). Vertical profile distribution of organic carbon (OC) was studied in sediment cores collected from Andaman mangroves. Average values of sediment organic carbon (% dry weight) were observed to be very high (4.3 – 5.2%) throughout the top metre of the soil profile (Figure 6.1.3).



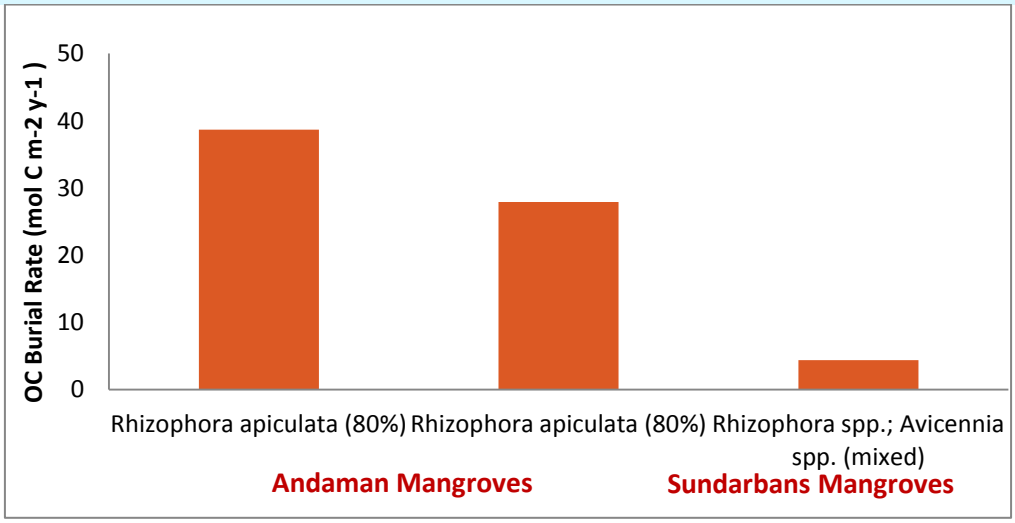
Sediment Organic carbon distributions in Diglipur and Bakultala cores of Andaman mangroves

The values of OC obtained in this study area are comparatively higher than those reported (2.78%) for various tidal and estuarine regions of southeast coast of India (Achyuthan et al. 2002). Soil bulk density (BD) did not differ significantly between two cores (generally 1.63 g cm^{-3}). Sedimentation rate in Diglipur and Bakultala were found to be 5.5 mm y^{-1} and 4.8 mm y^{-1}, respectively (Figure 6.1.4). The sedimentation rate in Andaman mangroves is comparable with other mangrove systems like Sundarbans Mangroves 3.0 – 4.8 mm y^{-1} (Banerjee et al., 2012); North Australian mangroves 6 mm y^{-1} (Woodroffe, 1990). Organic carbon (OC) burial rate in Diglipur and Bakultala were 38.70 mol C m^{-2} y^{-1} and 27.91 mol C m^{-2} y^{-1},

respectively (Table 6.1.1). The organic carbon burial rate in Andamans is 6 to 9 times higher than the Sundarbans mangroves caused due to 6 times higher OC content in the mangrove sediment.

Table Sediment mass accumulation rate (MAR) and organic carbon content(%) in Andaman mangroves

Core Code	Type of Mangroves	MAR (g cm^{-2} yr^{-1})	OC %
Andaman-Diglipur	*Rhizophora apiculata (80%)*	0.90	5.18
Andaman-Bakultala	*Rhizophora apiculata (80%)*	0.78	4.28
Sundarbans	Rhizophora spp.; Avicennia spp. (mixed)	0.67	0.79



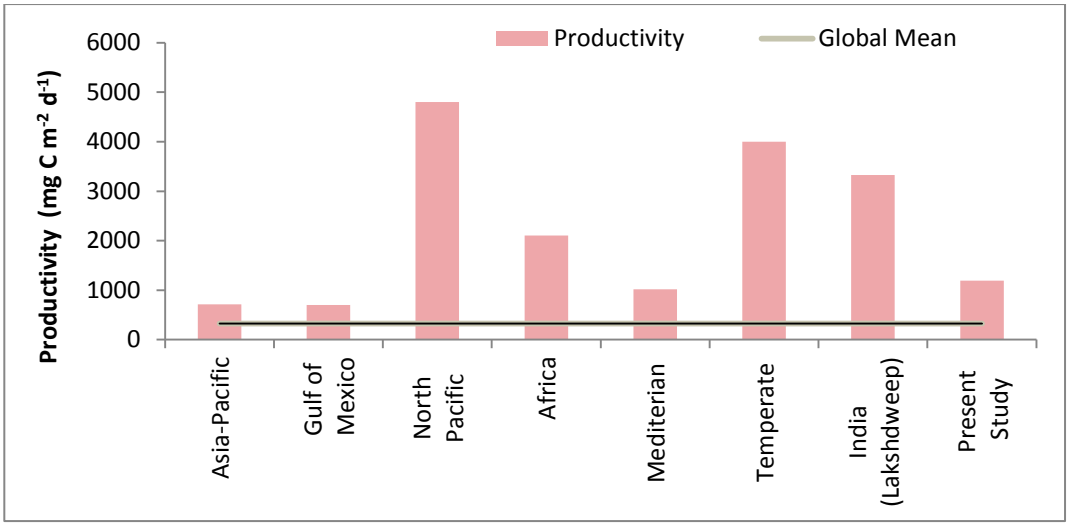
Organic C burial rates in Andaman mangroves with comparison Sundarbans mangroves

Blue Carbon Dynamics in Seagrass ecosystems

Ecosystem metabolism

Net productivity (NCP), gross primary productivity (GPP) and respiration(R) were calculated for each day from the data collected during dry and wet season. High community metabolism in seagrass meadows is common, with higher primary productivity rates in tropical meadows as compared to temperate ones (Duarte et al., 2010). In mixed seagrass bed (station 2) GPP, R and NCP were high in both the season as compared to *Cymodocea* sp dominated bed (station 1). Water column productivity by the available phytoplankton community was measured from discrete *in situ* incubation experiment. It was observed that during the dry season the water column metabolism followed a reverse trend to that of the net community metabolism. The magnitude of water column productivity was several folds lower than the net ecosystem metabolism Additionally, the water column productivity observed in Palk Bay (range -14.6 to 8.3 mM C $m^{-2}d^{-1}$) was significantly lower than the global mean of phytoplankton primary production of world's estuarine-coastal ecosystems (29.49 mM C $m^{-2}d^{-1}$, Uitz et al, 2010). Discrete measurements of GPP and R suggested that water column changed from net heterotrophic in dry season to net autotrophic in wet season (P:R ranges 0.57 to 1.36). Furthermore, water column productivity was recorded high in the wet season as compared to the dry season. The increase in the P:R ratio from dry to wet season can be attributed to the ecosystem response to nutrient enrichment during wet season. In contrary, the seagrass ecosystem at Palk bay remain highly productive system, where net community GPP exceeded R, throughout the study period (annual P:R ranges 1.5 to 1.56).

Rates of GPP and R for this system were comparable to those measured in other studies of temperate and tropical seagrass systems. The calculated mean NCP values form Palk bay seagrass meadows (99.31 $\pm$ 45.13 mM C m^{-2} d^{-1}) were well above the global mean NCP (27.17 mM C m^{-2} d^{-1}) reported from seagrass meadows by Duarte et al (2010).



Figxx: Comparison of net community production between various seagrass ecosystem in the world

Slow growing seagrass ecosystems are associated with higher NCP in the dry season, which is in association with higher PAR, water temperature and lower dissolved nutrients. In contrary, the water column productivity, dominated by fast growing phytoplankton community showed a reverse seasonal trend, with high values in the wet season. Contribution of biological activity (photosynthesis plus respiration) on O_2 concentration during daylight at an hourly basis was computed after removing the contribution of the air–sea fluxes from the measured values between two successive hours.

$$\left(\frac{\Delta O_2}{\Delta t}\right)\text{bio} = \left(\frac{\Delta O_2}{\Delta t}\right)\text{measured} + \left(\frac{\Delta O_2}{\Delta t}\right)\text{air} - \text{water}$$

To evaluate the relative role of water temperature, pH, nutrients, pCO_2 and hourly PAR, on the biologically produced O_2 during the daytime $((\Delta O_2)/\Delta t)_{bio}$, the stepwise multiple regression procedure was applied. Calculated values of $(\Delta O_2/\Delta t)_{bio}$ from hourly collected ambient $O_2$was the dependent variable and corresponding water temperature, pH, nutrients, pCO_2 and hourly PAR were the independent variables.

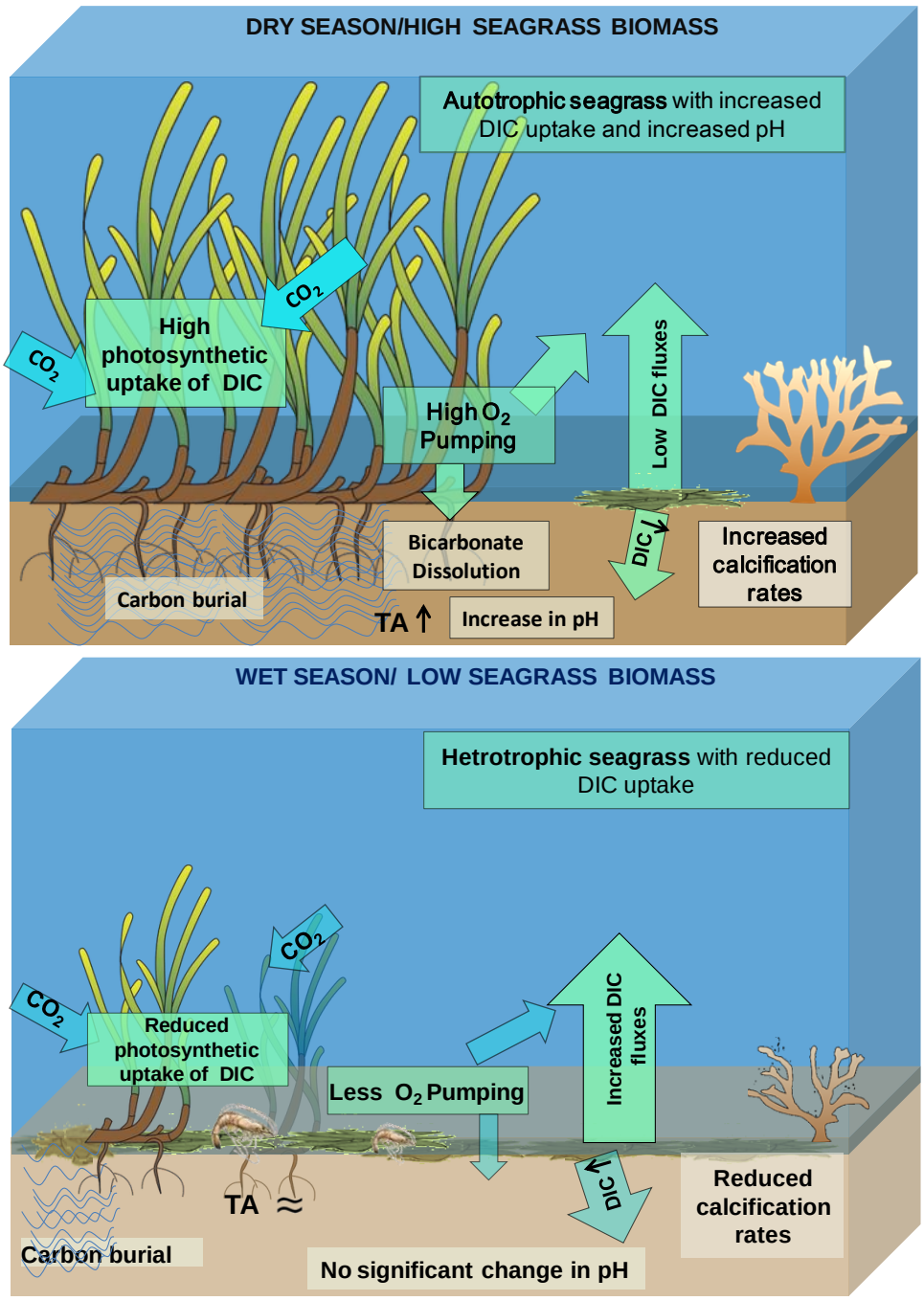
$(\Delta O_2/\Delta t)_{bio}$ = - 32 - 2.81 T_w + 4.0 pH + 0.519 SPM + 0.278 DIN + 18.4 DIP + 0.0622 $_pCO_2$ + 0.0180 PAR.

Explained variability of $(\Delta O_2/\Delta t)_{bio}$ was found 1.6 % for water temperature, 8.7% for pH , 12.4% for SPM, 0.1% for DIN, 8.9% for DIP, 24.4% for pCO_2 and 26.8% for hourly PAR. These results

support the greater dependence of seagrass dominated net ecosystem productivity on pCO_2 and PAR as compared to the other physicochemical parameters such as temperature, pH and dissolved nutrients. This indicated the variations in the dissolved oxygen, produces as a result of metabolic activities and is largely controlled by pCO_2 and available PAR, together. Russell et al (2013) has mentioned that under elevated concentrations of CO_2 conditions, the seagrass productivity and growth will increase followed by long time burial of the sequestered carbon as the below-ground biomass. This observation was well supported by our observations with the highest productivity in the seagrass meadows during the early morning hours when CO_2 concentrations were relatively higher than the rest of the day. Carbon pool and fluxes in the seagrass meadows in Palk Bay was given in figure 6.2.3.

Seagrass and carbonate chemistry, inter-linkage with corals

In coastal environment, there exists a novel linkage between corals and seagrasses, either as isolated colonies, or forming a gradient of habitat from reef to seagrass. With their potential to increase their productivity during the enrichment of CO_2, autotrophic seagrass has the capability to offset the ocean acidification, thus increasing the rate of calcification rates in the surrounding corals.



igure XX Conceptual diagram depicting the role of seagrass ecosystem on water chemistry and uptake of DIC (redrawn from Unsworth et al., 2012)

The DIC is effectively consumed by high photosynthetic activities, thus resulting in an increase in pH. However, the exact mechanism influencing the coral calcification is widely unknown various studies have pointed out the role of aragonite saturation for calcification, whereas recent studies have suggested bicarbonate and pH may play a decisive role (Figure 6.2.3) (Unsworth et al. 2012). Detailed studies in temporal and spatial

variability are needed to reach conclusive argument with respect to seagrass-seawater interactions.

DIC (sum of CO_3^{2-}, HCO_3^-, and aqueous CO_2 concentration) ranged between 1880 -2057 (µM kg^{-1}) in the study area with a maximum diurnal variation of ~8%, recorded during the dry season in the station 2. The carbonate system (pH, DIC, and aragonite saturation state (Ω_{Ar})) and O_2 within the meadows displayed strong diel variability driven by primary productivity, and changes in chemistry. Oxygen production by photosynthesis during the day directly influenced the carbonate system in the meadow, as there was a strong correlation between O_2 (in µmol kg^{-1}) and DIC (in µmol kg^{-1}) in the canopy with a daytime relationship for all the experimental sites of −0.90 µmol DIC/µmol O_2 (r^2 of 0.82). The combined inputs of DIC from the water column and benthic seagrass respiration during night time were estimated using changes in DO over the diurnal cycle (Figure 6.2.4) and it was observed that the values were in agreement with those expected for aerobic heterotrophic respiration (i.e., 1 mmol CO_2 produced per 1 mmol O_2 consumed).

The value of Ωarag was lower in the wet season, with mean values approximately 27% lower than the dry season. During the dry season, the Ω_{arag} values became extremely high in day time due to enhanced seagrass productivity. The highest Ωarag values (5.09±0.68) were comparable with that of the surface water of the Changjiang plume area, East China Sea (~5.8) in summer (Chou et al, 2013). On an average a diurnal variation of ~15% was recorded for Ω_{arag} in this study. Jokiel (2011, 2013) represented the [DIC]: [H^+] ratio as a measure of relative availability of reactant (inorganic carbon) in relation to the concentration of inhibitory calcification waste product (protons) in the bulk water surrounding the calcifier.

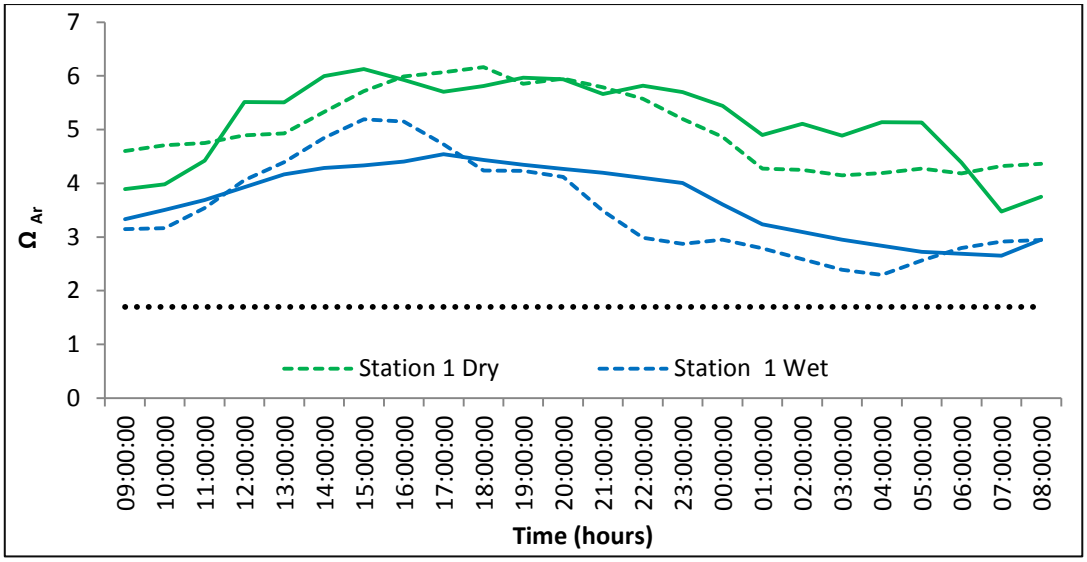


Fig. 6.2.5: Diurnal variations of aragonite saturation during dry and wet seasons in the Palk Bay water (Black dotted line represents the stress threshold below which the larval growth of shellfish becomes negative)

The present study indicates a relatively larger daily duration of high pH values mostly attributed to the seagrass productivity can contribute to the calcified organisms and associated the structural services they provide. Crook et al, (2013) earlier showed that calcification rates decrease significantly along a natural gradient in pH and aragonite saturation (Ω_{arag}). [HCO_3^-] has been identified as the preferred substrate for photosynthesis (algae) and calcification (Roleda, Boyd & Hurd, 2012 and others), whereas [CO_2] identified as the preferred substrate for photosynthesis for seagrass (Martin et al., 2008, Russel et al, 2013). Therefore, positive NCP in the seagrass bed simultaneously can increase the pH and Ω_{arag} as well as can shift the equilibrium between [HCO_3^-] and [CO_2]This result support the potential of seagrass meadows in offsetting ocean acidification impacts at the local scale (Anthony, et al 2011).

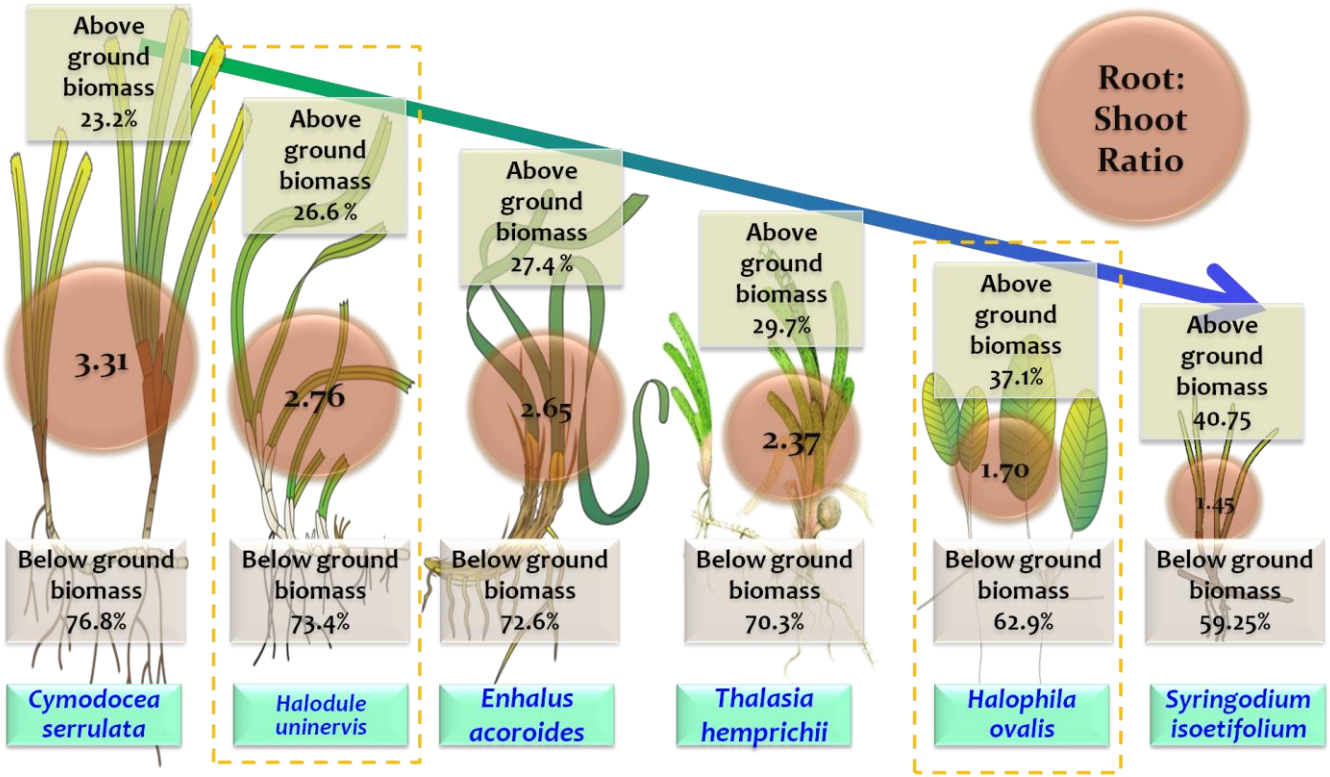
Role of Biomass in carbon sequestration

Seagrass was divided into above-ground biomass (AGB; leaves/sheaths) and below-ground biomass (BGB; roots/rhizomes). All material retained by the 3-mm mesh (excluding algae, mangrove leaves, Rhizophora propagules) was collected. All seagrass and detrital samples were oven-dried (90°C, 24 - 48 h) and weighed.

Samples were not treated with acid because there was little epiphyte contamination. Dry biomass of individual species (mean) we given in table 2, which represents the clear dominance of BGB over AGB for most of the species except *Cymodocea rotundata*. Above ground biomass varied between 21.6 and 47.44 g dry wt m^2 and below ground biomass between 37.06 and 63.6 g dry wt m^2. The ratios (dry wt.) of below to above ground biomass ranged between 0.92 and 3.27 (Fig. 6.2.6). Total carbon content in the dry seagrass biomass was measured by an elemental analyzer and finally expressed in terms of carbon. The below ground biomass was found higher than its counterpart in all the species except *Cymodocea rotundata*. The below-ground biomass of primary producers with root systems can be buried for centuries to millennia centuries to millennia. This makes the seagrass ecosystem a potential CO_2 sink and can be effective in mitigating the negative impacts on the ocean ecosystems during ocean acidification events. Organic carbon in the top 1 m of seagrass soil was measured and it varied from 2 to 0.44 % in *Cymodocea* sp. bed, whereas in *Syringodium isoetifolium* bed, it varied from 0.83 to 0.43%.

Other than biomass, carbon can be present in an ecosystem in different forms (both inorganic and organic). A large fraction is present in dissolved condition and the rest remains as particulate form. The amount of carbon present in the seagrass covered area (85.5 km^2) at Palk Bay (Average depth ~2m) in the form of dissolved inorganic carbon is calculated to be 4480 Mg C and as dissolved organic is 840 Mg C. Considering the total area (85.5 km^2) covered with thick seagrass vegetation (>70%) live biomass was calculated to be 2,524 Mg C in Palk Bay

Figure 6.2.6: Partitioning of carbon in the different compartment of seagrass ecosystem in the Chilika lagoon



This present study showed *that Cymodocea serrulata* was the dominated species, followed by *Syringodium isoetifolium*, *Enhalus* sp., *Cymodocea rotundata* and *Halodule pinifolia*. Reduction and degradation of the seagrass ecosystems were reported from northern Palk bay recently by Govindasamy and Arulpriya (2011).
Efforts have been made to quantify the carbon standing *stock* at a single point in time as a measure of watershed condition in the seagrass ecosystem in Chilika Lagoon. Two major species of seagrass (1. *Halophyla ovalies*, 2. *Halodule uninervis*) were studied for this purpose. Dry biomass of individual species (mean) was given in table 2, which represents the clear dominance of BGB over AGB for both *Halophyla* sp. and *Halodule* sp. These results indicate the efficient transport and storage of sequestered carbon (through photosynthesis) from the above ground to below ground part by the seagrass. Seagrass is also known for slowing down currents near the bottom, which increases the deposition of small sediment particles and decreases their erosion and re-suspension.

Seagrass roots also play an important part in stabilizing sediments and limiting disturbance caused by burrowing deposit-feeders. In spite of receiving lower amount of sediment and fresh water input, the sedimentation rate of the southern sector (with high abundance of seagrass) was found higher than that of the central sector of the lagoon.

Organic carbon in the top 1 m of seagrass soil was measured and it varied from 1.54 to 0.32 % in *Halophyla* sp. bed, whereas in *Halodule* sp. bed, it varied from 1.54 to 0.45%.The amount of carbon present in the seagrass covered area (~80 km^2) at Chilika Lagoon (Average depth ~1.5 m) in its various forms was calculated from the initial data. The fraction of dissolved inorganic carbon is calculated to be 2,652 Mg C and as dissolved organic carbon is 771 Mg C. Considering the total area (85.5 km^2) covered with thick seagrass vegetation (>70%) live biomass was calculated to be 2,375 Mg C in Chilika lagoon.

Carbon Sequestration in Seagrass Sediment

Seagrass meadows occupy less than 0.2% of the area of the world's oceans, and are estimated to bury 27.4 Tg C y^{-1}, which is roughly 10% of the yearly estimated C_{org} burial in the oceans (244 Tg C y^{-1})

(Duarte et al., 2005). A portion of the C that accumulates in seagrass meadows derives from excess photosynthetic carbon fixation within the meadows, some of which is placed directly into the sediments as roots and rhizomes. Seagrass meadows develop organic-rich soils composed of both autochthonous and allochthonous C_{org} (Kennedy et al. 2010).

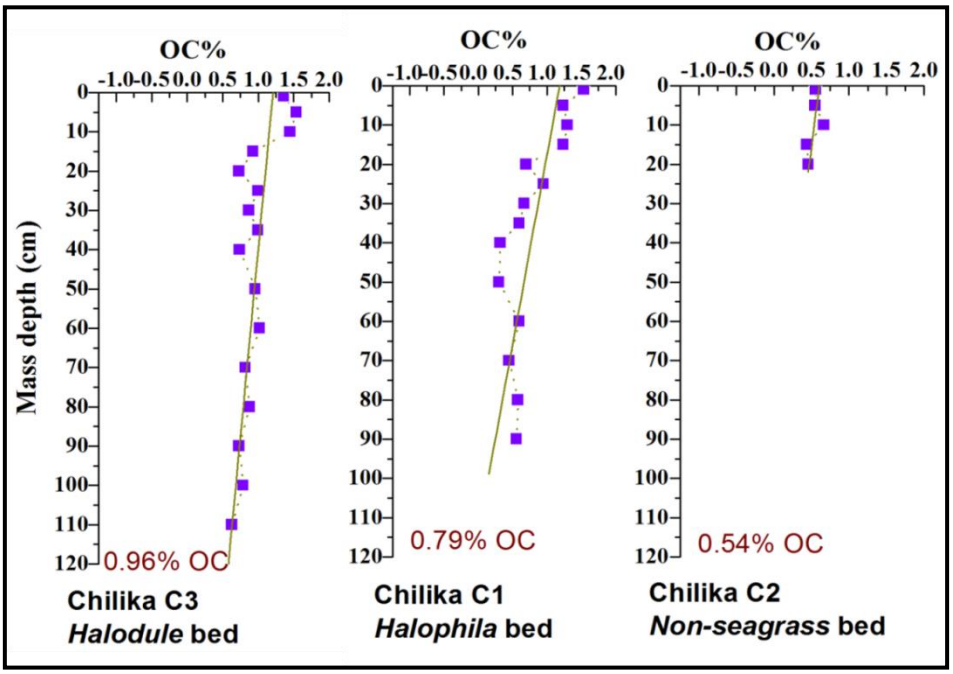


Figure XX Sediment Organic carbon distributions in Halophila, Halodule beds and in non-seagrass zones of Chilika Lagoon

Seagrass soils are largely anaerobic in nature, hence supports long term preservation of C_{org} in the soils for millennium scale. The data on the distribution of C_{org} from seagrass meadows are geographically biased owing to an imbalance in the research effort across regions (Orth et al., 2006). One recent study by Fourqurean et al. (2012) showed that there are no data available from the Indian region related to the C sequestration in the seagrass sediment. Our present study focussed on the organic C burial rate from two major Indian seagrass patches, i.e., Chilika lagoon and Palk Bay.

Southern sector of Chilika lagoon is dominated with seagrass meadows, with major species dominance of *Halophila* sp., *Halodule* sp. Two sediment cores (Avg. height ~ 1 m), each from *Halophila* and *Halodule* zones and one from non-seagrass zone were collected for comparison purpose. Depth-wise C_{org} distribution (upto 1 m) in all the cores is presented in Figure 6.2.7. Results shows that *Halodule* sp. is

more efficiently holding organic C in their soil compared to *Halophila* sp., whereas, sediment from non-seagrass zone contains the least. Sediment accumulation rates in seagrass beds are shown in Figure 6.2.8.

Similarly, in Palk Bay region two sediment cores (avg. height – 45 cm) were collected from dense seagrass beds, one from *Cymodocea* bed and another from mixed seagrass (*Cymodocea and Syringodium) zones. Depth profile of* C_{org} and sedimentation rates was shown in Figure 6.2.9 and 6.2.10. The overall carbon storage in the soil reservoir of Palk bay seagrass ecosystem is estimated to be 2.44 Tg C in the top 1 meter depth (assuming an area of ~175 km^2). Assuming the mean C burial rate of 5.35 mol C m^{-2} y^{-1} in the Palk bay seagrass ecosystem the mean turnover time of organic carbon in the sediment was found to be 1,162 years.

Carbon storage in the seagrass ecosystem

Palk Bay

A foremost part of the photosynthetically fixed carbon is transported as long-term storage to the sediments, underlying the seagrass meadow. Sediment organic carbon (top 60 cm soil) showed a greater concentration of 1.01 ± 0.25% in the dry season than in the wet (0.93 ± 0.29%) with an average bulk density of 1.36 ± 0.15 gm cc^{-1}. The dry bulk density (DBD) was significantly higher than the global mean (1.03 ± 0.02 g cc^{-1}), whereas the C_{org} of seagrass sediments was significantly lower than the global mean of 2.5 %. Assuming that the mean DBD and mean C_{org} content of soils in our database represent the central tendency of the top meter of all seagrass soils in Palk Bay, total organic carbon content of the top 1 meter of seagrass sediments contains 139.6 Mg C_{org} ha^{-1}. A decrease in C_{org} was observed with depth at the rate of −0.012 cm^{-1} whereas an increase in DBD was observed (4.9 ± 1.2 mg dry wt. ml^{-1}) cm^{-1}. A relatively higher rate of organic carbon depletion along the sediment depth could be attributed to the shallow, oxic water column and sediment texture dominated with sandy-clay substrate.

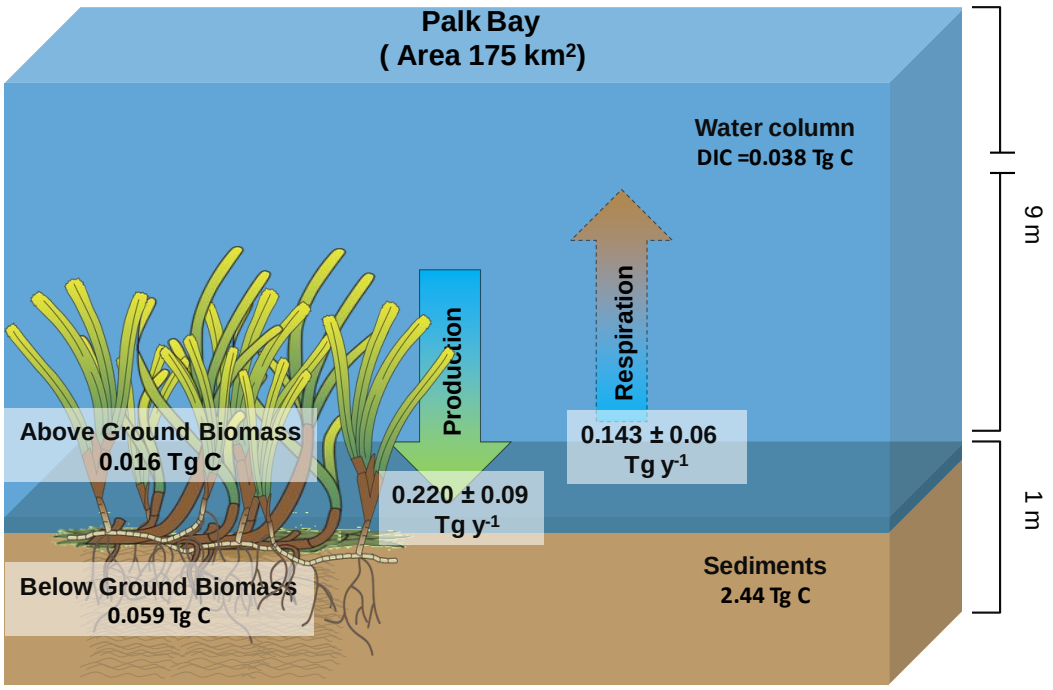


Fig. xx: Carbon pool and fluxes in Palk Bay

Manikandan et al (2011) quantified above-ground seagrass biomass, which ranged between 70.77, 129.16 and 163.75 g dry wt m^{-2} at near shore, middle and offshore, respectively. Assuming a global average organic carbon content of 35% in dry seagrass (Fourqurean et al, 2012, Durate, 1990) biomass, the total mean seagrass biomass in seagrass were calculated to be 0.43 Mg C_{org} ha^{-1}. This seagrass biomass was significantly lower than the global mean of 2.52 ± 0.48 Mg C ha^{-1}. Duarte et al, (2010), suggested that seagrass meadows with an average aboveground biomass in excess of 41 g dry wt m^{-2} can be considered autotrophic and may act as net CO_2 sinks (Fig. 6.2.12).

The seagrass above ground biomass of Palk Bay was relatively higher than the threshold (>41 g dry wt m^{-2}) supports the autotrophic nature of the seagrass meadows, although these values were lower than the global mean seagrass biomass (223.9 ± 17.5 g dry wt m^{-2}) as reported by Duarte and Chiscano (1999). Earlier studies have suggested that seagrass growth, abundance and morphology are strongly linked to available sediment, nutrient resources (Ferdie and Fourqurean, 2004). In the present study, the available nutrients in the seagrass sediment showed a reverse seasonal trend to that of the dissolved nutrient concentration in the water column. During the dry

season the sediment showed higher enrichment of inorganic N and P, supporting a relatively higher rate of net ecosystem productivity, compare to the wet season. However, in the wet season, the sediment became P limited with respect to the Redfield Ratio that could be attributed to the limited seasonal binding of phosphate in the sediments caused by the lowering of salinity.

Chilika seagrass ecosystem

Net ecosystem production of an ecosystem is the measure of organic carbon in an ecosystem available for storage whereas biological carbon sequestration is the process of capture (by photosynthesis) and long-term storage of atmospheric carbon dioxide (CO2). There are several analytical methods available to measure NEP form seagrass meadows with different degree of accuracy (Silva et al, 2009). However, factors such as transport of litters due to wave action, natural death, boat and human activities may result in the discrepancy in the measurement of NEP. Efforts to quantify this natural and human induced loss of captured carbon should be made to accurately determine the actual rate of carbon sequestration by the seagrass ecosystem.

The present study suggests during dry season, that the autotrophic processes supported by benthic halophilic seagrass surpass heterotrophic processes under favorable conditions in the southern sector. In the macrophyte dominated area of Northern part of lagoon, the NCP values during dry and wet season were negative (-13.26 mmol C m^{-2} d^{-1}, -2.36 mmol C m^{-2} d^{-1}, respectively), found to be lower than the seagrass bed waters. This indicated the seasonal shift of the trophic state from autotrophic to the heterotrophic the domination of the heterotrophic processes. Similar seasonal heterotrophy was observed in the freshwater dominated Delaware estuary (Hoch and Kirchman, 1993), and Indian systems such as Vembanad Lake (Gupta et al., 2009), and Mandovi-Zuari estuary (Ram et al., 2003).

Earlier studies showed that *Syringodium isoetifolium* and *Cymodocea serrulata* have higher above-ground biomass (AGB) and below-ground biomass (BGB) with marked seasonal variation. Our study combining the major seagrass species of Chilika and Palk Bay ecosystems suggests the clear dominance of BGB over AGB for most

of the species except *Cymodocea rotundata*. ABG varied between 21.6 and 47.44 g dry wt m^2 and BGB between 37.064 and 63.6 g dry wt m^2. The ratios (dry wt.) of below to above-ground biomass ranged between 0.92 and 3.27 (Unpublished results). A preliminary estimate of the partitioning of carbon in the different compartment of seagrass ecosystem in the Chilika lagoon is given in Figure 6.2.13.

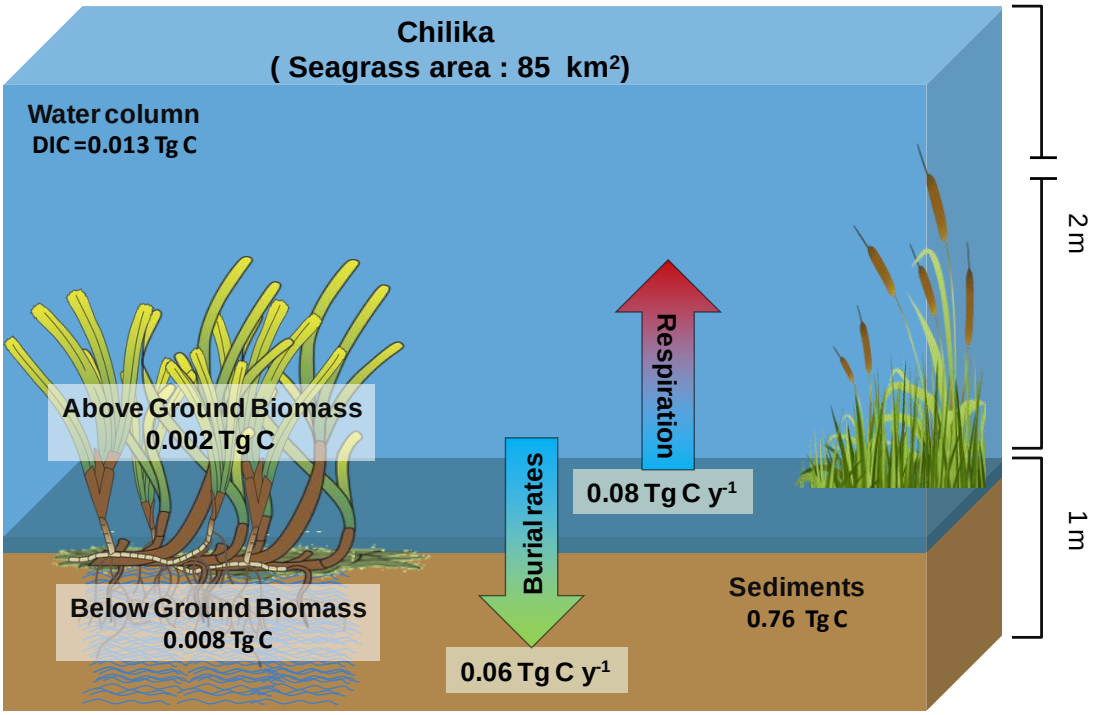


Fig.xx: Carbon pool and fluxes in Chilika Seagrass meadows

The task on preparation of IIM Plans for A&N Islands (ANI) has been initiated by NCSCM in the year 2013 based on the request by the A&N Administration to the MoEF&CC and with budget available with the NCSCM. IIM Plans for four islands viz., Smith Island (North Andaman), Aves Island (North & Middle Andaman), Flat Bay Island (South Andaman) and Rutland Island (South Andaman) are proposed to be completed in this work.

The State of Art Report on Islands can be useful as a resource document for government and research/planning departments for conservation and developmental plans of islands and for development of an Island Information System. In the study on Indigenous Knowledge of Andaman and Nicobar Islands, an attempt is made to analyze the scientific basis of this knowledge by encouraging some studies on bioactive compounds of different mangrove species

Completion of IIM Plan:

The MoEF&CC, Govt. of India issued the Coastal Regulation Zone (CRZ) Notification, 2011 on 6th January, 2011 for the mainland and the Island Protection Zone (IPZ) Notification, 2011 to protect the coastal environment of the Andaman & Nicobar and Lakshadweep group of Islands, on 6th January, 2011 under the Environment (Protection) Act,

1986, in supersession of the Coastal Regulation Zone Notification, 1991. Both these Notifications reconcile three objectives namely (i) protection of livelihood of traditional fisherfolk communities (ii) preservation of coastal ecology and (iii) Promotion of economic activity that have necessarily to be located in coastal regions.

The IPZ Notification, 2011 prescribes that the UTs of A&N and Lakshadweep are required to prepare their mandatory Island Coastal Regulation Zone (ICRZ) Plan and IIM Plan, in accordance with the prescribed guidelines, to regulate developmental activities in the Island Protection Zone (IPZ) and for integrated sustainable development of smaller islands. With regard to ANI, the Coastal Zone Management Plans already approved under CRZ notification, 1991 got extended up to 31st January, 2014 through an amendment to the IPZ Notification, 2011 on 22nd August, 2013.

ANI comprises 572 Islands, Islets and rocky outcrops. However, only 37 islands are inhabited, 10 islands in South Andaman District, 14 in North & Middle Andaman District and 13 in Nicobar District (Source: Census data 2011). Total geographical area is 8249 sq. km (Andaman group: 6408 sq.km; Nicobar group:1841 sq.km) with a coastline of 1962 km.

The task on preparation of IIM Plans for ANI was initiated by NCSCM in the year 2013 based on the request by the A&N Administration to the MoEF&CC and with budget available with the NCSCM. The NCSCM prepared IIM Plans for four islands viz., Smith Island (North Andaman), Aves Island (North & Middle Andaman), Flat Bay Island (South Andaman) and Rutland Island (South Andaman) after undertaking extensive field surveys. The draft IIM plans were submitted to the A&N Administration and extensively discussed in a meeting held on 22nd June 2015 with various departments of UT.

In the present task, the draft IIM plans will be revised taking into consideration of inputs given by various departments of UT and also based on the approach followed in the Lakshadweep IIM Plans that are accepted by MoEF&CC. Thereafter the revised report will be submitted to UT Administartion. As per the IPZ Notification, 2011, the UT Administrations shall widely publicise the draft plan and invite suggestions from the public and other stakeholders. Thereafter UT Administration/UT CZMA shall make necessary changes in the plans

and submit to Central Government in the MoEF&CC for its consideration and approval.

Further, two additional activities namely "State of the Art Report on Islands of India" and "Indigenous knowledge on some medicinal plants among the Andaman and Nicobar Islands" are proposed to be conducted under this project.

State of the Art Report on Islands of India:

The State of the Art Report on Islands is a resource document and provides information on the country's islands that is comprehensive and available in one compendium. Island wise (including mainland islands and oceanic islands of A&N and Lakshadweep) information such as geographical area, geology, climate, socio-economic profile, political profile, ecological profile and information of previous studies and surveys will be collected through review of existing reports, literature and published documents. Land use maps of islands will be prepared with available maps/data and satellite imageries with limited ground truth verifications and key issues and problems of the islands will be identified. The report will serve as a useful document for planners, policy makers, academicians and all those interested in becoming familiar with the islands of our county. The report can be further useful for development of an Island Information System.

Objectives

- To help the A&N Administration in implementation of the Island Protection Zone Notification, 2011.
- Preparation of the State of the Art Report on Islands of India
- Analysis of scientific basis of indigenous knowledge on some medicinal plants (Mangroves) among the Andaman and Nicobar Islands through conducting studies on bioactive compounds of different mangrove species.
- Acquiring baseline environmental and socio-economic data through review of published reports and literature for islands of India including A&N and Lakshadweep Islands.

1. Primary data/information on geomorphology, Ecologically Sensitive Areas (ESAs), land use & land cover features, infrastructure, tourism, alternate energy sources, waste management, potable water and all

other information according to the guidelines of IPZ Notification, 2011 will be collected from published reports/documents along with adequate field surveys.

2. Revising the draft IIMPs based on the comments and suggestions provided by the UT Administration indicating therein all present and future developments and conservation and preservation schemes.

3. Discussion on the revised draft IIMPs by inviting experts.

4. Completion of IIMPs for four islands of A&N Islands namely Smith, Aves, Flat Bay and Rutland Islands

5. Preparation of State of the Art Report on Islands of India.

6. Discussion on draft State of the Art Report on Islands of India by inviting experts.

Study Area:

Description of study area is as follows :

(i) **Smith Island:** Smith Island is situated on the eastern side of the North Andaman Island and falls under the Diglipur Tehsil of the District of North & Middle Andaman. The island is connected to the adjoining Ross Island, a wild life sanctuary (Ref: A&N Notification No. 113-86/CF/WL/50 Vol. 1 dt.16-02-1987), by sand bar which is visible during the low tide. During the high tide the Ross and Smith Islands get separated by seawater. The geographical location of these islands is in between 13°17'45" to 13°22'59" N Latitude and 93°02'09" to 93°05'36" E Longitude. The total area of Smith Island is 24.70 Sq.km and the total shore length is around 38 km. The island is mostly covered by forest with a small settlement area. It has extensive coverage of mangrove vegetation on the north western side and narrow fringing reefs on eastern and south western sides of the island. The reef flat contains mainly rocks, sand and dead coral heads. Extensive coral growth starts at a depth of four meters and extends up to 10 meters with a gradual slope. The western reef is sheltered and dominated by Porites spp. while the eastern reef is dominated by Acropora spp.

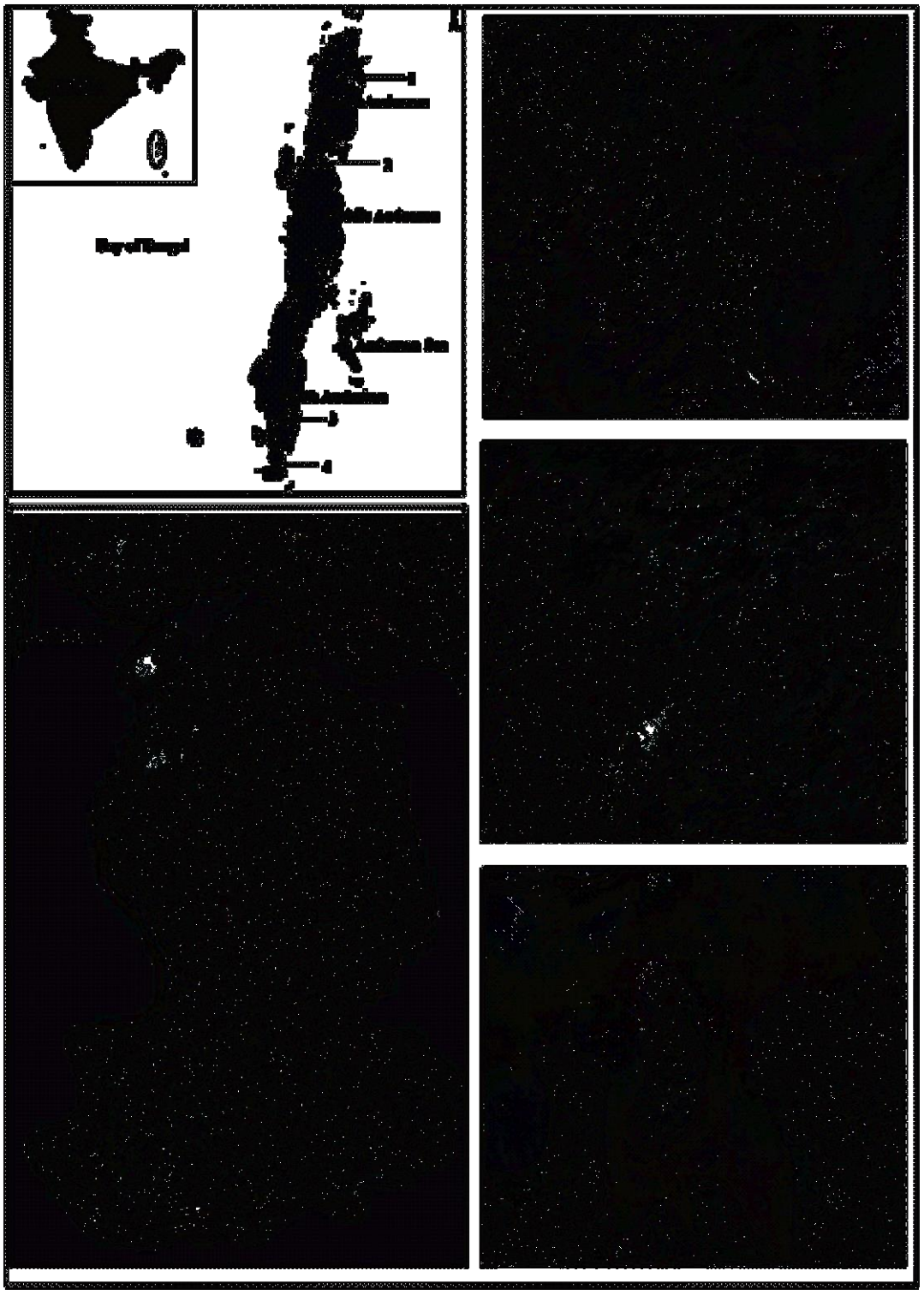
(ii) **Aves Island:** Aves Island is situated on the eastern side of Mayabundar Tehsil in North & Middle Andaman District, lies between 12054'4.52" to 12055'09.02" N Latitude and

92055'52.51" to 92056'13.07" E Longitude. The total geographical area of the island is about 20 ha (0.20 km2) with perimeter of 1.87 km(Fig. 10.1). Aves island has a plain topography in the northern side whereas the southern side has a hilly area with a maximum elevation of 24m. This Island is known for its beautiful sandy beaches. The island is covered by coconut plantation and forest. Coral reefs occur all around the island from a depth of 4 meters to 14 meters, except at the southern end, where the seabed is covered mainly by rocks. On the eastern and northern sides, Acropora and Porites dominate the coral reefs while on the western side Porites dominate coral reefs. The reef flat contains mainly rocks, sand and dead coral heads. Mangrove plants were sparsely distributed. The island did not receive much damage during the earthquake occurred on 26th December 2004 on the interface of India and Burma plates.

(iii) **Flat Bay Island**: Flat Bay is the smallest inhabited island (0.094km2) of the South Andaman district belonging to Ferrargunji Tehsil, with a total coastal length of about 16 km. The geographical location of the island is in between 13°17'45" to 13°22'59" N Latitude and 93°02'09" to 93°05'36" E Longitude. As per the census, 2011, this island has total population of five and total number of household is only two. The major agricultural crops grown in the island are Coconut and Arecanut.

(iv) **Rutland Island:** Rutland Island is located between the southern tip of South Andaman and north east of Little Andaman. This island is under Port Blair Tehsil of the South Andaman District. It is located between the latitudes 11°20'16" and 11°31'06" N and longitudes 92°34'41" and 92°42'42" E. The total geographical area of this island is about 137.20 km2 and its coastline measures ~60 km. Rutland Island has a rugged terrain with north to south fold structure. The mountainous origin of the island gives rise to an extremely convoluted coastline especially on the east with innumerable coves, deep inlets and wide bays. The highest elevation of the island is Mount Ford (435m) (Chaudhuri, 1992). There are two important bays locating east and west namely Woodmason Bay and Portman Bay respectively. The island possesses sensitive coastal ecosystems such as mangroves, coral reefs, beaches, turtle nesting grounds, creeks and algal beds. This island has extensive sandy beaches along the

coastline especially at Parsapahar, Komyo, Bakrabalu, Photonallah and Jahaji.



Map showing islands for IIM Plans for A&N Islands

The Ministry of Environment and Forests, Govt. of India issued the Coastal Regulation Zone (CRZ) Notification, 2011 for the mainland and the Island Protection Zone (IPZ) Notification, 2011, to protect the coastal environment of the Andaman & Nicobar (A&N) and Lakshadweep group of Islands.

As per the IPZ Notification, 2011, Integrated Island Management Plans (IIMPs), are required to be prepared by the Andaman Administration for the smaller islands. The other islands having large geographical areas under the Island Coastal Regulation Zone (ICRZ) category (North Andaman, Middle Andaman, Long Island, Baratang, South Andaman, Neil, Little Andaman, Havelock Island, Car Nicobar and Great Nicobar Island), and ICRZ plans have to be prepared for these islands.

Preparation of IIM Plan for Smith Island

The IIM plan for Smith Island provides setback line from High Tide Line (HTL), preservation and conservation areas of fragile ecosystems, livelihood opportunities for inhabitants and strategies for sustainable development.

Methodology

The IIM Plan has been prepared as per the guidelines stipulated in IPZ Notification, 2011 (Annexure-I). The methodology adopted for determination of setback line has been described in Annexure- II. A majority of the information listed in the guidelines was collected from the island during field surveys. Primary data/ information collected during the field survey, *interalia*, includes elevation and High Tide Line (HTL) using standard methods. RTK GPS and Total Station instruments were used to determine the elevation of the islands at 0.6m up to the highest elevation in the island.

Information on aerial coverage of Ecologically Sensitive Areas (ESAs) such as mangroves, coral reefs, seagrasses, seaweeds, turtle nesting grounds etc were collected using high resolution remote sensing data (LISS-IV (5.8m) of 2012-13) along with extensive ground verifications. The map on coral reef distribution prepared by Space Application Centre (SAC), Ahmedabad in 2007 was also taken into consideration for the present work.

Components of IIM Plan for Smith Island

The IIM Plan for Smith Island contains the following components:

(i) Demarcation of Setback Area
(ii) Existing Land Use
(iii) Existing Residential Area
(iv) Existing and Proposed Conservation & Preservation Areas
(v) Proposed Prohibited, Regulated & Permissible Activities
(vi) Existing and Proposed Infrastructure Development
(vii) Conservation Management Plan for ESAs
(viii) Water and Waste Management Plan
(ix) Energy Management Plan
(x) Tourism Management Plan
(xi) Sustainable Livelihood Development Plan

Demarcation of Setback Area

The coastal setback area is a 'No Development Zone', which refers to the stretch of coastal area (between HTL and Setback line) where developmental activities are prohibited or otherwise restricted. The criterion for determining the setback line is based on the approach adopted in Lakshadweep IIM Plan which was developed by Centre for Earth Science Studies (CESS), Trivandrum and accepted by a Committee of Experts.

The no-development setback or buffer zone in the island is determined on the basis of its differential exposure to anticipated sea level rise, which has been estimated as 0.6m by the end of this century. Since other hazards such as coastal erosion, which is mostly seasonal and do not a have regular pattern, storm surge and tsunami are time varied and rare events, these hazards were not taken into account while determining the setback line. Based on the scientific approach outlined in the Annexure-II, a uniform setback distance was assigned around the island as a conservation measure. The population in the island is safe from the impact of coastal flooding, tsunami, sea level rise, as they are located in the elevated areas.

Based on the topography, the maximum distance observed for the elevation of 0.6m is 50m from the HTL. Hence a NDZ of 50m is taken as a uniform setback distance around the island as a conservation measure.

Existing Land Use

The topography of the island is hilly and undulating with a maximum elevation of about 100m. Out of the total geographical area of 24.70 sq.km, the total forest area is 1,579 ha (61.90 %) and the non-forest area is 891 ha. (36.07%). The entire forest area of the Smith Island is classified as Protected Forest which includes the mangrove forests as well. Agricultural crops in the island include Paddy, Coconut, Arecanut and vegetables viz., Brinjal, Ginger, Ladies finger, Tomato, Bitter gourd and Pumpkin. There is no fishing activity around the island. The settlement in the island is concentrated mostly on the north central part in the revenue village namely 'Sagar Dweep'. The island has a poor road network. There is a narrow cement road of about three (3m) meter width, available in the village to facilitate local transport.

Existing Residential Area

In Smith Island (Sagar Dweep Village), the population is spread only in the north central and eastern part of the island comprising the areas viz., "Seventeen Families", "Six Families" and "Eight Families". As per the Census data 2011, the Smith Island has a population of 600 persons (Male: 328; Female: 272; No. of households=160). Among the other islands in Diglipur Tehsil, Smith Island has the most population next only to North Andaman which has the total population of 10,625. During interactions with the locals it was informed that around 200 persons have migrated from other places and settled in the island and most of them are agricultural workers, as agriculture is one of the major sources of income.

Existing and Proposed Conservation & Preservation Areas

Apart from the areas covered under protected forest, the ESAs and other important coastal geomorphological features of the island include coral reefs, mangroves, seagrass and seaweed beds, turtle nesting sites and sandy beaches. These areas were taken into consideration for preparing IIMP to protect the island's unique environment and its marine area (upto 12 nautical miles).

Mangroves and other forests

Smith Island possesses unique mangrove vegetation. Extensive mangrove vegetation is observed on the northwestern side of the island, which protects the land from natural hazard such as tsunami, cyclone, etc. Tall mangroves trees are found in this island; perhaps the height is due to island specific nature with the capacity to withstand during strong winds as well Asthe Island being devoid of commercial activity. The mangrove vegetation consists of species belonging to *Rhizophora, Avicennia, Bruguiera, Xylocarpus, Lumnitzera,* etc.

The north western part of island is carpeted, with pneumatophores wherever the mangrove forests are formed. The mangroves were seen with flowers during October -January. From the satellite data, it has been estimated that the total area under mangroves in this Island is about 300 hectares. The island forest has a variety of flora, from tall canopy trees to the underground herbs forming distinct layers or synusiae.

Heavy rainfall from the dual monsoons keep the forest in wet evergreen condition with different species belonging to trees, shrubs, herbs, climbers, etc. Champion and Seth (1968) classified vegetation of North Andaman into Andaman tropical evergreen, Andaman semi evergreen, Andaman moist deciduous, Mangroves and Littoral forest.

Coral Reefs

There are narrow fringing reefs on eastern and south western sides of the island. The reef flat contains mainly rocks, sand and dead coral heads. Extensive coral growth starts at a depth of 4 meters and extends along a gradual slope down to 12 meters. The reef is sheltered and dominated by Porites sp. The healthiest reef in this island is seen in the south eastern part of the island from a depth of 5 meters to 12 meters. The reef in the western side is dominated by dead *Porites* and *Heliopora*. New recruitments species of *Acropora* were recorded throughout the reefs, which is an indicator of reef recovery in this island. The survey during December, 2013 showed a live coral cover of less than 10% in the west side of the island whereas the reef in the south east part of the island shows a live coral cover of 25% of the total coral reef area of about 2 Sq km. However, a detailed survey of coral reef areas and mapping of corals in 1: 10000 scales is necessary. This is essential to demarcate preservation and conservation areas.

Apart from the scleractinian corals, the reef also supports a wide variety of biodiversity. The survey conducted in this island resulted in as many as 364 species of associated fauna from the coral reef areas apart from corals, seaweed and seagrass. 29 species of echinoderms, 24 species of crabs, 67 species of molluscs, 239 species of reef fishes and 5 species of marine sponges (Porifera) have been reported.

- It is suggested to avoid any fishing pressure on the coral reefs of Smith Island to protect the recovering coral reef in case it is proposed to promote fisheries to the island.

- Also, a detailed survey is necessary to assess the coral reef distribution and their status at the north eastern part of the island, as this area has not been surveyed adequately.

c. Turtle nesting sites and sandy beaches

The green turtle and the Olive Ridley are reported in the north eastern and south eastern side of Smith Island. The main nesting period of green turtle is from June to November with peak nesting in July whereas the Olive Ridley nests during October to April with a peak from January to February. A turtle hatchery has been constructed by the Forest Department on the backshore of about 350m north of sandbar to protect the turtle eggs from predators such as dogs, wild cats and crabs. The forest department staffs are deployed in the Island to collect the turtle eggs during early morning and place them in the hatchery.

There are several coastal stretches on the eastern side of the island with sandy beaches. The beach area at southern tip and the sand bar connecting the adjoining Ross Island attract tourists to this area. If developments are not planned properly it can lead to a variety of short and long-term ecological and economic losses.

d. Seaweed and Seagrass beds

The coastal area of the Smith Island is mainly rocky on the south east& west, muddy on the North West and sandy near the southern tip adjoining Ross Islands and in other areas of the Island. During the field survey undertaken in October 2013, it was observed that there were sparse seagrass and seaweed beds in the south eastern side of the island. Seaweeds were mostly seen mixed with dead corals rocks and debris. Mudflats with sandy, rocks and coral rubbles promote the growth

of seaweeds in this island. The rocky area gets exposed during low tide and gets covered by algae.

It was estimated that the total area covered by seagrass meadow on the south western side between Smith and Ross Islands is around 8 ha. A total number of 14 seaweed and three seagrass species were recorded during the survey. However, a detailed survey of seagrass areas in 1:10000 scale is necessary and to be carried out. This is essential to demarcate preservation and conservation areas.

Natural hazards such as cyclone, strong winds and tsunami are the major threats to the seagrass cover of the Smith Island and there are no man-made threats observed. However, as the island has been proposed for tourism development, it must be ensured that tourist boats are anchored in areas away from seagrass meadow at southern tip of the Smith Island, in order to protect the seagrass cover. The following habitats are brought under the proposed conservation and preservation areas for the Smith Island:

Conservation areas	Preservation areas
1. Reef flat with dead coral	1) Mangroves and other forest area
2. Jetty area	2) Seaweed / Seagrass bed
3. Tourism destination	3) Live coral cover
	4) Sandy beaches
	5) Turtle nesting ground

Proposed Prohibited, Regulated & Permissible Activities

In order to prescribe the activities that could be permitted, prohibited and regulated in the land and aquatic area, relevant provisions of the ICRZ of the IPZ Notification, 2011were considered. The notification deals with NDZ as a separate area and prescribes prohibited activities (and some exemptions) with a view to facilitate conservation of NDZ area. The methodology for determining NDZ has been described in Annexure-II. In this regard, Para III (D) (3) (a) of IPZ Notification dated 6th Jan 2011 may be relevant for A&N also. As the notification does not describe NDZ aspects for A&N (Aves Island, North & Middle Andaman) which are to be dealt under IIMPs, ICRZ provisions for prescribing prohibited and regulated activities are felt to be ideal and could be used in IIMPs of A&N islands.

Accordingly the following classifications, along with details of prohibited, permitted and regulated activities, are suggested. As the sea and landmass of the islands are inter-connected in terms of ecology, the entire island consisting of land and adjoining sea is considered as a single ecosystem. Accordingly, the island ecosystem is categorized into:

(i) **Preservation zone**: Reserve Forest, Mangroves, Reef slope with live coral, Seagrass bed, Seaweeds, sandy beach (turtle nesting ground) and other zones that will be declared by Island Administration as and when existence of endangered/rare/vulnerable species of plants and animals is recorded.

(ii) **Conservation Zone**: Setback area (No Development Zone - NDZ), Reef flat with dead coral.

(iii) **Regulated Development Zone**: It includes beach (outside setback area -NDZ) and non-forest land part of the island which is undeveloped and sparsely populated.

Different zones such as conservation zone, preservation zone, buffer zone, regulated development zone, etc., would have different regulations and are briefly summarized in the report. The activities which are permitted in the No Development Zone (NDZ) (as given in IPZ 2011 Notification for ICRZ - I areas) are also given in report.

Existing and Proposed Infrastructure Development

All the existing and the proposed development schemes for the coming 10 years (2011-21) have been mapped in consultation with the UT Administration of A&N. The existing scheme has government establishments including

- Two Govt. Middle Schools (one up to eighth std. and other up to fourth std.)
- One Primary Health Sub-Centre
- One Veterinary Dispensary
- Two DG sets
- One Water Storage Tank
- Temple

- One Police Outpost
- A Community Hall.

As far as other infrastructure is concerned, jetty and internal road are the existing major developments.

Suggestions for development

- Out of the total geographical area of the island (2470 ha), the non-forest land is about 890 ha. (36%).The non-forest area may be considered for any development after conducting carrying capacity study for this island, bearing in mind the fragile ecology and limited freshwater resources available in the island.

- In order to ensure safety to human life, location of settlement areas need to be based on the elevation as recommended in the report prepared by the committee "Scientific Team to Study Seismic pattern, Tidal pattern and Submergence to help locate resettlement areas in Andaman and Nicobar Islands" constituted by Dept of Science & Technology, Govt. of India, in 2005. As recommended by the Team, the areas up to 10m elevation from the coastline have been marked in the map of IIM Plan for location of settlements and other relevant establishments.

- It is to be noted that the entire belt of Andaman and Nicobar group of Islands in an area of intense seismic activity and is included in the highest hazard seismic zone V of the seismic zoning map of India. It is, therefore, of great importance that all construction including houses, schools, hospitals, elevated water retention structures, defense installations, etc. adheres to the BIS code on earthquake resistant designs. All structures should be engineered and the super structure especially for single story residential houses should be made of light material. If the area is storm prone facing high winds, then the alignment of houses should take into consideration the wind direction.

Two departments in the A&N namely, (i) Gram Panchayat, Keralapuram (Diglipur, North Andaman) and (ii) Andaman Chamber of Commerce and Industry (ACCI) submitted the following proposed developmental plans and suggestions for preparation of IIM Plan for Smith Island.

The Integrated Coastal Zone Management (ICZM) Programme is being implemented in a phased manner in India. A Guideline on preparation of ICZM plans was prepared by NCSCM during 2012-13 and was sent to coastal states for feedback in the first phase and needs to be updated to reflect current needs.

The major tasks in this phase include:

Guideline for ICZM Plan Preparation. This includes updating the ICZM Guideline and development of strategy to consolidate and disseminate NCSCM's research outputs.

Development of Training Modules for Training of Trainers. Development of modules for Training of Trainers (ToT) and conducting training programmes for different stakeholder groups will be part of this task.

Rationale

India's coast is under extensive development pressure. Apart from fisheries and aquaculture, the coast has been important for trade since

time immemorial with many ports named in historical records. A number of settlements are located on the coast. Industrialization and urbanization of coastal areas has proceeded at a rapid pace especially in the last half century. The 7500 km coast is also rich in a variety of ecosystems such as lagoons and other wetlands, mangroves, estuaries, tidal flats, coral reefs and seagrass beds (SAC, 2012). The path of industrialization that has been followed has resulted in a wide variety of activities along the coast, of which the development of ports and harbours, industries and settlements have resulted in the considerable alteration of the coastline. According to studies by the NCSCM, over 40 percent of the Indian coastline is undergoing erosion. Large stretches of the coast are protected, usually by seawalls; but it is also now understood that hard coastal structures as protection are not always appropriate as they can cause down drift erosion.

There are also problems due to the damming of rivers that has resulted in diminished water and sediment flow reaching the coast. Coastal waters are affected by untreated/ partially treated sewage and industrial wastes that are let into rivers and streams in the upper and middle reaches of rivers that reach the coastal ocean causing degradation of coastal waters which in turn has affected near shore fisheries. Coastal ecosystems are not considered as important income generators as ports or industries and hence it is assumed that, for example, replacing mangroves with an industry or reclamation of a marsh for housing is of greater benefit to the community and country.

India's coast is under protection through the Coastal Regulation Zone Notification (1991, 2011) combined with the Environmental Impact Assessment Notification (1994, 2006), both declared under the Environment (Protection) Act, 1986. While the former restricts location of development activities in the 500 m zone (from the High Tide Line), the latter is used to check and mitigate adverse impacts of those activities that are permitted in the CRZ (as well as other areas). However, the CRZ is arbitrary (being a uniform 500m distance from the HTL) and restrictive in terms of management as it can cut across boundaries (administrative, ecosystem). It also does not take into account regional planning issues or requirements. It is understood that most problems caused by development are due to the traditional sectoral approach that focuses on the development of each sector

without consideration of how it can affect others. Thus, for example, the development of ports and harbours is often at the cost of local ecosystems such as mangroves as well as local livelihoods such as fishing.

Recognized as a problem worldwide, Chapter 17 of Agenda 21, the blueprint for sustainable development brought out at the 1992 UNCED recommended that States look *to integrated management of their coastal areas* for ensuring sustainable development. Integrated Coastal Management (ICM) is a process that unites government and the community, science and management, sectoral and public interests in preparing and implementing an integrated plan for the protection and development of coastal ecosystems and resources'. To extend the planning boundary, India has embarked on a programme to implement integrated management of the coast beginning with pilot research studies in three states. A guidance manual has been prepared to assist in the process of preparation of the ICZM Plan for the selected area. The process involves extensive coordination between different departments and institutions that have a stake in the coastal areas. Integrated Coastal Management is a conscious management process that acknowledges the interrelationships among most coastal and ocean uses and the environments they potentially affect. This process is designed to overcome the fragmentation inherent in single-sector management approaches (fishing operations, oil and gas development, etc.), in the splits in jurisdiction among different levels of government, and in the land-water interface'.

In the first Phase, three states (Odisha, Gujarat and West Bengal) developed ICZM Programmes in pilot sites. In the next phase, other states are expected to prepare ICZM Plans for selected sites in each state. The guidance document is to help in understanding the philosophy and functioning of ICZM Plans and preparation of such plans. While the Guidance Document has been sent to all coastal states, feedback is yet to be received. However, in the period since the guideline was drafted, there has been greater understanding of the ground issues indicating the need to update the guidance manual. NCSCM's own research plans have also brought out some important inputs to be included in the document. These need to consolidated and formatted for wider dissemination and a strategy

developed to enable their inclusion in future policies. The above activities are to be carried out during the next few months.

For effective coordination to overcome fragmentation, it is essential that capacity is built among a variety of stakeholders, especially government officials, on integrated coastal management for the effective development and implementation of ICZM plans and processes. However, as a first objective, the primary target will be the core team from each state that has been assigned the task of building the integrated coastal zone management plan. Since the capacity has to be built in a relatively short time frame, it is essential to have structured modules that can be used for rapid training of a large number of people. This is to be carried out by having a Training of Trainers (ToT) who will in turn impart training to small groups of those involved in ICZM plan preparation and implementation (practitioners).

The purpose of developing Training Modules includes the following:

(i) as a guide for the trainer

(ii) as a guide and later reference for trainees

(iii) documenting procedures and best practices

(iv) enabling rapid understanding and basic competence in handling issues related to coastal management

Objectives of Research Study take by KGP

This study of 'ICZM Plan preparation guidance document and training materials' will have ***two objectives*** as follows:

a. Guideline for ICZM Plan Preparation

(i). Updating ICZM guideline

- Feedback for the ICZM plans prepared in 2012-13 from various coastal states
- Improvement in guideline as per current requirements

(ii) Develop strategy to consolidate/ format studies/knowledge systems from NCSCM's research outputs for wider dissemination

- Collecting, collating and disseminating results from studies/knowledge systems from NCSCM

- Develop strategies to incorporate research outcomes into appropriate polices and plans in future

b. Development of Training Modules for Training of Trainers

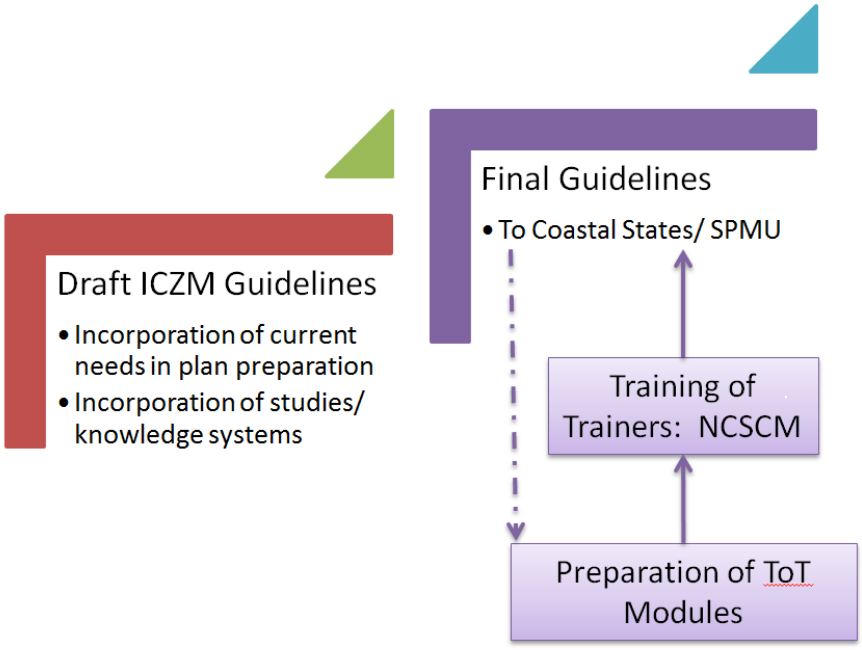
(i). Development of ToT Modules for ICZM Plan preparation

Development of content for the training manuals as well as pedagogy for training trainers

(ii). Conducting training programmes for different stakeholder groups

To conduct training programmes for different stakeholder groups

Development of ICZM Plans for other coastal states and union territories are under preparation. With the guideline prepared by NCSCM during 2012-13, feedback from the coastal states for improvement is awaited



Activities pertaining to preparation of Guidelines for ICZM Plan Preparation

Development of Guideline for ICZM Plan Preparation

Updating ICZM guideline

The draft guideline contains the process of preparing an ICZM Plan for a designated area. This has been presented to some of the stakeholders. With more states taking up ICZM plan preparation in the second phase, and with the knowledge gained in the interim period, an updated version of the guideline is required taking into account current requirements.

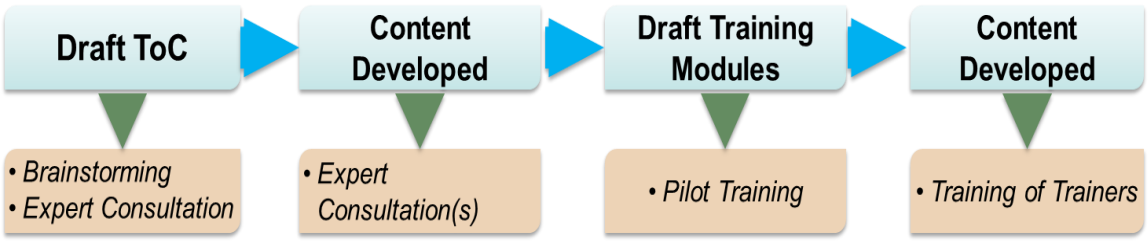
Develop strategy to consolidate/ format studies/knowledge systems from NCSCM's research outputs for wider dissemination

NCSCM has undertaken research studies and developed knowledge systems to support evidence-based sustainable environmental management. This task includes collecting, collating and disseminating results of the following studies/knowledge systems as well as developing strategies to incorporate outcomes into appropriate polices and plans in future.

- Coastal Strategy for Shoreline Management Plan of ICZM
- **CEIA** for Pollution management plan of ICZM
- **EHRC** for Environment management plan of ICZM
- **ESA Knowledge system** for Conservation Management Plan of ICZM
- **CVCA-Dependence framework** for supporting livelihood management plans of ICZM
- **CoMBINe** to aid in biodiversity conservation
- **Carrying capacity framework** for tourism management plan of ICZM

Development of Training Modules for Training of Trainers

The development of the Training Module for ICZM is likely to follow the format as shown in Fig.12 2 below:



Objectives of the Training Modules for ICZM

Consultations

1. For finalization of the updated ICZM guidance document
2. For approval of content for the ICZM ToT training modules

Desk Activity

- Update guidelines based on interim experience in ICZMP preparation requirements from the states

Consolidation and formatting of results from the studies/knowledge systems carried out by NCSCM for wider dissemination as well as into the governance/ policy frameworks

- ***Multi media***

- Power point presentations to carry out training,
- Facilitators guide
- Audio-visuals: a collection of short films will be put together
  - Existing films, if available; or commissioning of new films

Web-based learning:

Problem solving using games will be developed as part of each training module (especial focus on the use of decision making systems)

Training Programmes *For training of trainers (ToT)*

Mapping of Fishing Spaces

A livelihood is a means of making a living. A livelihood comprises the capabilities, assets and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base"(Chambers & Conway 1991).The sustainable livelihoods idea was first introduced by the Brundtland Commission(1987) on Environment and Development as a way of linking socioeconomic and ecological considerations in a cohesive, policy-relevant structure. The 1992 United Nations Conference on Environment and Development (UNCED) expanded the concept, especially in the context of Agenda 21, and advocated for the achievement of sustainable livelihoods as a broad goal for poverty eradication. It stated that sustainable livelihoods could serve as 'an integrating factor that allows policies to address' development, sustainable resource management, and poverty eradication simultaneously(UNDP 1997). In addition, the dominant theme and objective of National Environment Policy (2006) of Government of India states that conservation of environmental resources is necessary to secure livelihoods particularly poor communities, which are most dependent on environmental resources for their livelihoods(NEP 2006).

Traditionally, marine fishing was a communal activity, with each member contributing to the effort in kind. There has been a shift in fishing operations from subsistence-based artisanal occupations to profit-oriented business transactions, and cause un-employment to the traditional skills, knowledge and manual labour abilities of the traditional fishermen and their livelihood assets. The result is that community based, small scale fishing has given way to production based on industrial principles of organization and complex technology in order to feed international markets (Salagrama 2006).The traditional fishermen assets and capacities include many from the land they used for their occupation to the skills they identify the fish schools. In general, the livelihood assets of the fishing villages have been classified as natural capital, physical capital, human capital, social-political capital, and financial capital.

Coastal land is very significant to fishermen livelihood analysis since that area have traditionally used by the fishermen community for boat landing, fish drying, boat repairing, net mending, net drying, processing, housing, marketing etc. The common coastal land areas of the fishermen villages are shrinking due to the pressure from other non-fishery related activities / stakeholders. 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 as reported by the (MoEFCC 2009) Expert Committee on the draft Coastal Management Zone (CMZ) notification under the Chairmanship of Prof. M. S. Swaminathan.

The development of Indian fisheries over the last 50 years has resulted in the superimposition of a modern, capital-intensive, specialized technology on the existing traditional base, which was largely labour intensive and of great technical diversity. In sustainable livelihood terms, the fisheries sector in India developed largely on the principle of enhancing physical assets to maximize returns from the exploitation of natural assets. Limited attentions have been paid to the development

of other assets viz., social, human, financial to enable acceptance of the physical assets(Salagrama 2006).

M.S. Swaminathan Committee (2009), on Policy and legal framework for Integrated Coastal Zone Management, has emphasized that need for the conservation of the coastal areas is the habitats of fishing communities. These communities are in double danger as well – ironically, from conservation and from development. There were many studies conducted related to livelihood of fishermen communities. But they are conducted for special objective to analyse a specific livelihood capital of fishermen communities. The trends in poverty and livelihoods in coastal fishing communities of Orissa State conducted by FAO in 2006 is a comprehensive study analysed the livelihood assets of coastal fishermen communities.

It investigates the relationships between livelihoods and coastal poverty and seeks to develop simple qualitative indicators to monitor the changes in these relationships over time. It finds that key trends affecting the livelihoods of the poor in the coastal fishing communities in Orissa range across the whole spectrum of "assets / capitals" – i.e. the natural, physical, social, human and financial which influences over the terms of availability as well as access to the assets for the fishermen community. The study developed a framework to identify the poverty indicators of fishermen.

Similarly, sustainable livelihood frameworks have been developed by UNDP which is being used as an analytical framework (or tool) for programme planning and assessment. Since 1994 CARE is using Household Livelihood Security (HLS) as a framework for programme analysis, design, monitoring, and evaluation. DFID's is applying sustainable livelihood approach to increase the agency's effectiveness in poverty reduction. All three agencies use the SL approach as a strategy towards poverty alleviation. They also use similar definitions of what constitutes sustainable livelihoods(Krantz 2001).

Objectives of Research Study

1. To reduce poverty in fishing communities
2. Protect and promote livelihood capitals of coastal communities by studying interactions between them and to develop a framework

for sustainable livelihood

3. To analyse the pattern of coastal land use in fishing villages
4. To suggest policies and programs for the protection of livelihood of fishermen

Assessment of Coastal and Marine Ecosystem Goods and Service

Coastal ecosystems are supplying both stock and flow resources that can be used as direct and indirect inputs for production and consumption activities. Thereby the coastal ecosystems are source of production and growth in overall economic system. Estimation of coastal ecosystem services and accounts confirmed that they have the highest servicing capacity on per hectare basis (Costanza et al., 1997). Similarly, like other assets, enhancing or diminishing the condition of coastal ecosystem assets shall increase or reduces the benefits derived (Defra., 2007). Estimation of total economic value of an ecosystem helps in the assessment of the total benefits of restoration and/or conservation of an ecosystem. Quantifying and valuing ecosystem goods and services is increasingly used to guide decision making in the search for sustainability of natural environment. Outputs or outcomes derived from ecosystem services are directly and indirectly influencing human wellbeing, and shall provide opportunity to take an economic approach for coastal ecosystem functioning. It shall also assess the policy appraisals for considering the costs and benefits of the natural environment and highlighting the implications of human well being. These would offer new opportunities for investment and employment, and improve living standards and quality of life. Understanding the economic value of coastal ecosystem services is useful for decision making and sustainable management of the resources in the coastal zone. Values develop an opportunity to rewrite the economic equations by involving natural capitals. Millennium Ecosystem Assessment (MEA) has emphasized to value ecosystem services in a systematic way for human well-being and to practice sustainable function of coastal environment (MEA, 2005). At present, quantifying and valuing ecosystem goods and services is increasingly used to guide decision making in the search for sustainability (Adrienne., G.R., Etal., 2015).

In general, ecosystem services are considered to be ecological in nature and delivered by the living components of the ecosystem (Fisher et al., 2009). To quantify and qualify the abiotic outputs (e.g., oil and gas) of the ecosystems, a complementary Common International Classification of Ecosystem Services (CICES) has been developed which is advantage to incorporate values for non-ecological services from ecosystems (Haines-Young and Potschin 2013). A number of ecosystem service classifications have subsequently been developed using CICES, which can be applicable to coastal ecosystems also (Fisher et al., 2009; EEA, 2013; Caroline Hattam etal., 2015). It is widely accepted that the classification systems shall be applicable for context, management requirement, ecosystem status and situations (de Groot et al., 2010). In National context, to value coastal ecosystems services, functions, and benefits a classification system shall be followed which shall be suitable for application and implementation sustainable functioning of the Indias coast.

The Millennium Ecosystem Assessment (MEA, 2005) and The Economics of Ecosystems and Biodiversity (TEEB, 2009) are two of the large-scale studies that have examined the consequences of ecosystem change for human wellbeing and provided the scientific basis for actions needed to enhance the conservation and sustainable use of natural resources. However, there is still a scarcity of studies, particularly those related to marine and coastal ecosystems, that follow up on operational guidelines to support more inclusive assessments and decision-making processes that explicitly account for and articulate multiple ecosystem values (Lopes.Ret.al.,2013). Available information about the coastal environmental economics especially India is very meagre. A literature review on economic valuation of estuaries and coasts found that out of 300 sources reviewed only 30 are explicitly addressing economic valuation of coastal ecosystem goods and services (Raheem.Net al., 2010). Hence, a literature review shall be essential for selection of suitable methods to value various goods and services resulting from the coastal ecosystems for meta analysis. Many methods for measuring the economic value of ecosystem services are found in environmental economics literatures. A comprehensive review of literature has to be undertaken in order to assess the sufficiency of available information to support the valuation exercise, the gaps in existing knowledge database and the potential for future research.

Assessing and quantifying every aspect of ecosystem services is a challenging task, especially when the relationship between services, functions and underlying biodiversity remains poorly understood (Kremen, 2005). Usage of ecosystem goods and services are different in various regions. Listing and classification of goods and services of an ecosystem shall be necessary to value coastal ecosystems. Once the conceptual benefits of an ecosystem are identified, economic values can be assigned to these benefits using various methodologies adopted and practiced. Having these assigned values allows policy makers to quantitatively assess the economic benefits that society might gain from marginal improvements in the integrity of the coastal ecosystems (Lopes .Ret.al., 2013).

Meta-analysis was first proposed as a research synthesis method and applied in many fields of research, not least in the area of environmental economics (Nelson and Kennedy, 2009). Meta-analysis is a method of synthesising the results of multiple studies that examine the same phenomenon, through the identification of a common effect, which is then 'explained' using regression techniques in a meta-regression model. It is widely recognised that the large and expanding literature on the economic value of ecosystem services has become difficult to interpret and that there is a need for research synthesis techniques, and in particular statistical meta-analysis, to aggregate results and insights (Stanley, 2001). This meta analysis also supporting the convenience and base for transferring values from studied sites to new policy sites (Rosenberger and Phipps, 2007.

To assess the ecosystem services identified by a classification system, the capacity of the ecosystem to deliver ecosystem services in biophysical terms and their ability to maintain this over time (sustainability) must be determined (TEEB, 2010). Since, interactions between natural systems and human society are complex and regionally varied (Atkins et al., 2011), the direct and indirect contributions that ecosystems make to human well-being and impacts of human activities on ecosystem services which influencing the functioning of the coast shall be explored for interventions (de Groot et al., 2010; Millennium Ecosystem Assessment, 2005). Use of various indicators can facilitate this Process (Caroline Hattam etal., 2015). Indicators are proxies for complex phenomena and can be used to reflect the provision of a service and how it is changing over time. Indicators, where measureable, are useful for supporting

management activities as well as contributing to studies aiming to model and value changes in ecosystem service provision (Niemeijer and de Groot, 2008). Identifying applicable function, service and benefit indicators remains a challenge. The greatest challenge is the lack of suitable data for the marine environment, as well as limited understanding of the links between ecosystem functions, services and benefits (Caroline Hattam etal., 2015). There is no selective guideline for indicators for ecosystem services (van Oudenhoven et al., 2012; UNEP-WCMC, 2011). Feld et al. (2009) found that most indicators are measured at regional or local scales, although functional indicators and indicators reflecting temporal differences are rarely measured at all, irrespective of scale. Hence, indicators of the ecosystem services, functions and benefits of the coastal ecosystesm shall be studied to value of coastal ecosystem services.

The regulatory framework governing coastal zone (CRZ 2011) and National Environmental Policy (NEP, 2006) directs to consider all types of benefits and costs for market, non-market, and investments (developments). According to Ledoux and Turner (2002), valuing ecosystem services is a crucial way to inform decision making, but it has yet to be determined how to integrate this information into the decision-making process (Ledouxet.al.,2002).

The Coastal Regulation Zone 2011 (CRZ., 2011) has indicated nine costal ecosystems and geomorpohological features play a role in the maintaining the integrity of the coast as Ecologically Sensitive Areas (ESAs) and various measures have been initiated to protect and conserve for the sustainable development of coast.

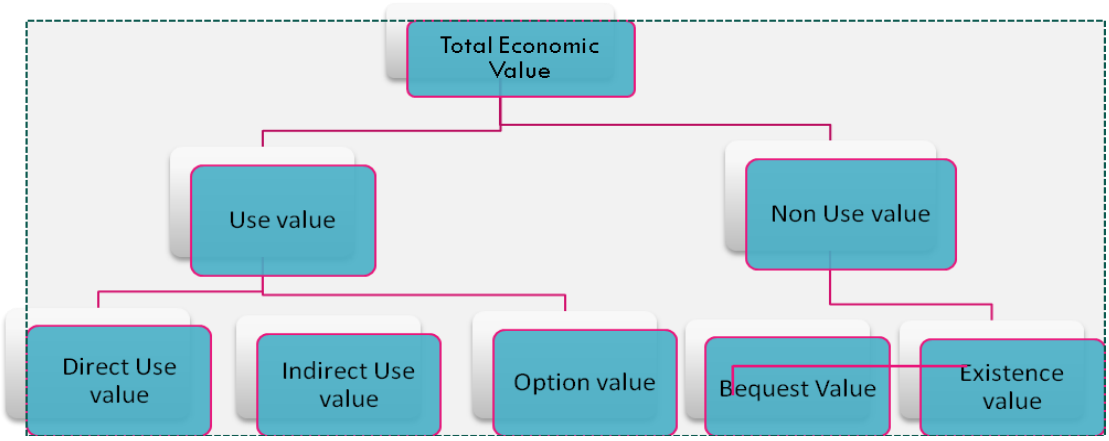
Indicated ESAs in CRZ 2011 are mangroves, corals and coral reefs; sand dunes; mudflats; salt marshes; turtle nesting grounds; horse shoe crabs habitats; sea grass beds; nesting grounds of birds. These ecosystems will be evaluated under this study to ensure efficient use of environmental resources in the sense of reduction in their use per unit of economic output, and to minimize adverse environmental impacts.

Ecosystem services are defined as services provided by the natural environment that benefit people. While there is no single, agreed method of categorising all ecosystem services, the Millennium Ecosystem Assessment framework is widely accepted and is seen as a useful starting

point. The most common framework of valuation of ecosystems is given at fig. 10.1 below.

The framework includes (i) Direct use value; (ii) indirect use value; (iii) option value; and (iv) non-use value. The first three are generally referred to together as 'use value'.

Direct use values refer to ecosystem goods and services that are used directly by human beings. They include the value of consumptive uses such as harvesting of food products, timber for fuel or construction, and medicinal products and hunting of animals for consumption; and the value of non-consumptive uses such as the enjoyment of recreational and cultural activities that do not require harvesting of products. Direct use values are most often enjoyed by people visiting or residing in the ecosystem itself.



Total Economic Value

Indirect use values are derived from ecosystem services that provide benefits outside the ecosystem. Examples include natural water filtration which often benefits people far downstream, the storm protection function of mangrove forests which benefits costal properties and infrastructure, and carbon sequestration which benefits the entire global community by abating climate change.

Option values are derived from preserving the option to use in the future ecosystem goods and services that may not be used at present, either by oneself (option value) or by others/heirs (bequest value). Provisioning, regulating, supporting and cultural services may all form part of option value to the extent that they are not used now but may be used in the

future. Non-use values refer to the enjoyment people may experience simply by knowing that a resource exists even if they never expect to use that resource directly themselves.

Four theoretically plausible valuation methods have been used in the neoclassical economic literature to place valid dollar values on wetland resources. These plausible valuation methods are; the net factor income(NFI) method, the contingent valuation method (CVM), the travel cost method (TCM), and the hedonic price method (HPM).General valuation techniques, approaches and applications are given in table 11.1.

Economic Valuation techniques for Ecosystems

Methodology	Approach	Applications	Data requirements	Limitations
Revealed preference methods				
Production function (also known as 'change in productivity')	Trace impact of change in ecosystem services on produced goods	Any impact that affects produced goods	Change in service; impact on production; net value of produced goods	Data on change in service and consequent impact on production often lacking
Cost of illness, human capital	Trace impact of change in ecosystem services on morbidity and mortality	Any impact that affects health (e.g. air or water pollution)	Change in service; impact on health (dose-response functions); cost of illness or value of life	Dose-response functions linking environmentto health often lacking; value of life cannot be

				estimated easily
Replacement cost	Use cost of replacing the lost good or service	Any loss of goods or services	Extent of loss of goods or services, cost of replacing them	Tends to overestimate actual value; should be used with extreme caution
Travel cost (TCM)	Derive demand curve from data on actual travel costs	Recreation	Survey to collect monetary and time costs of travel to destination, distance traveled	Limited to recreational benefits; hard to use when trips are to multiple destinations
Hedonic pricing	Extract effect of environmental factors on price of goods	Air quality, Scenic beauty, cultural benefits	Prices and characteristics of goods	Requires vast data; very sensitive to specification
Stated preference methods				
Contingent valuation (CV)	Ask respondents directly their WTP for a specified	Any service	Survey that presents scenario and elicits WTP for specified service	Many potential sources of bias in responses; guidelines

	service			exist for reliable application
Choice modeling	Ask respondents to choose their preferred option from a set of alternatives	Any service	Survey of respondents	Similar to those of CV; analysis of the data generated is complex
Other methods				
Benefits transfer	Use results obtained in one context in a different context	Any for which suitable comparison studies are available	Valuation exercises at another, similar site	Can be very inaccurate, as many factors vary even when contexts seem 'similar'; should be used with extreme caution

Source: (Stefano Pagiola,et,al., 2004. In collaboration with The Nature Conservancy and IUCN—The World Conservation Union, Assessing the Economic Value of Ecosystem Conservation)

Objectives

Objectives of Research Study

1. Analysis of various methods adapted to value ecosystems services (meta analysis) and study the application potentials for coastal ecosystems of India
2. Identification of indictors of changes in the coastal ecosystems
3. Selection of suitable frameworks to value ecosystem services indicated in ESAs under CRZ Notification

Analysis of mechanisms for application of ecosystem values for sustainable functioning of coastal resources

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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
M.No. 019177
For K.Ramanan & Co
Chartered
Accountants
FRN No. 02926S

K. RAMANAN, F.C.A.,
Chartered Accountant
AH - 46, Shanthi Colony
Anna Nagar, Chennai - 600 040.
E-mail : kramanan1949@gmail.com
Website : www.caramanan.com

Office : 044-2621 5936
Res : 044-2654 3854
Mobile: 98401 49391

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 2016, the Income & Expenditure Accounts and Receipts & Payments Accounts for the year then ended, and a summary of significant accounting policies, notes to accounts and other explanatory information.

Management's Responsibility for the Financial Statements

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

Auditor's Responsibility

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

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

K. RAMANAN & CO. K. RAMANAN M. No. 018177 AH - 46, SHANTHI COLONY CHENNAI - 40 Chartered Accountants

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, 2016;

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 : 24/11/2017

NATIONAL CENTRE FOR SUSTAINABLE COASTAL MANAGEMENT

Annexure to the Balance Sheet as on March 31st,2016

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. Events after the date of Balance Sheet:-
   One of the asset "Wave Rider Buoy" costing around Rs.53.46 lakhs was lost during field research in the FY: 2016-17 which was also reported in the last year's annexure. The insurance proceeds are still not yet claimed. Appropriate measures for disposal taken are slow. Due attention is required at the earliest.
2. Being a Society it is not mandatory to give previous year's figures in the Balance Sheet.

For National Centre for Sustainable Coastal Management

Director

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

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 : 24.11.2017

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, 2016

(in Rs.)

RECEIPTS	AMOUNT	PAYMENTS	AMOUNT
Opening Balance		Bid Security	6,00,000.00
Bank Accounts	3,75,60,913.12	Car Advance	1,400.00
		GIC	160.00
EPF	91,631.00	GPF Advance	11,400.00
Labour Cess	4,92,809.00	GSLI	120.00
Liquidity Damages	1,58,310.00	TDS Payable - Others	2,88,748.00
Notice Pay	88,000.00	TDS PAYABLE - Staff	96,470.00
NPMU - Fund Received	19,95,00,000.00	NCSCM	2,88,094.00
NPMU - Interest on FD	18,95,785.00	Sundry Creditors	85,046.00
NPMU -SB Interest	46,319.00	Equipment and Facilities	1,79,200.00
NPS	3,420.00	Civil Works	7,23,192.00
PF	12,875.00	Construction of New Building and Facilities	7,10,46,351.00
Professional Tax	57,567.00	Goods and Equipment (Scientific)	4,09,62,145.42
Retention Money-Renaatus	36,13,470.00	Audio Conferencing System	30,500.00
Unreconcilied deposit from staff	1,25,046.00	HR Software	13,48,320.00
Interest on Grant in AID	1,99,028.00	LPS Image Station	64,15,978.00
VAT TDS	13,93,335.00	NAS Storage Box	85,000.00
Provisions	34,365.00	PRIMER 7-Software	1,12,998.00
NCR Recoveries-Civil Work	5,54,242.00	UPS	98,685.00
Performance Guarantee	1,11,245.00	Delta-Almirah	51,000.00
SICOM Overhead-CTG-A	7,14,887.00	Advances to Institutes	1,03,70,036.00
SICOM Overhead-CTG-B	1,76,000.00	Advances to Suppliers	6,040.00
SICOM Overhead-CTG-C	5,03,350.00	Contingency Advance	13,08,785.00
SICOM Overhead-CTG-RD	1,25,602.00	Advance to Contractor	3,28,28,056.00
Duties & Taxes	4,66,491.10	TA Advance	12,11,071.40
Contigency Income	50,97,857.00	ESA Advance	3,89,498.00
IC-Consultancy Income	20,74,742.12	Deisel Advance	1,03,857.00
Manpower Income	96,61,658.78	Imprest account Of Employee	20,060.00
Material Income	10,65,579.00	TAX CREDIT-CTG-A	2,78,627.00
NCSCM Overhead Income	16,16,154.20	TAX CREDIT-CTG-B	2,32,320.00
TA/DA Income	30,83,666.00	TAX CREDIT-CTG-C	5,57,389.00
Interest on Saving Bank A/c	5,89,327.13	Sundry Debtors	7,41,328.00
Deposits (Asset)	1,34,10,000.00	Work Shops & Seminar	6,85,400.00
TV Sundaram Motors	17,118.00	Consultancy/studies	18,31,800.66
MPM Travel Xs Pvt Ltd	1,06,708.00	National/International Workshops	2,49,823.00
		Special Training Programme	2,90,982.00
		Advertisement	1,72,977.00
		Website Maintenance charges	6,072.00
		Consumables	29,02,947.00
		Inhouse Research	11,03,774.00
		Manpower	4,85,84,432.00
		Books & Periodical	14,490.00
		Postage & Telegraph	24,171.00
		Printing & Stationary	9,19,114.00
		Repairs &Maintenance	3,03,230.00
		Other Office Overhead	16,67,605.00
		SICOM /MOEFCC alloted Project	35,988.00
		Travel & Boarding	67,15,727.00
		Bank Charges	14,191.05
		Electricity & Telephone	2,34,522.00
		Hiring of Vehicles	10,06,358.00
		Insurance Premium for Equipment	9,84,880.00
		Meeting Expenses	2,47,287.00
		Vehicle Runing & Maintenance	1,36,357.00
		Sedimental Cell Contigencies	60,280.00
		Sedimental Cell staff Salaries	2,59,758.00
		HTL/LTL Travel	6,80,644.00
		IIMP Lakshwadeep	7,64,756.53
		Project Staff Salaries	61,92,108.00
		Watch And Ward &Securities	7,15,024.00
		Truc others	1,86,551.00
		Contingency Expenses	4,37,214.00
		TA/DA Expenses	4,74,417.50
		NCSCM Overhead Expenses	4,20,000.00
		Closing Balance	
		Bank Accounts	3,58,42,744.89
		Cash in Hand	10,000.00
Total	**28,46,47,500.45**	**Total**	**28,46,47,500.45**

K. RAMANAN & CO.
K. RAMANAN
M. No. 019177
AH... 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

For National Centre for Sustainable Coastal Management

Director

Place: Chennai
Date : 24/11/2017

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

(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 Tax Assessment Year 2016-17

Statement showing fulfillment of Provision under Section- 11(1)(a)

Sl. No.	Particulars	Amount (Rs.)
A)	Opening Balance as on 01.04.2015	3,75,60,913.12
	Add :- Receipts during the year	24,70,86,587.30
B)	Total Funds available for application	28,46,47,500.42
	Less :- Funds applied during the year	-24,87,94,755.50
C)	Closing Balance as on 31.03.2016	**3,58,52,744.92**
	C as a % of **B**	**12.50%** (which is less then 15%)

Note:- Since **87.5%** of funds available for application of income is applied (which is more then the statutory requirement of **atleast 85%**), the Provision of Section-11(1)(a) stands fulfilled.

Director
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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, 2016

(In Rs

Particulars	Amount	Amount	Particulars	Amount	Amount
1. NCSCM		7,85,13,256.67	**1. NCSCM**		
Capacity Building & Projects	1,17,63,431.66		Grants in Aid		19,14,24,145.09
Communication	1,47,207.00				
Hazard & ESA Mapping	21,98,300.00				
Operational Cost	6,21,20,958.01				
Sedimental Cell Project	22,83,360.00				
2. TRUC & DELTA		18,40,042.00	**2. TRUC & DELTA**		
Utilisation of Fund Delta	11,60,939.00		Grants in Aid (TRUC)		18,91,042.00
Utilisation of Fund Truc	6,79,103.00				
3. ESA & CVCA MAPPING			**3. ESA & CVCA MAPPING**		
Operational Cost		2,04,44,188.02	Grants in Aid		2,85,35,669.02
4. REVENUE ACTIVITY		4,69,657.00	**4. REVENUE ACTIVITY**		95,31,195.75
TA/DA Expenses	49,657.00		Material Income	1,04,562.00	
Overhead Expenses	4,20,000.00		Manpower Income	48,56,804.62	
			TA/DA Income	11,01,000.00	
			Contingency Income	14,97,857.00	
			NCSCM-Overhead Income	6,81,365.00	
			IC-Consultancy Income	7,00,280.00	
			Interest From Savings Bank A/C	5,89,327.13	
Excess of income over expenditure		**13,01,14,908.17**			
Total		**23,13,82,051.86**	**Total**		**23,13,82,051.86**

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 : 24.11.2017

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

Consolidated Balance Sheet as on 31st March 2016

(In Rs.)

Liabilities	Sch. No.	Amount	Assets	Sch. No.	Amount
Capital Account:-			**Fixed Assets:-**		
Corpus Fund - Assets	1	50,03,40,866.27	Investment Cost	-	4,81,53,446.00
Cash Corpus	-	90,61,538.95	Physical	-	43,58,69,902.27
			Project Management (ESA)	-	1,58,09,090.00
Current Liabilities:-			Facilities & Equipment (DELTA)	-	1,90,579.00
Provisions	2	23,741.00	Facilities & Equipment (TRUC)	-	1,37,528.00
NCR Recoveries	-	15,43,004.00			
Perfomance Guarantee	-	9,66,890.00	**Investment:-**		
Bid Security		22,75,000.00	Fixed Deposit (UBI)	-	3,80,375.00
Income Recognition Deferred	3	1,36,57,788.28			
Duties & Taxes (Revenue Actv.)	-	4,66,491.10	**Current Assets:-**		
Labour Cess	-	4,64,036.00	Bank Accounts	7	3,58,42,744.89
Liquidity Damages	-	3,46,412.00	Cash in hand	-	10,000.00
MS Cholamandalam Tax Credit	-	44,920.00	Tax Credit (Revenue Activity)	8	11,13,256.00
Notional Recoveries from Salary	-	2,92,072.00	Expense Recognition Deferred	9	18,61,942.50
Notice Pay	-	88,000.00	SICOM New Delhi	-	6,073.00
NPMU - Fund Received	4	7,69,90,973.17	Advances	10	8,26,57,430.00
Interest on Grants in Aid (T&D)	-	2,47,422.00			
Professional Tax	5	85,495.00			
Retention Money	-	94,15,043.00			
SICOM Overhead	6	15,19,839.00			
TDS Payable - Others	11	46,694.89			
TDS Payable - Staff	12	2,10,737.00			
Unreconciled Deposits from Staff	-	1,25,046.00			
VAT TDS	-	17,67,662.00			
MOES- DELTA	-	12,90,770.00			
MOES- TRUC	-	7,61,925.00			
TOTAL		**62,20,32,366.66**	**TOTAL**		**62,20,32,366.66**

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 : 24.11.2017

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, 2016

Schedule-1 : Corpus Fund

Particulars	Amount
NCSCM	48,42,03,669.27
ESA & CVCA	1,58,09,090.00
TRUCK & DELTA	3,28,107.00
REVENUE ACTIVITY- Cash Corpus	90,61,538.95
TOTAL	**50,94,02,405.22**

Schedule-2 : Provisions

Particulars	Amount
NCSCM	8,853.00
REVENUE ACTIVITY	14,888.00
TOTAL	**23,741.00**

Schedule-3 : Income Recognition Deferred (Revenue Activity)

Particulars	Amount
CONTINGENCY INCOME DEFERRED	36,00,000.00
IC-CONSULTANCY INCOME DEFERRED	13,74,462.12
MANPOWER INCOME DEFERRED	48,04,854.16
MATERIAL INCOME DEFERRED	9,61,017.00
NCSCM-OVERHEAD INCOME DEFERRED	9,34,789.00
TA/DA INCOME DEFERRED	19,82,666.00
TOTAL	**1,36,57,788.28**

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 : NPMU Fund Received

Particulars	Amount
NCSCM	7,37,81,816.69
ESA & CVCA	32,09,156.48
TOTAL	**7,69,90,973.17**

Schedule-5 : Professional Tax

Particulars	Amount
NCSCM	62,065.00
TRUCK & DELTA	98.00
ESA & CVCA	23,332.00
TOTAL	**85,495.00**

Schedule-6 : SICOM Overheads

Particulars	Amount
SICOM-OVERHEAD-CTG-A	7,14,887.00
SICOM-OVERHEAD-CTG-B	1,76,000.00
SICOM-OVERHEAD-CTG-C	5,03,350.00
SICOM-OVERHEAD-RD	1,25,602.00
TOTAL	**15,19,839.00**

Schedule-7 : Bank Accounts

Particulars	Current A/c Advance
NCSCM	1,25,49,343.58
ESA & CVCA	6,28,132.48
REVENUE ACTIVITY	2,05,12,769.83
TRUC & DELTA	21,52,499.00
TOTAL	**3,58,42,744.89**

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 : Tax Credit (Revenue Activity)

Particulars	Amount
TAX CREDIT CLAIMED	5,61,610.00
TAX CREDIT DEFERRED	5,51,646.00
TOTAL	**11,13,256.00**

Schedule-9 : Expense Recognition Deferred (Revenue Activity)

Particulars	Amount
TA/DA EXP. DEFERED	6,49,378.50
CONTINENCY EXP. DEFERRED	4,35,064.00
MANPOWER EXP. DEFERRED	7,77,500.00
TOTAL	**18,61,942.50**

Schedule-10 : Advances

Particulars	Amount
NCSCM	7,90,44,382.00
ESA & CVCA	31,24,189.00
REVENUE ACTIVITY	3,18,110.00
TRUC & DELTA	1,70,749.00
TOTAL	**8,26,57,430.00**

Schedule-11 : TDS Payable - Others

Particulars	Current A/c Advance
NCSCM	41,847.89
ESA & CVCA	8,000.00
TRUC & DELTA	-3,153.00
TOTAL	**46,694.89**

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 : TDS Payable - Staff

Particulars	Current A/c Advance
NCSCM	1,92,825.00
ESA & CVCA	17,912.00
TOTAL	**2,10,737.00**

Director
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Ministry of Environment, Forest and Climate Change
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NATIONAL CENTER FOR SUSTAINABLE COSATAL MANAGEMENT

ANNA UNIVERSITY CAMPUS
GUINDY
CHENNAI - 600025

Receipts and Payments Account for the year ended on March 31st, 2016

(In Rs.)

RECEIPTS	AMOUNT	PAYMENTS	AMOUNT
Opening Balance			
Bank Accounts	3,43,09,513.67	Bid Security	6,00,000.00
		Car Advance	1,400.00
EPF	91,631.00	GIC	160.00
Labour Cess	4,92,809.00	GPF Advance	11,400.00
Liquidity Damages	82,709.00	GSLI	120.00
Notice Pay	88,000.00	TDS Payable - Others	2,85,595.00
NPMU - Fund Received	18,45,00,000.00	TDS Payable - Staff	96,470.00
NPMU - Interest on FD	15,28,825.00	Provisions	22,211.00
NPMU -SB Interest	46,319.00	Investment Cost	9,02,392.00
NPS	3,420.00	Physical	11,20,08,496.42
PF	12,875.00	Advances	3,70,29,960.00
Professional Tax	57,569.00	Capacity Building & Projects	27,69,420.66
Retention Money-Renaatus	36,13,470.00	Communication	1,47,207.00
NCR Recoveries	5,54,242.00	Operational Cost	6,02,66,795.01
Unreconcilied Deposits From Staff	1,25,046.00	Sedimental Cell Project	3,20,038.00
VAT TDS	13,93,335.00		
Performance Guarantee	1,11,245.00	**Closing Balance**	
		Bank Accounts	1,25,49,343.58
Total	**22,70,11,008.67**	**Total**	**22,70,11,008.67**

For National Centre for Sustainable Coastal Management

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

Director

Place: Chennai
Date : 24.11.2017

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

K. RAMANAN & CO.
K. RAMANAN
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(CA. K.Ramanan)
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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,2016

(In Rs.)

Particulars	Amount	Amount	Particulars	Amount	Amount
Indirect Expenses		**7,85,13,256.67**	**Indirect Incomes**		**19,14,24,145.09**
Capacity Building & Projects	1,17,63,431.66				
Communication	1,47,207.00		Grants in Aid	19,14,24,145.09	
Hazard & ESA Mapping	21,98,300.00				
Operational Cost	6,21,20,958.01				
Sedimental Cell Project	22,83,360.00				
Excess of income over expenditure		**11,29,10,888.42**			
Total		**19,14,24,145.09**	**Total**		**19,14,24,145.09**

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 : 24.11.2017

As per the Audit Report of even date attached
For K.Ramanan&Co
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FRN: 02926S

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, 2016

(In Rs.)

Liabilities	Sch. No.	Amount	Assets	Sch. No.	Amount
Capital Account:-			**Fixed Assets:-**		
Corpus Fund	-	48,42,03,669.27	Investment Cost	3	4,81,53,446.00
			Physical	4	43,58,69,902.27
Current Liabilities:-					
Provisions	1	8,853.00	**Investments:-**		
NCR Recoveries	-	15,43,004.00	Fixed Deposit - UBI	-	3,80,375.00
Performance Guarantee	2	9,66,890.00			
Bid Security	-	22,75,000.00	**Current Assets:-**		
Labour Cess	-	4,64,036.00	Advances	5	7,85,39,502.00
Liquidity Damages	-	2,70,812.00	Bank Accounts	6	1,25,49,343.58
Notional Recovery from Salary	7	2,92,072.00	SICOM New Delhi	-	6,073.00
Notice Pay	-	88,000.00			
NPMU - Fund Received	-	7,37,81,816.69			
Professional Tax	-	62,065.00			
Retention Money-Renaatus	-	94,15,043.00			
TDS Payable - Others	-	41,847.89			
TDS PAYABLE - STAFF	-	1,92,825.00			
Unreconcilied Deposits From Staff	-	1,25,046.00			
VAT TDS	-	17,67,662.00			
TOTAL		**57,54,98,641.85**	**TOTAL**		**57,54,98,641.85**

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 : 24.11.2017

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 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, 2016

Schedule-1 : Provisions

Particulars	Amount
EXCESS DEPOSIT BY STAFF	1,303.00
TDS REFUND TO ANAND KUMAR	7,550.00
TOTAL	**8,853.00**

Schedule-2 : Performance Guarantee

Particulars	Amount
AMC/CMC PERORMANCE SECURITY	179495.00
ABP ENGINERING LEAFE AREA INDEX METER	34250.00
AMKETTEE ANALYTICS	69300.00
Creations	70717.00
ELECTRONIK LAB	10000.00
GLOBAL TECHNOLOGIES CHENNAI	247525.00
MICRO SCIENCE	132000.00
MICRO SCIENCE -DC	145197.00
SWAN ENVIRONMENT PVT LTD	41632.00
Universal Technologies	36774.00
TOTAL	**9,66,890.00**

Schedule-3 : Investment Cost

Particulars	Amount
COMPUTERS & SYSTEMS	3,30,48,302.00
EQUIPMENTS & FACILITIES	35,50,609.00
CIVIL WORKS	99,99,261.00
FURNITURE & FITTINGS	6,45,568.00
VEHICLE	9,09,706.00
TOTAL	**4,81,53,446.00**

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 : Physical

Particulars	Amount
CONSTRUCTION OF NEW BUILDING & FACILITIES	16,86,32,480.00
GOODS & EQUIPMENTS (SCIENTIFIC)	25,54,72,898.27
OFFICE& IT EQUIPMENTS	1,17,64,524.00
TOTAL	**43,58,69,902.27**

Schedule-5 : Advances

Particulars	Amount
ADVANCE TO CONTRACTOR	3,99,71,645.00
ADVANCE TO OTHER INSTITUTIONS	15,90,076.00
ADVANCE TO PARTNER INSTITUTIONS	38,47,629.00
CONTINGENCY ADVANCE	7,42,321.00
TA ADVANCE	5,10,457.00
ADVANCE FOR ESA	4,11,568.00
ADVANCE TO STAFF OTHERS	-73,583.00
ADVANCE TO STAFF: TA	4,534.00
ADVANCE TO NRSC, HYDERABAD	3,23,84,384.00
GAYATRI AUTO SERVICE	41,859.00
TRUC PROJECT	20,060.00
TV SUNDARAM MOTORS	5,000.00
REVENUE ACTIVITY	-9,42,634.00
TRUC & DELTA	26,186.00
TOTAL	**7,85,39,502.00**

Schedule-6 : Bank Accounts

Particulars	Amount
UBI CURRENT A/C	15,23,590.64
UBI SEDIMENT CELL SAVING A/C	20,446.94
STATE BANK OF INDIA	5,38,306.00
FLEXI BALANCE	15,90,000.00
LC MARGIN	88,77,000.00
TOTAL	**1,25,49,343.58**

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 : Notional Recovery from Salary

Particulars	Amount
EPF	2,85,382.00
GPF Advance	-11,400.00
GSLI	-120.00
NPS	4,610.00
PF	15,000.00
Car Advance	-1,400.00
TOTAL	**2,92,072.00**

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, 2016

(in Rs.)

RECEIPTS	AMOUNT	PAYMENTS	AMOUNT
		Opening Balance	
Liquidity Damages	75,600.00	Bank Accounts	6,10,811.55
Provisions	56,576.00		
NPMU	1,53,66,960.00	NCSCM	2,88,094.00
Deposits (Asset)	1,34,50,000.00	Project Management	80,91,481.00
		Deposits (Asset)	40,000.00
		Advance To Institutes	75,35,871.00
		Advance To Suppliers	6,040.00
		Contingency Advances	1,81,193.00
		TA Advance	5,13,711.40
		Operational Cost	1,10,43,801.57
		Closing Balance	
		Bank Accounts	6,28,132.48
		Cash-in-hand	10,000.00
Total	**2,89,49,136.00**	**Total**	**2,89,49,136.00**

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 : 24.11.2017

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, 2016

(In Rs.)

Particulars	Schedule	Amount	Particulars	Schedule	Amount
Indirect Expenses			**Indirect Incomes**		
Operational Cost	6	2,04,44,188.02	Grants in Aid	-	2,85,35,669.02
Excess of income over expenditure		**80,91,481.00**			
Total		**2,85,35,669.02**	**Total**		**2,85,35,669.02**

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 : 24.11.2017

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

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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

Balance Sheet as on 31st March, 2016

(In Rs.)

Liabilities	Sch. No.	Amount	Assets	Sch. No.	Amount
Capital Account:-			**Fixed Assets:-**		
Corpus Fund	-	1,58,09,090.00	Project Management	2	1,58,09,090.00
Loans(Liability)			**Current Assets:-**		
Liquidity Damages	-	75,600.00	Cash in Hand	-	10,000.00
			Advances to Institutes	3	29,51,953.00
Current Liabilities:-			TA Advance	4	1,46,183.00
Professional Tax	-	23,332.00	Contingency Advance	5	26,053.00
NPMU Funds	1	32,09,156.48	Bank Accounts	-	6,28,132.48
NCSCM	-	4,11,568.00			
Revenue Activity	-	16,753.00			
TDS Others	-	8,000.00			
TDS Salary	-	17,912.00			
TOTAL		**1,95,71,411.48**	**TOTAL**		**1,95,71,411.48**

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
Director Chennai - 600 025, India

Place: Chennai
Date : 24.11.2017

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

K. RAMANAN & CO.
K. RAMANAN
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CHENNAI - 40
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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, 2016

Schedule-1 : NPMU Funds

Particulars	Amount
Funds from NPMU	26,24,672.48
Funds from NPMU-INTEREST	5,84,379.00
Interest on Savings Account	105.00
TOTAL	**32,09,156.48**

Schedule-2 : Project Management

Particulars	Amount
3G DONGLE	13000.00
AIR CONDITIONERS	259900.00
AUDIO CONFERENCING SYSTEM	30500.00
CIVIL WORKS	1463378.00
DESKTOP COMPUTER	922964.00
HR SOFTWARE	1348320.00
LPS IMAGE STATION	6415978.00
NAS STORAGE BOX	85000.00
OTHER FACILITIES & EQUIPMENTS	151580.00
PRIMER 7-SOFTWARE	112998.00
SCANNER & PRINTER	13067.00
SOFTWARES INCLUDING CUSTOMISATION	674160.00
TABLETS	2158960.00
UNDER WATER CAMERA	32000.00
UPS	98685.00
WORK STATION COMPUTER	2028600.00
TOTAL	**1,58,09,090.00**

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-3 : Advance to Institutes

Particulars	Amount
CEE AHEMADABAD	1760200.00
CMFRI KOCHI	664414.00
IOM AU	3629.00
KVFSU-BIDAR	-182571.00
WBUAFS KOLKATA	710136.00
ZSI	-230000.00
ANAMALAI UNIVERSITY	-235000.00
ICAR -CIFE-COMMUNITY DEPENDANCY ACHRA	48073.00
REGISTRAR IIS BANGALURE	73072.00
SACON-MAPPING KEY NESTING SITE	340000.00
TOTAL	**29,51,953.00**

Schedule-4 : TA Advance

Particulars	Amount
ABHILASH TA ADV	-15,000.00
ARUN BHARATHI M-TA ADV	20,000.00
KRISHNAN P-TA ADV	33,059.00
KUMARAN E-TA ADV	20,000.00
MANODHEEPAN KK TA ADV	20,000.00
RAJARAM P -TA ADV	20,000.00
SANKAR R TA ADV	48,123.00
SUBRAMANIAN E-TA ADV	1.00
TOTAL	**1,46,183.00**

Schedule-5 : Contingency Advance

Particulars	Amount
ABHILASH KR-CONT ADV	25,300.00
NITHYA S	753.00
TOTAL	**26,053.00**

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-6 : Operational Cost

Particulars	Amount
Consumables	130946.00
Travel Boarding	625534.40
Advertisement	31842.00
Bank Charges	860.04
CONSULTANCIES/STUDIES	8343777.00
HTL/LTL TRAVEL	883596.00
IIMP LAKSHADWEEP	864975.53
OTHER OFFICE COST	36856.00
POWER&FUEL	11797.00
PRINTING&STATIONERY	344076.00
PROJECT CONSULTANT	76000.00
PROJECT STAFF SALARY	6569030.00
REPAIR&MAINTENANCE	85785.00
Travel,Boarding & Accommodation	1499849.05
WATCH AND WARD &SECURITIES	715024.00
WORKSHOPS/CONSULTANCIES	224240.00
TOTAL	**2,04,44,188.02**

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, 2016

(in Rs.)

RECEIPTS	AMOUNT	PAYMENTS	AMOUNT
Opening Balance	-		
		Tax Credit-CTG-A	2,78,627.00
SICOM-Overhead-CTG-A	7,14,887.00	Tax Credit-CTG-B	2,32,320.00
SICOM-Overhead-CTG-B	1,76,000.00	Tax Credit-CTG-C	5,57,389.00
SICOM-Overhead-CTG-C	5,03,350.00	Sundry Debtors	8,70,719.00
SICOM-Overhead-RD	1,25,602.00	Contingency Advance	4,40,298.00
Duties & Taxes	4,66,491.10	Contingency Expenses	4,37,214.00
Contingency Income	50,97,857.00	Manpower Expenses	7,77,500.00
IC-Consultancy Income	20,74,742.12	NCSCM Overhead Expenses	4,20,000.00
Manpower Income	96,61,658.78	TA/DA Expenses	4,74,417.50
Material Income	10,65,579.00	TA Advance given	1,74,060.00
NCSCM Overhead Income	16,16,154.20		
TA/DA Income	30,83,666.00		
Interest on Saving Bank A/c	5,89,327.13	**Closing Balance**	
		Bank Accounts	2,05,12,769.83
Total	**2,51,75,314.33**	**Total**	**2,51,75,314.33**

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 : 24.11.2017

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)
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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, 2016

Particulars	Amount	Particulars	Amount
Indirect Expenses		**Indirect Incomes**	
TA/ DA Expenses	49,657.00	Material Income	1,04,562.00
Overhead Expenses	4,20,000.00	Manpower Income	48,56,804.62
		TA/DA Income	11,01,000.00
		Contingency Income	14,97,857.00
		NCSCM-Overhead Income	6,81,365.00
		IC-Consultancy Income	7,00,280.00
		Interest From Savings Bank A/C	5,89,327.13
Excess of income over expenditure	90,61,538.75		
Total	**95,31,195.75**	**Total**	**95,31,195.75**

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 : 24.11.2017

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)
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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, 2016

(In Rs.)

Liabilities	Sch. No.	Amount	Assets	Sch. No.	Amount
Capital Account			**Current Assets**		
Corpus Fund	-	90,61,538.95	Sundry Debtors	8	9,59,387.00
			Bank Accounts	-	2,05,12,769.83
			Contingency Advance	9	3,17,960.00
Current Liabilities			TA/DA Exp. Defered	-	6,49,378.50
Duties & Taxes	1	4,66,491.10	Contingency Exp. Deferred	-	4,35,064.00
Provisions	-	14,888.00	Manpower Exp. Deferred	-	7,77,500.00
Contingency Income Deferred	2	3600000.00	TA Advance	-	150.00
IC-Consultancy Income Deferred	3	1374462.12	Tax Credit - CTG-A	10	3,23,547.00
Manpower Income Deferred	4	4804854.16	Tax Credit - CTG-B (Deferred)	-	2,32,320.00
Material Income Deferred	5	961017.00	Tax Credit - CTG-C	11	5,57,389.00
NCSCM-Overhead Income Deferred	6	934789.00			
TA/DA Income Deferred	7	1982666.00			
Tax Credit : MS Cholamandalam	-	44,920.00			
SICOM Overhead - CTG-A	-	7,14,887.00			
SICOM-Overhead - CTG-B	-	1,76,000.00			
SICOM-Overhead - CTG-C	-	5,03,350.00			
SICOM-Overhead - RD	-	1,25,602.00			
Total		**2,47,65,465.33**	**Total**		**2,47,65,465.33**

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 : 24.11.2017

As per the Audit Report of even date attached
For K.Ramanan & Co
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K. RAMANAN & CO.
K. RAMANAN
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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, 2016

Schedule-1 : Duties & Taxes

Particulars	Amount
SERVICE TAX PAYABLE	3,61,123.30
SWATCH BHARAT CESS PAYABLE	24,255.80
TDS-194C	3,362.00
TDS-194-J	77,750.00
TOTAL	**4,66,491.10**

Schedule-2 : Contingency Income Deferred

Particulars	Amount
CONSULTANCY : CTG- A	11,20,000.00
CONSULTANCY : CTG- B	10,40,000.00
CONSULTANCY : CTG- C	14,40,000.00
TOTAL	**36,00,000.00**

Schedule-3 : IC-Consultancy Income Deferred

Particulars	Amount
CONSULTANCY : CTG- A	6,04,737.12
CONSULTANCY : CTG- B	2,11,200.00
CONSULTANCY : CTG- C	5,58,525.00
TOTAL	**13,74,462.12**

Schedule-4 : Manpower Income Deferred

Particulars	Amount
CONSULTANCY : CTG- A	27,81,854.16
CONSULTANCY : CTG- B	2,40,000.00
CONSULTANCY : CTG- C	17,83,000.00
TOTAL	**48,04,854.16**

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 : Material Income Deferred

Particulars	Amount
CONSULTANCY : CTG- A	2,83,517.00
CONSULTANCY : CTG- B	3,20,000.00
CONSULTANCY : CTG- C	3,57,500.00
TOTAL	**9,61,017.00**

Schedule-6 : NCSCM-Overhead Income Deferred

Particulars	Amount
CONSULTANCY : CTG- A	4,89,314.00
CONSULTANCY : CTG- B	1,76,000.00
CONSULTANCY : CTG- C	2,69,475.00
TOTAL	**9,34,789.00**

Schedule-7 : TA/DA Income Deferred

Particulars	Amount
CONSULTANCY : CTG- A	11,81,990.00
CONSULTANCY : CTG- B	1,60,000.00
CONSULTANCY : CTG- C	6,40,676.00
TOTAL	**19,82,666.00**

Schedule-8 : Sundry Debtors

Particulars	Amount
ADVANCE TO ESA	16,753.00
ICZMP	9,42,634.00
TOTAL	**9,59,387.00**

Schedule-9 : Contingency Advances

Particulars	Amount
DEBASISH T	1,30,000.00
ROBIN RS	1,88,000.00
SACHITHANANDHANAM	-40.00
TOTAL	**3,17,960.00**

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 : Tax Credit : CTG-A

Particulars	Amount
TAX CREDIT CLAIMED	2,36,610.00
TAX CREDIT DEFERRED	86,937.00
TOTAL	**3,23,547.00**

Schedule-11 : 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
National Centre for Sustainable Coastal Management
Ministry of Environment, Forest and Climate Change
Government of India, Anna University Campus
Chennai - 600 025. India

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, 2016

(in Rs.)

RECEIPTS	AMOUNT	PAYMENTS	AMOUNT
Opening Balance			
Bank Accounts	38,62,211.00	DELTA-PROFESSIONAL TAX	2.00
		TRUC-TDS OTHERS	3,153.00
INTEREST ON GRANTS IN AID	1,99,028.00	Sundry Creditors	85,046.00
Kakolee Banarjee- Cont Adv	33,312.00	FACILITIES&EQUIPMENTS-DELTA	51,000.00
Mpm Travel Xs Pvt Ltd	1,06,708.00	Loans & Advances (Asset)	2,43,072.00
		UTILISATION OF FUND: DELTA	11,60,939.00
		UTILISATION OF FUND: TRUC	5,05,548.00
		Closing Balance	
		Bank Accounts	21,52,499.00
Total	**42,01,259.00**	**Total**	**42,01,259.00**

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 : 24/11/2017

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

TRUC&DELTA

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, 2016

(In Rs.)

Particulars	Schedule	Amount	Particulars	Schedule	Amount
Indirect Expenses			**Indirect Incomes**		
Utilisation Of Fund - DELTA	5	11,60,939.00	Grants In Aid TRUC	-	18,91,042.00
Utilisation Of Fund - TRUC	6	6,79,103.00			
Excess of income over expenditure	-	**51,000.00**			
Total		**18,91,042.00**	**Total**		**18,91,042.00**

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 :24.11.2017

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

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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 2016

(In Rs.)

Liabilities	Sch.No	AMOUNT	Assets	Sch.No	AMOUNT
Capital Account:-			**Fixed Assets:-**		
Corpus	1	3,28,107.00	Facilities & Equipments - DELTA	2	1,90,579.00
			Facilities & Equipments - TRUC	3	1,37,528.00
Current Liabilities:-					
DELTA - Professional Tax	-	98.00	**Current Assets:-**		
Interest on Grants in Aid	-	2,47,422.00	Bank Accounts	4	21,52,499.00
MOES - DELTA	-	12,90,770.00	Loans & Advances	-	1,70,749.00
MOES - TRUC	-	7,61,925.00			
Sundry Creditors (NCSCM)	-	26,186.00			
TRUC- TDS Others	-	-3,153.00			
Total		**26,51,355.00**	**Total**		**26,51,355.00**

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 : 24/11/2017

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-600025

Schedules forming part of the accounts for the Year ended 31st March, 2016

Schedule-1 : Corpus Fund

Particulars	Amount
CORPUS DELTA	1,90,579.00
CORPUS TRUC	1,37,528.00
TOTAL	**3,28,107.00**

Schedule-2 : Facilities & Equipments - DELTA

Partculers	Amount
DELTA PRINTERS	1,27,679.00
DELTA-ALMIRAH	51,000.00
DELTA CHAIR	11,900.00
TOTAL	**1,90,579.00**

Schedule-3 : Facilities & Equipments - TRUC

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

Schedule-4 : Bank Accounts

Partculers	Amount
FLEXI ACCOUNT	21,00,000.00
UNION BANK OF INDIA	52,499.00
TOTAL	**21,52,499.00**

Director
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Schedule-5 : Utilisation Of Fund - DELTA

Partculers	Amount
Consumables	11,25,533.00
Project Staff Salaries	35,406.00
TOTAL	**11,60,939.00**

Schedule-6 : Utilisation Of Fund - TRUC

Partculers	Amount
Consumables	550.00
Others	1,86,551.00
Travel	4,81,620.00
Project Staff Salaries	10,382.00
TOTAL	**6,79,103.00**

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