INTEGRATED COASTAL ZONE MANAGEMENT PROJECT
WEST BENGAL
INTEGRATED COASTAL ZONE
MANAGEMENT OF WEST BENGAL COAST

State Project Management Unit (SPMU), West Bengal
Integrated Coastal Zone Management (ICZM) Project

Funded by: The World Bank

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INTEGRATED COASTAL ZONE MANAGEMENT OF WEST BENGAL COAST

STATE PROJECT REPORT

DEPARTMENT OF ENVIRONMENT
GOVERNMENT OF WEST BENGAL

July 2010
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<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>APC</td>
<td>Areas of Particular Concern</td>
</tr>
<tr>
<td>b.g.l</td>
<td>Below ground level</td>
</tr>
<tr>
<td>BMC</td>
<td>Biodiversity Management Committee</td>
</tr>
<tr>
<td>BOD</td>
<td>Biochemical Oxygen Demand</td>
</tr>
<tr>
<td>BSI</td>
<td>Botanical Survey of India</td>
</tr>
<tr>
<td>COD</td>
<td>Chemical Oxygen Demand</td>
</tr>
<tr>
<td>CMLRE</td>
<td>Centre for Marine Living Resources &amp; Ecology, Kochi</td>
</tr>
<tr>
<td>CPCB</td>
<td>Central Pollution Control Board</td>
</tr>
<tr>
<td>CMZ</td>
<td>Coastal Management Zone</td>
</tr>
<tr>
<td>CRZ</td>
<td>Coastal Regulation Zone</td>
</tr>
<tr>
<td>CSIR</td>
<td>Council of Scientific and Industrial Research</td>
</tr>
<tr>
<td>CWPRS</td>
<td>Central Water and Power Research Station, Pune</td>
</tr>
<tr>
<td>DSDA</td>
<td>Digha-Sankarpur Development Authority</td>
</tr>
<tr>
<td>EIA</td>
<td>Environmental Impact Assessment</td>
</tr>
<tr>
<td>ESA</td>
<td>Ecologically Sensitive Areas</td>
</tr>
<tr>
<td>GSI</td>
<td>Geological Survey of India</td>
</tr>
<tr>
<td>GOB</td>
<td>Government of West Bengal</td>
</tr>
<tr>
<td>GOI</td>
<td>Government of India</td>
</tr>
<tr>
<td>HTL</td>
<td>High Tide Line</td>
</tr>
<tr>
<td>LTL</td>
<td>Low Tide Line</td>
</tr>
<tr>
<td>I &amp; W D</td>
<td>Irrigation and Waterways Department</td>
</tr>
<tr>
<td>ICZM</td>
<td>Integrated Coastal Zone Management</td>
</tr>
<tr>
<td>ICZMP</td>
<td>Integrated Coastal Zone Management Plan</td>
</tr>
<tr>
<td>INCOIS</td>
<td>Indian National Centre for Ocean Information Services Hyderabad</td>
</tr>
<tr>
<td>ICMAM-PD</td>
<td>Integrated Coastal and Marine Area Management Project Directorate, Chennai</td>
</tr>
<tr>
<td>IUCN</td>
<td>International Union for the Conservation of Nature</td>
</tr>
<tr>
<td>MCM</td>
<td>Million cubic metre</td>
</tr>
<tr>
<td>MLD</td>
<td>Million litres per day</td>
</tr>
<tr>
<td>MOEF</td>
<td>Ministry of Environment and Forests</td>
</tr>
<tr>
<td>MoES</td>
<td>Ministry of Earth Sciences</td>
</tr>
<tr>
<td>NBA</td>
<td>National Biodiversity Authority</td>
</tr>
<tr>
<td>NCAOR</td>
<td>National Centre for Antarctic &amp; Ocean Research, Goa</td>
</tr>
<tr>
<td>NIO</td>
<td>National Institute of Oceanography, Goa</td>
</tr>
<tr>
<td>NIOT</td>
<td>National Institute of Ocean Technology, Chennai</td>
</tr>
<tr>
<td>ppt</td>
<td>Parts per thousand</td>
</tr>
<tr>
<td>SBB</td>
<td>State Biodiversity Board</td>
</tr>
<tr>
<td>SBR</td>
<td>Sundarban Biosphere Reserve</td>
</tr>
<tr>
<td>SEZ</td>
<td>Special Economic Zone</td>
</tr>
<tr>
<td>STR</td>
<td>Sundarban Tiger Reserve</td>
</tr>
<tr>
<td>TPD</td>
<td>Tonnes per day</td>
</tr>
<tr>
<td>UNESCO</td>
<td>United Nation Educational Social and Cultural Organisation</td>
</tr>
<tr>
<td>WBPCB</td>
<td>West Bengal Pollution Control Board</td>
</tr>
</tbody>
</table>
INTRODUCTION

1. Integrated Coastal Zone Management (ICZM) has now been recognized and used as an essential tool/process for formulating plans to protect and develop coastal ecosystem and resources. Keeping this in mind, the government has decided to take proactive steps to prepare state wise project report on integrated coastal zone management of littoral states of India. The state project reports are designed to include details of the key components of the project reflecting some key ecological, developmental, livelihood and governance issues along some chosen stretches of the coasts of the states. In essence, the report will develop the implementation plan of state level approaches to ICZM. It has been decided that, to start with, this initiative will be taken with the support of World Bank for three states of India, – Gujarat, Orissa and West Bengal. Accordingly, the state project report of West Bengal has been drafted as per contents decided in consultation with the Bank.

SECTION I – PROJECT CONTEXT

A. State of West Bengal – A Brief Profile

2. The state of West Bengal is the gateway to the northeast of India and also to the Far East countries like Bangladesh, Myanmar, Vietnam, Cambodia, Laos, Malaysia, Singapore, Indonesia etc. The state borders Orissa in the southwest and Bihar & Jharkhand to the west. It shares a long border with Bangladesh on the east and in the north, shares borders with Assam, Bhutan and Nepal. The southern boundary of the state is formed by Bay of Bengal. The location, therefore, makes the state a very strategic economic centre. Together with its vast hinterland to the west with rich natural resources, the state offers immense scope for trade, commerce and industrial activities and people from different parts of India including those from the adjoining states and far have settled for their livelihood especially in and around the capital metropolitan city of Kolkata. There are 19 districts in West Bengal (Figure 1) out of these only three districts – East Medinipur, North 24-Parganas and South 24 Parganas- fall within the coastal zone [Figure 2].

3. The total area of the state is about 88,752 sq km with a total population of a little over 80 million giving a population density of 903 inhabitants per sq km and making it one of the most densely populated states of India. The decadal (1991-2001) population growth rate of
Figure 1. Political map of West Bengal showing district boundaries, major place names, names of adjoining states and Bangladesh and Bay of Bengal.

Districts of West Bengal

1. Darjeeling
2. Jalpaiguri
3. Cooch Behar
4. Uttar Dinajpur
5. Dakshin Dinajpur
6. Malda
7. Birbhum
8. Murshidabad
9. Bardhaman
10. Nadia
11. Purulia
12. Bankura
13. Hooghly
14. North 24 Parganas
15. Paschim Medinipur
16. Howrah
17. Kolkata
18. South 24 Parganas
19. Purba Medinipur

Bay of Bengal

the state is 17.77 %. 71% of the population of West Bengal lives in rural areas. The literacy rate is about 70%.
4. Agriculture is the major occupation of people of the state. Apart from the food crops, jute is the main cash crop that used to support thriving jute mills till recently. The northern part of the state is dotted with tea gardens that produce high quality Darjeeling tea. The coastal reaches and Sundarban are important fishing grounds. Service sector activities, including IT industry are rapidly growing in the state. Metallurgical and manufacturing industries related to engineering products, electronics and electrical equipment, leather, textiles etc. are well developed in the state. Major industrial activities include coal mines in the western part, integrated steel plant at Durgapur and petrochemical industry at Haldia port. Since the pronouncement of new industrial policy in early nineties and through recent initiatives, major investments are expected in automobile, steel, petrochemical, ship building/breaking and IT industry and in infrastructure sector inclusive of construction of a deep water port at Sagar. Sector wise contributions to the gross domestic product of the state are 51% from service sector, 27% from agriculture and 22% from industries.

5. Much of the vegetation of the western part of the state shares floristic similarities with the plants of the Chota Nagpur plateau in the adjoining state of Jharkhand. The predominant commercial tree species is *Shorea robusta*, commonly known as Sal. The coastal region of Purba Medinipur exhibits coastal vegetation, the predominant tree is the *Casuarina*. On the eastern side of Bhagirathi-Hugli river in North and South 24 Parganas districts, the littoral mangrove forests of Sundarban, a Biosphere Reserve, are present. The most valuable tree from the Sundarban is the ubiquitous sundari (*Heritieria fomes*) from which the forest gets its name.

B. Physiography of West Bengal

6. Physiographically the state of West Bengal is quite unique and varied. In the far north is mountainous tract formed by Himalayan mountain chain. It can be divided into Central Himalaya zone exceeding altitudes more than 3000m and consisting of ice capped peaks including the spectacular Kachanjangha, the third highest mountain peak of the world. Immediately south of this zone, the Lesser Himalayan zone stretches up to the foothills that give place to the Terai plain or Piedmont plain having a southward sloping altitude between 150 to 100m. The coalescing alluvial fans of the Piedmont plain are bordered by the Jalpaiguri plain on the south to be followed by the Kochbihar plain further south. The plains are the result of fluvial action. The low lands in the western part of the Malda district and
almost the whole of North Dinajpur are often referred physiographically as Mahananda plain. The spectacular Barind upland (Balurghat and Gaur plains) that covers eastern part of Malda and South Dinajpur districts forms valley wall to the Mahananda plain.

7. A number of physiographic zones are easily discernable in the southern West Bengal west of the Bhagirathi-Hugli River. In the southwestern corner of the Purulia district, dissected outliers of the Ranchi plateau known as the Ayodhya plateau having an altitude of over 450m stand as blocks of highland. Further south of the Ayodhya plateau runs the Dalma hills separated from it by the alluvial deposits of Kumari River. The rest of the Purulia district and a small part of the adjoining Bankura, Birbhum and West Medinipur districts can be described as high plain (Purulia upland) sloping eastward. The Rarh upland with ferrallitic soil cover is present to the east of Purulia upland. The Upland is undulating in character subjected to severe soil erosion. To the east an extensive fluvial plain known from north to south as Kandi plain, Mayurakshi plain, lower Damodar plain, west Bhagirathi plain and Medinipur plain make up the landscape of this low lying area. South of the Damodar River and also within the Medinipur Plain water-logged marshy areas (now partially reclaimed), like the Dankuni, Ghatal and Dubda basins are characteristic back swamp areas of the landscape. The landscape east of the Bhagirathi river up to the Bangladesh border (the western part of the upper delta plain of the Ganga-Brahmaputra delta) is made up of overlapping and cross cutting meander belts of which the oldest is the proto-Padma meander belt running from north to south up to the northern limit of the lower delta plain.

8. The Kanthi coastal plain lying between the estuary of the Subarnarekha River and Hugli River is a northeast-southwest trending coastal zone characterized by rows of beach ridges and intervening low-lying swales (mudflats). The sea front is in dynamic equilibrium with some stretches experiencing erosion while the other part is accreting although net loss has been indicated. The coast is a meso-tidal wave dominated coast. The wave environment of the Kanthi coast is dominated by wind driven waves coming from SE or SSE. Wave height in the open sea is below 1 m which increases substantially as the waves move over sloping near shore sea bottom (the bathymetric contours are mostly shore parallel) at a small angle to the coast line. The predominant direction of littoral drift is from west to east although a mild littoral drift from east to west during winter months has been recorded. The
volume of sediment carried by the long shore drift is in the order of 455,000 cubic metre per month during the monsoon.

9. The Ganga (Hugli) delta in the south 24 Parganas district is a tide dominated delta. The tidal ranges sometimes exceed 5m. The area supports a dense mangrove forest, known as Sundarban, in the inter-distributary marshes of large funnel-shaped estuaries opening to the sea (southwards) with wide mudflats exposed during the low tide. The biological productivity of the mangrove plants are very high and contributes to the built up of the land by decaying material that combines with the fine sediments trapped by the mangrove roots. The entire landscape is, therefore, made up of islands separated by tidal channels. The delta is apparently formed by amalgamation of islands that are in various stages of welding in a jig-saw puzzle pattern. Extensive embankments have been constructed along some of the creeks to prevent overtopping of banks on to the inter-distributary low lying areas. Narrow silty to sandy beaches are present along the sea front of the islands facing directly to the sea. The off-shore areas of the delta are characterized by coast-perpendicular tidal shoals and channels up to the shelf edge. Near the coast, some tidal shoals are exposed during the low tide and are rapidly colonized by mangrove plants. The shoals gradually grow in size by trapping of sediments and organic debris to ultimately accrete to the main land mass. The process of delta accretion through this process has now ceased due to reasons not understood precisely. Sea level rise could be one of the factors. Connected with this event is the apparent net loss of land by erosion of the coast along the entire sea front of the Sundarban.

C. Coastal Resources/Marine areas of West Bengal

10. The length of the coastline in West Bengal is 220 km with a coastal zone [stretching from LTL to 500 m (as CRZ) inland and up to the landward extension of the successive series of older sand dune stretching up to Orissa Coast Canal in the western part; and LTL to Dampier-Hodges line, which serves as the boundary of the Sundarban Biosphere Reserve, also sensu stricto physiographically] of about 9,630 square km. The coastal zone supports an approximate population of 7 million.

11. Based on tidal amplitude only, West Bengal coast can be sub-divided into two different coastal environments namely (Figure 3):

1. The macro tidal (tidal range > 4 m) Hugli estuarine plain characterized by a network of creeks encompassing the islands with spectacular mangrove vegetation
and off-shore linear tidal shoals from Sagar Island to the border of Bangladesh to the east.

2. Meso tidal (tidal range 2 – 4 m) Medinipur (Digha-Sankarpur-Junput) coastal plain to the west of the Hugli estuary with rows of sandy dunes separated by clayey tidal flats from Sagar Island to Orissa border to the west.

![Figure 3: Location map of West Bengal coast. Erosional shores are outlined in blue, accretional areas in red.](image)

This contrasting physical nature of the West Bengal is also reflected in the coastal resources east and west of Hugli estuary.

**C.1 Living Resources**

**C.1.1 Digha-Sankarpur Coast**

**Flora**

12. Coastal flora of special interest is found in the mini estuaries of Digha-Sankarpur area. The eastern extension of the Subarnarekha estuary has given rise to regeneration of *Avicennia* within the Talseri area adjacent to Digha. A similar mini-estuary at Jatra nala harbours mangal diversity like the highly valuable morphine rich medicinal mangrove *Acanthus illicifolius* thickets and *Clerodendron inerme* the back mangal. Further east the Digha Mohona was once a mangrove reserve now converted into a large aquaculture area. Even then the remnant mangrove species of *Avicennia marina*, *A. alba*, *Excoecaria agallocha*, *Clerodendron inerme* and *Acanthus illicifolius* are common. Salt marshes like *Sweda maritime*, *Salicornia brachiata*, *Heliotropium curassavicum* are met with. Another
small estuary to the east is Jalda creek where salt marshes and sedges (*Fimbrystylis* *spp* and *Cyperus* *spp*) dominate.

**Fauna**

13. Digha-Sankarpur area under Ramnagar Block-I in the western coastal stretch contributes a rich fishery from middle August to middle February of the year. Edible fish diversity of Digha-Sankarpur coast has been estimated from landing statistics as below:

*Tenulosa ilisa, Pama pama, Setipinna* *spp.*, *Trichiurus* *spp*, *Harpodon nehereus, Coilia* *spp.*, *Ilisha elonhata, Sciaena biauritus, Polynemus indicus, Chirocentrus doral, Prawns* – (*Penaeus monodon, Acetes* *spp.*, *Macrobrachium rosenbergii*), *Tachydurus jella, Stromateus cinereus, Polynemus paradiseus, Coilia* *spp*, etc. The efficiency and operating range of traditional fishing activities have undergone drastic changes in recent years (from about 1987) due to the impact of mechanization of fishing craft and by use of synthetic fibers for gears (specially trawling). The total marine catch has increased with regard to fishing area and coastline (Table below)

<table>
<thead>
<tr>
<th>Year</th>
<th>Total catch (000 tonnes)</th>
<th>No of mechanized boats</th>
<th>Calculated CPUE (tones per boat)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000-01</td>
<td>106.32</td>
<td>3622</td>
<td>3.26</td>
</tr>
<tr>
<td>2001-02</td>
<td>107.32</td>
<td>3556</td>
<td>3.09</td>
</tr>
<tr>
<td>2002-03</td>
<td>107.51</td>
<td>4175</td>
<td>2.86</td>
</tr>
<tr>
<td>2003-04</td>
<td>108.5</td>
<td>4481</td>
<td>2.69</td>
</tr>
</tbody>
</table>

However, the data indicate that during the last five years the total fish catch has shown only marginal increase in spite of significant increase in fishing effort. Thus catch per unit effort (considering mechanized boat only) has shown considerable decline pointing to non-sustainability of fishing in this part of the coast in future. Presently 143 species of finfish and 19 species of shellfish (crustaceans) are reportedly available at the landing stations of Digha-Sankarpur area.

14. The main fish landing centres are located in and around Digha, i.e., Digha Mohona, Sankarpur, Jalda and new Jalda (Dadanpatrabar). The majority of landed catch is transported to Kolkata and other markets of south directly. Hilsa constitutes the major (20%) portion of the fish catch (Table below)
<table>
<thead>
<tr>
<th>Name of species</th>
<th>Range of availability (%)</th>
<th>Average (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>H. ilisha</em></td>
<td>8.4 – 46.4</td>
<td>19.9</td>
</tr>
<tr>
<td><em>P. pama</em></td>
<td>1.4 – 24.5</td>
<td>12.3</td>
</tr>
<tr>
<td>Prawn</td>
<td>0.6 – 16.4</td>
<td>10.2</td>
</tr>
<tr>
<td><em>T. jella</em></td>
<td>4.9 – 14.1</td>
<td>10.2</td>
</tr>
<tr>
<td><em>S. cinercus</em></td>
<td>4.9 – 12.1</td>
<td>8.4</td>
</tr>
<tr>
<td><em>S. biauritus</em></td>
<td>1.5 – 11.6</td>
<td>7.1</td>
</tr>
<tr>
<td><em>Setipping sp.</em></td>
<td>0.3 – 7.1</td>
<td>3.5</td>
</tr>
<tr>
<td><em>Coilia sp.</em></td>
<td>0.1 – 6.4</td>
<td>3.2</td>
</tr>
<tr>
<td><em>H. nehereus</em></td>
<td>1.0 – 3.4</td>
<td>2.1</td>
</tr>
<tr>
<td><em>Trichiurus sp.</em></td>
<td>0.3 – 2.8</td>
<td>1.6</td>
</tr>
</tbody>
</table>

Out of the 4 World Bank aided shrimp culture projects, one each is located at Digha (74 ha) and Dadanpatra (250 ha). The target production is from 500 to 1000 kg/ha/year. Through State Government initiative two fresh water prawn (*Macrobrachium rosenbergii*) and one crab hatchery are running in pilot scale.

15. The speciality of Digha-Sankarpur coast is the occurrence of two endangered species *viz* *Lepidochelys olivacea* the marine turtle and the *Carcinoscorpius rotundicauda* the valuable medicinal invertebrate the “Horse shoes”. Not much is known about their habitat and other details.

C.1.2 Sagar-Sundarban Coastal areas

General Characteristics

16. Sundarban with an area of about 10200 square kilometer of mangrove forest extends over two countries India (4,267 sq.km.) and Bangladesh (6,000 sq.km.). Out of this area of 4,267 sq. km., about 2,300 sq.km. is under forest canopy. An additional 5,400 sq.km. non-forest (reclaimed forest) human habited area along the north and northwestern fringe of mangrove forest within the Indian territory is also known as Sundarban. The Dampier-Hodges line has been accepted as the administrative landward boundary of Sundarban. The total area of Sundarban in India is therefore about 9600 sq.km. which forms the Sundarban Biosphere Reserve (SBR). SBR was notified under the administrative control of Department of Forests, Government of West Bengal in 1989 and was ultimately constituted as National
Biosphere Reserve by UNESCO in 2001. The eastern part of the mangrove forest (about 2,585 sq.km.) has been declared as Sundarban Tiger Reserve (STR) area. A large part of the STR area (1,330 sq. km.) has been further declared as a National Park (known as Core area) by the Ministry of Environment and Forests, Government of India. Also three islands within the mangrove forests namely Sajnekhali, Lothian and Halliday have also been declared as Wildlife Sanctuaries by MOEF. Considering the overall ecological interest of forests of Sundarban, it has been declared as a World Heritage Site by IUCN.

**Flora**

17. The dominant flora of Sundarban is the mangrove. Altogether thirty true mangrove species, thirty mangrove associated plant species (back mangal) and thirty non-mangrove halophytic plant species have so far been identified from Sundarban. There are altogether fifty species of phytoplankton constituted by forty species of diatoms, eight species of dianoflagellates and one species of chlorophyceae and cyanophyceae. Sixteen types of zooplankton have so far recorded from Sundarban. About eighty species of algae adapted to salinity value from 15 to 35 ppt have been recorded from Sundarban. A succession of plant growth depending on the relative height of the land and consequent time of inundation by tidal water could be seen. In the lower intertidal mud flats, the halophytic grass is the pioneer species that rapidly colonises the newly silted up substrate. Floating seeds and seedlings of mangrove plants are arrested in this grass land and are anchored and germinate there. These seedling plants ultimately develop into dense mangrove forests of *Avicennia, Sonneratia, Rhizophora, Ceriops* and *Bruguiera* on these intertidal landforms. *Ceriops, Phoenix, Xylocarpeus* and *Nypa* grow on the upper intertidal levels to form ridge forests.

**Fauna**

18. The diversity and distribution of animals in Sundarban Biosphere Reserve can be appreciated from the following Table (ENVIS Newsletter).

<table>
<thead>
<tr>
<th>Phylum</th>
<th>Number of species occurring in:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Terrestrial Habitat</td>
</tr>
<tr>
<td><strong>1</strong> Kingdom Protista</td>
<td></td>
</tr>
<tr>
<td>Subkingdom</td>
<td>Protozoa</td>
</tr>
<tr>
<td>Phylum</td>
<td>Sarcomastigophora</td>
</tr>
<tr>
<td></td>
<td>Apicomplexa</td>
</tr>
<tr>
<td>Phylum</td>
<td>Number of species occurring in:</td>
</tr>
<tr>
<td>--------</td>
<td>--------------------------------</td>
</tr>
<tr>
<td></td>
<td>Terrestrial Habitat</td>
</tr>
<tr>
<td>Myxozoa</td>
<td>--</td>
</tr>
<tr>
<td>Cilioohora</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>47</td>
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</table>

<table>
<thead>
<tr>
<th>II Kingdom</th>
<th>Animalia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phylum</td>
<td>Porifera</td>
</tr>
<tr>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Cnidaria</td>
<td>-</td>
</tr>
<tr>
<td>Ctenophora</td>
<td>-</td>
</tr>
<tr>
<td>Platyhelminthes</td>
<td>-</td>
</tr>
<tr>
<td>Nemathelminthes</td>
<td>-</td>
</tr>
<tr>
<td>Acanthocephala</td>
<td>-</td>
</tr>
<tr>
<td>Nemartines</td>
<td>-</td>
</tr>
<tr>
<td>Rotifera</td>
<td>-</td>
</tr>
<tr>
<td>Mollusca</td>
<td>3</td>
</tr>
<tr>
<td>Sipuncula</td>
<td>-</td>
</tr>
<tr>
<td>Echiura</td>
<td>-</td>
</tr>
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<tr>
<td>Entoprocta</td>
<td>-</td>
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<tr>
<td>Bryozoa</td>
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<tr>
<td>Brachiopoda</td>
<td>-</td>
</tr>
<tr>
<td>Chaetognatha</td>
<td>-</td>
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<tr>
<td>Echinodermata</td>
<td>-</td>
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<tr>
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<tr>
<td>Aves</td>
<td>153</td>
</tr>
<tr>
<td>Other classes</td>
<td>-</td>
</tr>
</tbody>
</table>

| Total | 487 | 993 | 1480 |
| Grand Total | 534 | 1052 | 1586 |

19. Many rivers run across the Sundarban and falls into the Bay of Bengal. These rivers contain various fish species. Sundarban provides 90% of fish species of eastern coast and the coastal fishery of East India is dependent upon the Sundarban. There are over 300 species of marine and freshwater fishes, prawns and crabs occurring in this region. Among fin fish species there are: *Lates calcarifer, hilsha ilisha, Liza parsia, Liza tade, Harpador nehereus,*
*Plotosus canius, Pompus argenteus, Pangasius pangasius, Chanos chanos, Eleutheronema tetradyactylum, Polynemous paradiseus* and *Pama pama*. Shellfish species includes *Penaeus monodon* and *Metapenaeus monoceros*. There are two types of edible crabs: *Scylla serrata* and *neptunus pelagiens*. Among these, the most highly valued economic species is the Tiger prawn (*Penaeus monodon*). In fact, major economic activities of this region centre round this species through collecting and marketing seeds as well as rearing and farming in brackish water bheries. Amongst the fin fishes, the highly priced hilsa (*Teualosa ilisha*), bhetki (*Lates calcarifer*), bhangone (*Liza tade*), parse (*Liza parsia*), etc., form a lucrative fishery of this region. More than 500 tonnes of the mud crab (*Scylla serrata*) is exported alive to far eastern countries. Indiscriminate exploitation of fishery resources and unregulated use of shooting nets of small mesh size in the estuary for the collection of tiger prawns (*Penaeus monodon*) seeds are resulting in tremendous loss of diversity of faunal components in the estuaries of SBR. The result of such rampant destruction of other juvenile fish seeds has been reflected in the drop in availability and catch of other fish species in the estuaries. The estimated number of fish species lost by this process is about 30 in number which are of indigenous type. These species breed naturally in the estuaries and cannot be breed in captivity. The loss in biodiversity has also been evident by species wise drop in fish catch by the fishermen.

20. The annual total fish yield (in metric ton) in Sundarban varies from about 26000 to 51000 with about 80% of the fish catch taking place during November to January. Out of the total annual catch, the annual Hilsha Drift Gillnet Fishery yields about 1000 to 7500 tons.

21. The land is inhabited by Royal Bengal Tigers. Wildlife of Sunderbans also harbours jungle cats, fishing cats, Axis deer, wild boar, Rhesus monkeys, mongooses and the largest estuarine crocodiles in the world. Sunderbans is the breeding ground of immense variety of birds like Heron, Egret, Cormorant, Fishing Eagle, White Bellied Sea Eagle, Seagul, Tern, Kingfisher as well as migratory birds like Whimprel, Black-tailed Godwit, Little Stint, Eastern Knot, Curlew, Sandpiper, Golden Plover, Pintail, White-eyed Pochard and also Whistling teal. Wide variety of aquatic and reptile life forms are present that include Olive Ridley sea turtle, hardshelled Batgur Terrapin, Pythons, King cobra, Chequered killback, Monitor and lizards including the Salvator lizards. The Sundarban ecosystem is characterised by a very dynamic environment due to the effect of tide, flooding, salinity and cyclones. As a result several remarkable species are found such as estuarine crocodile (*Crocodilus porosus*),
spotted deer (*Axis axis*), dolphins (*Platanista gangetica, Orcaella brevirostris, Peponocephala electra, Neophocaena phocaenoides*), marine turtles (*Caretta caretta, Chelonia mydas, Eretmochelys imbricata, Lepidochelys olivacea* and *Dermochelys coriacea*) and, the flagship species, the Royal Bengal Tiger (*Panthera tigris*).

22. The biodiversity is represented by the following taxonomic groups: over 40 mammal species, over 270 bird species, over 45 reptile species, at least 11 amphibian species, over 120 fish species, an unknown number of invertebrates, more than 330 plant species. The Sundarban tiger population is supposed to be the largest surviving tiger population in the world. Estimated number of tigers in the Sundarban is 274 as per 2006 census. The estimates for the deer in this area are 50-80,000, for wild boar 20,000, smooth Indian otter (*Lutra perspicillata*) 20,000 and rhesus monkey (*Macaca mulatta*) 40,000 to 70,000.

23. The colourful bird life along the waterways includes species such as kingfishers (9 species), raptors (38 species), herons, egrets, storks, sandpipers, whimbrel, curlew, gulls, terns, woodpeckers, barbets, shrikes, drongos, mynahs, minivets, babblers and many others. Lucky birders may catch a glimpse of masket finfoot (*Heliopais personata*).

The Sundarban is surrounded by a very densely populated area, therefore human pressure is important. Around 1.2 million local users reside seasonally in the area for fishing and other resource use activities. Commercial hunting was a problem mainly before the 1970s and this resulted particularly in a serious depletion of the crocodile populations and to a lesser extent to the deer population. Although the protection has improved significantly in the last decades, illegal hunting is still occurring on an incidental basis and fishery is having an adverse impact on the populations of the remaining turtle and crocodile populations as these animals drown frequently in fishing nets.

24. Due to natural processes, fresh water discharge of the Ganges and Brahmaputra catchment is decreasing as main waterways are shifting eastwards (excepting Hugli estuary where fresh water of about 40000 cusec flows at least during the driest days through Farakka barrage). Further, the total annual discharge is decreasing due to intensifying land use (namely irrigation) upstream. The role of this change is not yet clear, but is evident that it will influence wildlife populations and vegetation in the long term.

25. However, the main threat today may come from outside the area in the form of pollution. Toxic products (pesticides, etc.) enter the system due to upstream pollution in the
huge Ganges catchment. Pollution may be a direct source of mortality, but it may also reduce the health, increasing the mortality rate on the long term. Many products such as pesticides have also been proved to reduce the reproductivity (birth rate) in animal populations. A future threat is the exploitation of mineral gas, which is likely to be found abundant in the underground of the Sundarban.

26. Some species that have become extinct during the last century are: javan rhinoceros (Rhinoceros sondaicus), water buffalo (Bubalus bubalis), swamp deer (Cervus duvauceli), gaur (Bos gaurus), hog deer (Axis porcinus), marsh crocodile, (Crocodilus palustris).

C.2 Non-living Resources

Placer minerals

27. There is no placer mineral deposit on and off shore part of the coastal zone of West Bengal.

Minor Forest Produce of Sundarban

28. Tree farming programme on private land, village wood lots as well as roadside plantations and mangrove plantations raised on the mudflats of the numerous streams and rivers outside government forests help to meet the need of the local people for fuel wood and small timber, including building materials. The habitat shows evidence of excessive felling in the past. Timber smuggling is still a threat to this Tiger Reserve. Honey collection on permit basis is limited to the buffer area. Annually, about 38.2 MT of honey and 1.4 MT of wax are collected from the SBR (based on 2006-07 figure).

Tourism

29. Digha in East Medinipur district is the only major tourist resort of West Bengal. It receives about 43% of the tourist flow of West Bengal. About a lakh of foreign and about 25 lakh domestic tourists visit this coastal resort. Amongst the tourists, a large number are day trippers belonging mostly to middle and low income groups. For these day trippers there is only one facility at Digha (Khanika). Infrastructural facilities and civic amenities are limited in Digha, New Digha and Sankarpur. Although there are a large number of budget hotels, star accommodation are available one each in Digha, New Digha and Sankarpur. Old Digha has become congested. The area does not have proper facilities for treatment of solid and liquid waste. Coastal erosion and construction of structures to prevent coastal erosion has robbed the Digha coast of its accessibility and natural beauty. Beach has also become dangerous in
some stretches especially in high tides during late monsoon when surging water suddenly cut off all escape routes for people who had inadvertently strayed into beach. In spite of all these drawbacks, Old Digha, New Digha and Sankarpur have tremendous potential to attract a large number of tourists if an integrated (development) management plan is drawn up and implemented.

30. Sagar Island is a tourist destination especially around the Sagar mela time when around five lakh pilgrims visit the island. If the main bottleneck of problems of communication involving crossing of river by ferry and lack of grid electricity are solved, it can grow into a viable coastal tourist resort.

31. In Sundarban area, a small coastal resort Bakkhali (Fraseganj) attracts some tourist inflow. Better communication facilities and grid electricity are required to make this beach resort an attractive tourist destination for pristine, unspoilt and quiet beach resort to unwind.

32. Tourists are allowed in the buffer area of Sundarban. A tourist lodge at Sajnakhali has accommodation facilities for the tourists. Zilla Parishad, 24 North Parganas has also created accommodation facility at Hemnagar, close to the northern boundary of the Sundarban Tiger Reserve. There is tremendous potential for development of eco tourism resources of the Sundarban. Ecotourism is now on a very low key with inadequate facilities. A well thought out eco tourism plan for Sundarban is the need of the hour. Development of infrastructural facilities in tune with the extant landscape and ambience for the promotion of ecotourism in Sundarban will be a challenge.

33. The main attractions of the Sundarban are for wildlife enthusiasts, the opportunity to sail in the solitude of wilderness through its hundreds of channels, to learn more about the tiger behaviour and the possibility to view this majestic creature on a sand bank or crossing a river or devouring its prey, to see an old Hindu temple in the middle of nowhere, to view estuarine and marsh crocodiles under the stars, and to learn more about the mangrove forest and its importance.

**Ports and harbours**

34. Haldia Port is located about 104 km south of Kolkata. The fourth largest port in India, Haldia dock system forms part of the Kolkata port complex. It is situated at the confluence of the Haldi and the Hugli rivers away from the open coast. The dock complex is located on the west bank of the river Hugli, 100 km from the pilotage station at Sandheads in the Bay of
Bengal. The port handles over 28 million tons of cargo every year. It has a modern dock system for handling large vessels. Other facilities include a full-fledged container handling facility and a jetty for handling bulk chemicals. Haldia maintains a nominal ship-waiting period and a low turn round time for vessels. The dock complex is connected through National Highway 41. The port has been on a forefront of privatisation. Two of its berths have been leased to leading enterprises and a large number of leading organisations are keenly interested in leasing facilities as well as leasing land for setting up port facilities. The Dock System has two riverine oil jetties and eight berths inside an impounded dock.

**Ground Water**

35. In the coastal area of West Bengal a clay blanket of 20 – 30m thickness is generally present below which brackish water aquifers occur within 120 m depth in the western part of Hugli river and within 150 – 180 m in the eastern part of it. A group of fresh water aquifers occur in coastal tract of East Medinipur within the depth span of 120-360 m sandwiched between saline/brackish water aquifers. In the extreme south-eastern part of the coastal belt brackish water aquifers occur within 360m depth. The fresh and brackish water aquifers are separated by a 15 – 20m thick impervious clay layer.

36. In the Digha-Ramnagar area of East Medinipur district, a shallow fresh water aquifer exists down to a depth of 12 m bgl in the sediments of present day dunes from which water may not percolate downward due to the presence of underlying thick plastic clay. An area of 150 sq km around Contai, Purba Medinipur district, aquifers contain brackish to saline water at various depths except those near surface and sand dune aquifers. Also in some localized pockets in South 24 Parganas district, sand horizons within a zone of 20 – 50m at the top having fresh water occur. The distribution of salt water – fresh water aquifers in the coastal tract is generally uniform with fresh ground water overlying saline ground water underneath.

37. The Haldia region is important from the point of view of ground water utilization in a rapidly growing coast based industrial hub of West Bengal. Drilling for ground water within the Haldia Industrial complex area reveals that sediments down to a depth of 115 b.g.l. are generally argillaceous in nature with few sand horizons with brackish to saline water. Below the depth of about 115 metres, the sediments are by and large arenaceous down to depths of little over 300 m. These sandy aquifers contain fresh ground water. Below the depth of 305
m, the unconsolidated sediments by and large comprise clayey material with sub-ordinate sand horizons. Assuming ground water draft of 400 MCM, a balance of about 80 MCM may now be available balance resources available in the Haldia region.

38. In the Digha Sankarpur area, two freshwater and one brackish to saline water aquifer horizons have been identified:

1. Basal sand dominated confined aquifer system, extending from 160 m to 300 m drilled depth with fresh water of very high quality. Salinity in this zone is from 0.6 to 0.9 gm/litre and iron content is generally high.

2. Middle coarse sand dominated aquifer extending between 15 and 80 m, with occasional brackish contamination with salinity range of 4-6 gram/litre with impermeable clay layers separating the fresh water bearing zone.

3. Upper dune sand sequence forming unconfined fresh water aquifer extending up to 9 m with a salinity range of 0.7 to 1.1 gm/litre increasing downward. Although used extensively in the villages, hotels and holiday homes, the water quality is poor due to contamination of coliform bacteria and high concentration of chloride and iron and high hardness and alkalinity.

All the aquifers are recharged by monsoon rain but the piezometric surface of the deep aquifer is depressed by 9 metres during January to March due to heavy withdrawal for cultivation. Increasing demand and drawal of ground water from the deep aquifer, there is real threat of saline water ingestion if excessive withdrawal is regulated.

D. Coastal Zone Management – Status

D.1 Laws and Policies – CRZ and CMZ

39. The Environment (Protection) Act, 1986 was enacted to provide an umbrella national legislation for protection of environment inclusive of the coastal region. The notification No. 114(E) of 1991 by Ministry of Environment and Forests, Government of India under section 3(1) and section 3(2) of the Act and Rules 5 (3) (D) of Environment (Protection) Rules, 1986 declaring coastal stretches as coastal regulation zone (CRZ) and regulating activities in the CRZ was the first serious attempt of legislation on coastal issues. This notification along with other legislations as detailed below provides broad framework regulating activities in coastal stretches.

D.1.1 The Water (Prevention and Control of Pollution) Act, 1974
40. The Act is one of the major environment related legislations that deals with all basic aspects, means and mechanisms related to control of water pollution in the country up to 5 km into the sea.

**D.1.2 Environment (Protection) Act, 1986**

41. As already mentioned the Environment (Protection) Act, 1986 is an umbrella act governing all aspects of Environment in the country. The act specially deals with pollution aspects of air, water, hazardous substances, industrial emissions and wastes. The act also specifies permissible standards of emissions by the industries and includes legal provisions for enforcement as is applicable over the entire land area of India and the off-shore areas included in the coastal zone.

**D.1.3 Coastal Regulation Zone Notification, 1991**

**General Characteristics**

42. As stated earlier a notification popularly known as Coastal Regulation Zone (CRZ) notification was issued by the Ministry of Environment and Forests, Government of India on 19 February, 1991. The Central Government through this notification declared the coastal stretches of seas, bays, estuaries, creeks, rivers and backwaters which are influenced by tidal action (in the land ward side) up to 500 metres from the High Tide Line (HTL) and the land between the Low Tide Line (LTL) and the HTL as Coastal Regulation Zone.

43. Restrictions on setting up and expansion of industries, operations or processes etc. were imposed in the said CRZ prohibiting activities to set up of new industries and expansion of existing industries except (a) those directly related to water front or directly needing foreshore facilities, (b) projects of Department of Atomic Energy and (c) non-polluting industries in the field of information technology and other service industries in the CRZ of Special Economic Zones (SEZ).

44. The permissible activities in the CRZ are as follows:

A. Activities other than those prohibited.

B. Any activity within CRZ that requires water front and foreshore with governmental clearance

C. Activities that will require environmental clearance were also listed.

45. For regulating development activities, the coastal stretches within 500 metres of HTL on the landward side have been classified into four categories as under:
A. **Category I (CRZ – I)**

46. The CRZ - I will include

   (i) Areas that are ecologically sensitive and important such as national parks/marine parks, sanctuaries, reserve forests, wildlife habitats, mangroves, corals/coral reefs
   Areas close to breeding and spawning grounds of fish and other marine life
   Areas of outstanding natural beauty/historical heritage areas
   Areas rich in genetic diversity
   Areas likely to be inundated due to rise in sea level consequent upon global warming and
   Such other areas as may be declared by the Central Government or the concerned authorities at the State/Union Territory level from time to time

   (ii) Area between the LTL and the HTL

47. The development or construction activities in CRZ - I areas shall be regulated by the concerned authorities at the State/Union Territory level in accordance with the specified norms. Between LTL and the HTL, activities as specified are permitted.

B. **Category II (CRZ II)**

48. The areas that have already been developed up to close to the shore-line. For this purpose, "developed area" is referred to as that area within the municipal limits or in other legally designated urban areas which is already substantially built up and which has been provided with drainage and approach roads and other infrastructural facilities, such as water supply and sewerage mains.

49. The development or construction activities in CRZ - II areas shall be regulated by the concerned authorities at the State/Union Territory level in accordance with the specified norms.

C. **Category III (CRZ-III)**

50. Areas that are relatively undisturbed and those which do not belong to either Category I or II. These will include coastal zone in the rural areas (developed and undeveloped) and also areas within Municipal limits or in other legally designated urban areas which are not substantially built up.

51. The development or construction activities in CRZ - III areas shall be regulated by the concerned authorities at the State/Union Territory level in accordance with the specified norms.
norms. The area up to 200 metres from the High Tide Line is to be earmarked as 'No Development Zone", provided that such area does not fall within any notified port limits or any notified Special Economic Zone.

D. Category IV (CRZ IV)

52. Coastal stretches in the Andaman and Nicobar, Lakshadweep and small islands, except those designated as CRZ I, CRZ II OR CRZ III. The development or construction activities in CRZ - IV areas shall be regulated by the concerned authorities at the State/Union Territory level in accordance with the specified norms.

D 1.4 Coastal Zone Management (CZM) Notification, 2008

53. Implementation of CRZ notification of 1991 posed problems over the years in its effective implementation for the sustainable development of coastal regions as well as conservation of coastal resources. A committee under the chairmanship of Prof. M S Swaminathan reviewed the existing Notification and made specific recommendations to build on the strengths of existing regulations and institutional structures and fill gaps for conservation and improving the management of the coastal resources by enhancing the living and non-living resources of the coastal zone; by ensuring protection to coastal populations and structures from risk of inundation and also ensuring livelihood security of coastal populations. Accordingly based on these recommendations Central government has issued the draft of a new Coastal Zone Management (CZM) Notification superseding the CRZ Notification.

54. The draft Notification defines coastal zone as the area from the territorial waters limit (12 nautical miles measured from the appropriate baseline) including its sea bed, the adjacent land area along the coast, and inland water bodies influenced by tidal action including its bed, up to the landward boundary of the local self government or local authority abutting the sea coast. In case of ecologically and culturally sensitive areas, the entire biological or physical boundary of the area will be included. For the purposes of management and regulation, the coastal zone is to be divided into four categories, namely:

1. Coastal Management Zone – I (CMZ – I) consisting of areas designated as Ecologically Sensitive Areas (ESA) such as Mangrove, Coral reefs, Sandy beaches and Sand dunes, Turtle nesting grounds, Salt marshes, Nesting ground of birds, etc
2. Coastal Management Zone – II (CMZ – II) consisting of areas other than CMZ – I and coastal waters, identified as “Areas of Particular Concern (APC)” such as economically important areas, high population density areas, and culturally and, or strategically important areas like coastal Municipalities/Corporations, coastal Panchayets with population density more than 400 persons per sq km, Ports and Harbours, notified Tourism areas, Heritage areas, Defence areas/installations, Mining sites. The administrative boundaries of these APCs would be boundaries of CMZ – II.

3. Coastal Management Zone – III (CMZ – III) consisting of all other open areas including coastal waters and tidal influenced inland water bodies, that is all areas excluding those classified as CMZ – I, II and IV.

4. Coastal Management Zone – IV (CMZ – IV) consisting of island territories of Andaman and Nicobar, Lakshadweep, and other off-shore islands.

55. The Notification retains the existing National/State/Union Territory Coastal Zone Management Authorities set up under the Environment (Protection) Act, 1986. The management methodology and approach for the Coastal Management Zone are to be related to the delineation of set back line for the entire coast excluding CMZ I and CMZ – IV areas based on its vulnerability to sea level rise, flooding and shore line changes. The parameters to be considered for drawing up the set back line will be elevation, geomorphology, sea level trends and horizontal shoreline displacement.

56. All activities in CMZ – I areas are to be regulated on the basis of an Integrated Coastal Zone Management Plan (ICZMP) that is a land use plan or development plan to protect coastal population and infrastructure and to protect and conserve coastal and marine areas and resources and sustainable development. Similarly all activities in CMZ – II are to be regulated based on an approved ICZMP. Activities on the seaward side of the set back line will be regulated to ensure that no further development takes place other than foreshore requiring facilities and basic infrastructure. The development on the land ward of the set back line will be as per the local town and country planning rules.

57. The ICZM Plan of CMZ - II will take into account the comprehensive guidelines as notified that include the following key provisions:
1. No construction to be permitted on the seaward side of any existing approved building or a tarred or surfaced road.

2. New schools, market areas and other public facilities to be located beyond the vulnerable area.

3. Along seaward side sufficient bio-shield with local vegetation, trees including mangroves to be planted.

4. The beaches should be left free of any development.

5. New houses and settlements to be planned on landward side of the set back line.

6. Sand dunes, being natural speed breakers in the event of hazards to be maintained or regenerated by planting shrubs or through appropriate measures.

58. The activities that may be permitted by the local or concerned authorities on the seaward side of the set back line in CMZ - III areas include boating, shipping and navigation, fisheries, agriculture, construction of cyclone shelters and public toilets, etc. Activities on the seaward side of the set back line in CMZ - III areas that will require approval from State or Union Territory Coastal Zone Management Authority are construction of boat jetties and fishing harbours, temporary construction of tourism facilities, water sports and recreation facilities, discharge facilities of treated effluents, etc. Activities on the seaward side of the set back line in CMZ - III areas that can be permitted by MOEF with EIA and EMP will be construction of Integrated port, harbour, jetties and moored facilities, Dredging and disposal of dredged materials, Reclamation within port limits and for coastal protection, Hydrocarbon exploration and extraction, Mining of Placer minerals, Defence related projects, Ship-building yards, etc. All activities in Coastal Management Zone – IV are to conform to the approved Integrated Coastal Zone Management Plans. No developments are however permitted in the corals, mangroves, breeding and spawning of endangered species.

**D.1.5 Other Acts**

59. The other acts relevant to coastal zone management are:

1. **Wildlife (Protection) Act 1972 amended in 2006**

60. The Act provides for the protection of wild animals, birds and plants and for matters connected with wildlife. The schedules in the Act specify the degree of protection that has been granted to animals included in a particular schedule. Wildlife included under Schedule I and part II of Schedule II enjoy absolute protection and belong mostly to endangered species.
Royal Bengal Tiger and Olive Ridley Turtle found in Sundarban have listed under Schedule I.

2. Forest Conservation Act, 1980

61. Forest Conservation Act, 1980 provides for regulatory mechanism controlling indiscriminate diversion of forest lands for non-forestry purposes and strives to maintain a balance between conservation and development needs. The Act also provides for compensatory afforestation, catchment area treatment plan, wild life habitat improvement plan and rehabilitation plan in case diversion of forest land for non-forest purposes is approved.

3. Biodiversity Act

62. The Biological Diversity Act 2002 is a law meant to achieve three main objectives:

- the conservation of biodiversity;
- the sustainable use of biological resources;
- equity in sharing benefits from such use of resources.

Its key provisions aimed at achieving the above include in CMZ context:

- Measures to conserve and sustainably use biological resources, including habitat and species protection, environmental impact assessments (EIAs) of projects, integration of biodiversity into the plans, programmes, and policies of various departments/sectors;
- Setting up of Biodiversity Management Committees (BMC) at local village level, State Biodiversity Board (SBB) at state level, and a National Biodiversity Authority (NBA).

D.2 Institutions and Authorities (Roles and Responsibilities)

D.2.1 Central Government

63. Several central government ministries, departments and agencies are vitally connected with coastal zone activities of India. They include the following:

Ministry of Environment & Forests

64. The Ministry of Environment & Forests is the nodal agency in the administrative structure of the Central Government, for the planning, promotion, co-ordination and overseeing the implementation of environmental and forestry programmes. The principal activities undertaken by Ministry of Environment & Forests, consist of conservation &
survey of flora, fauna, forests and wildlife, prevention & control of pollution, afforestation & regeneration of degraded areas and protection of environment, in the frame work of legislations. Management of coastal zone of the country is regulated by the Ministry and clearances for use of the coastal zone are given by the Ministry also.

**Ministry of Earth Sciences**

65. The Ministry of Earth Sciences (MoES) is mandated to provide the nation with best possible services in forecasting the monsoons and other weather/climate parameters, ocean state, earthquakes, tsunamis and other phenomena related to earth systems through well integrated programmes. The Ministry also deals with science and technology for exploration and exploitation of ocean resources (living and non-living), and play nodal role for Antarctic/Arctic and Southern Ocean research. The Ministry’s mandate is to look after Atmospheric Sciences, Ocean Science & Technology and Seismology in an integrated manner. The various Units under the Ministry of Earth Sciences include National Institute of Ocean Technology (NIOT) Chennai, National Centre for Antarctic & Ocean Research (NCAOR) Goa, Indian National Centre for Ocean Information Services (INCOIS) Hyderabad, Integrated Coastal and Marine Area Management Project Directorate (ICMAM-PD) Chennai, and Centre for Marine Living Resources & Ecology (CMLRE) Kochi under the Ocean Science & Technology sector. MoES aims to create a framework for understanding the complex interactions among key elements of the Earth System, namely ocean, atmosphere and solid earth, by encompassing national programmes in Ocean science, meteorology, climate, environment and seismology.

**Marine Wing, Geological Survey of India**

66. The Marine Wing of Geological Survey of India is mandated to carry out sea bed mapping within limits of territorial water of India. The mapping includes also working out the geophysical characteristics and assessment of economic minerals that may be present in the sea bed. Special studies related to geotechnical assessment of coastal areas are also undertaken for specialized development requirements

**Zoological Survey of India**

67. The Zoological Survey of India, the only organization in the country involved in the study of all kinds of animals from Protozoa to Mammalia, occurring in all possible habitats from deepest depth of the ocean to the peaks of Himalaya, was established on 1st July, 1916
to promote survey, explore and research leading to the advancement in our knowledge of the various aspects of the exceptionally rich animal life. The organisation is a vast repository of National Zoological Collection in the form of various types and reference collections needed for the bio-systematic research and conservation strategies. Exploration activities of the Department in different ecosystems are as follows.

(i) Estuarine and Marine Surveys

Marine ecosystem survey includes study of faunal status and composition and their interaction with the marine ecosystems. Survey of faunal resources of estuarine areas, brackish-water lakes and back-waters of the eastern coast of India have been recently taken up by the newly established Estuarine Biological Research Station at Gopalpur on Sea, Ganjam, Orissa.

(ii) Mangrove Faunal Surveys:

For the collection and study of mangrove organisms, faunistic surveys are being undertaken in the Andaman and Nicobar Islands, Sunderbans (West Bengal) and Pitchavaram Islands (Tamil Nadu). The fauna is being thoroughly studied to assess the quantitative and qualitative distribution in these areas.

Botanical Survey of India

BSI is the nodal agency in the central government mandated to carry out botanical survey of the whole country inclusive of the coastal area. Several publications have been brought out by the Survey on floral characteristics of coastal regions of India that give comprehensive accounts of the flora endemic to various coastal regions.

D.2.2 National Institutions

National Institute of Oceanography

The National Institute of Oceanography (NIO) is one of the 38 constituent laboratories of the Council of Scientific & Industrial Research (CSIR), New Delhi and was established on 1 January 1966. The objective of NIO is to develop knowledge on physical, chemical, biological, geological, geophysical, engineering and pollution aspects of the waters around India and to provide support to various industries, government and non-government organisations through consultancy and contract research. The focus of research has been on observing and understanding the special oceanographic features that the North Indian basin offers. The inferences from this research have been reported in about 5000 research articles.
so far. The major research areas include the four traditional branches of oceanography - biological, chemical, geological/geophysical, and physical - and some other areas such as marine instrumentation and archaeology. The institute also operates a coastal research vessel CRV Sagar Sukti, a 23 m vessel equipped for multidisciplinary oceanographic observations. NIO’s scientists also have access to the ocean going research vessel ORV Sagar Kanya, operated by the Ministry of Earth Sciences. The institute also carries out applied research sponsored by the industry. These studies include oceanographic data collection, environmental impact assessment, and modeling to predict environmental impact. The institute also provides consultancy on a number of issues including marine environmental protection and coastal zone regulations.

**National Institute of Ocean Technology**

70. The National Institute of Ocean Technology (NIOT) was established in November 1993 as an autonomous society under the Ministry of Earth Sciences, Government of India. The major aim of starting NIOT is to develop reliable indigenous technology to solve the various engineering problems associated with harvesting of non-living and living resources in the Indian Exclusive Economic Zone (EEZ), which is about two-thirds of the land area of India. The organizational mission is to develop world class technologies and their applications for sustainable utilization of ocean resources, to provide competitive, value added technical services and solutions to organizations working in the oceans and to develop a knowledgebase and institutional capabilities in India for management of ocean resources and environment.

**Central Water and Power Research Station, Pune**

71. The Central Water and Power Research Station (CWPRS), Pune was established in 1916 with a limited mandate to modify irrigation practice to meet agricultural requirements. Over years CWPRS has become the principal central agency to cater to the R&D needs of projects in the fields of water and energy resources development and water-borne transport. Indeed it is now one of the foremost organisations in the world in the field of hydraulics and allied research. CWPRS provides specialised services through physical and mathematical model studies in river training and flood control, hydraulic structures, harbours, coastal protection, foundation engineering, construction materials, pumps and turbines, ship hydrodynamics, hydraulic design of bridges, environmental studies, earth sciences, and
cooling water intakes. As the Regional Laboratory of ESCAP since 1971, CWPRS has offered its services to a number of projects in the neighbourhood as well as in countries in Middle East and Africa.

**Kolkata Port Trust**

72. KPT has two dock systems – the Calcutta dock system and Haldia dock system. Both these port system require hydrographic data regularly for safe navigation. The Marine department of the Trust as well as its Hydraulic Study Unit provides the necessary vital input. River training work for adequate draft in the approaches of the dock systems in the Hugli estuary are carried out by the Trust. Haldia dock system occupies and uses vital stretches of the coastal area.

**Eastern Regional office of Central Pollution Control Board**

73. Central Pollution Control Board (CPCB) was constituted in September, 1974 under the Water (Prevention and Control of Pollution) Act, 1974. Further, CPCB was entrusted with the powers and functions under the Air (Prevention and Control of Pollution) Act, 1981. It serves as a field formation and also provides technical services to the Ministry of Environment and Forests of the provisions of the Environment (Protection) Act, 1986. Principal functions of the CPCB are (i) to promote cleanliness of streams and wells in different areas of the States by prevention, control and abatement of water pollution, and (ii) to improve the quality of air and to prevent, control or abate air pollution in the country. Important projects of Kolkata Zonal Office during 2006-2007 include Environment status of beaches in the Eastern Zone, Studies on Environmental Status of Coastal aquaculture including Effluent Treatment System in West Bengal & Orissa, Studies on Marine Debris, Status of fish processing industries in Orissa & West Bengal.

**D.2.3 Government of West Bengal**

74. Several departments of the Government of West Bengal play important roles in the management of coastal areas of West Bengal. They are as follows:

**Department of Environment**

75. The Environment Department was created on 02/06/1982 with the following business: Environment & Ecology, Prevention and Control of Pollution of Air, Water and Land, Co-ordination between Departments & Agencies of the State and the Union Government concerned with policies and schemes relating to environment and all matters
connected with the Bengal Smoke Nuisance Commission and the West Bengal Pollution Control Board. The department is the state level agency that regulate and controls the use of the coastal areas of West Bengal.

**Department of Fisheries**

76. The Fisheries Department is a major developmental department of the Government of West Bengal that works for the development of fisheries in the state by bringing all types of water bodies into fishery in an eco-friendly manner, involving people within the sector thereby uplifting their socio-economic condition and production of maximum fish food from unit area.

**Department of Sundarban Affairs**

77. The department plays an important role in managing the ecologically sensitive Sundarban areas including regulating developmental needs of the region and promoting eco compatible livelihood of the people living in the Sundarban. The department co-ordinates the developmental activities in the Sundarban region of different line departments of the state.

**Irrigation and Waterways Department**

78. The department maintains the waterways of the state and arranges of surface water irrigation facilities to agricultural fields. Construction of engineering structures to protect vulnerable stretches of any natural or man made waterways including sea front and coastal areas are one of the important responsibilities of the Department.

**Department of Forests**

79. The Forest Department of the State protects, manages and regulates use of the forests of the state in general. It has got a special responsibility in managing the Sundarban region both in respect of its forest resources but also the unique wild life of the region. In coastal areas the department often takes up forestry mainly to provide bioshield to the region from devastating cyclones, tidal surge and coastal erosion.

**Public Health Engineering Department**

80. Construction and operation of drinking water supply system in the rural areas of the State including the coastal areas is the primary responsibility of the Department. Erection of sewerage and drainage system including treatment of waste water in non-municipal areas including coastal areas is one of the responsibilities of the department.

**D.2.4 State Institutions**
Several autonomous and statutory bodies under the Government of West Bengal have important roles/responsibilities in specified areas of coastal zone management:

82. **West Bengal Biodiversity Board (WBBB)** was established in 2004 in compliance with the Biodiversity Act, 2002 as a statutory body under Department of Environment, Government of West Bengal. Documenting biodiversity and associated traditional knowledge enforcing restriction on usage of biological resources, promoting conservation and sustainable use of biological resources are some of the major mandates of WBBB.

83. **West Bengal Pollution Control Board (WBPCB)** is a statutory authority entrusted to implement environmental laws and rules within the jurisdiction of the state of West Bengal. Amongst its responsibilities, the most important one is with respect to monitoring of water quality in coastal rivers, lakes and seas, inventorisation of polluting industries in the coastal zone and ensuring their compliance to the pollution control norms especially for industries discharging wastewater into the coastal waters through regulation of the relevant environmental permits.

84. **Institute of Environmental Studies and Wetland Management (IESWM)** was established in March, 1986 with the primary objective of carrying out studies related to wetland functions and its ecology including the coastal wetlands. Ministry of Environment & Forest, Government of India declared this Institute as an authorised agency for demarcation of High Tide Line, Low Tide Line along the entire Indian Coast, thus upgrading it to a national stature. The maps prepared by this Institute helped many Government, Inter-governmental agencies and Industries to carry out their planned development programmes in coastal areas following proper environmental rules and regulations. To its credit, it has standardised the technique for mangrove assemblage zonation which helps in baseline database creation about the mangroves in Sundarban (which is extremely inaccessible) and Andamans. The Institute is equipped with all modern equipments for survey with DGPS (both single frequency and dual frequency), Total station etc. Works have been carried out here using GIS softwares like ARC GIS (version 9.1), Arc view, Arc Map, AutoCad Map, Map Object 2.4; Remote Sensing softwares like ERDAS Imagine, PCI Geomatica, Geomedia et cetera.

85. **Digha-Sankarpur Development Authority (DSDA)** was established in 1993 under the Town and Country Planning Act in the Department of Urban Development. The
Authority has been given wide ranging power to plan and implement schemes for improvement of urban infrastructure in the coastal town. Presently the Authority has jurisdiction over 42 mouzas.

86. **Marine Science Department, University of Kolkata** was established in 1983. The Department is active in the field of research on biodiversity of mangrove ecosystem, ecology of phytoplankton and zooplankton, pollution in coastal environment, etc.

87. **School of Oceanography, Jadavpur University** was set up in 1988 with the objective of manpower training and multidisciplinary research on ocean sciences and technology. The School has already undertaken important programmes in teaching, research and manpower training. It was selected in 1999 as the lead centre in India for a collaborative programme with the University of Newcastle upon Tyne, UK, under the DFID programme, for setting up a centre for "Integrated Coastal Zone Management Training".

88. **River Research Institute**, West Bengal, was established in 1943. It is a premier research institute on hydraulics, soil mechanics, hydrology and statistics, under Irrigation and Waterways Department, Govt. of West Bengal. In general they provide the scientific and technological input to I & W department in its engineering works in coastal region.

89. **Sea Explorer Institute** founded in 1986 has been championing the spirit of adventure and sport for the last 20 years. Nearly 9,000 students have undergone training in adventure sports and training courses offered by the institute. As the name suggests, the institute principally focuses on marine activities. A notable feature of the Sea Explorers' Institute is that it attempts to temper adventure with a sense of responsibility for the marine environment. Indeed, all the expeditions (10 to date) have had a very strong marine research orientation. The Sundarban expedition studied the effect of pollutants in water at different spots in the estuaries.

**D.3 Status of Implementation**

90. For proposals of developmental activities the provisions of CRZ act are met through preparation of a coastal zone management plan (of the relevant part of the coastal zone) that delineates in appropriate scale the LTL, HTL, CRZ I, II and III, the 500 and 200m line along the open coast and width of the river or not less than 100m whichever is lower for coastal rivers. The lay out plans of proposals of developmental activities are evaluated to see
whether activities of the proposed facilities falling in the different segments of the chosen coastal zone are permissible under the provisions of CRZ notification.

91. West Bengal Coastal Zone Management Authority (WBCZMA) is responsible for administering the provisions of the CRZ notification. The State prepared the first Integrated Coastal Zone Management Plan as per provisions of the Notification in 1997 which was duly approved by Ministry of Environment and Forests, GOI in October, 1997. However, it was felt that the plan needs to be upgraded and accordingly a new plan was prepared for Digha-Sankarpur coast which is pending approval in MOEF. ICZM plan for the rest of the coast in West Bengal is under preparation.

92. The basic requirement of preparation of a Coastal Zone Management Plan of the entire coastal region delineating Coastal Zone as defined and CRZ I, CRZ II, CRZ III with the set back line of 200 m has been done on a lower scale map (1:50,000) using mostly remote sensing data.

93. The present capacity building programmes are being carried out by several governmental and non-governmental institutes through their respective research programmes. The Institute of Environmental Studies and Wetland Management (IESWM) carries out basic and applied research programme on various aspects of coastal zone management through deployment of young scientists who get the opportunity to learn and develop research tools for coastal zone management. Remarkable capacity building has been achieved in the Institute in the field of processing of remotely sense data and application of GIS techniques in coastal zone management problems. But if this Institute has to play a major role, its capacity needs to be augmented through induction of a large number of permanent qualified man power.

94. West Bengal Pollution Control Board has high quality expertise and laboratory facilities in monitoring of pollution of coastal water. Through several in house research and monitoring programmes and training of junior scientists, the Board is continually building up its capacity related to CZM activities.

95. Department of Forest has a core capacity to manage the forests in the coastal region of West Bengal. The department has time tested mechanism of on the job training of its
technical field staff in biodiversity conservation in coastal areas including specialized conservation issues of tigers of Sundarban.

96. **WBBB** has a scientific manpower of 7 research officers in the core team. Another group of 17 scientists from various Universities and Institutes are involved in collaborative research programmes with the Board. At present about 12 research projects are continuing in the Biodiversity Board. The scientists of the Board regularly participate in various national seminar and bring out publications which are highly acclaimed in the scientific community.

97. **Sundarban Development Board (SDB)** has over the years has achieved success in promoting and funding several schemes in the Sundarban region on livelihood development of the local population. The Board played a pivotal role for a balanced development of the Sundarban region by co-ordinating the programmes of various line departments of the State. Ecotourism and preparedness for disaster management are the other fields in which SDB played a stellar and catalytical role. The Board obviously needs dedicated well trained man power if it has to play its role to the fullest extent.

98. **DSDA** has been able to imbibe a scientific flavour in local planning and administration of the critically sensitive tourist resort of Digha-Sankarpur having multi-faceted challenges relating to coastal zone management. However, the Authority lacks organized trained and qualified man power to carry forward the modest beginning made by it.

99. **School of Oceanographic Study, Jadavpur University** has developed specialized research expertise in various fields of coastal research. Their research endeavour encompasses physical, chemical and biological aspects of coastal eco-system. A major achievement of the School is in their working out the tell-tale effects of sea level rise particularly in Sundarban areas where a net loss of land areas has been established during the last century. The School has built up substantial capacity in trained man power and instrumentation in the field of remote sensing and GIS techniques but their entire expertise relies heavily on part time efforts of key personnel. Lack of a suitable second line expertise level may affect its working in the coming years.

100. The major bottleneck in the state for capacity building in CZM activities is lack of adequate number of scientific personnel in most fields. IESWM and to some extent WBPCB hire temporary research scholars who form the back bone of CZM activities in these
institutes. But very often scientific expertise built up with great efforts and dedication are lost as the research scholars of necessity accept outside permanent jobs not related to coastal zone management. Equipment-wise the present capacity requires some addition to take up most of the CZM activities.

D.5 Overall budget/resources spent in CZM in West Bengal

Implementation of essential projects to protect the coast and coastal infrastructure and developing coastal resources as part of the coastal zone management of West Bengal is being carried out from different government and autonomous institutions/agencies of the state. A large sum of money is spent yearly and a considerable number of scientists and engineers and other professionals are deployed for the above purposes which could be said to be part of CZM activities. The major expenditure incurred by the following departments of GOWB in CZM activities from 2003-2004 to 2007-2008 financial year is given in the Table below. This shows that a staggering amount of about 8000 crores was spent in CZM activities for the last 5 years by different departments of GOWB:
<table>
<thead>
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</thead>
<tbody>
<tr>
<td>Environment</td>
<td>7,700,000.00</td>
<td>7,067,000.00</td>
<td>11,199,000.00</td>
<td>15,123,000.00</td>
<td>22,930,000.00</td>
<td>64,019,000.00</td>
</tr>
<tr>
<td>Fisheries</td>
<td>87,159,000.00</td>
<td>117,364,000.00</td>
<td>131,305,000.00</td>
<td>147,962,000.00</td>
<td>196,715,000.00</td>
<td>680,505,000.00</td>
</tr>
<tr>
<td>Forests</td>
<td>278,194,000.00</td>
<td>253,243,000.00</td>
<td>266,893,000.00</td>
<td>297,320,000.00</td>
<td>331,587,000.00</td>
<td>1,427,237,000.00</td>
</tr>
<tr>
<td>Tourism</td>
<td>28,777,000.00</td>
<td>26,414,000.00</td>
<td>27,997,000.00</td>
<td>21,699,000.00</td>
<td>55,833,000.00</td>
<td>160,720,000.00</td>
</tr>
<tr>
<td>Sundarban Affairs</td>
<td>169,989,000.00</td>
<td>269,106,000.00</td>
<td>522,944,000.00</td>
<td>748,705,000.00</td>
<td>971,387,000.00</td>
<td>2,682,131,000.00</td>
</tr>
<tr>
<td>Irrigation &amp; Waterways</td>
<td>647,584,000.00</td>
<td>636,979,000.00</td>
<td>846,262,000.00</td>
<td>1,021,000,000.00</td>
<td>1,079,045,000.00</td>
<td>4,230,870,000.00</td>
</tr>
<tr>
<td>Panchayats and Rural Development</td>
<td>981,354,000.00</td>
<td>1,170,855,000.00</td>
<td>647,474,000.00</td>
<td>2,353,597,000.00</td>
<td>3,247,607,000.00</td>
<td>8,400,887,000.00</td>
</tr>
<tr>
<td>Public Health</td>
<td>477,530,000.00</td>
<td>508,529,000.00</td>
<td>594,819,000.00</td>
<td>929,678,000.00</td>
<td>1,225,556,000.00</td>
<td>3,736,112,000.00</td>
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<tr>
<td>Engineering</td>
<td>2,135,551,000.00</td>
<td>2,167,692,000.00</td>
<td>2,577,006,000.00</td>
<td>2,865,050,000.00</td>
<td>3,002,631,000.00</td>
<td>12,747,930,000.00</td>
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<tr>
<td>Health</td>
<td>6,281,682,000.00</td>
<td>6,510,338,000.00</td>
<td>7,321,979,000.00</td>
<td>8,441,942,000.00</td>
<td>8,964,708,000.00</td>
<td>37,520,649,000.00</td>
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<tr>
<td>Education (School)</td>
<td>1,056,110,000.00</td>
<td>1,055,642,000.00</td>
<td>1,223,652,000.00</td>
<td>1,380,904,000.00</td>
<td>1,395,381,000.00</td>
<td>6,111,689,000.00</td>
</tr>
<tr>
<td>Technical Education</td>
<td>106,494,000.00</td>
<td>97,106,000.00</td>
<td>105,730,000.00</td>
<td>164,685,000.00</td>
<td>179,843,000.00</td>
<td>653,858,000.00</td>
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<tr>
<td><strong>Grand Total</strong></td>
<td></td>
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<td></td>
<td></td>
<td><strong>78,416,607,000.00</strong></td>
</tr>
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</table>
D.6 Key Issues in coastal zone management of West Bengal

D.6.1 Institutional Co-ordination

102. Lack of a co-ordination mechanism among various agencies connected with studies related to problems and issues of CZM is a key issue in coastal zone management. The programmes by various institutes are not complimentary and there are cases of overlapping efforts. There is no single point where results of all investigations in CZM activities are archived for access by the concerned persons. In its absence valuable data accessed and generated at great cost and pain-staking efforts will not be available in drawing up of the ICZMP as per new draft Notification. Infrastructural facilities are being created in different institutes at great costs that are not complimentary in nature. As a result same facilities are being created at different institutes leading to idle capacity.

D.6.2 Pollution of coastal water

103. The existing land use pattern of coastal belt of West Bengal reveals that important sectors like agriculture constitute about 1348 square kms.; mud flats and beach cover about 200 square kms., coastal aquaculture impoundment 267 square kms., salt pans and salt marsh 28.6 and 22.13 square kms, respectively. The forest area covers 1952 square kms. of actual dense mangrove zone within the Coastal Regulation Zone I of 4164 square kms. Major sources of pollution in the coast of West Bengal are wastewater generated from domestic, agricultural and industrial activities. Status of these discharges and their load into coastal waters are detailed below.

Domestic waste

104. Major sources of domestic waste in the state are the busy coastal towns and tourist resorts namely Digha, Haldia, Kakdwip, Bakkhali, Diamond Harbour, Canning and Basanti from which substantial quantity of municipal waste, totally untreated, find their way into coastal sea throughout the year either directly or indirectly through creeks/canals and estuaries. As per estimates of CPCB, around 785.4 MLD sewage is generated from cities and town in West Bengal of which only around 141.7 MLD is treated and balance is discharged into coastal waters untreated. This translates into discharge of around 146 and 378 TPD of BOD and COD respectively into the coastal waters. It is estimated that municipal waste to the tune of about 400 tonnes of sewage every day from Kolkata metropolis is discharged into coastal waters of Sundarban..

Oil wastes in water bodies

105. Operational activities at port (Haldia), shipping discharge, discharge from major fish centres at Sankarpur and Namkhana and also from mechanized fishing and cargo boats form
some sources of residual oil, grease and solid rejects in addition to material loss during loading and unloading activities. Pollution in Sundarban is mainly caused by discharge of burnt oil and grease from mechanized boats

**Industrial waste**

106. There is no direct influence of industries along the coast of West Bengal. But, at about 20 nautical miles upstream, an industrial complex at Haldia on the west bank of Hugli river, makes significant contribution to coastal pollution. In addition to that, the Hugli river carries discharge from a large number of industries located upstream (62 large and medium in West Bengal). It is reported that around 22 MLD of industrial wastewater is discharged into coastal waters in West Bengal.

**Tourism related wastes**

107. The tourist resort with respect to major pollution source is the Digha region and to a minor degree the Bakkhali (Fraserganj) area. There are about 400 hotels, holiday homes, some eating joints and sweetmeat shops in Digha. And only a few (about 10) such facilities are present in Bakkhali area. Other tourist areas within the Sundarban area include Sajnekhal, Pakhiralay, etc. Though there is no inventory available, the wastes generated from these resources are also directly discharged into the coastal waters. Water sample analysis from coastal sea of Digha Sankarpur area clearly shows considerable amount of biological pollution especially near New Digha and Digha beach. The coliform counts are also significantly high especially in the New Digha and Digha.

**Agricultural waste**

108. A portion of agricultural waste in the form of fertilizers, pesticides and insecticides also constitute an unaccounted pollution load, which drain ultimately into the coastal waters through creeks and rivers. It is reported that in 2003-2004, the total fertilizer use in the state was around 1261450 tonnes. Consumption of pesticides in the period 2002-2003 was around 3000 tonnes per year. Assuming that 1% of this fertilizer and pesticide use ends up as runoff in the water bodies, the annual fertilizer load in the coastal water would be around 5213 tonnes per year of nitrogen, 2574 tonnes per year of phosphorus and 4815 tonnes per year of potassium. While the pollution load for pesticides would be 4 kg/day of organic chlorine and 32 kg/day of organic phosphorus.

**D.6.3 Coastal erosion**

**Digha-Sankarpur area**

109. The shoreline between the Subarnarekha and the Rasulpur deltas is characterised by sand dunes and a wide sandy beach. Several small tidal creeks cross the shore, the largest
being the Shankapur Creek east of Digha. The outstanding management problems at the moment are related to the erosion of the dune face at Digha, a process that, according to anecdotal evidence probably commenced around 1950 and beach lowering. Before 1960s, there were an accretional zone in New Digha, an erosional zone at old Digha and an accretional zone at Sankarpur Dadanpatrabar region. Recent analysis shows that along Digha Sankarpur coast six contrasting accretional and erosional segments could be identified. Being a popular tourist resort, coastal erosion is therefore a critical issue in coastal zone management in this sector of West Bengal coast.

Sundarban areas inclusive of Sagar

110. Researchers from School of Oceanography, Jadavpur University undertook a time series analysis of the change in the shape, size and geomorphic features of the islands over a period of 32 years (1969-2001). The important observations regarding the erosion accretion pattern of the island system can be summarized as follows:

1. Total erosion over the 30 years time span is estimated to be 162.879 sq.km. Few islands like Lohachara and Bedford (6.212 sq. km.) have already vanished from the map.

2. Erosion zones are most prominent among the 12 sea facing southern islands from Sagar to the west to Bhangaduni in the east. The southwestern corners of the islands are particularly susceptible to sustained erosion. Erosion is also seen along the sea facing shoreline that is oblique to the incoming waves.

3. The western banks of the inner islands are more vulnerable to erosion than the eastern banks and the rate of retreat of western banks is more severe. Accretion is localized in the inner estuaries particularly along eastern and northern margins and along the coasts of islands trending parallel to the incoming waves. The amount of land accretion over the past 30 years is estimated at 82.505 sq. km.

4. Within the island system, the Sagar island has suffered the bulk of erosion with an areal loss of 30 sq. km. with marginal accretion.

The net loss in land area in the eastern part of West Bengal coastal zone is probably due to erosion and/or submergence attributed to sea level rise consequent upon recent climate change and global warming. Therefore, in this sector of West Bengal coast coastal erosion is a key issue in coastal zone management.

D.6.4 Other Natural Disasters Issues

Cyclones
111. The east coast of India is prone to incidences of cyclones. Records of incidence of cyclonic storms and severe cyclonic storms in Orissa section of the Bay of Bengal of India Meteorological Department (1877 to 1980) give the average month wise numbers as follows:

<table>
<thead>
<tr>
<th></th>
<th>January</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>August</th>
<th>September</th>
<th>October-December</th>
<th>November</th>
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<td>0 (0)</td>
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<td>0 (0)</td>
<td>0 (0)</td>
<td>24 (3)</td>
<td>36 (7)</td>
<td>29 (9)</td>
<td>29 (8)</td>
<td>8 (7)</td>
<td>9 (5)</td>
<td>0 (0)</td>
</tr>
</tbody>
</table>

The probable maximum storm surge in metres that expected is as follows:
- Contai – 12.5
- Sagar – 11.5
- Moore Island - 8.5

**Earthquakes**

112. There are records of a number of moderate magnitude (M 4 to 5.5) earthquakes in the coastal areas of West Bengal. A few of them are:
- 11.10.1937 (22.6/88.4) with intensity X
- 9.12.1852 (22.4/88.4) with magnitude 5.7
- 23.1.1860 (21.8/87.8) with magnitude 5.0
- 26.12.1906 (22.6/88.4) with magnitude 5.0
- 15.4.1964 (21.7/87.7) Contai earthquake with magnitude 5
- 27.4.1993 (22.0/88.0) with magnitude 4.2
- 12.6.1993 (21.8/89.7) with magnitude 5.7

Depth of focus of these earthquake events varies from a few km to 60 km. The maximum intensity reached around the mouth of Ganga has been VIII in MM scale.

113. The Indian Bureau of Standard has divided the whole country into 4 zones (Zone II to V according to the expected earthquake hazard potential of the country – zone II having minimum vulnerability and zone V having maximum hazard potential. According to this classification, coastal areas of West Bengal east of the mouth of Ganga fall in zone IV having expected earthquake intensity of VII in MSK scale. The coastal areas lying west of mouth of Ganga fall in zone III having expected earthquake intensity of VII in MSK scale. Therefore, it is clear that the coastal areas of West Bengal are vulnerable to face damages by earthquake of moderate magnitude.

**Tsunamis**

114. A major and devastating tsunami affected parts of coastal areas of Andaman & Nicobar Islands and coastal states of Andhra Pradesh, Tamil Nadu and Kerala on December 26, 2004. The tsunami was generated because of an earthquake (M 9.1) in the Bay of Bengal. The earthquake and the attendant tsunami originated due to westward thrust given to the water column of the ocean by a landmass (Myanmar, Andaman and Sunda micro-plate) measuring 1200 km by 150 km that moved along the inclined plane (subduction zone) over
the Antarctic and Indo-Australian plate) for a distance of 15 m gaining maximum net vertical height of 6 m in the ocean floor in a time span of 500 second. The maximum run up elevation of the tsunami reached in Tamil Nadu coast was 5.2 m and the maximum lateral inundation had been 800 m in Nagapattanam. In Andaman Island the maximum run up elevation and the maximum lateral inundation had been 7 m and 2000 m respectively. There is no evidence to show that the tsunami waves reached the coastal zone of West Bengal. The zone of rupture along with the displacement that took place is an active one and it continues to the north covered by recent bay sediments up to the mouth of Ganges-Brahmaputra River. It may not be possible with the present state of our knowledge to say definitely about the return period of tsunamis that may be generated in the Bay of Bengal in near future due to active tectonism along the Sumatra-Andaman subduction zone and also their magnitude. However, keeping in mind the tectonic set up in the Bay Bengal with an active subduction zone running from Indonesia to Andaman and Nicobar Islands and further north, it is not improbable that a tsunami may be generated if there is a rupture in the sea bed along the subduction zone in the near future. The experience of the 2004 tsunami brought out that although the occurrence of a tsunami is a low frequency but high magnitude natural event bringing in unprecedented disaster, there is hardly any provision in current coastal zone management plan to mitigate the threats posed in the coastal states of India especially those bordering the Bay of Bengal and islands in the Bay. Therefore it is imperative that while formulating the ICZMP of West Bengal, investigations on run up distance and altitude and mitigation measures including mechanism to receive early warnings related to probable tsunami that may be generated in the Bay of Bengal in the future are adequately provided for.

D.6.5 Hazards from Man’s activities

Stress on marine life and resources

115. Undersize fishing, fishing in breeding season, use of detrimental fishing gear, and building of dams and embankments are posing major threats to the fish resources of West Bengal coast inclusive of the Sundarban areas. Added to this, pollution of estuarine and coastal water has led to survival of only pollution resistant aquatic species and depletion of bio-diversity in certain parts of the coastal water bodies. West Bengal government is trying its best to stop the bad practices. Due to shrinking fish population many fishermen in these areas are compelled to leave their profession. Fishing on permit basis is now limited to the buffer area of Sundarban. But large scale catching of tiger prawn seeds in Sundarban is causing reduction in mullet population of other fishes.
Dredging in and around Haldia port

116. Haldia being an estuarine port on a major river, the channels leading to the port requires regular maintenance dredging for keeping a minimum draft to allow large ships to anchor in the port. The dredged materials are often disposed in the channel itself away from the ship channels. The channels over years show migration from one path to another within the wide funnel shaped estuary some times making capital dredging essential to open up a channel with adequate draft. River training works to maintain the dredged channel is also part of the maintenance work. Although dredging is unavoidable in and around the Haldia port, nevertheless it disturbs the bottom dwelling organisms and their habitat.

Oil and hazardous waste spilling

117. The major incidents that lead to oil spills are the collision, grounding and other accidents by ships and especially tankers that carry petroleum products to the Haldia and Kolkata ports and such vessels cruising off from Paradeep port. The coastal pipelines carrying petroleum crude from Paradeep to Haldia and Haldia to Barauni are also susceptible to accidental leakage in coastal area through which they pass. Minor oil spills may occur in coastal areas of Sundarban and off-shore areas of West Bengal coast (having fishing and other activities involving mechanized boats) from accidents involving fishing trawlers, ferry launches carrying passengers and ships/barges carrying various cargos including those carrying fly ash to Bangladesh. The port facilities at Haldia and Kolkata and Indian Oil Corporation installations are having arrangements and protocols in place that prevent collision and/or grounding of ships/tankers/barges. Even then absence of more advanced navigational instruments and human error may lead to oil spills endangering marine life. Appropriate contingency plans that are in place require constant review and upgradation so as to tackle oil spills of at least 100 tonnes. In the inhabited areas of Sundarban, there are considerable riverine traffic for various communication and economic activities. The authorities need to develop contingency plan in case of accidental oil seepage and hazardous waste like fly ash spilling from accidents and/or malfunctioning of the plying vessels.

Seawater intrusion in paddy fields due to failure of embankments

118. Agriculture is extensively practiced in coastal areas of West Bengal. In the near absence of any surface water irrigation scheme and as ground water occurs at considerable depth, the agriculture is dependent on monsoon rainfall. However, the meso and macro tides along the West Bengal coast coupled with storm surges during the cyclone months tend to flood the agricultural fields with brackish to salt water. To prevent the agricultural fields from salt water intrusion in the Sundarban areas, extensive embankments have been
constructed long time back along the creeks of this estuarine track. This embankment system is in various stages of disrepair and often the vulnerable sections are breached leading to flooding of the paddy fields with saline/brackish water. Once a field is polluted with brackish water it takes several monsoon seasons to wash out the salt from the soil back into the creeks so as to make the area suitable for agriculture.

**Fresh water depletion and salinity ingress in coastal aquifers**

119. The geohydrological set up of coastal zones of West Bengal is known to a reasonable of detail. A fresh water aquifer sandwiched between two saline/brackish water bearing zones is present along the coast. In areas marked by sandy dune systems along the coast, a shallow fresh water zone is present from surface to a few metres depth. Two areas of concern are Haldia and Digha-Sankarpur. Organised withdrawal of ground water has been in place in Haldia to supplement the fresh water supply from surface sources. To protect the ground water from over withdrawal, appropriate statutory notification has been promulgated by Central Ground Water Authority. In Digha-Sankarpur area un regulated shallow to deep tube wells are being sunk for drawal of fresh water. In both places no systematic study has been made to assess whether there is any depletion of fresh water in the region. Further it has also not been investigated whether due to drawal of fresh water whether the wedge of salt water-fresh water interface is moving land wards.

**D.6.6 Livelihood Issues and Conflicts**

120. The major part of coastal areas of West Bengal is rural in nature. Eastern part of the coast in the South 24 Parganas is mostly uninhabited due to the presence of dense mangrove forest. There is only one township (Haldia) located on the coast of West Bengal. The major activities of the coastal communities are rural in nature. These activities include agriculture, fishing, collection of minor forest produce in Sundarban, dairy and poultry development activities, small scale retail trading and service sector activities. In and around Haldia, many members of the coastal population are employed in the organized industries and in various trading activities or service oriented professions. In and around Digha, the local people are engaged in various professions related to tourism inclusive of the transport sector employment. Self employed rural artisans of various handicraft products are a small group having a difficult livelihood.

121. There are two livelihood issues that may lead to conflicts in coastal areas of West Bengal because of inevitable change that may be forthcoming. The first is between the choice of agriculture and aquaculture in the coastal areas. The real economic and employment potential of one in preference to the other are often obliterated by social and/or
market forces. The average economic return from agriculture per unit area may be less than that from aquaculture, but agriculture can keep a relatively large number of people employed/engaged over at least half the year compared to the situation in case of aquaculture. The choice is tricky as a large rural population having no engagement/employment but with money is always a potent social problem. Secondly, there is considerable interest now created in the coastal areas especially on the western part of the state in terms of development of coast based core industries including siting of large petrochemical hubs. If these initiatives are to be realized in some form or other, perhaps large coastal agricultural land is to be acquired. People although will be compensated with an one time payment but a large number of these people will loose their family-land and traditional livelihood. It is uncertain how many of the present generation of the population will get employment in the up-coming industries as new skill and entrepreneurship will be required in the industry and related opportunities in the service sector. These skills can not be acquired easily even with retraining facilities. A well researched ICZMP with in-built social engineering solutions may perhaps provide answers to these potent livelihood conflicts.

D.6.7 Climate Change and sea level rise
122. Global climatic change induced by high concentration of carbon dioxide in the atmosphere that includes warmer climate, melting of glaciers, sea level rise, increase in incidences of tropical cyclonic storms, etc. are issues particularly relevant to Sundarban and other coastal areas of West Bengal. Amongst these, sea-level rise is the greatest threat and challenge for sustainable adaptation within such area. A 45 cm rise in global sea levels would lead to the destruction of 75 percent of the Sundarban mangroves. Along with global sea level rise, there is a continuous natural subsidence in the Sundarban, causing a rise of about 2.2 mm per year. The resulting net rise rate is estimated at 3.1 mm per year at Sagar. The consequences in terms of flooding of low-lying deltas, retreat of shorelines, salinisation and acidification of soils, and changes in the water table raise serious concerns for the well being of the local population. Additional sources of stress, not related to climate change, include the diversion of upstream freshwater inflow of the Ganges by the Farraka Barrage in India since 1974 to alleviate the rapid siltation in the port of Kolkata. Jointly, the sea level rise and lower freshwater flow in winter will also result in increased salinity in the area, threatening the conservation of the Sundarban mangroves. The issues of climate change, therefore, constitute one of the major challenges of the 21st century and call for an integrated approach to issues of environmental preservation and sustainable development.

E. Key Learning from CMZ Activity
Different agencies of the State and Central governments have implemented several projects pertaining to some characteristics of coastal areas of West Bengal either as part of their routine yearly activities or special efforts on specific issues or as per their regulatory functions under various acts and rules.

**E.1 Important activities implemented in last 10 years**

124. One of the major activities that have been carried out by the State under CRZ notification, 1991 was demarcation of boundaries of the coastal zone along the open coast (500 m from HTL) and along coastal rivers and water bodies affected by tides (up to a distance equal to width of the creek or not less than 100m whichever is less). Delineation of HTL and LTL as per definition is at the core of such demarcation. This has been done for the entire coast of West Bengal and plotted on mouza scale map. Division of the coastal zone into CRZ I, CRZ II and CRZ III have been completed and plotted on mouza scale map. The 200m set back line has also been demarcated.

125. CRZ clearances of projects requiring environmental clearance and falling within the CRZ was made mandatory and all proposals with the required information and reports falling within the prescribed category have been examined at the State level and forwarded to central government with recommendations.

126. Eco tourism proposals in the Sundarban by various agencies have been examined and regulated so as not to affect the extant eco-system.

127. As part of National Water Quality Monitoring Program (NWQMP), West Bengal Pollution Control Board has carried out each water quality monitoring of 8 stations on Hugli river, 1 station on Rupnarayan river and one station on Hugli river after confluence of Rupnarayan to River Hugli.

128. Geological Survey of India has carried out sea bed mapping and mineralogy of sea bed sediments within EEZ off West Bengal coast. GSI also carried out beach profile monitoring along several transects all over the coast of West Bengal.

129. Central Pollution Control Board through its Eastern Regional office carried out environmental monitoring of coastal waters of West Bengal under their COMAP programme.

130. School of Oceanography, Jadavpur University has carried out research programme on erosional scenario of Sundarban and Digha coast. Marine Science Department, University of Kolkata carried out research on biological aspect of coastal stretches of West Bengal.

**E.2 Success & Failure**
131. The outcome of the important activities as mentioned in the previous paragraph is the success story of implementing some aspects of management of coastal areas of West Bengal without stressing the eco system and preserving the resources. Such activities have built up the foundation on which ICZMP of West Bengal as envisaged in the recent draft CZM notification could be formulated.

132. In spite of the impressive successes that have been achieved, coastal zone management initiative could not prevent some of activities that are not desirable. These apparent failures include:

1. Absence of an approved science-driven CRZ management plan with maps capitalizing on opportunities and guarding against constraints
2. Pollution of coastal waters from various anthropogenic activities
3. Absence or non-functioning of a modern sewerage and drainage system with sewage treatment plant and also solid waste management system in Digha-Sankarpur tourist resort area
4. Over fishing and indiscriminate collection of fish and prawn seeds in the estuaries of Sundarban area
5. Continued coastal erosion in spite substantial investment in shore protection work in and around places of importance.

The present project proposal will capitalize on the successes that have been achieved and will remove the failures that have been identified.

F. Justification for the Project (SWOT)

133. The extant eco system of the coastal region of West Bengal is endowed with resources that are unique in the country. On one hand the world famous Sundarban offer a rich mangrove habitat with characteristic fauna inclusive of the Royal Bengal Tiger and veritable stock of coastal fishes and exquisite scenic beauty of winding creeks with unspoilt thick mangrove vegetation. On the other, such setting also creates demands for development of ecotourism in the region on a world class standard. The local inhabitants also would like to harness the fish resources, develop brackish water aquaculture, collect minor forest produce like timber, honey etc. There are pressures also to develop new settlements in the Sundarban reclaiming new areas. The coastal areas and the islands making up the Sundarban are experiencing net erosion, the causes of which are somewhat speculative. Fresh water required for various anthropogenic activities is limited in availability. Cyclones with storm surges are regular features causing damage to the vegetation and the populace. Threats of rising sea level due to climate change or otherwise appear to be a reality.
134. On the western coastal areas, tourism and fishery including aquaculture potential are immense. But the infrastructure to support a burgeoning tourism demand has not kept pace and thereby setting in degradation and pollution of the environment. There are early signs of over exploitation of marine and coastal resources. Coastal erosion in spite of several protection measures has not been arrested completely and further erosion and inundation of coastal areas are looming large. In the eastern part of the western coast of West Bengal, development of industries requiring sea fronts, like new ports/harbour at Sagar Island, coast based petro-chemical hubs with down stream industries, ship breaking/building yards are contemplated to bring in new investment for renewed industrialization efforts of the State.

135. The above analysis clearly brings out the competing and sometimes conflicting demands on the using the coastal resources of West Bengal. These demands are related to livelihood issues of the local population as well to the economic resurgence of the state as a whole and can not be denied. At the same time to sustain such use, the location, scale and the process selected/adopted for the use of the coastal resources should have a harmonious relation and co-existence with the preservation and acceptable functioning of the coastal system. A well thought and balanced integrated coastal zone management plan of the coastal regions of West Bengal is therefore a necessity and the state project proposal on this count is eminently justified.

136. In summary, the state project proposals have be drawn up in order to ensure preservation of the valuable and developing coastal environment, rational but sustained utilization of its resources and at the same time facilitating use of the coastal zone for compatible activities. A tentative SWOT analysis for the priority state project proposals has been made as follows:

<table>
<thead>
<tr>
<th>STRENGTH</th>
<th>WEAKNESS</th>
<th>OPPORTUNITIES</th>
<th>THREAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Providing solution to coastal erosion problem</td>
<td>Ill understood coastal processes causing erosion</td>
<td>Some coastal prevention work are in place and seems to be working</td>
<td>Due to choice of wrong protection measures, coastal erosion is not arrested</td>
</tr>
<tr>
<td>Providing solution to the salinity ingress in coastal aquifers</td>
<td>Data base on the current situation is inadequate</td>
<td>Geohydrological solutions to the problem is well known provided relevant scientific data are available</td>
<td>Inadequate enforcement of regulatory measures for sinking of tube wells</td>
</tr>
<tr>
<td>Promoting tourism including eco-tourism in Sundarban</td>
<td>The right balance between preservation of eco-system ad eco-</td>
<td>Currently eco-tourism is on a low key especially in Sundarban and</td>
<td>Inadequate enforcement of prohibitory activities by the</td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th>STRENGTH</th>
<th>WEAKNESS</th>
<th>OPPORTUNITIES</th>
<th>THREAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>tourism development is not known</td>
<td>therefore development potential will not be saturated in the near future</td>
<td>tourists; inadequate public awareness on fragility of the eco-system</td>
<td></td>
</tr>
<tr>
<td>Providing essential infrastructural facilities like grid electricity to Sagar Island</td>
<td>Adverse cost-economic return ratio if social benefits in monetary terms are excluded</td>
<td>Use of electricity for lifting ground water for multi-crop agriculture</td>
<td>Snapping of the transmission line across the wide river and during high intensity cyclones</td>
</tr>
<tr>
<td>Preventing of pollution of populated coastal region from discharge of waste water especially in the semi-urban areas (port/tourist resort) by construction of underground system and also of treatment plants</td>
<td>Not all waste water generating sources covered under the scheme</td>
<td>Partially constructed system and treatment plant is already in place in some areas</td>
<td>Inadequate maintenance of the system; lack of public awareness</td>
</tr>
<tr>
<td>Preventing pollution of populated coastal region from solid waste especially in the semi-urban areas (port/tourist resort) by introducing a viable collection, transportation and disposal system</td>
<td>Not all solid waste generating sources covered under the scheme</td>
<td>Some rudimentary collection system and disposal area are available</td>
<td>Inadequate operation of the system; lack of public awareness</td>
</tr>
</tbody>
</table>

### SECTION II – THE PROJECT

A. West Bengal’s Vision and Strategy for ICZM
137. The state of West Bengal is endowed with unique coastal eco-system areas including a stretch to the east occupied by Sundarban Biosphere Reserve. The mangrove vegetation in SBR supporting a unique habitat of estuarine flora and fauna including the Royal Bengal Tiger and some other endangered species provides challenges for sustainable conservation. To the west, the beach-dune-mudflat system presents different kind of management challenges including prevention of coastal erosion and development of sustainable tourism with effective control of pollution of the coastal region. In both the stretches livelihood issues of a large number of coastal population who depend on the coastal resources (fishery, aquaculture, agriculture, etc) are to be satisfactorily solved/answered. Infra-structural facilities (construction/expansion of ports, extraction of ground water, construction of essential roads and other communication facilities) need to be developed without putting stress on the coastal environment or worst degrading the eco-system. The vision of ICZM in West Bengal is therefore to ensure minimum but acceptable planned intervention for development needs in the coastal zone so as to preserve the pristine nature of the prevailing environment making allowances for sustainable exploitation of living and non-living resources for the livelihood of the coastal population.

138. On a broad perspective/scale, the strategy for ICZM will be to understand, analyse and address implications of development plans and their threshold limits to cause environmental degradation, conflicting uses and interrelationships between coastal physical and biological processes and anthropogenic activities. The emphasis will be to promote linkages and harmonization among sectoral coastal and ocean activities requiring cooperative management and inter-sectoral coordination through full involvement of all the stakeholders in a comprehensive and integrated program. In essence the strategy will be to

- Minimize costly delays in project implementation
- Minimize damage to the coastal environment and its resources
- Minimize losses to the various users (from resource depletion, loss of land, access limitation, etc)
- Promote most efficient use of infrastructure, resources, favourable environmental situations, favourable coastal processes
- Avoid conflicting use of coastal and marine resources and environment

139. The strategic need for ICZM will be to collect and generate relevant data and extraction of information from the synthesis of the data on resources of the coastal zone, its vulnerability to natural disasters, extent of fragility of the eco-system, role of coastal processes to sustain the coastal environment, extent of pollution of the coastal environment, current land use of the coastal zone and livelihood of the coastal population. To achieve the same, a detailed monitoring and evaluation program has been included under Section V.
B. Project Objectives and Key Indicators

140. Keeping the key general issues of the West Bengal coast in perspective the project objectives is related to finding solutions to the following specific problems/situations of the coast:

- Coastal erosion especially west of Hugli estuary and shoreline protection especially during storm surges
- Loss of biodiversity (including conservation of wildlife) especially of Sundarban area and their restoration
- Environmental degradation of coastal areas especially of Digha-Sankarpur area and non-functioning of solid waste management and sewage treatment systems
- Problems of indiscriminate but inadequate development of tourism facilities especially in Sundarban areas and their regulation
- Social vulnerability and problems of livelihood support etc.
- Infrastructure development to support trade, industry and commerce, livelihood, tourism, etc.
- Vulnerability of coastal resource base, coastal infrastructure and coastal population to climate change – identification of future scenarios and finding adaptation options.

141. The suggested pilot programs given under sub-section F of this Section II represent solutions to most of the specific problems/situations stated above but restricting the operational area to the Sagar Island and the Digha-Sankarpur stretches of the coast in West Bengal as representing two end member types of coastal situations in the state.

142. The key indicators to measure the success of ICZMP will be as follows:

- No retreat/advance of the coast line along the Digha-Sankarpur sector over a sufficient number of years indicating an equilibrium beach
- No net land loss in the Sundarban areas inclusive of Sagar Island
- No shrinkage of mangrove covered areas in Sundarban
- No reduction in the population of keystone species in the Sundarban in the next census
- Near clean environment in and around Haldia and Digha-Sankarpur with water quality meeting the required discharge standard
- Increase or at least no decrease in fish catch (catch per effort) along coasts
- No report of dead olive ridley turtle from Sundarban
- Change over to multi crop agriculture with availability of grid power in Sagar Island
- Increase in GDP of the coastal districts of West Bengal
• No reduction in the number tourists visiting Digha-Sankarpur areas

143. Positive response in any or all of the above indictors will point towards success and sustainability of the ICMZP. To evaluate the above achievements, a detailed program on monitoring of key indicators and evaluation of the monitoring results has been included under Section V. The data will be used to see compliance of the enumerated indicators.

C. Project’s Guiding Principles and Key Design Features

144. In order to realize the laid down objectives, the main conceived guiding principles are as follows:

• Recognition and acknowledgment of cross-sectoral issues: Many of the coastal management problems that require attention have inter-related and inter-dependent issues. Fresh ground water extraction from coastal aquifers may induce salt water ingress in the subsurface affecting sustainability of fresh water supply. Conservation of bio-diversity may lead to severe restrictions on livelihood option to resource dependent population. Disturbing the course of sediment transport by long shore current through construction of break waters for a coastal port may lead to beach erosion in a nearby coastal resort on the down drift side. The adverse impacts produced by a well meaning conservation or developmental intervention need to be recognized, addressed and solved. Developmental/livelihood activities must incorporate the required environmental protection measures.

• Protecting ecosystem for sustainable livelihood generation: The entire coastal population of West Bengal, more so the Sundarban, depends on goods and services derived from the biologically productive ecosystem for their livelihood. Honey and wax collection, coastal fishery, eco-tourism are some of the examples of livelihood generated from coastal ecosystem. However, such ecosystems are intrinsically founded on a narrow base of biodiversity. Any stress on the ecosystem be it increase in salinity or sea level rise or pollution or over exploitation for example may threaten the ecosystem by eroding biodiversity base. All livelihood options adopted should respect this biological supply limit of the ecosystem.

• Ensuring habitat protection for sustaining bio-diversity: Natural disaster and anthropogenic interventions may destroy physical nature of the habitat that sustains biodiversity. Biodiversity conservation at a landscape level is the approach to be adopted.

• Respecting the rights of coastal communities over coastal resources: People living in coastal areas including those living in buffer zone of Sundarban would
continue to earn their livelihood from fishing, aquaculture and minor forest produce like timber and honey. Their livelihood needs (not affecting sustainability of biodiversity) need to be assured even with provision of alternate livelihood or value addition, if necessary.

- **Protecting the environment adequately**: Potential adverse environmental impacts of coastal developmental projects or any other interventions in coastal areas are to be anticipated and mitigation measures through change in design, construction and operational measures ensured.

- **Promoting sustainable and rational use of coastal space**: Utilization of coastal space is to be promoted after a thorough evaluation of its compatibility to environment, resources, societal relevance and complimentary other activities in the coastal region.

145. Each component of State Project Proposals will address separately the above guiding principles and contrasting issues and prescribe designs that are appropriate. The rationale behind adoption of such design features has been explained in the description of each project components. Therefore the adopted design parameters are not included here but have been adequately described in the appropriate section of the project component description and in the corresponding DPRs.

**D. Project Area Description**

146. Two unique coastal ecosystems exist in the project area, namely deltaic mangrove-swamp coast of the eastern part and dune – inter dune coast of the west, coinciding with above mentioned different tidal environments, and are separated by the Hugli estuary.

- The Estuarine Coast is represented by the Sundarban starting from Sagar Point to the Border of Bangladesh.
- The Open Coast represented by the Digha-Sankarpur-Junput from Sagar Point to the Border of Orissa.

147. Components of the project proposals aiming at adoption of the concept of ICZM practices will address priority areas of concern in these two sectors. The physical, chemical and biological aspects of description of these two sectors have been adequately described in the Project Context Section and are not repeated here.

**E. Project Description and Scope**

148. As stated earlier, ICZM project aims to identify and implement programs that will hopefully solve the pressing and emerging issues in the coastal zone that are sometimes inter-sectoral in nature. Some of the priority actions that have been included in the Project are summarized below:
• To implement a new/modified coastal protection plan (both hard and soft) along Digha-Sankarpur coast based on clear understanding of the coastal processes and causes of coastal erosion,
• To implement an extended and/or modified sewage system of Digha area including laying of sewer network, treatment of waste water by oxidation pond method, phyto-remediation and disposal of treated waste water,
• To promote better and sustainable livelihood in Digha Sankarpur coastal area through value addition of existing products, better marketing arrangement and development of some key infrastructure.
• To formulate and implement a plan to clean up the area with creation of infrastructural facilities like day centre, pay and use toilets, solid waste management system etc. for continued clean upkeep of the area,
• To implement a new or modified protection plan based on clear understanding of the estuarine and coastal processes and causes of estuarine and coastal erosion at Sagar Island,
• To promote better and sustainable livelihood in Sagar island area though value addition of existing products, better marketing arrangement and development of some key infrastructure.
• To implement construction of a major infrastructure facility, namely extension of grid electricity to Sagar Island with transmission line crossing Hugli river and
• To identify areas of capacity building and draw up plans of enhancement of capacity of institutions working in coastal zone management.

149. As a whole the scope of the entire project will be geared
• To identify the factors/activities responsible for depletion and degradation of coastal resources and their analysis,
• To identify the sectors affected by depletion and degradation of coastal resources,
• To formulate sector specific remedial measures for resource depletion/degradation including development of alternate livelihood,
• To identify ecosystem under stress, to analyse its causes and responsible factors and to formulate in applicable cases remedial measures to restore the physical/chemical/biological characters that were lost/modified/degraded,
• To identify extent and sectors affected by degradation due to pollution of estuarine and coastal environmental quality and to develop sector specific monitoring and mitigation plans including regulatory measures,
• To formulate a rational utilization plan of coastal space for developmental and conservational activities including space to be required for support of livelihood of local populace for environmentally, inter-sectorally and socially compatible development and management of the coastal zone and
• To estimate the effects of climate change and its impact on coastal infrastructure and livelihood and to plan for development consistent with the perceived climate change scenario.

F. Project Components and Component Description

150. As has been stated earlier the project proposal takes into account the priority areas of concern along the selected stretches of the coast. These concerns could be grouped into three categories and include the following:

F.1 Component A - Problems of coastal erosion
Component A.1 – Prevention of coastal erosion around Sagar Island

151. In case of Sagar Island, recent observations by John Pethick (2008) suggest that four major areas of erosion are present: in the north east (Kuchuberia); the south east centre; Dublat on the south coast, and Beguakhali on the south coast. In contrast to these erosional areas, the remainder of the Island appears to be accreting. Large areas of recently developed mangrove and salt marsh are present on both east and west coasts and a substantial area of accretion was observed in the centre of the south coast east of Sagar Mela ground. Moreover both the south and west coasts of the Island have wide intertidal areas with sediment consisting mainly of fine sand. Sand accretion on the north-east coast is particularly rapid although, further north, the island of Ghoramara, that was formerly accreting, is reported to have eroded significantly over the past few years. In order to plan strengthening of any existing remedial measures and to bring in new remedial measures in both the areas, a thorough understanding of the coastal processes is required.

152. The erosion-accretion pattern in the Sundarban coastal zone has probably been made over-simplified because of the scale of investigation and reliance on only archived map and imagery data. Detailed picture may be exemplified by observations made in 2008 in Sagar Island.

Figure 12: Major embankment erosion sites on Sagar Island. Ghoramara Island is an accretional site included for identification purposes (Pethick, 2008).
153. All inhabited islands of Sundarban including the Sagar Island have embankments along the periphery of the islands to prevent overtopping due to high flood/tide and erosion by meandering creeks bordering them. In addition to the low standard of defence provided by the embankment, a further hazard is presented by the erosion of the largely earth embankment. Recent observations suggest that four major areas of erosion are present: in the north east (Kuchuberia); the south east centre; Dublat on the south coast, and Beguakhali on the south coast (see Figure 12). In addition to these localised areas of high erosion, it appears from a preliminary scrutiny of the 1967 topographic maps and the 2006 satellite image that the entire south coast of the island has been eroding at least for the past 50 years. This general erosion appears to be at a much slower rate than that presently experienced at either Dublat or Beguakhali. In contrast to these erosional areas, the remainder of the Island appears, from field observations supported by map/satellite analysis, to be accreting. Large areas of recently developed mangrove and salt marsh are present on both east and west coasts and a substantial area of accretion was observed in the centre of the south coast east of Sagar Mela ground. Moreover both the south and west coasts of the Island have wide intertidal areas with sediment consisting mainly of fine sand. Sand accretion on the north-east coast is particularly rapid although, further north, the island of Ghoramara, that was formerly accreting, is reported to have eroded significantly over the past few years (see Figure 12). These sand beaches appear to play a central role in protecting the embankment from erosion and encouraging mangrove and salty marsh colonisation.

**Estuarine meanders**

154. According to John Pethick (2008) the pattern of erosion and accretion on the east coast of Sagar Island, where it is bordered by the large estuarine channel of the Muriganga, appears to follow a meandering pattern of the tidal channel. Meander wavelength and amplitude are positively correlated with tidal discharge and, as discharge increases towards the estuary mouth, so the meander pattern is one of gradual increase seaward.

East bank

155. If the satellite image for the Island is inspected (Figure 13), it will be seen that the pattern of erosion at the present time could be explained by the meandering pattern of the Muriganga channel. The outside bend of the meander forms characteristic scrolls or bays in the east coast of Sagar Island and similar ones on the east bank of the Muriganga. These scrolls develop by erosion of the banks of the channel forming the bays seen both in the field and in the satellite image. A possible configuration of the meander responsible for these scrolls is shown in Figure 13. Further inspection shows that there are several other such
meander scrolls, now abandoned, located along both banks of the Muri Ganga. These scrolls or bays have been subsequently infilled by sediment deposition and colonised by mangrove (the dark red colour in the satellite image: Figure 13) A possible former meander pattern that might explain these abandoned meander scrolls is shown in Figure 13. It is possible that these two distinct meander patterns are caused by deposition in the Hugli estuary forcing the channel in the Muri Ganga to avulse (i.e. switch from one pathway to another) possibly as a response to the alternate accretion and erosion of the estuarine bed surrounding the island of Ghoramara.

Figure 13: Conjectural meander pathways in the Muriganga channel. The present situation is indicated by the thick black line. A possible former meander pathway is shown by the dotted line. Note that erosional areas are predicted at the outside of each meander bend (Pethick, 2008).

156. Since the amplitude of a tidal meander is related to the tidal discharge and since the tidal discharge of the Muriganga is unlikely to change significantly, even allowing for sea level rise, it may be proposed that the size of these meander scrolls and thus the erosion associated with them, will not increase. Thus a finite erosional zone could be defined along the east coast of Sagar Island. It is equally apparent that the location of these erosion scrolls may switch from place to place along the coast of Sagar Island depending on the pattern of change in the larger Hugli system.
Figure 14. Conjectural meander pathways in the Hooghly Estuary. Present situation is shown by the thick white line. A possible former pathway is indicated by the dotted line. The location of a training wall that may have triggered avulsion is indicated (Pethick, 2008).

West bank

157. The western or Hugli bank of Sagar Island is almost wholly accretional at the present time. It appears from anecdotal evidence that this is a relatively recent development and that erosion formerly characterized much of this coast. There may be several explanations of this reversal from erosion to accretion. One possibility proposed here is again connected to the tidal meander, this time of the Hugli itself. The mangrove area located immediately south of the arrow shown in Figure 14 represents a former meander bend. The meander pathway that may have caused this erosion is shown as a dotted white line in Figure 14. Avulsion of this meander to its present pathway, shown as a thick white line in Figure 14, may be a result of the construction of a training wall running north east from the extreme northerly tip of Nayachar Island. This training wall could have intercepted the dominant ebb tidal flow that previously was directed into the Haldia channel, forcing flow eastward into the main channel and causing avulsion of the meander to its present location. This in turn has led to the west coast of Sagar becoming located at the extreme southerly tip of the inside of the meander bend and thus receiving sediment from the flow rather than losing it to erosion as formerly was the case. Majority of sediment, both fine sand and silts are derived from the land and
carried down to Sagar Island by the Hugli. Most of this sediment transport will be during monsoon periods when fresh water discharge is high.

158. The sediment pathways diverge to the north of Sagar Island at Ghoramara Island (Figure15). Most sediment carries on in the Hugli estuary but some is diverted into the Muriganga. Before the building of the embankment, the fine grained silts carried by these flows would have been carried into the interior of Sagar island and deposited from the low velocity flows that would have resulted there both due to the shallow water depths and the presence of salt marsh and mangrove vegetation. The embankment has prevented this sediment deposition save for those areas where mangrove lies seaward of the embankment. Instead the silts are unable to be deposited in the high inter-tidal flows and are carried seaward where they are lost to coastal systems.

159. The critical deposition velocity for the coarser grained fine sand content of the tidal flows is much higher than that of the silts so that these sands are deposited seaward of the embankment in areas not covered by salt marsh or mangrove. It is these sands that form the extensive inter-tidal beaches on both south and west coast of the island and to a lesser extent the inter-tidal area of the east coast.

160. After field investigation, coupled with detailed examination of satellite imagery, of the coastal landforms along the coast of the island, John Pethick suggests the pattern of sediment movement as shown in Figure 15. Sediment moves south along the shore of the Muriganga driven by tidal currents. As it moves into the south shore, the transport process becomes wave dominated with waves approaching from the south to south west, and sediment is moved westward towards Beguakhali. Here it enters the Hugli system and continues northwards until it meets the southerly moving sediment brought down stream by the Hugli ebb tide. The meeting of these two opposing flows results in a sediment convergence and extensive and rapid deposition. This deposition has in turn resulted in the formation of a wide inter-tidal area in the centre of the west coast of Sagar with significant areas of mangrove forming inshore of this.
Figure 15: Possible sediment transport pathways around Sagar Island based on configuration of coastal landforms. A sediment convergence zone is proposed on the west coast (Pethick, 2008).

**South coast erosion**

161. The overall erosion of the south coast of Sagar Island appeared to John Pethick (2008) to be a product of rising sea levels and is to be explained by the estuarine roll-over model. This general background erosion is however at a much slower rate (approximately 1m per year) than the erosion rate at Dublat and Beguakhali where rates of 10m per year are experienced at present. It is noticeable that both these erosional areas are located at the ‘corners’ of the island: that is where sediment transport pathways must change direction abruptly. A possible explanation for these high erosion rates is therefore that sediment carried along the coast is temporarily moved offshore at these ‘corners’ causing sediment starvation and erosion as they do so. This process may be exacerbated by the specific landforms at each site.

Figure 16 shows that the hard coastal defences at Beguakhali erected to protect the former lighthouse and pilot station, although they have failed to arrest the erosion here, have succeeded in slowing the erosion rate down relative to that of the earth embankments on either side. The result is that the defended stretch now forms a headland along which increased current velocities prevent the deposition of fine sand. Figure 12 shows that at
Dublat the formation of a spit, probably aided by the planting of casuarinas trees, has forced the sediment transport pathway offshore and caused a sediment starvation zone immediately to the west.

**Figure 16:** Sketch map showing the coastal headland at Beguakhali. Proposed embankment realignment shown as dashed line (Pethick, 2008).

**Figure 16:** Sketch map showing the impact of a spit on the sediment pathway at Dublat. Proposed embankment realignment shown as dashed line (Pethick, 2008).

163. In both cases erosion may be reduced, if not eliminated, if a gentler shoreline curve was to develop, rather than the existing abrupt change in orientation as shown in Figure 15 and Figure 16. It seems probable that such pathways will eventually emerge as a result of the differential erosion and accretion on both sections of coast.

**Protection Measures**
The initial study has indicated that there will be two prong solutions, namely short-term and long-term. The long-term solution will be to devise and design measures like construction of hydraulic groins through opening up of the mouth of estuaries, removal of naturally created barrier to supply sediment at the starved regions, etc. and will be based on sediment flow analysis and outcome of more specific research on coastal processes around Sagar Island as per Component N. Such designing will be completed concurrently with coastal process monitoring scheduled for 3 years.

Short-term solution will be taken up at Dublat where heavy waves breaking continuously at the foot of the embankment erode the embankment during high tide period. The embankment as a result fails very often resulting in tidal inundation and consequence loss of crops and public properties. The planned short-term solution will include strengthening and armouring of the embankments. It is proposed to armour the embankment for 1500 m length by 2.0 m x 1.0 m x 0.60 m thick M-15 concrete block pitching works over filter beds in addition to construction of cross walls. The design parameters are as follows:

- **Existing ground level (average)**: (+) 2.00 m GTS
- **Highest and average high tide level**: (+) 5.40 m GTS and (+) 4.50 m GTS
- **Average and lowest low tide level**: (-) 1.20 m GTS and (-) 2.00 m GTS
- **Sea side berm level and height of wave**: 1.00 – 2.00 m and 1.50 – 2.00 m
- **Formation level of proposed sea dyke**: (+) 8.20 m GTS
- **Top level of proposed block pitching**: (+) 7.90 m GTS
- **Sea- and country side slope of proposed sea dyke**: 1:6 and 1:2
- **Height of proposed sea dyke above beach level**: 6.70 m
- **Sea dyke encased in sea side below berm level**: 1.50 m
- **Conventional size of C.C. (1:2:4) block**: 2.00 m x 1.00 m x 0.60 m
- **Size of sausage at the toe of block pitching**: 1.00 m x 0.60 m
- **Top of sea side portion at +8.20 m level**: Brick wall with corbelling in R/S Top
- **Length of the proposed sea dyke**: 1500.00 m
- **Total sea side slope length of proposed sea dyke**: 48.05 m
- **Free board of the proposed dyke**: 3.70 m
- **Thickness of geofabric filter**: 2.0 mm
- **Spacing of intermediate cross wall**: 15.00 m apart
- **Thickness of cross wall and depth**: 400 cm thick, 1050 mm depth

The implementing agency for the short-term construction work will be Sundarban Infrastructure Development Corporation Ltd (SIDCL). The cost has been estimated at Rs
27.33 crores having a works cost component of 25.36 crores. The short term work will be completed in 3 years but at present no budgetary fund allocation has been made.

**Component A.2 - Prevention of coastal erosion by development of coastal bio-shield in Digha-Sankarpur area**

167. Bio-shields, or vegetative cover, along coastal zones play a significant role in shore protection and also in protection of the coastal human habitations and agricultural crops against impacts of cyclones, storm surges, tidal waves etc. They contribute to overall shore protection. Under this component, coastal bio-shields are to be created in the Digha Sankarpur area, on government land.

168. The project is to be implemented by the Directorate of Forests, Government of West Bengal over a period of seven years. The villagers and/or local self government will be involved in the management of the proposed plantations jointly with Forest department. The approach will meet the objective of promoting joint management of coastal resources. The programme will contribute towards capacity building of coastal communities and government for community based activities related to regeneration of mangrove and other coastal plantations as bio-shields and as part of integrated coastal zone management. Involvement of the local population in creation, protection and management of the forest so created is an integral part of the project.

169. During feasibility study, a number of sites in the Digha-Sankarpur area were examined for development of bio-shields. Out of these, fourteen sites were finally chosen.

**Site for mangrove plantation**

170. The sites for the mangrove plantations were selected taking into consideration the topography of the coastal areas which have mudflats and gentle slopes. The sites are regularly inundated regularly by high tides. The sites are Kanaichhatta, Kaluberia, Balughata, Chakrabortyanchak, Rayaunachak, Mehidinaar, Dhoaghata, Katagechia, Nijkasba under Contai and Bajkul forest ranges.

**Site for coastal shelter belt (casurina) plantation**

171. The sites for coastal shelter belt plantation were selected taking into consideration the topography of the coastal areas of Contai and Bajkul forest ranges that have also sandy soil. These areas are basically not inundated by high tides and are suitable for planting Casurina and other miscellaneous species.

**Site for gap plantation**

172. The sites for gap plantation are selected in the old plantations of coastal shelter belt mainly consisting of monoculture plantation of casurina. These sites under Contai and
Bajkul forest ranges have been selected to fill up the vacant areas with suitable miscellaneous species so that these old plantations assume multiculture and multi tier character.

173. The plantation models that will be adopted will include the following:

- Nursery raised sapling or potted seedlings
- Earthen mound technique
- Direct dibbling
- Plantation in trenches

174. For creation of bio-shields, miscellaneous plantations and mangrove plantations will be taken up along the coastal zone. Apart from this, Farm Forestry and strip plantations over a limited zone will also be taken over.

Shelter belt

175. Miscellaneous Plantation will be raised along the beach to act as a shelterbelt. The major plant species which will be planted will mainly consist of coastal jhaw, *Thespesia*, *Melaleuca*, *Azadirachta indica*, *Pongamia pinata*, *Acacia*, *Eucalyptus*, *Prosopis* spp, *Acanthus illicifolius*, *Ipomoea biloba*, *Pandanus* spp, *Lagerstroemis* spp. etc.

Mangrove

176. A part of the coastal area is to be brought under mangrove plantation. The vegetation will comprise trees and bushes, which have the requisite features to grow in condition where their root system are regularly inundated by saline water and diluted by fresh water surface run off, occasionally. The species to be used in the plantation will mainly be *Avicennia*, *Brugiera*, *Sonneratia*, *Excoecaria*, *Zylocarpus*, *Eylocarpus*. The mangrove plantation is proposed to be brought up in blank muddy flats on the foreshores areas of rivers and creeks to arrest silt and prevent of erosion.

Palisade

177. These works will be taken up along the fragile coast line where height of the bank is low. It will help to arrest the flying sand by accumulating them at the base of the structure and there by preparing the area for coastal Jhaw plantation.

Strip plantation

178. Strip plantations will be raised on road sides, canal banks, embankments, township areas, and river banks and rail way lands

Farm forestry

179. Planting will be in lines around the agricultural field.

Block or mixed plantation
When plantation are raised in blocks (solid tree planting on agricultural waste or fallow land), it may be a pure block or mixed one. Nature of species will be with deep root system.

The areas of plantation have already been identified by the Forest Department. The location details, land characteristics and suggestions for plantation of the chosen sites of the proposed plantation areas are given below:

<table>
<thead>
<tr>
<th>Name of Mouza</th>
<th>Administrative Block</th>
<th>Forest Range</th>
<th>Forest Beat</th>
<th>Present land use</th>
<th>Topography</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mangrove Plantation</td>
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<tr>
<td>Kanaichatta, Kaluraibarh</td>
<td>Contai – II</td>
<td>Contai</td>
<td>Junput</td>
<td>Sea residing area</td>
<td>Mudflat and gentle slope</td>
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<td>Ramnagar - I</td>
<td>Contai</td>
<td>Digha</td>
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<td>Bajkul</td>
<td>Balughata</td>
<td>Forest land &amp; Sea coastal bhumi</td>
<td>Mudflat and gentle slope</td>
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<td>Nijkasba</td>
<td>Forest land &amp; Sea coastal bhumi</td>
<td>Mudflat and gentle slope</td>
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<td>Contai</td>
<td>Junput</td>
<td>Sandy zone</td>
<td>Flat and sandy land</td>
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<td>Digha</td>
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<td>Sandy land</td>
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<td>Sankarpur</td>
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<td>Sandy land</td>
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<td>Sandy land</td>
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<td>Khejuri</td>
<td>Sandy zone</td>
<td>Sandy land</td>
<td>Area suitable for CSB plantation</td>
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<td>Forest Beat</td>
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<td>Seashore area and sandy land</td>
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<td>Bajkul</td>
<td>Nijkasba</td>
<td>Irrigation &amp; Forest</td>
<td>Bundh &amp; Flat</td>
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<td>Contai Junput</td>
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<td>Sea dyke</td>
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<td>Contai Digha</td>
<td>Embankment</td>
<td>Sea dyke</td>
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<td>Gap Plantation</td>
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<td>Baguran Jalpai</td>
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<td>Contai Junput</td>
<td>Under older plantation</td>
<td>Sandy soil</td>
<td></td>
<td>Permanent gaps within plantation; suitable for gap plantation</td>
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<td>Dauttapur, Paschim Gadadharpur</td>
<td>Ramnagar I</td>
<td>Contai Digha</td>
<td>Under older plantation</td>
<td>Sandy soil</td>
<td></td>
<td>Permanent gaps within plantation; suitable for gap plantation</td>
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<td>Contai Sankarpur</td>
<td>Under older plantation</td>
<td>Sandy soil</td>
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<td>Permanent gaps within plantation; suitable for gap plantation</td>
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<td>Bajkul</td>
<td>Nijkasba</td>
<td>Under older plantation</td>
<td>Sandy soil</td>
<td>Permanent gaps within plantation; suitable for</td>
</tr>
</tbody>
</table>
182. The local population of the project area, totaling about 5 million will be directly or indirectly be benefited by this project as the plantation activities under this project will be carried out involving the local village population. This will act as a source of income for them during the years of advance work (i.e. raising of nursery and soil preparation at site), creation phase (transplantation of seedlings from nursery to the field, or directly raising seedlings in the field) and the subsequent years of maintenance. Forest Protection Committees will be formed involving such villages where ever feasible in accordance with the existing rules and regulations so that the accordant usufructuary benefits are extended to them.

Financial Involvement

183. The total project cost is Rs.539,11,000/- inclusive of cost of operation and monitoring & evaluation over the project period of seven years. Head-wise breakup of the works and their costs are given below.

<table>
<thead>
<tr>
<th>Main components</th>
<th>INR in lakhs</th>
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<td>A1</td>
<td>Investment cost</td>
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<tr>
<td>A2</td>
<td>Operational cost</td>
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<td>A</td>
<td>Institutional cost</td>
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<tr>
<td>B</td>
<td>Capacity building</td>
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<tr>
<td>C</td>
<td>Monitoring &amp; Evaluation</td>
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<tr>
<td>D</td>
<td>Awareness and Extension</td>
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<td>E1</td>
<td>Civil works</td>
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<tr>
<td>E2</td>
<td>Other physical work that includes the main plantation work, JFM support activities and Bio-diversity Conservation</td>
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<td>E3</td>
<td>Grant/Assistance</td>
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<tr>
<td>E4</td>
<td>Goods and Equipment</td>
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<td>E</td>
<td>Physical</td>
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<td>F1</td>
<td>Operational cost</td>
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<tr>
<td>F2</td>
<td>Support cost</td>
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<td>F</td>
<td>Department cost not to be financed</td>
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<td>Grand Total</td>
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<tr>
<td>Total to be financed</td>
<td>439.11</td>
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</table>
F.2 Component B - Pollution prevention/ environmental quality management

184. The Digha-Sankarpur area is one of the busy tourism areas of the state. The tourism is generally heavy (except during the monsoon months) and particularly so during the holiday seasons/periods and on weekends. Day trippers are also frequent in this coastal area. Since 2004 DSDA is the nodal agency for looking after the planning and development in the Digha-Sankarpur planning area, which is spread over an area of 8752.63 acres. It has 42 nos. Mouzas and is partly covered by three nos. of Gram Panchayets namely Padima-I, Padima-II, Talgachari-II. The total population is 50,000 (approx.).

185. There is no functional underground sewerage and drainage system with house connections and treatment facilities. Solid waste collection and sanitary disposal system are almost absent. Day trippers pollute the area indiscriminately due to inadequate civic facilities. Therefore a separate component encompassing (i) beach cleaning and sanitation at Digha, (ii) Laying of sewer lines and treatment of DWF at Digha (iii) Solid waste management in areas under Digha-Sankarpur Development Authority (DSDA), and (iv) Development of drainage system at Digha.

Component B.1 – Beach cleaning and sanitation at Digha

186. Beach area at Digha is getting constantly polluted due to presence of large number of vendors operating from unauthorized shanties constructed on sea front. The items of transactions particularly food items prepared and sold by the vendors are source of pollution mainly as organic waste. The fishermen undertaking fishing operation at sea shore are also responsible for polluting the beach by dumping dead fishes and also other living organism. The day trippers visiting the area leave trashes and litters during their stay at the beach area. As a result, the beach area is getting vitiated by the unwanted dumpings. The system of collection of refuge by the DSDA is very weak resulting in beach area remaining dirty. Moreover, due to inadequate presence of amenities like toilets and change room with shower facilities the day trippers visiting the beach area are inconvenienced forcing them to pollute the areas by using those as open toilets. The problem is not so acute at Sankarpur as no shanties have grown up in the beach area owing to lesser number of tourists visiting Sankarpur as the beach area is threatened by menacing beach erosion. Beach cleaning and sanitation is considered most important for maintaining a clean environment for attracting more tourists to Digha. A number of strategies have been evolved to make the beach area clean and improve its sanitation.

187. The strategies proposed are given below:
i) Beach cleaning
ii) Pay & use toilets along with changing rooms with shower facilities
iii) Pay and use toilets without shower facilities
iv) Removal of unauthorised shops/structures closest to the beach area and introducing rehabilitation scheme for such shop-owners.

i. Beach Cleaning

188. Sea beach cleaning involves the removal of materials left by the tides on Digha shorelines. Stranded seaweed provides an important food source for beach food chain and should be left in place where possible. Human debris can pose a hazard to humans and animals, and should be removed. The use of machanised beach cleaning equipment may cause serious disturbances to the bio-diversity in sea beach and shorelines. Though sea turtles are not found in Digha sea beach, but plenty of crabs could be seen along the beach.

189. Digha sea beach is approximately 5000 metre length. Around 2300 metres of the sea beach is packed with concrete block and boulders. This stretch of the beach covers Old Digha fully and New Digha partly. The beach cleaning operation in this stretch needs to be carried out manually. It will be difficult to operate mechanical cleaners along this specified stretch. The remaining approximately 2700 metre stretch of sea beach is concrete free and boulder free. The sea beach varies between 40 metres and 50 metres during non-tidal period.

190. The Digha sea beach is not presently cleaned regularly. Tourists pollute the sea beach by throwing solid waste indiscriminately. This includes good quantum of plastic materials. The plastic materials (especially tea cups) go into sea during tide. The plastic cups could be seen inside the sea when these get arrested in the fishing nets. A few stalls, mainly selling tea and snacks, could be seen in the sea beach.

191. The beach cleaning operation will be carried out as suggested below:
   - Litter bins will be installed at places where crowding occurs by the tourists (50 nos. @ 100 meters interval);
   - Manual cleaning by hand picking and sweeping is recommended in sea beach covered with concrete steps and boulders (5 nos. of sweepers);
   - Manual cleaning by hand picking and sweeping is also recommended in the sea beach in rest of the stretches (5 nos. of sweepers);
   - Hand operated mechanical beach cleaner (1 no.) is recommended for the use;
   - Motorised vehicle for cleaning of sea beach through hand picking (1 no.).

ii. Pay & Use Toilet along with Shower Facilities
192. Creation of pay and use toilet-cum-change room with shower facility has been considered essential to maintain a clean and hygienic environment within the area. In addition, this has been considered as one of the most important basic amenities for the tourists during their stay at Digha. The establishment of these facilities spatially distributed within the town will go a long way in mitigating the vital deficiency of infrastructure to promote the designed tourism for Digha. In all 9 (nine) such facilities have been proposed within the area. Keeping an eye to economy in cost and space, a standard module has been developed to be repeated within the area. The development plan takes care of the separate provisions for the exclusive use of males and females for toilet, bathing and drinking water facility. The toilets, bath-cum-change room facilities, sanitary conveniences have been designed on a certain rational presumption regarding the dispersion of the tourist population in the area.

193. The water supply, drainage and sanitation required for the above facility have been designed on the assumption that 30 % of tourist population estimated for a design period of 30 years onwards of 2009 (peak seasonal weekends) will use the amenities created. In determining the above requirements, two minimum standards indicated in Indian Standard Code for basic requirement for Water Supply, Drainage and Sanitation, one for Domestic Airports and the other for Bus stands, Railway Station (Intermediate) and Seaports have been considered.

194. The development planning consists of integrating the two separate blocks for ladies and gents with a common waiting lobby, ensuring complete privacy for the ladies toilet. The space planning has been evolved to accommodate the required number of W.Cs, urinals, bath-cum-change rooms, washbasins and drinking water facility for both male and female. The space planning for water closets, urinals, bath-cum-change rooms and washbasins with their inter-linkage with the waiting lobby have been made to offer easy and convenient movement of the users. The drinking water facility, which is a free service, has been provided within the waiting hall for common use of both male and female. The building has been conceived to have pitch roofing with provision of false ceiling to provide a decent interior look. The ceiling height at eaves level from the floor has been fixed at 3500 mm. with large number of doors and windows as required ensuring natural ventilation, day light, thermal comfort and easy access for the tourists. Due care has been given to the selection of locations of such blocks so that the conveniences can be used easily by the users for which they are meant. With a sufficiently high plinth level – 900 mm. from the access road and the
surrounding area being covered with abundant tree plantation, the toilet and bath-cum-
change room facility will offer a most hygienic and green environment to its users.

195. As regards internal electrification, concealed wiring with energy efficient luminaries
for providing proper level of illumination in W.C.s, change rooms and waiting lobby and
electric fans in waiting lobby as required for displacement of air have been proposed. The
main power distribution board of the building will receive power from WBSEDCL from its
nearest transformer. The technical specifications of civil structures have been given in the
DPR.

iii. Pay & Use Toilet without Shower Facility

196. Pay and use toilets in the areas away from the beach have been planned to maintain a
clean and hygienic environment within the townships. The development plan takes care of
the separate provisions for the exclusive use of males and females for toilet and drinking
water facilities. The W.C., urinal and other sanitary conveniences have been designed on a
certain rational presumption regarding the probable number of users. The development
planning consists of integrating the two separate blocks for ladies and gents with a common
waiting lobby, ensuring complete privacy for the ladies toilet. The space planning has been
evolved to accommodate the required number of W.C.s, urinals, washbasins and drinking
water facility for both male and female. The space planning for water closets, urinals, and
washbasins with their interlinkage with the waiting lobby have been made to offer easy and
convenient movement of the users. The drinking water facility, which is a free service, has
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mm. with large number of doors and windows as required ensuring natural ventilation, day
light, thermal comfort and easy access for the tourists. Due care has been given to the
selection of locations of such blocks so that the conveniences can be used easily by the users
for which they are meant. With a sufficiently high plinth level – 900 mm. from the access
road and the surrounding area being covered with abundant tree plantation, the toilet facility
will offer a most hygienic and green environment to its users. As regards internal
electrification, concealed wiring with energy efficient luminaries for providing proper level
of illumination in W.C.s, change rooms and waiting lobby and electric fans in waiting lobby
as required for displacement of air have been proposed. The main power distribution board
of the building will receive power from WBSEDCL from its nearest transformer. The
technical specifications are given in the DPR.
iv. **Removal of unauthorized structures and introducing rehabilitation scheme for shop-owners**

197. There are 1485 number of unauthorized shops dealing with local crafts, food items (fish, cashew etc.). These shops are presently situated along the cross roads joining the Fore Shore road and Embankment. The majority of the shops have come into existence near the Blue View Ghat at Old Digha and Kshanika Ghat at New Digha. These shops have been built up in haphazard manner causing nuisance to the area along the crossroads by dumped garbage and creating interference with the easy movement in the area. To get rid of the unsightly situation, it has been decided to shift the shops to Vendors’ Rehabilitation Centers at three sites identified by DSDA. The 3 sites identified for rehabilitation are planned to accommodate as many as 620 shops among the 1485 shops during the project phase. The rehabilitation shops have internal dimension of about 3.0 M. X 2.5 M. The plan form of the rehabilitation center has been developed to house the individual shops in multiple rows with common passages in between the rows. The planning takes into account the requirement of free movement of the people inside the complex for transacting the wares and of finding easy access from all sides by means of plenty of entry and exit points. Sufficient ventilation and natural lighting have been ensured for providing comfort both to the purchasers and vendors.

198. The building will have ceiling height of 3.5 M. from the plinth level covered with temporary roofing made of tubular trusses covered with GCI sheet membrane. A pitch roof of single span truss has been proposed for convenient disposal of rainwater falling on the roof membrane. Provision of covered drain running along the passage has been made to dispose of the rainwater coming from the roof. A false ceiling has been proposed to offer an aesthetically pleasing view to the visitors. Each rehabilitation center will have access from all abutting roads and will be enclosed with a decorated brick built boundary wall to ensure a pleasing and secured environment. Landscape elements along with illuminations have been provided within the 3 sites as much as possible to enhance the beauty and aesthetics of the centers. The entire sites will be covered with interlocking paver tiles for easy movement of pedestrians. As regards internal electrification, concealed wiring with energy efficient luminaries to provide proper level of illumination in shops and passages, and electric fans in shops as required for displacement of air have been proposed. The main power distribution board of the complex will receive power from nearest WBSEDCL transformer. The technical specifications are given in the DPR. The component will be implemented by DSDA.

**Work elements**
199. The work elements to arrive at cost estimates are as follows:

1. Dismantling of shanties (unauthorised stalls) and construction of temporary sheds for rehabilitation
2. Rehabilitation Centre - 1
3. Rehabilitation Centre - 2
4. Rehabilitation Centre - 3
5. Land levelling for Rehabilitation Centres
6. Paved area for all Rehabilitation Centres
7. Tubewells
8. Pump room
9. Semi-underground water reservoir for all Rehabilitation Centre
10. Elevated RCC platform
11. Distribution pipelines network
12. Pay and Use toilets with shower facilities (9 nos)
13. Pay and Use toilets without shower facilities (2 nos)
14. Constant beach cleaning

Component B.2 – Renovation of sanitary sewerage system of Digha

200. Sanitary sewage treatment scheme is a long perceived need in Digha. There is no centralized sewerage system in the region and stand-alone systems (septic tank with soak pit) do not work very well in this region owing to high water table. Being a tourist area (with about 300 hotels), sewer load generated in this region is high and fluctuating. Well planned centralized sewerage system is one of the major building blocks for implementation of Integrated Coastal Zone Management Plan in the region.

201. The first plan of sewage treatment scheme was prepared by Planning Circle I, PHE at an estimated cost of Rs.244.27 lakhs. This was revised again in 1996 to bring some additional areas under the purview of the scheme with an estimated cost of Rs.409 lakhs. The scheme was taken up for execution in 1997. After a portion of sewer line was laid, work was suspended due to sand boiling at 1.45m (R.L.). This necessitated further review of the scheme. Revised scheme was prepared again with due consideration to the following points.

- to restrict sand boiling problem during laying of sewer line.
- ground water infiltration @ 5000 litres / hectare / day.
- the rate of per capita water supply at 125 litres / day.

202. Based on the re-design, the suspended work was resumed in 2000 and laying of 6496 metres of different diameter sewer line and 1248 metre of different diameter pumping main. One main pumping station and 4 sewage lifting stations were also constructed within the sanctioned of Rs 409.00 lakhs against the estimated re-designed cost of Rs 457.41 lakhs. Work has remained suspended since then due to lack of fund.
203. The suspended sanitary sewerage scheme of Digha area has now been re-designed considering a design period up to 2025 and additionally including Udaypur area of New Digha and is proposed to be taken up as a component of the SPR of West Bengal.

204. The design parameters of the scheme are as follows:

i. Design population in 2025: 61,115
ii. Anticipated floating tourist in 2025: 14,920
iii. Per capita sewage flow: 100 lpd (assuming per capita water supply as 125 litres/day and spend water flow as 80%)
iv. Ground water infiltration for a command area of 300 hectares: 1500 KLD
v. Total sewage generation: 6.7 MLD
vi. Existing length of sewer line: 6496 m
vii. Proposed length of sewer line: 12150 m
viii. Diameter range of sewer line: 150 mm to 600 mm
ix. Existing length pumping main: 1248 m
x. Proposed length pumping main: 1040 m
xi. Existing sewage lifting stations: 3
xii. Proposed sewage lifting stations: 1
xiii. Existing sewage pumping stations: 1
xiv. Proposed sewage pumping stations: 1
xv. Capacity of sewage treatment plant: 6.7 MLD
xvi. Process of sewage treatment: Waste Water Pond

205. The methodology of treatment proposed is Waste Water Pond (WSP) comprising anaerobic, facultative and maturation ponds. The top dimension including free board of the anaerobic (4 nos), facultative (8 nos) and maturation ponds (24 nos) will be 53 m x 30 m x 3.5 m, 88 m x 44 m x 2 m and 45 m x 17.7 m x 2 m respectively.

206. The total time required for execution of the proposed component is three years including time required for tendering, vendor selection and six months of trial run. The total estimated cost of the renovation work of Digha sanitary sewage scheme is Rs 3559.23 lakhs (project cost to be financed is Rs 3424.50 lakhs) comprising costs related to civil works as well as mechanical/electrical works. The cost also includes charges for service connection as well as cost of trial run and guarantee for initial three years of operation and maintenance by the agency (Rs 180.00 lakhs) executing the entire work on turn-key basis. Monitoring and evaluation cost has not been given separately in DPR. The scheme will be implemented by the Public Health Engineering Directorate of Government of West Bengal.

Component B.3 - Solid Waste Management in areas under Digha-Sankarpur Development Authority (DSDA)

207. Although Digha town was established long time back, no worthwhile solid waste management system has been in place resulting in unscientific disposal of refuse and thereby
environmental pollution goes unabated. A pilot scheme was initiated sometime back to take care of bio-degradable wastes, applying process of vermicomposting. The said scheme at present is lying non-functional. Sankarpur is comparatively a new area emerging as a tourists’ destination. Sankarpur suffers from total absence of any solid waste management to handle the daily refuge generated by tourists as well as by the local residents. As a result, the beach area is getting continuously polluted. In order to address the problem confronted both at Digha and Sankarpur, a solid waste management system has been planned to be commissioned for both the areas. The system of solid waste management for both the towns will be created in the same manner.

The proposed management system consists of primary sorting of the solid waste at the points of generation, collection and transportation of sorted refuge, putting the biodegradable materials into process of vermicomposting, recycling of the non biodegradable but reusable refuge components and finally disposal of non biodegradable remnants through engineered sanitary land filling system. Towards sanitary land filling, one suitable site common to both Digha and Sankarpur has been identified. The proposed site for solid waste disposal at Padima mouza of Digha lies beyond the Coastal Regulation Zone within land ward side. Therefore, no CRZ compliance is necessary.

The primary segregation of waste at sources will be undertaken in dwelling houses, hotels and commercial establishment in three categories namely, organic waste, inorganic non recyclable waste and inorganic recyclable wastes by depositing each category of waste in different colour identified containers. Similarly, waste generated in community use will be collected in separate bins meant for organic waste and inorganic waste. The street waste will also be collected in community bins. The segregated wastes will be collected and transported in containers by pedal tricycles to primary transfer stations (PTS) to be located in nine places for which the Digha town will be divided into nine segments. The wastes from the containers of each tricycle will be transferred to bigger containers at PTS whence the wastes will be transported by prime movers to the disposal ground. The solid wastes on reaching the disposal ground will be finally treated for safe disposal in the following three processes:

i) Composting
ii) Secured Land Filling
iii) Recycling

The organic solid will be put to composting by two different process viz. vermicomposting (50% of organic waste) and windrow composting (50% of organic waste) under one composting shed. The recyclable non-organic will be disposed of through agency
to be selected. The inorganic non-recyclable waste will be treated by engineered secured land filling.

211. The container for storage of solid waste will be made of plastic with lid and handle. The pedal tricycle will have a capacity to accommodate 6 nos of 50 litres containers that will also be made of plastic with lid and handle. The community bin may be constructed of masonry with tile finish outside having a size of 1200 mm x 900 mm x 800 mm with 2 flap doors and two flap shutters. Litter bins (50 nos) will be made of fibre glass attached to concrete posts. The PTS will be of masonry construction with provision of ramps for movement of pedal tricycles. It will have unloading quay.

212. The vermiculture unit will require spraying of water regularly. It will be kept under shed for protection from sunlight. Initial decomposed organic waste will be placed over vermiculture unit. The windrow composting will have marked bay where the day's organic waste will be placed in rows. Water will be sprayed to have 50% moisture. On every sixth day the waste row will be tilted upside down for proper mixing. The organic waste will be converted to compost in 21 days. 15 days maturation period is required before use. Secured landfilling will be engineered operation with earth cover and compaction. The landfill will have a final cover of 30 mm earth and landscaped top.

213. The design of solid waste management system for the town Digha has been done with the following considerations:

- Primary Storage, Primary Collection and Transportation
  Design Year : Present - 2009; Future - 2016
- Secondary Transportation
  Design Year : Present - 2009; Future - 2016
- Treatment and Disposal
  Design Year : 2039 (30 years design period)

The current (2009) generation of solid in Digha is given below

- Weekends (non-seasonal) – 11.44 MT
- Weekends (seasonal) - 14.04 MT
- Weekends/holidays (seasonal-peak) – 15.67 MT

There is an increase of 2% per year.

214. The total container requirement (2009) has been estimated as follows:

Residential houses

Number of Green Bin (organic waste) of 5 litres capacity: 3718
Number of Black Bin (inorganic non-recyclables) of 5 litres capacity: 3718;
Number of (35 cm X 25 cm size) Bag (inorganic recyclables): 3380

Hotels
Number of Green Bin (organic waste) of 15 litres capacity: 1359
Number of Black Bin (inorganic non-recyclables) of 15 litres capacity: 1359

215. Community bins are to be provided at suitable locations. Each community bin will have provision for storage of organic and inorganic solid waste. Mostly, the street food vendors will deposit solid waste in the community bins. The street sweeps will be also deposited in the community bins.

216. Street sweeping services are to be provided in the areas where tourists move. These areas are mostly on the southern side of Foreshore Road, between sea guard wall and Foreshore Road. Street sweeping services are also necessary in market places and congested localities of the other southern side of Foreshore Road. Pedal tricycles fitted with containers will be used for collection and transportations of street sweepings. The size of each community bin is 1200 mm X 900 m X 800 mm. Each community bin will be divided in to two equal parts to store organic and inorganic waste separately.

217. The total number community bins required are
   
   Old Digha: 6 Nos.
   New Digha: 8 Nos.

Litter bins are to be placed in suitable locations, especially where tourists move around. It is suggested to provide 50 nos. bins of capacity 10 litres each.

Primary Transportation

218. Solid waste from all sources initially will be collected and transported by pedal tricycles. The pedal tricycle will contain 6 nos. of 50 litres containers. The total number of pedal tricycle required for collection of solid wastes from all sources has been estimated at 54.

Primary Transfer Stations (PTS)

219. The town is to be divided in 9 segments. Each segment will have one Primary Transfer Station (PTS) as designed. The solid waste will be collected from all sources by pedal tricycles and the waste will be transferred to bigger containers at PTS. The PTS will be comprised of ramp road with elevated platform for unloading solid wastes from pedal tricycles to bigger containers which will be taken thereafter by prime movers to the disposal ground. Total number of PTS = 9; Area requirement for each PTS =150 sq. m.

Secondary Transportation
220. The solid waste will be transported to treatment and disposal sites from nine specified PTSs. The secondary transportation system will comprise of tractor and hydraulic lifting arrangement for container attachment to tractor. There are different standard sizes of containers with hydraulic lifting arrangement. As per field survey of Digha, it is recommended to use 3.5 m$^3$ containers. The total no. of tractor required is 4 and the total number of trailer containers required is 16.

221. The solid waste will be disposed by the following methods:
   a) Composting;
   b) Secured land filling;
   c) Recycling.

222. It is proposed to carry out composting of organic solid waste by the following two processes:
   a) Vermicomposting (50% of organic waste);
   b) Windrow composting (50% of organic waste).

The total area required for vermiculture unit has been estimated at 675 m$^2$.

The total area required for windrow unit inclusive of maturation pond and screening and packaging has been estimated at 1356 m$^2$.

223. The non biodegradable, non recyclable and inert wastes will be disposed off as sanitary land filling. The total land requirement for SLF inclusive area for office building (60 m$^2$) and plantation area (800 m$^2$) will be about 42389 sq.m. A land measuring 5.99 hectares belonging to Digha-Sankarpur Development Authority (DSDA) is available at Padima Mouza for treatment and disposal of solid waste. The land is accessible by road. The land is low-lying in nature. The land is suitable for treatment and disposal of solid waste.

224. The methodology of solid waste management at Sankarpur will be same as that of Digha. The target and principle of solid waste management in Sankarpur accordingly will also be same as that of Digha. The expected solid waste generation (2009) will be 2.30 Mt, 2.82 MT and 3.14 MT during weekends (non-seasonal), weekends (seasonal) and weekends/holidays (seasonal-peak) respectively.

225. The requirement of household containers will be
   Green, 5 litres capacity = 1355;
   Black, 5 litres capacity = 1355;
   Inorganic recyclables = 1200

The other requirements are
   Community bins = 10
Litter bins – 10 litres capacity = 35;
Pedal tricycle = 17 (9 pedal tricycles for house to house collection+6 pedal tricycles for street sweeping+2 pedal tricycles as standby);
Primary transfer stations = 6 (area will be divided in 6 segments);
Tractors = 2 (including 1 as standby);
Tractor containers = 10 (6 trailers for 6 zones, 2 for 2 tractors and 2 as standby)

226. As there no space available for treatment of solid waste at Sankarpur, the entire segregated waste will be transported to the Digha facilities for treatment and disposal.

Cost
227. The estimated work components are as follows:
1. Sanitary landfill area development at Digha
2. Vermi-composting sheds at Digha
3. Office building for vermin-composting sheds at Digha
4. Concrete yard for wind row at Digha
5. Tubewell
6. Internal surface drains and site development works
7. Internal roads
8. Primary and secondary collection equipment for Digha and Sankarpur separately

Total estimated cost of implementation is **Rs 922.50 lakhs**.

**Component B.4 - Development of Drainage System at Digha**

228. Absence of a properly implemented drainage system is causing adverse effect on the hygienic condition in the town of Digha. The drains are too few and were constructed mainly to flush out excess water during high tides. More importantly, the drains also are carrying sullage water and the polluted water is discharged into the sea causing appreciable deterioration in the quality of sea water. It is a fact that the area lying near the sea coast is mainly of silty sand allowing high rate of percolation of surface run off to ground for which widespread water logging is not in evidence in the area till now, yet with the town getting more populated day by day, incidence of tourists’ visit looking up along with hotels and institutional buildings getting concentrated in localized area, the need for commissioning an engineered drainage system has been badly felt to discharge the water efficiently into the sea without causing any harmful effect on the environment. Such a drainage system will exclude any chance of water logging and at the same time will offer a clean and pleasant look for the town. Open surface drains, to be built with brick masonry, have been designed and planned
for implementation at Digha only to collect the surface run off and carry the water at a non-silting velocity by gravity flow. Sankarpur, being sparsely populated and having a very few hotels /lodges all surrounded by vast expanse of agricultural lands, has been left out of such drainage facility at present. Construction of storm water drains is an allowed item under CRZ regulation, since it is of the white water quality and mostly the high water during spring tides coming inside the coastal area will be discharged through the storm water drains into the sea.

The existing surface drain passing by the side of beach embankment at Digha meant for carrying storm water is charged with sullage water and effluents of septic tanks. The water carried by the drains is thus highly contaminated with organic wastes and becomes septic with high concentration of BOD$_5$. This septic water gets discharged into the sea in violation of environmental safety. An attempt has been made to clean the water by effectively reducing the BOD$_5$ content by subjecting the urban liquid waste to the process of environmental-friendly, cheap but widely accepted process of phyto-remediation. In fact, phyto-remediation was adopted as a pilot project at Digha to clean the water at a very low cost, which produced a satisfactory result in increasing the dissolved oxygen so long as the project at Digha was under operation. Later on due to lack of proper monitoring, the process failed to achieve the desired result and at present is lying non-functional. It is now proposed in this project to reintroduce the process of cleaning the water through phyto-remediation at Digha on a much wider scale. A stretch of area measuring 300 meter by 50 meter along the beach has been selected and reserved for phyto-remediation. The septic water from the surface drain will be made to flow in a number of channels properly designed with implantation of specific variety of plants to interact with pollutants and thereby to reduce the toxicity and make the water suitable for discharging into the sea with BOD$_5$ concentration less than 30 ppm. Sankarpur has been left out of the system of phyto-remediation for the present on the grounds mentioned earlier. Discharge of treated waste and effluent into the sea is an allowed item under Section-2 (v) of CRZ Notification, 1991.

229. There is practically no planned drainage net work in Digha area. In some parts there are road side open drains but it is very inadequate. A combined drainage sewerage system exists in some stretches. The existing drains are insufficient to convey storm water during monsoon. The existing drainage system, therefore, needs immediate upgradation and improvement. Accordingly, it has been proposed to lay surface drainage system for Digha area under DSDA. The drainage system will have several outfalls leading directly and
indirectly to the Bay of Bengal and to the Canal besides Digha Bypass. The existing kachha drains will be lined.

230. The technical specifications are as follows:
   i) Type of drain – Brick built open type surface drain
   ii) Base of drain – PCC 100mm thick to be laid on 1 layer of brick flat soling
   iii) Side walls – Brick masonry wall varying in thickness from 250 mm to 750 mm to be constructed with burnt bricks having crushing strength 75 kg./cm², bonded with sand cement mortar in 6:1 proportion
   iv) Finishing – The external surface and the top surface of the drain section will be finished with 20mm thick sand cement plaster in 1:4 proportion to be rendered with 1.6mm thick cement punning.

231. So far the attempts to bring the entire city sewage of Digha Township under a STP have not met with success due to level difficulties arising out of older dunes on which a major portion of the Old Digha town had developed. During 2007-08 an attempt was made for a pilot Bioremediation STP behind the Aparajita Cottages which was quite successful in reducing the BOD load and the outfall DO attained a concentration of 6.5 mg./l.

232. Two numbers of aeration ditches in series will be created to have sufficient capacity to retain liquid wastes for 3 days with a buffer of 1 day. The outflow from the ditches will be made to pass in 4 furrows intercepted by mangroveOne Storm W root zones which will act to reduce the septicity of water to the tolerance limit, through root zone absorption.

The technical specifications as worked out are given below:
   - Aeration ditches – 2 each of 3000 m³ capacity
   - Residence time – 3 days plus 1 day buffer
   - Ridges and furrows – 4 each 0.9 m deep and 20 m long
   - Clearing period – every 2 months
   - Plants to be provided
     - Aeration pond – water hyacinth or duckweed
     - Furrows – acanthus ilicifolius and sonneratia caseolaris
     - Ridges – minjiri (cassia siamea), eucalyptus

**Cost**

233. The cost estimates are as follows:

<table>
<thead>
<tr>
<th>Description</th>
<th>Rs in Lakhs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Construction of storm water drains</td>
<td>1461.61</td>
</tr>
<tr>
<td>2. Construction of phyto-remediation of urban sewage system</td>
<td>32.11</td>
</tr>
</tbody>
</table>
Total (excluding cost towards electrical works, goods & equipment, operation & maintenance and monitoring & evaluation) 1493.72

Component B.5 - Provision of grid electricity to Sagar Island

234. Sagar Island depends on diesel generating sets for electricity requirement and electricity is available for a part of the population on an organized scale only during the evening hours. However, during Sagar mela in January every year, power supply continues throughout evening and night hours.

235. The existing distribution system comprises 20 no 11/0.433 K.V. distribution substations with 44 km 11 K.V. feeder and 26 km M & L.V. lines catering power to domestic, commercial and industrial consumers. The inadequacy of power supply is at the root of any substantial developmental activities and livelihood upgradation/enhancements of the inhabitants. The immense possibilities of development of tourism, of multi-crop cultivation through energized withdrawal of ground water (without inviting saline water ingress) and of fish preservation and processing could be realised with the availability of grid electricity.

236. WBESDCL has already initiated on its own a project to connect Sagar island with grid power available at Kakdwip 33/11 K.V. sub-station via Lot 8 (ckt-I) and Gouranga Math (ckt-II) and a crossing over river Muriganga at Harwood point on towers to the proposed Rudranagar 33/11 K.V. sub-station. Works are in various stages of tendering/construction.

237. The present component of work under SPR has been proposed so as to reach grid electricity to the existing and new consumers for 24 hours from the Rudranagar 33/11 K.V. sub-station that is expected to start shortly.

238. The work elements will include erection of 488.51 km of 11 K.V. line, 443.00 km of L & MV line and distribution sub-station (11/0.433 K.V.) – 356 numbers of 25 K.V.A. and 265 numbers of 10 K.V.A.

Summary statistics related to the proposed project are tabulated below:

<table>
<thead>
<tr>
<th>Expected Consumers</th>
<th>31000</th>
<th>Schools</th>
<th>12</th>
<th>(i) Project cost in Rupees in lakhs</th>
<th>3470.26</th>
</tr>
</thead>
<tbody>
<tr>
<td>(ii) Project cost to be financed in Rupees in lakhs</td>
<td>3424.50</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Domestic (other than BPL)</td>
<td>22906</td>
<td>Panchayet Samiti office</td>
<td>9</td>
<td>Scheme implementation Period</td>
<td>2 years</td>
</tr>
<tr>
<td>Domestic (BPL)</td>
<td>6094</td>
<td>Hospital/ health centre</td>
<td>3</td>
<td>Implementing Authority</td>
<td>WBSEDCL</td>
</tr>
<tr>
<td>Commercial</td>
<td>1024</td>
<td>Police/outposts</td>
<td>4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Agricultural & 120 & Water works & 10 & \\
Small industries & 48 & Sagar mela offices & 15 & \\
Others & 67 & Zilla Parishad/DM/SP offices & 5 & \\

F.3 Component C - Eco-tourism and related service sector livelihood option – Digha- Sankarpur coast and Sagar Island

239. Digha is a small coastal town located in the western side of River Hugli. Sankarpur is a satellite town located further west at a distance of about 14 km from Digha. Both the townships are under the administrative control of Digha-Sankarpur Development Authority. These two are the most popular coastal tourism spots in West Bengal, particularly amongst the Bengali middle class. Administratively, both the townships are located under Ramnagar-I block. There are three Gram Panchayats namely, Padima-I, Padima-II and Talgachari-I which cover the areas under these two townships. Total number of annual tourists staying in different hotels presently has been estimated to be around 2 million. Considerable number of tourists here are day-tourists, who use to come and spend the day for picnic for celebration on different holidays and in specific occasions like Christmas, 1st January, Independence Day, Republic Day or during Durga Puja etc. It has been estimated that by the year 2020, total number of annual tourists is expected to be around 5 million. One of the major problems of development of tourism industry here is that apart from the presence of sea, nothing further exists here. In the evening, after the Sun set, there is hardly any activity which can attract tourists. As a result, most of the tourists choose to stay here for comparatively less period of time, about two days and use to leave. This weekend tourism needs to be changed so that tourists spend here for a comparatively longer period of time and enjoy certain facility which will ultimately boost up the local economy. The major emphasis is the involvement of local people and local organisations so that ultimately it will boost up the local economy. Within a bunch of such options, only five following items have been chosen, as below:

Component C.1 - Modernization of Marine Aquarium and Research Centre at Digha

240. Marine Aquarium and Research Centre (MARC), Digha was established during the year 1989. Every day, about 1000 people visit the aquarium. The main objective of the centre is to exhibit live marine fauna in aquarium for education and recreational purposes as well as to conduct research on selected marine fauna in captivity. MARC is the largest inbuilt marine aquarium in the country and equipped with 22 tanks (each 8000 litre capacity)
and 2 large size (14000 litre) tanks. Another 8 small tanks are for fresh water fishes exhibits. The aquarium has three divisions of exhibits i.e. the species of conservation importance, the local & ornamental species and freshwater species. The water intake and filtration set up in the present aquarium is not sufficient and most of the pumps meant for water circulation system are defective. Due to these defects the fishes in the aquarium do not survive for the longer periods and mortality occurs within 4 to 5 days.

241. The modernization of Marine Aquarium and Research Centre project is proposed with following two aims:

- Development of Coastal Marine Museum exhibits and interpretation centre for public outreach and education on coastal and marine life and
- To upgrade the existing aquarium with the best filtration system that meets the requirements of marine aquarium and equipping the tanks with appropriate marine species and other ancillary facilities

242. The modernization of the filtration system will be accomplished with the following new proposed set up:

- The existing filtration system of the aquarium will be centralized and made semi-closed.
- Water exchange will be done at the rate of 20% for every 4 days. The exchanged water can be recycled; this will give best results, because the water chemistry will remain the same.
- R.O. unit is to be included in the system which will produce water with very low TDS (Total Dissolved Solids). This can be used for regular topping up.
- Two U.V. sterilizers, one at the multi bed pressure filter and other at the discharge area of the storage tank, are to be installed. Inclusion of U.V. sterilizer will make water recycling more effective and will give pathogen free water.
- Micron filters can also be included before both the U.V. sterilizer to avoid suspended particles entering the effectiveness of U.V.

FLOW CHART OF THE CENTRAL FILTRATION SYSTEM
[Water Recycling System]
The following tanks will be set up after the modern filtration system is in place:

Community fish tank, community tank with invertebrates and fishes, invertebrate only tank, planted aquarium (seaweed and seagrass) with sea horse and pipe fishes, tank with marine eels, jelly fishes, etc, deep sea vision (blue colour), damsel fish tank, sea anemone & anemone fishes (clownfish) tank, poisonous fish aquarium, live rock & polychaete worm tank, wrasses, angel & squirrel fishes, grouper, sea bass, rabbit & other edible fishes, basslet, banner, banner, moorish idol, parrot fishes etc, crustacean tank (crabs, shrimps, lobster, hermit crab), molluscan tank, dotty back, tangs, powder blue & trigger fishes, butterflies, batfish & sweetlips, estuarine fishes (etroplus etc), fresh water aquarium, fresh water planted aquarium, fresh water fish aquarium, arowana tank, long tank-I & long tank-II, fish quarantine system and live-feed culture tank.

**Budget**

Total budget requirement for modernization of Marine Aquarium and Research Centre of Rs. 593.00 (Rupees Five hundred ninety three lakhs only) consists of the two items:

- Development of Coastal Marine Museum exhibits for public outreach and education.
• To upgrade the existing aquarium with the best filtration system that meets the requirements of marine aquarium, with appropriate facilities in each tank and to purchase marine creatures, etc

The project cost to be financed is **Rs 268.00 lakhs** only.

245. The component will be implemented by the Zoological Survey of India over a period of 10 months. The O & M cost of Rs 3,25,00,000/- for a period of five years will be borne by the ZSI.

**Component C.2 - Livelihood Generation in DSDA Area**

246. The project proposal has been designed to attach high priority to fostering livelihood generation as an integral component. Digha-Sankarpur and their adjoining areas have a rich tradition in artisan technology. The mats prepared by the local artisans have international demand. Conch polishing and shell artifacts are other products of much attraction. The major problem for generating income out of these local crafts is the non availability of proper market facility. In addition, these artisans also require some training for refinements of their products to have edge in marketing. They also require some training in proper packaging of their products to claim a share in domestic and international markets.

247. Digha and Sankarpur are also places where tourism provides scope for income generation in a good measure. A large number of people earn their livelihood in different fields associated with tourism and hospitality. As tourism is largely dependent on availability of hotels and ancillary services, hotel services and tour operation also play important roles in income generation. All people associated with the above fields require some sort of training to acquire skills in their respective fields. The present project has been evolved to take care of the above aspects to boost income generation among the local people by imparting professional training in their field. Due emphasis has also been given on capacity building of local people, market facilities for the local craftsmen and providing infrastructure for administering training in different fields as below:

i) Travel and tourism  
ii) Secretarial practice  
iii) Vocational training  
iv) Food processing (cashew kernel processing, cashew nut shell liquid extraction)  
v) Handicrafts (Jute, polishing procedure and utilization procedure for exportable shells, stitching and cutting of garments)  
vi) Aquaculture (pisciculture, prawn culture, crab culture, oyster culture)  
vii) Floriculture  
viii) Horticulture (preservation of medicinal plant parts for maximum yield)  
ix) Civil works (masonry, plumbing, carpentry)  
x) Electrical works
A three-storied building has been planned near Nehru Market at Old Digha to serve the above purposes at the request of the DSDA authorities. The first two floors of the building will be utilized mainly as market facilities to be provided to local artisans for selling their products, while the top floor will be used for imparting different trainings as planned. The location of the building falls on an area where construction of three-storeyed buildings is permissible. The necessary internal sanitary, plumbing arrangements and electrical installations including provision of passenger lifts have been included. The water supply will be effected by sinking one deep tube well with submersible pump for lifting water in addition to water supply to be received from PHE’s water supply system. Considering the fact that the building will be mainly used as mercantile (retail) activities, adequate provision for fire fighting has also been considered. The sewage load generated daily will be discharged into public sewage system. Internal pathways, outdoor lighting and boundary fencing have also been included to make the building complete in all respects. The livelihood generation facilities/schemes proposed in this para are meant to be used/shared by the people of both Digha and Sankarpur. The proposed location for construction of a 3-storied building near Nehru market at old Digha for the purpose of livelihood generation and value addition activities lies in an allowed site under CRZ regulations.

In order to bolster the economic activity of the surrounding areas of Digha and Sankarpur, and support the growth of traditional craftsmanship nurtured in the region, creation of a 3-storied building to serve as a centre for skill development and handicrafts has been planned. Areas adjacent to DSDA area are famous for different handicraft articles and wares having demand in domestic and international markets which the craftsman and artisans produce by acquiring skills in traditional method. These people require some sort of training to improve and hone their skills and to develop entrepreneurship acumen to make a more sustained dent in the market through acceptance of their products. Moreover, with the rapid development of tourism industry in the areas, more and more people trained in hospitality services and tour operation for the tourists is required. Keeping the above requirements in view, the space planning of the building has been undertaken to create a good amount of market facilities for the artisans and craftsmen while sufficient and judicious spaces have been reserved at the 2nd floor for facilitating training in different fields.

The site for the building has been selected in the main business district of the town of Digha to bring the market facilities at the door step of the artisans. 7 room spaces have been kept separate and reserved for artisans who will be allotted spaces separately by rotation to produce and showcase their products to the visitors and will have ample opportunities to
exploit the market facilities offered to them. Each such room space has been designed taking into account the working space required for display. In addition 103 room spaces has been designed for allotment to shop owners on monthly rent who would prefer to open their handicraft business. The 2nd floor of the building has been devoted for holding trainings in Workshops and Class rooms. A sufficiently large conference hall has been included to hold seminars and interactive sessions. Rooms for trainers and space for maintaining a small office have also been considered and included. At the 2nd floor, two guest rooms have been designed for the overnight stay of outstation instructors. The building has been designed as RCC structure complete with all services in compliance with the development norms of the DSDA and coastal zone regulations of MoEF, Govt. of India. As the selected location of the building falls on CRZ- II on landward side of the beach, construction of permanent building with building height within 11 meters with usual allowances in height for stair room, lift machine room, etc. is permissible. Various types of services have been identified to exploit the prime location of the site as much as possible. The necessity of a wide drive way and provision for sufficient number of parking spaces have been given due importance. As part of the building will be used as a mercantile building, provision for fire fighting arrangements has been kept in mind in determining the utilities. Due provision of lift has been included for the use of aged and handicapped persons visiting the building. Sufficiently wide stairs, corridors and entrance lobby have been planned to provide easy movement of the visitors inside the building and for providing quick evacuation during emergency.

251. The salient features are as follows:

   i) Area of land – 1.18 acres
   ii) Total covered area of the building - 5471 sq.mtrs.
   iii) Built up area of ground floor - 1814 sq.mtrs.
   iv) Built up area of 1st floor – 1735 sq.mtrs.
   v) Built up area of 2nd floor – 1922 sq.mtrs.
   vi) Ground coverage – 39.95% against permissible ground coverage of 49.5%
   vii) Type of lift – 8 passenger capacity automatic lift

252. Detailed technical specifications are given in the DPR. The structural system of the proposed building shall be a R.C.C structure consisting of load bearing structural elements like R.C.C slabs, beams and columns. The liquid waste generated for the 3 storied building - Centre for Skill Development & Local Handicrafts will be disposed of through public sewerage system available near the project site. The sewage will be transported by laying NP2 RCC pipe laid underground, at proper grade to maintain non-silting velocity by gravity flow. Sufficient number of inspection pits, and a master trap will be provided for safe discharge of sewage to the public system. Disposal of surface run off will be done by
underground SW pipes to be laid at adequate slope to transport the water. The pipe lines will be provided with inspection pits – 900 mm x 750 mm to be constructed with brick walls and masonry catch pits 600 mm x 600 mm with gratings at top.

Component C.3 - Beach Beautification and Illumination at Digha

254. Digha is one of the most important tourist spots in West Bengal. People mostly from the middle class families prefer this sea side resort for easy accessibility from Calcutta and elsewhere in the State. A large part of the tourist population comprises day-trippers who generally visit on week ends mainly for recreational purposes, holidaying or enjoying in fiesta. One of the major problems faced at Digha is the absence of recreational items that can attract a larger mass of tourists to stay here for a longer time than making a short trip as is now the usual practice. To target visits of more tourists as a means to boost the local tourism industry, attempts have been made to create amenities that can play a positive role in causing more footfalls of the visitors to this sea side resort. Among such amenities, beautification of the long stretch of beach has been considered very important. It has been planned to adequately beautify the available spaces along the beach embankment, cross roads and seaward side of the arterial road traversing in east-west direction parallel to the sea by creating landscaped gardens, greeneries for amusement of the visitors and at the same time for providing further amenities for recreation. Along with this type of beautification, area illumination and garden illumination have also been given due attention. The DSDA authorities have initiated works of illumination along the beach embankment and the proposal made here will complement the efforts initiated by the DSDA. Schemes for beach beautification and illumination at Sankarpur have not been proposed in this DPR as Sankarpur beach first need major protection measure and development of an arterial road parallel to the beach.

255. The beach at Digha stretches 5 km in east-west direction covering both old Digha and new Digha. The sea front at Digha looses much of its attractiveness due to near absence of properly designed parks and gardens spatially distributed along the beach. In fact, the tourists roaming along the beach to enjoy the scenic beauty have got no halting facilities to fully enjoy their visit. In order to mitigate the deficiency, it has been proposed to create a number of parks and landscaped garden with seat outs along the beach embankment where tourists gather in large number. The landscaped gardens have been designed to include visually pleasant garden pathways, water bodies, greeneries and tree plantation to create the right ambience for enjoyment of scenic beauty. To beautify the gardens adequately,
illumination by providing low height post mounted garden light fixtures with energy efficient 1x11 watt CFL lamps has been proposed.

256. Grass lawns will be created by depositing and spreading good earth mixed with manure in the proportion of 1:1. The grass sods will be planted at the interval of 50mm in either row. The grass lawns thus created will be maintained for 2 months by watering and after that mowing will be resorted to for presenting a uniform green surface. Holes 600 mm in dia up to 600 mm in depth will be dug and the holes will subsequently be filled up with good earth mixed with damp manure in the proportion 2:1. Trees will be planted and tree guards made of split bamboo will be erected for the protection of saplings. For flower gardens, trenches up to 600mm will be dug and the empty trenches will be filled up with good earth mixed with manure. The flowering trees will be planted on the filled up trenches and will be maintained with watering as necessary. For hedging, similar trenches will be made and filled up with good earth mixed with manure for plantation of hedges and shrubberies. 50 mm dia. posts 8 ft high conforming to appropriate metal coat will be provided with 1x11W CFL lamp.

Cost

257. The cost towards implementation of the three components of works (B.1 – Beach cleaning and sanitation at Digha, C.2 - Livelihood Generation in DSDA Area and C.3 - Beach Beautification and Illumination at Digha) to be implemented by DSDA is Rs 4109.44 lakhs and the project cost to be financed Rs 4092.94 lakhs.

Component C.4 - Post harvest handling and fish auction centre at Digha Mohana

258. A temporary auction market comprising shanties/thatched sheds for auction of marine fish is functioning at Digha Mohana for more than two decades. It is proposed to construct a permanent marine auction market at Digha with the required ancillary facilities to accommodate increased volume of fish trade in a hygienic environment.

259. The project facilities will include

- one auction hall with 104 auction places (5 m x 6 m) with a proposed covered area having a dimension of about 93 m x 85 m,
- proper drainage system with 600 mm diameter hume pipe (NP-3) covered drain with discharge at effluent treatment plant,
- internal road network with concrete paved 3.5 m wide carriage way and two main entrances and exits,
- one box washing room with suitable washing system and disinfecting arrangements outside the auction hall,
• one public change room in between two entrances,
• feet washing place at the downstream side of every entrance gate with disinfecting sink and appropriate drainage, treatment and disposal of waste water,
• public utility with toilet and bathing facilities and appropriate drainage, treatment and disposal of waste water,
• electrical installations with street lighting and spot lamps at auction places,
• fire fighting system with 25 fire extinguishers and provisions of emergency exits,
• waste water management system,
• cold storage and flake ice plant,
• connecting road and
• quality control laboratory.

260. The project will be implemented by West Bengal Fisheries Corporation Limited with a total Project cost of **Rs 601. 72 lakhs**.

**Component C.5 - Development of Eco-tourism in Sagar Island**

261. Sagar Island has immense potential for planned eco-tourism destination. If this potential is realized through development of infra-structural facilities compatible with its surroundings there will be increase in the volume of quality tourists throughout the year apart from mass pilgrimage tourism during the Makar Sankranti mela. This will create a positive impact on the socio-economic status of the locality. The local people, be they skilled or un-skilled labour, small shop keepers and people engaged in providing transport and other services will get the opportunity to earn more as the money spent for development of infrastructure facilities and also by the tourists will create a multiplier effect on the local economy.

262. The Kapil Muni temple complex and its surroundings have been identified for creation of eco-tourism facilities. Three different sites have been selected for creation of tourism products/facilities compatible with ecological, mythological and cultural heritage of Kapil Muni Temple Complex in Sagar Island.

263. Site No. 1 representing Kapil Muni Temple Complex (30 km from Kachuberia) will provide the following pilgrim tourist facilities/infrastructure in the vicinity of the existing temple complex.

• *nat mandir* – a covered space outside the temple proper to be constructed for the pilgrims to gather, wait for offering puja and chanting religious songs
• *dala arcade* – consisting of covered stalls to be constructed adjacent to the temple complex in order to relocate present stall owners selling materials for offering *puja* from shops lying haphazardly in the temple complex
• change rooms – new facilities to be created for tourist conveniences before/after sea bath
• medical centre – new facilities offering emergency medical help
• toilet block – new facilities for improving better sanitary condition around the temple complex

About 35.8 acres of government land is currently available that is proposed to be part utilized for the above purposes.

264. Site No. 2 – Development of Eco-tourism centre consisting of the following eco-tourism products/facilities is proposed to be created on the west side of the existing windmill campus.

• meditation centre
• Kapil muni mythological interpretation centre
• bio-diversity interpretation centre
• marine aquarium-cum museum
• green house
• toilet block

About 16 acres government land is available near the windmill campus to accommodate these facilities

265. In both the sites, the following support services have been planned:

• road network
• water supply system
• sewage disposal system
• solid waste management system
• landscaping

266. Site No. 3 – Development of the following eco-tourism products/facilities is proposed to be created in the campus of the mangrove interpretation centre-cum-women biotechnology centre – Centre for Arts and crafts.

• handicraft centre – for promoting local handicraft items
• folk entertainment centre – for promoting local folk music and dance
• development of the existing pond with lighting and benches
• construction of a toilet block
• landscaping

About 4 acres of government land is available that can be utilized for this purpose.

267. The cost estimate for implementation of the component is Rs 3684.30 lakhs with the following items:

<table>
<thead>
<tr>
<th>Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>1  Kapil Muni Temple Complex</td>
</tr>
<tr>
<td>2  Sagar eco-tourism centre</td>
</tr>
<tr>
<td>3  Centre for arts and crafts</td>
</tr>
<tr>
<td>4  Services</td>
</tr>
<tr>
<td>5  Electrical works</td>
</tr>
<tr>
<td>6  Commissioning</td>
</tr>
<tr>
<td>7  Goods and equipment</td>
</tr>
<tr>
<td>8  Project Implementation and O &amp; M for 5 years inclusive of M &amp; E</td>
</tr>
</tbody>
</table>

268. Sundarban Infrastructure Development Corporation Ltd (SIDCL) a state government undertaking under the administrative control of the Department of Sundarban Affairs, Government of West Bengal is the Project Implementing Agency (PIA) of this component of SPR.

**Component C. 6 - Enhancing Livelihoods in Sagar Island**

269. An estimated 15000 families constitute the poor and marginalized in Sagar Island. Of these 8000 to 10000 families live in close proximity to embankment areas. The poor are either landless or small and marginal farmers. They work as agricultural labourers and wage labourers in fishing trawlers. Those living close to the water engage in prawn/shrimp seed collection. Livelihood assessment in Sagar Island reveals that there are not any livelihoods that are exclusively practiced by the poor except for shrimp seed collection. However, the scale in which the poor practice their livelihoods is very small compared to the non-poor. Further the number of employment/work days of the poor is relatively less. Also the poor are not engaged in any kind of value addition activities thus occupying the lower rungs of the value chain.

270. Therefore the component proposes the following to enhance the livelihoods of the Sagar islanders:

• Organize women and youth around savings, credit and micro-insurance in to SHGs
• Undertake participatory livelihoods
• Include pro-active eco-support and natural resource enhancing activities like RWH, tourism and tourism-based livelihoods
• Include livelihoods enabling infrastructure like vocational training centres, procurement centres, worksheds for enterprises, shops/outlets, skill building centres
• Facilitate bank linkages and convergence with other programs
• Utilize the maintenance funds for embankment for enhancing livelihoods as revolving funds
• Build skills of the youth in vocational training centres for meeting the services required in the island
• Explore the employment opportunities outside the island and provide them training in these opportunities for placement

271. The budget for the livelihood component of the five year Sagar pilot is Rs 2779.00 lakhs with the following work element break-up:

<table>
<thead>
<tr>
<th>Work Item</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Support for institutions of livelihood</td>
<td></td>
</tr>
<tr>
<td>Community mobilization – Institution and capacity building</td>
<td></td>
</tr>
<tr>
<td><strong>Funds to the community for enhancing livelihood</strong></td>
<td></td>
</tr>
<tr>
<td>Revolving funds for community institutions</td>
<td></td>
</tr>
<tr>
<td>Funds for skills for gainful employment</td>
<td></td>
</tr>
<tr>
<td>Funds for livelihoods and business development</td>
<td></td>
</tr>
<tr>
<td>Incentive funds for pro-poor GPs</td>
<td></td>
</tr>
<tr>
<td>Funds for innovative ideas in livelihood</td>
<td></td>
</tr>
<tr>
<td>Support to livelihood – capacity building</td>
<td></td>
</tr>
<tr>
<td>Support to livelihoods – livelihoods and business support</td>
<td></td>
</tr>
</tbody>
</table>

272. Sundarban Infrastructure Development Corporation Ltd (SIDCL) a state government undertaking under the administrative control of the Department of Sundarban Affairs, Government of West Bengal is the Project Implementing Agency (PIA) of this component of SPR.

F. 5 Component E – Capacity Building in ICZM activities

273. A common agreement about the ICZM project at West Bengal between Government of West Bengal and the Bank is that capacity building is the most critical issue for improved management of the coastal zones in the state. Although the state has a number of relevant institutes (notably Institute of Environmental Studies & Wetland Management, West Bengal Biodiversity Board, Indian Institute of Technology– Kharagpur, University of Calcutta, Jadavpur University, etc) and experts, the idea is to build capacity of a higher order, especially in terms of operationalization and application for integrating coastal zone management tools and approaches. Government of West Bengal also wants that the project should assist capacity building of the Digha-Sankarpur Development Authority, the Sundarban Development Board, and the non-government organizations currently involved in coastal zone management and coastal people’s livelihood activities. For this, training need assessment and relevant introspection is going on. However, in first phase, Capacity Building of IESWM and University of Calcutta through procurement of instruments has been prepared and placed below:
Component E.1 – Capacity building of Institute of Environmental Studies & Wetland Management (IESWM)

274. Capacity building in major centres of coastal research and study in West Bengal is an important component of the development of facilities for integrated coastal zone management in the state. One of the centres that have been identified for this purpose is Institute of Environmental Studies & Wetland Management (IESWM), Government of West Bengal.

275. The objectives of capacity building for ICZM in IESWM are to provide new and cutting edge equipment, computer hardware and software that could be successfully used on-site and off-site as part of some identified investigations of importance. The objective is also to address some current fundamental scientific issues related to ICZM deploying these equipments so as to verify their efficacy in addressing emerging coastal research issues. Such capacity building will also pave the way for taking up in future other major issues of ICZM. In short the program includes the following:

- procurement and installation of some advanced field monitoring instruments to monitor coastal processes in the Sundarban area of West Bengal,
- procurement and installation of remote sensing related hardware and software at IESWM office at Kolkata, to supplement physical monitoring of coastal processes, including registering of micro level change in form elements of the coastal landscape and
- undertaking one research program (deploying the instruments, software and hardware) on modeling of coastal form-process responses in Sundarban due to climate change
- Assistance towards construction and operation of an Interpretation Centre on the Sundarbans by Tagore Society for Rural Development

Coastal Studies Division (CSD) of IESWM

Activities

276. IESWM [formerly known as Institute of Wetland Management & Ecological Design (IWMED)] under the Department of Environment, Government of West Bengal has been working in the coastal areas of West Bengal using mainly remote sensing (RS) & geographical information system (GIS) technology for the last 20 years. One of the major thrust areas where RS and GIS technology has been immensely useful was in the field of coastal zone management which is exclusively the domain of activity of one of the divisions [Coastal Studies Division (CSD)] of IESWM. The activities of CSD are presently being
carried out in collaboration with Space Applications Centre (SAC), National Remote Sensing Agency (NRSA), Ministry of Environment & Forests (MOEF) and Ministry of Earth Sciences, Government of India (GOI). Major activities of CSD of IESWM in the field of coastal zone studies & management are preparation of natural resources inventory and formulation of management plans pertaining to coastal wetlands, mangroves, coral reefs, etc, monitoring of basic physical processes operative in the estuarine and near shore areas, implications of climate change and related phenomena in the coastal regime of West Bengal. Progressively greater emphasis is being given towards acquiring of instrumental and computational facilities for building up of form-process-material interaction models currently operative and also expected under different climatic scenarios in different segments of West Bengal coast.

277. The above core activities and research of CSD was initiated by a small group of earth scientists, especially geologists but later on, scientists from other related disciplines like botany, environmental science, atmospheric science, RS and GIS were inducted for developing a multi-disciplinary approach to research problems at hand.

278. Till recently majority of research works involved use of both visual and digital image processing techniques for mapping and inventorying purposes supplemented by detailed ground truth verification for form identification and mapping. Subsequently techniques relating to Geographical Information System (GIS), Global Positioning System (GPS), Differential Global Positioning System (DGPS) etc were introduced for a multi-disciplinary approach. Very recently, dynamic process and material monitoring in estuarine and near shore areas including time lapse recording of bathymetry, tidal ranges, wave period, tide and wave velocity, sediment size etc have been introduced.

279. Noting the work carried out by this division of IESWM in the coastal zone, Ministry of Environment & Forests, Government of India has recognised IESWM as an authorised institute for demarcation of High Tide Line (HTL), Low Tide Line (LTL) and Coastal Regulation Zone (CRZ) along the Indian coast in 1998.

Projects of CSD

280. A number of projects have already been completed by CSD of IESWM with the application of Remote Sensing & GIS and other related technologies. Some of the important ones are mentioned below:

- Wetland mapping of West Bengal
- Wetland mapping of Tripura
• Status of surface water resources of Howrah, Burdwan and Nadia districts of West Bengal
• Mapping and monitoring of coastal wetlands of West Bengal using ERS-1 SAR Data
• Wasteland mapping of Koch Behar district of West Bengal
• Land use mapping of coastal regulation zone of West Bengal
• Coastal studies project
• Upgradation of coastal zone maps of West Bengal
• Wetland Information System
• Coastal Zone Management for selected areas of West Bengal

281. The list of important on-going projects is as follows:
• Preparation of Integrated Coastal Zone Management Plan for identified coastal stretches of West Bengal
• Coastal zone studies for West Bengal and Andaman Islands
• Ecosystem modeling of parts of Sundarban
• Development of location specific oil spill trajectory models (OSTM) along Hugli estuary under ‘COMAPS’ programme

282. Through different activities carried out during last 15 years or so, CSD of IESWM has collected and is collecting data on coastal processes of West Bengal. Some of the important works, which have already been carried out along coast are mentioned below:
• Erosion / Deposition along major estuaries
• Changes in land use and land cover
• Changes in floral composition of mangroves
• Changes in land cover due to change in management practices
• Changes in saline incrustation pattern
• Sea level rise and shoreline changes

A modest beginning has also been made in the study of carbon sequestration and in regional model generation on sea level rise.

Proposed programme

283. Compared to the responsibilities bestowed upon CSD for tackling coastal zone management issues including progressive need of coastal process monitoring with available infrastructure and equipment facilities, a crippling lack of adequate advanced monitoring equipments, their continuous field deployment and appropriate processing of continuous data sets are proving to be a major hindrance. In order to provide adequate support in the activities in the above areas it is proposed to equip the existing RS and GIS laboratory and the Estuarine & near shore survey & research (ENSSR) unit of CSD of IESWM with state-of-the-art facilities thereby augmenting the Division’s capabilities and upgrading the facilities to a national standard. The upgradation has been linked to a proposed topical research programme involving inter alia continuous data acquisition on estuarine and near shore form, process and response dynamics in Sundarban area of West Bengal.
Over the last 150-200 years climate change has been taking place rapidly and certain plant and animal species have found it hard to adapt. Human activities are said to be responsible for the speed at which this change has occurred and it is now a cause of concern. Although, there are controversies and doubts regarding the scale of climate change and consequent sea level rise, after the publication of Fourth Assessment Report of IPCC, it has been accepted world wide that global climatic change is a reality and the mankind should start preparing to adapt and perhaps mitigate the same.

Global climate and sea level changes will have severe impact on the highly populated coastal zones all over the world. Currently the changes are not only threatening the very existence of coastal installations, constructions and investments but also creating serious impediments for demarcation of boundaries of coastal zones based on high tide line. In order to formulate any worthwhile coastal zone management plan of West Bengal especially of the Sundarban region, it is therefore imperative to work out the changing morphology of the major estuaries of Sundarban, to identify and monitor the dynamic rate of coastal erosion / accretion and to record land use changes in the Sundarban using principally RS and GIS techniques.

The other important area of research, that will have a direct bearing on response of climate change in the Sundarban, is continuous field measurements of estuarine/coastal process and response parameters. This will include such process parameters like tides, waves, weather and their responses like possible sea level rise through time, estuarine bathymetry, suspended sediment concentration, bottom sediment characteristics, etc. The measured data sets of these variables over a sufficient long period of time would then provide the necessary input towards understanding of the impact of perceived climate change on estuarine dynamics of the Sundarban and towards reliable application of climate change model for realistic prediction of sea level rise, change in estuarine process dynamics and related adjustment of estuarine form elements with their material make up like suspended sediment concentration, bed load transport rate and bottom sediment characteristics.

Work Elements of proposed programme

The proposed research programme on Estuarine dynamics of Sundarban and their response to possible climate change will be implemented through integrated efforts of the RS & GIS laboratory and Estuarine & near shore survey & research (ENSSR) unit of CSD. The major work elements are as follows:

RS & GIS laboratory
• Procurement of digital data products (of Sundarban region of West Bengal), appropriate hardware and software for extraction of relevant information relating to
  ➢ morphological changes and channel geometry of major estuaries of Sundarban since the earliest days of remote sensing
  ➢ shoreline changes across the Sundarban since the earliest days of remote sensing
• Procurement of one license of appropriate software of hydraulic modeling (MIKE 21) from DHI

289. Estuarine & near shore survey & research (ENSSR) unit
• Design and construction of five permanent tide gauge stations with solar power supply system on five estuaries, viz., Saptamukhi, Matla, Bidya, Raimangal and Thakuran.
• Selection, procurement, installation (at five permanent tide gauge stations) and calibration of
  ➢ 5 nos Tide gauge (strain gauge type) with display option
  ➢ 1 no Automatic weather station with sensors for wind speed & direction, precipitation, humidity, temperature and atmospheric pressure
  ➢ 5 nos DGPS with V-sat system for data transmission
  ➢ 1 no post processing software (gammit/bernes)
  ➢ 3 no Directional Tide gauge & wave recorder with optional turbidity sensor for mobile campaign
  ➢ 3 no. of Wave and Tide Recorder with the optional sensors
  ➢ 2 nos of Recording Current Meters with light mooring frame/ bottom mounted frame, battery etc with sensors like conductivity, Pressure, Temperature, Oxygen, Turbidity and wave tide sensor.
  ➢ 2 nos Recording Doppler Current Profilers upto a depth range of 300 meters
  ➢ 1 no Eco-sounder
  ➢ 1 no. of Bathymetry data recording software
  ➢ 1 no Bottom sediment sampler

Required Facilities

290. In order to attain greater sophistication in RS & GIS Laboratory, to provide input in integrated coastal zone management issues and to address emerging issues relating to research on climate change, high level computing system and specific climate research software are required as follows.

• Computer systems with networking facilities
• Software for Marine & Estuarine system
• Image analysis software
• Digitisation software
• GIS software
• Data Base Management software
- Input / output devices like large format scanner cum plotter
- Ground truthing systems (DGPS, radiometer, equipment for sediment measurements, chlorophyll, coral reef conditions, etc)

**Budget**

291. The cost of implementation of the project over a period of 5 years including the cost of procurement of the required instruments is as follows:

<table>
<thead>
<tr>
<th>Component</th>
<th>Cost (INR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Manpower</td>
<td>1,27,20,000.00</td>
</tr>
<tr>
<td>II. Equipment</td>
<td>194,78,000.00 + 2,05,50,000.00</td>
</tr>
<tr>
<td>III. Travel</td>
<td>24,00,000.00</td>
</tr>
<tr>
<td>IV Other Costs</td>
<td>2,11,30,000.00</td>
</tr>
<tr>
<td>V Tagore Society for Rural Development</td>
<td>61,25,000.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>8,24,03,000.00</strong></td>
</tr>
</tbody>
</table>

**Component E.2 - Capacity Building Of Calcutta University Under ICZM Project Of West Bengal: Cataloguing the biodiversity of Sundarbans in the backdrop of climate change**

**Introduction**

292. Ever since the earth came into being there has been a climate system for sustenance of life and through out the earth’s history there have been several phases of changes in climate. As a result there have been well marked cold and hot periods. Interestingly over the last 150-200 years, i.e. since the industrial revolution, climate change in the form of elevated mean global temperature has been taking place. It has been proved beyond doubt that human activities during this period have been releasing more and more green house gases to the atmosphere which in turn has given rise to the recent climate change through rise in global mean temperature. Two important effects of this global warming are sea level rise and increase in number, frequency and intensity of cyclones and hurricanes both of which are and will affect the coastal areas substantially.

**Background**

293. The eastern part of the coastal region of West Bengal is characterized by the spectacular mangrove forest of Sundarban. The forest performs several important ecological functions for its sustenance. On one hand, the mangrove forest acts as a bio-shield against severe storms and cyclones coming from the Bay of Bengal that have the potential of causing large scale damage to the coastal areas. On the other hand, the mangrove forest participates in complex physical, chemical and biological interactions that produce an unique ambience for healthy and luxuriant growth of the forest. People living in and around the forest draw their livelihood from the living and renewable resources provided by the forest. The forest acts as a sink of carbon in as much as it is suspected that they emit methane, a green house gas, to the atmosphere. It is also known that CO₂ is produced by heterotrophic
activity in a mangrove swamp. However, a correct assessment of the contribution of mangrove forest towards controlling the climate change/global warming is still not available due to absence of reliable measurement data. Conversely, the expected changes in carbon bio-geochemical cycle in the mangrove system in relation to the anticipated climate change/global warming are still to be understood/worked out due to the same reasons.

The life forms in the Sundarban have a complex inter-related existence in dynamic equilibrium with the extant physical and chemical environment. The mangrove produces rich organic debris (consisting of decaying spores, pollens, seeds, leaves, fruits, twigs and branches of trees, etc) due to its high biological productivity with unique concentrations of nutrients in the debris. The nutrients are released both to the water and soil of the mangrove wetland of Sundarban. Parts of these “foods” are consumed by a group of organisms (like fishes, birds, amphibians, mammals, etc) either directly or through the water or the soil medium to sustain their body metabolic functions. The other parts are assimilated in the substrate soil, “consumed” by various forms of microbes which return some part of the “digested” consumed food to the soil as organic fertilizers. The fertilized soil (BY humification) thus supports further luxuriant growth of the mangrove forest. There is, however, a residual flow of nutrients and organic carbon from the mangrove system to the coastal water. The microbial diversity of a mangrove forest is mind-boggling and the various forms interact with the environment at various energy levels to set up a complex food web and growth of mangrove vegetation.

Objectives

The above discussion brings out that there are at least five frontier areas of enquiries on functioning of the Sundarban mangrove forest that can be pursued as part of climate change program providing important inputs in drawing up an integrated coastal zone management plan of the coastal areas of West Bengal. The objectives of each of the five areas of enquiries are as follows:

- Understanding the functioning of the Sundarban mangrove system through the activities of the microbes present in the substrate sediments and understanding the role of microbial diversity in maintaining the system,
- understanding the natural process of capture of carbon and emission of greenhouse gases from mangrove forests of Sundarban thereby assessing the contribution of mangrove forest towards controlling global warming,
- predicting the changes in carbon bio-geochemical cycle in the mangrove system of Sundarban in relation to climate change/global warming,
understanding the natural process of flow of nutrients and organic carbon from the mangrove system to the coastal sediment and water in Sundarban to self support the mangrove system of Sundarban

• assessing the amount of carbon sequestration through mangrove forest of Sundarban towards controlling global warming

Work Plan

296. Planned procurement of the instruments as envisaged in the present project will essentially support two research programs as part of capacity building of the participating departments (Biochemistry, Microbiology, Agriculture, Environmental Science and Atmospheric Science) of the University of Calcutta.

297. The first program will involve collection of representative soil and water samples from areas of Sundarban having different vegetation assemblages and analyzing the microbial diversity using structural and functional metagenomics. For this purpose one Thermocycler or PCR machine is proposed to be purchased. The second instrument that is proposed for purchase is Pyrosequencer for performing both structural and functional metagenomics for understanding microbial diversity. A Gel Doc Documentation System is also included for procurement.

• Pyrosequencer
• Gel Doc system
• PCR

298. The second program will involve the following major works:

• measurement of CO₂ sequestration and CH₄ emission from the mangrove forest and water,
• estimation of bacterial abundance (BA) and bacterial productivity (BP),
• measurement of inadvertent fertilization by nutrient flux (dissolved inorganic nitrogen), dissolved inorganic phosphate silicate from rivers.
• measurement/estimation of residual flow of nutrients and organic carbon from the mangrove system to the coastal water.

The instrumental requirements for the second program are as follows:

• Upright wide field research microscope with bright field, dark field, phase contrast and fluorescence with CCD camera and software
• Total carbon analyzer
• Liquid scintillation counter
• Low temperature programmable Incubator with Shaker system
• Nitric oxide analyzer
• Fluorescence Lifetime measurement spectrometer

Budget
The project cost has been estimated at Rupees 5.6 crores out of which capital cost will be about Rupees 3.125 crores towards purchase of equipments and recurring cost will be about Rupees 2.475 crores. The net financial impact will be addition of cutting-edge instruments in the Calcutta University for carrying out advanced research in biotechnology and biochemistry having applications in coastal management research. Such impact will also be in the form of peer-reviewed scientific publications in internationally reputed scientific journals.

**G. Project Costs**

**G.1 Estimates**

300. The total ICZM project cost estimates are summarized in the following Table. It could be seen that a sum of about Rs 300.2626 crores has been estimated for implementation of the suggested components of the State Project proposals for ICZM over a period of five years.

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Item of work</th>
<th>Total Project cost (Rs in lakhs)</th>
<th>Project cost to be financed (Rs in lakhs)</th>
<th>Implementing Agency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Component A.1 – Prevention of coastal erosion around Sagar Island</td>
<td>-</td>
<td>-</td>
<td>Sundarban Infrastructure Development Corporation Ltd</td>
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<tr>
<td>2</td>
<td>Component A.2 - Prevention of coastal erosion by development of coastal bio-shield in Digha-Sankarpur area</td>
<td>539.11</td>
<td>439.11</td>
<td>Forest Directorate, GoWB</td>
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<tr>
<td>3</td>
<td>Component A.3 – Construction of cyclone shelters</td>
<td>3200.00</td>
<td>3200.00</td>
<td>Dept of Disaster Management, GoWB</td>
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<tr>
<td>4</td>
<td>Component B.1 – Beach cleaning and sanitation at Digha</td>
<td>4109.44 (including cost under sl nos. 9 &amp; 10)</td>
<td>4092.94 (including cost under sl nos. 9 &amp; 10)</td>
<td>Digha Sankarpur Development Authority</td>
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<tr>
<td>5</td>
<td>Component B.2 – Renovation of sanitary sewerage system of Digha</td>
<td>3559.23</td>
<td>2982.57</td>
<td>Public Health Engineering Directorate, GoWB</td>
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<tr>
<td>6</td>
<td>Component B.3 - Solid Waste Management in areas under Digha-Sankarpur Development Authority (DSDA)</td>
<td>922.50</td>
<td>922.50</td>
<td>Digha Sankarpur Development Authority</td>
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<tr>
<td>7</td>
<td>Component B.4 - Development of Drainage System at Digha</td>
<td>1493.72</td>
<td>1493.72</td>
<td>Digha Sankarpur Development Authority</td>
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<tr>
<td>8</td>
<td>Component B.5 - Provision of grid electricity to Sagar Island</td>
<td>3470.26</td>
<td>3424.50</td>
<td>West Bengal State Electricity</td>
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<tr>
<td>Sl. No</td>
<td>Item of work</td>
<td>Total Project cost (Rs in lakhs)</td>
<td>Project cost to be financed (Rs in lakhs)</td>
<td>Implementing Agency</td>
</tr>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Distribution Company Ltd</td>
</tr>
<tr>
<td>Component C - Eco-tourism and related service sector livelihood option – Digha- Sankarpur coast and Sagar Island</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Component C.1 - Modernization of Marine Aquarium and Research Centre at Digha</td>
<td>593.00</td>
<td>268.00</td>
<td>Zoological Survey of India</td>
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<tr>
<td>10</td>
<td>Component C.2 - Livelihood Generation in DSDA Area</td>
<td>Included in sl.no. 4</td>
<td>Digha Sankarpur Development Authority</td>
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<tr>
<td>11</td>
<td>Component C.3 - Beach Beautification and Illumination at Digha</td>
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<td>Digha Sankarpur Development Authority</td>
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<tr>
<td>12</td>
<td>Component C.4 - Post harvest handling and fish auction centre at Digha Mohana</td>
<td>601.72</td>
<td>601.72</td>
<td>West Bengal Fisheries Development Corporation Ltd</td>
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<tr>
<td>13</td>
<td>Component C.5 - Development of Eco-tourism in Sagar Island</td>
<td>3684.30</td>
<td>3684.30</td>
<td>Sundarban Infrastructure Development Corporation Ltd</td>
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<tr>
<td>14</td>
<td>Component C. 6 - Enhancing Livelihoods in Sagar Island</td>
<td>2779.00</td>
<td>2779.00</td>
<td>Sundarban Infrastructure Development Corporation Ltd</td>
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<tr>
<td>Component E – Capacity Building in ICZM activities</td>
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<td></td>
</tr>
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<td>14.</td>
<td>Component E.1 – Capacity building of Institute of Environmental Studies &amp; Wetland Management (IESWM)</td>
<td>824.03</td>
<td>824.03</td>
<td>Institute of Environmental Studies &amp; Wetland Management (IESWM)</td>
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<tr>
<td>15.</td>
<td>Component E.2 - Capacity Building in Climate Change Research in University of Calcutta</td>
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<td>560.00</td>
<td>University of Calcutta</td>
</tr>
<tr>
<td>16.</td>
<td>Component E.3 – Capacity building of Forest Directorate and Department of Environment, Government of West Bengal</td>
<td>1148.10</td>
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<td>Forest Directorate and Department of Environment, GoWB</td>
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<td>17.</td>
<td>Component E.4 – ICZM Plan preparation</td>
<td>1569.48</td>
<td>1569.48</td>
<td>SPMU</td>
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<tr>
<td>18</td>
<td>SPMU Secretariat</td>
<td>2036.28</td>
<td>2036.28</td>
<td>SPMU</td>
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<tr>
<td></td>
<td>Total</td>
<td>31090.17</td>
<td>30026.26</td>
<td></td>
</tr>
</tbody>
</table>

**G.2 Project’s Finance and Fund Flow Arrangement**

301. Funds will be received by IESWM from the Ministry of Environment and Forests, Government of India annually. The IESWM will in turn allocate funds periodically to various agencies implementing the identified components of the State Project Proposals. The implementing agencies will follow the standard government financial controls for
expenditure sanction and payment, prepare the duly audited account statements and submit those to IESWM who in turn will prepare a consolidated utilization account. This account will reach the MOEF, GOI through the DOE, GOWB for further release of fund.

302. Further the following procedure will be in place

1. The SPMU created under IESWM for the project, will prepare the Annual Action Plan and Annual Plan Budget with the help of implementation agencies which is approved by Project Steering Committee.

2. Once the Annual Plan Budget is approved, requisition for release of annual fund requirement will be placed by the DOE, GoWB to the MOEF, GOI. The released funds will be allocated to SPMU on its exclusive Bank account under the ICZM project.

3. Based on the AAP, line departments/implementing agencies will submit their individual demands from time-to-time to the SPMU. After scrutiny of the proposal of release of fund, SPMU will accord sanctions for the expenditure and release the funds directly to the implementing agencies. Funds would be allocated to each implementing agency by the SPMU on quarterly basis based on annual budgetary allocation.

4. Expenditure reports will be submitted periodically by the implementing agencies to SPMU

5. Account at SPMU will be maintained in the double entry system in Tally (In 9.2 version). Consolidated account on expenditure statement of each IA will be prepared. Accounts so consolidated will be closed annually in March. SPMU will submit the audited consolidated account to NPMU as per the guideline of Financial Management Manual (FMM).

SECTION – III PROJECT IMPLEMENTATION ARRANGEMENT

A. Institutional Arrangement

A.1 Overall Institutional Model

A.1.1 Rationale

326. The outstanding key issues in coastal zone management of West Bengal coast have been brought out in subsection D.6 of Section – I. These issues relate mainly to lack of institutional co-ordination, pollution of coastal land and water due to various anthropogenic activities, coastal erosion, damages inflicted by other natural disasters like cyclones, earthquakes, tsunamis, etc, hazards (other than pollution of coastal land and water) arising out of man’s activities, lack of adequate sustainable non-conflicting but appropriate livelihood (fishing, agriculture, horticulture, eco-tourism, etc) for the coastal populace and inadequate appreciation of effects of probable climate change and consequent sea level rise on the West Bengal coast. In order to address these issues, several important as well as
relevant pilot programmes have been drawn up that will provide important inputs in the formulation of an integrated coastal zone management plan of West Bengal. In conformity with this rationale there is a growing recognition that an overall institutional model is required to deliver the expected benefits from implementation of these pilot programmes. Keeping the above arguments in perspective the overall institutional model and the staffing plan have been designed.

A.1.2 State Steering Committee

327. The State Steering Committee (SSC) for ICZM-West Bengal is the apex body. The Chairman of the SSC is the Chief Secretary, Government of West Bengal while the Principal Secretary, Department of Environment is the Vice-Chairman. The Principal Secretary/Secretary/Head of the implementing Government Departments and Agencies of ICZM Project will be the members of State Steering Committee (SSC). Besides, Principal Secretary of Finance Department will also be a member of SSC. Project Director of ICZM Project Management Unit will act as Convener of the State Steering Committee.

A.1.3 Project Management Unit

328. The implementation of the ICZM pilots by different agencies will be monitored by the Project Management Unit (PMU) to be constituted as a wing of the IESWM (a registered society under the administrative control of the Department of Environment, Government of West Bengal). The PMU will be the principal arm of the ICZM-West Bengal that will ensure the successful implementation of the pilot programs by providing the required administrative, scientific and financial support to the implementing agencies, will constantly
ICZMP-WEST BENGAL-Institutional Model

State Steering Committee

Chairman
Chief Secretary

Vice-Chairman
Addl. Chief Secretary
Environment

Principal Secretary
Sundarban Affairs
Principal Secretary
Forest
Chairman
Digha-Sankarpur Dev. Authority
Chairman
West Bengal Pollution Control Board
Principal Secretary
Fisheries
Principal Secretary
Water Resources
Principal Secretary
Finance
Principal Secretary
Tourism
Secretary
Irrigation and Waterways
Principal Secretary
Industries
Principal Secretary
Public Health Engineering
Director
IESWM
Project Director
ICZMP West Bengal - Convener
monitor and evaluate the performances of each intervention and will introduce mid-term corrections, if required, to rectify any deficiency in implementation of the pilot programs.

329. The Unit will be headed by a Project Director (PD). It will include three Programme Units – **Operation Unit**, **Finance & Administration Unit** and **Communication & Documentation Unit**. Each Programme Unit will be headed by an experienced manager and will be designated as Programme Manager Operation, Programme Manager Finance & Administration and Programme Manager Communication & Documentation respectively.

330. The **Operation Unit** will be constituted of five Scientists/Specialists as Ecologist/Environmentalist, Planner/Engineer, Oceanographer/Marine Scientist, Fishery Specialist and Rural Development expert. Discipline-specific and time-bound expert in put from selected Consultant(s) will be a part of the staffing plan of PMU. Such in put will be restricted to 36 man-months. **Finance & Administration Unit** will have 3 officers – Administration Officer, Accounts Officer and Procurement Officer. **Communication & Documentation Unit** will have similarly 3 officers – Documentation Officer, MIS expert and Communication Officer. In addition 4 **Technical Assistants**, 1 **Cashier-cum-Accounts Assistant**, 1 **Administrative and Procurement Assistant**, 4 **General Duty Attendants** will be recruited and will assist the Project Director and different Programme Management Units of the project for their smooth functioning. The above structure is given in the following Table.
A.2. Roles and Responsibilities

A.2.1 Terms of Reference of State Steering Committee

330. The State Steering Committee (SSC) is the apex body, which would guide and advise the project Director and the other programme managers under its umbrella for sustainable management of natural and coastal resources of the coastal environment. It shall review the activities/progress of the ICZM Project on an annual basis and advise the project Director/Programme managers to initiate appropriate actions to fill the gaps if any. It shall monitor the suitability and effectiveness of the regional coastal plan and recommend to the government accordingly for appropriate management of coastal activities. In case of lapses, if any, the SSC shall recommend to the government to initiate actions as appropriate for proper implementation of the project. It shall review the implementation/execution of ICZM project in the state. Meeting of the SSC will be held once in every six month. Special meeting of SSC can be convened with prior permission of the Chairman. All meetings of the SSC will be presided over by the Chairman. Project Director as Convenor of SSC shall convene the meeting of the SSC with the permission of the Chairman. He will prepare the proceedings and circulate to the concerned members/Officers.

A.2.2 Terms of Reference of Project Management Unit

331. ICZM Project Management Unit is the body which would be responsible for successful implementation of ICZM Project and to achieve the objectives in the scheduled time frame. In effect the PMU will co-ordinate all project activities and it particular the unit will also have the following specific activities:

- To interact among the State Departments and participating Agencies, Ministry of Environment and Forest Government of India, World Bank and the Consultants and Experts for the implementation of the project in the state.
- To coordinate in preparation and submission of all financial proposals from state to MoEF and obtain funds for distribution to state implementing departments.
- To render periodical progress reports expenditure statements etc. to State Government/MoEF/ World Bank
- To organise regular monitoring and evaluation for all components of the Project
- To organise periodical review meetings with the implementing agencies of ICZM pilot programs
- To organise camps, exposure visits, training etc. for capacity building and orientation of implementing Departments/ Agencies, Coastal Community, CBOs and NGOs
- To prepare documents, compilation and analysis of relevant data, publicity of Project activity, and creation of awareness among public on positive impact of the project
- To co-ordinate in the preparation of inception, interim and completion reports for all components of the Project
The specific responsibilities of various functionaries of PMU are given in the following Table.

<table>
<thead>
<tr>
<th>Who will do what?</th>
<th>PM Operation Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Project Director</strong></td>
<td>1. <strong>PM Operation Unit</strong> shall render all technical support to the implementing agencies (e.g. Different Govt. Dept. who have submitted DPR) and ensure successful implementation of ICZM project.</td>
</tr>
<tr>
<td>1. PD shall be responsible for overall implementation, monitoring and evaluation of ICZM project in the state.</td>
<td>2. The unit will evaluate the physical and financial progress of each component of the project.</td>
</tr>
<tr>
<td>2. PD shall report to the Vice-Chairman SSC and appraise the functioning of the ICZM project</td>
<td>3. The Unit shall be responsible for monitoring and evaluation of the ICZM project on a quarterly basis either through progress report or through review meetings followed by program/report submission.</td>
</tr>
<tr>
<td>3. PD shall direct the program managers of the three different units.</td>
<td></td>
</tr>
<tr>
<td>4. He shall be responsible for administration and financial management of the project.</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Program Managers (PM)</th>
<th>PM-Finance and Administration Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Program managers of the three units shall be appointed either through deputation basis or through open advertisement and shall report to the PD.</td>
<td>PM-Finance and Administration shall extend all administration and financial help for procurement and execution through Operation Unit and for proper monitoring and evaluation of the project</td>
</tr>
<tr>
<td>2. Program Manager of individual unit shall be responsible for smooth and proper management of the unit and thereby act as catalistic agent for successful implementation of the ICZM Project.</td>
<td></td>
</tr>
<tr>
<td>3. Proper co-ordination between Operation unit, and Finance and administration unit is essential to make the process smoother and to procure need based items.</td>
<td></td>
</tr>
<tr>
<td>4. There shall be close link between Operation unit and Communication and Documentation unit to make the process feasible, realistic and to achieve the objectives of the ICZM project</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>PM-Finance and Administration</th>
<th>PM-Communication &amp; Documentation Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM-Finance and Administration</td>
<td>1. <strong>PM Communication &amp; Documentation Unit</strong> shall be responsible for all project documents and report</td>
</tr>
<tr>
<td>shall extend all administration and financial help for procurement and execution through Operation Unit and for proper monitoring and evaluation of the project</td>
<td>2. The Unit shall be responsible for creation of Management Information System</td>
</tr>
<tr>
<td></td>
<td>3. The Unit shall be responsible for compilation and analysis of reports and returns</td>
</tr>
<tr>
<td></td>
<td>4. The Unit shall be responsible for publicity and awareness for ICZM project</td>
</tr>
<tr>
<td></td>
<td>5. The Unit will also act as Public Information Office for Project Management Unit</td>
</tr>
<tr>
<td>Role</td>
<td>Responsibilities</td>
</tr>
<tr>
<td>-----------------------------</td>
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</tr>
</tbody>
</table>
| Ecologist/Environmentalist | 1. Ecologist/ Environmentalist shall be appointed either through deputation or through open advertisement  
2. Ecologist/ Environmentalist shall extend all technical help to implanting agencies like Environment and forest Dept, Fishery Department and Wild Life Department while ensuring conservation and sustainable development of coastal ecosystem  
3. The responsibilities of the scientist are to monitor, evaluate and assess the impacts of ICZM projects on the immediate coastal environment. The scientist shall keep close liasoning with the Forest and Environment Department, Wild Life Department and extend all technical help and support for implementation of ICZM Project.  
4. He/ she shall monitor and evaluate the progress of ICZM project on a quarterly basis particularly relating to water qualities and pollution along West Bengal |
| Fishery Specialist         | Fishery Scientist shall monitor and evaluate fishery resources, particularly marine and coastal aquaculture. He/she shall render help and guidance to the Fishery Department, Govt. of West Bengal for proper implementation of their ICZM Project.  

| Rural Development Expert   | Expert on rural development shall design appropriate plan for socio-economic development of coastal inhabitants and thereby reduce the socio-economic vulnerability of coastal population. Also to render technical help/guidance to fisheries, tourism and culture department to bring value addition to fisheries and tourism which have not been explored yet. |
| Administrative Officer     | Administrative Officer shall be responsible for the general and human resources administration of the project                                                                                      |
| Planner/Engineer           | 1. Planner/Engineer shall provide all technical help/expertise for designing/Planning of coastal ecology and habitats as well as construction coastal structures to prevent coastal erosion, inundation and saline intrusion.  
2. Planner/ Engineer shall keep close liaison with all implementing Govt. Departments and shall provide technical expertise in resource planning as well as infrastructure development.  
3. Planner/ Engineer shall guide/help implementing organisations like Water Resources Department, Tourism Department, Department of Culture, etc. for proper implementation and monitoring of their ICZM project. |
| Accounts Officer           | Accounts officer shall be responsible for maintaining the detailed accounts as per the rules/procedures followed by the Finance Department, Govt. of West Bengal for all purchases and expenditure incurred for execution of ICZM project |
| Procurement Officer        | 1. Procurement Officer shall conduct a need based survey to prepare an inventory of items required to be procured and later to be used by the Technical and Monitoring and Evaluation units.  
2. He/she shall follow the laws/manual of the Govt. of West Bengal for procurement of required items, from appropriate agencies/firms, maintain the stock register and issue the items for the required work. |
| Oceanographer/ Marine Scientist | 1. Oceanographer is the key to assess the oceanographic processes which are operating along West Bengal coast and their impact on coastal erosion shoreline changes, coastal habitat etc.  
2. Vulnerability assessment due to natural disasters such as floods and tropical cyclones and suggest the Revenue department and water resources department to take appropriate measures.  
3. West Bengal coast is bestowed with abundant coastal and marine resources, both living and non-living. Thus, the scientist shall be responsible to properly monitor the living and non-living marine resources of the West Bengal coast and suggest measures for their conservation and preservation. |
| Documentation Officer      | 1. He/ She shall be responsible for all project documentation  
2. He/ She shall be responsible for creation of baseline data base  
3. He/ She shall coordinate all inter sectoral departments and agencies for project activity progress reports and any other relevant information  
4. He/ She shall assist the Steering Committee for report & documentation |
| MIS Expert                 | 1. He/ She shall be responsible for data processing, collection of data from all implementing departments and agencies  
2. He/ She shall be responsible for programming data management  
3. He/ She shall provide necessary support (data sharing) in preparation of activity progress reports |
| Communication Officer      | The officer shall be responsible for publicity on project activities and creation of awareness on positive impact of the project |
A website will be set up and maintained by the PMU to disseminate information about the pilot projects to the public bringing in the desired transparency in the implementation of the ICZM project. All information regarding progress of the pilot projects, recruitment notices, tender notices and relevant scientific and technical data should be periodically uploaded. An interactive feedback mechanism will be built in the system for obtaining public opinion.

A.2 Implementing Agencies – roles and responsibilities

The implementing agencies of the ICZM-West Bengal project are:
1) Department of Disaster Management, Government of West Bengal,
2) Digha-Sankarpur Development Authority,
3) Public Health Engineering Directorate, Government of West Bengal
4) West Bengal State Electricity Distribution Company Limited
5) West Bengal Fisheries Development Corporation Ltd
6) Sundarban Infra-structure Development Corporation Ltd
7) Zoological Survey of India
8) Forest Directorate, Government of West Bengal
9) Institute of Environmental Studies and Wetland Management
10) University of Calcutta

The roles and responsibilities of the above mentioned implementing agencies are as follows:

Department of Disaster Management, Government of West Bengal

The department is a relatively new player in coastal areas. Although it has decentralised set-up with district, sub-division and block level disaster management officers, it lacks technical man power to guide the construction and operation & maintenance of the proposed multi-purpose cyclone shelters. It has been proposed to execute the program through the office of district magistrates.

Digha-Sankarpur Development Authority

DSDA will implement a number of relatively small but important projects that have a strong local perspective. The pilot projects are in the form of several small interventions aiming towards cleaning the beach and beach front at Digha and providing civic amenities to the tourists so as to keep the beach clean including awareness measures. The proposed work elements like construction of pay and use toilets, construction of small kiosks in place of make shift shops, provision of litter bins, arrangement of beach lighting, construction of sitting facilities along the beach and construction of activity areas for children etc are
generally carried out by the municipal authorities and therefore DSDA has been assigned this project so as to keep the Digha beach clean for everyone to enjoy.

**Public Health Engineering Directorate, Government of West Bengal**

338. PHED is one of the important engineering departments of Government of West Bengal that has done commendable work in providing safe drinking water to the rural population of West Bengal. They are also instrumental in providing basic sanitation needs in non-municipal areas. In the Digha area because of growing population, large urban tourist influx and construction of hotels and restaurants the problems of sanitation related waste management and treatment including construction of a sanitary landfill along with vermi-composting facility, construction of underground sewer lines and a sewage treatment facility are required to be addressed. Accordingly PHED will take up the related construction work as pilots project under ICZM. The Department will prepare the detailed project report with bid documents including the required drawings and BOQ, evaluate the tenders, select the vendor, issue work order, sign the contract, supervise the construction work and release payment to the contractor as per measurement at agreed rates.

**West Bengal State Electricity Distribution Company Limited**

339. WBESDCL, the only company other than CESC engaged in distribution of electric power in West Bengal, plans to provide grid electricity to the residents of Sagar Island as part of ICZM so that there is a quantum jump in improving quality of life of the local people. The Company proposes to bring power line by crossing the Hugli river through towers. The preliminary design report has already been prepared by the Company. The Department will prepare the detailed project report with bid documents including the required drawings and BOQ, evaluate the tenders, select the vendor, issue work order, sign the contract, supervise the construction work and release payment to the contractor as per measurement at agreed rates. A revenue model for collection of charges on account of electricity drawn by the consumers will also be worked out by the Company.

**West Bengal Fisheries Development Corporation Ltd**

340. The WBFDCL will execute the construction of the proposed fish auction centre at Digha l man power providing a modern and eco-friendly facility complaint with public health norms

**Sundarban Infra-structure Development Corporation Ltd**

341. SIDCL will execute Sundarban specific pilot programs of ICZM having a direct bearing on improved livelihood in the Sundarban areas. These will include construction of infrastructural facilities related to various aspects of agriculture, construction of improved
road and water transport facility for convenient marketing of agricultural produce, training and awareness campaign for livelihood options, etc. SIDCL will also facilitate implementation of the Eco-tourism project in Sagar Island involving quality civil constructions.

**Zoological Survey of India**

342. ZSI maintains a marine aquarium in Digha that now require modernisation and renovation. The responsibility of ZSI will be to draw up a DPR identifying the work components, invite tender, select the vendor and supervise the work or the company awarded the work. All actions will follow the standing rules of the Central Government.

**Forest Directorate, Government of West Bengal**

343. High velocity wind along the coastal areas causes much physical damage of human habitation and agricultural crops. Bioshields, or vegetative cover, along coastal zones play a significant role in shore protection and also in protection of the coastal habitations against GOWB will be to create coastal bioshields in the Digha Sankarpur area on government land as part of ICZM project. The Directorate will raise and maintain appropriate plantation in an area of 700 hectares following the departmental norms of expenditure over a five year period.

**Institute of Environmental Studies and Wetland Management**

344. IESWM will be responsible for the preparation of ICZMP of West Bengal. Based on the data input from pilot projects as well as its own research on all aspects of coastal processes and socio-economics of the region the ICZMP will be prepared by IESWM. The Institute will play the role of a catalyst in mobilising coastal zone research having a bearing on ICZMP and will be responsible to build the base of form-process-material-biology-socioeconomic interaction model on which the ICZMP will stand.

345. As part of capacity building of IESWM, facility augmentation of the existing Remote Sensing & GIS laboratory, creation of computing facilities for climate change studies along with overseas training of scientists, procurement of advanced coastal process monitoring equipments have been proposed. The responsibility of IESWM in this capacity building effort will be to procure the right instrument following the laid down procedures in government, install and calibrate them, keep them in running condition and to ensure generation of quality date adequately.

**University of Calcutta**

346. The project on Capacity Building of Calcutta University is mainly geared towards procurement and installation of some advanced instruments as a part of
capacity building of the participating departments (Biochemistry, Microbiology, Agriculture, Environmental Science, Atmospheric Science) of Calcutta University. The installed instruments will be used for undertaking two research programs – one on deciphering the microbial diversity of soil and water of Sundarbans in West Bengal and the other mainly on measurement of CO₂ sequestration, CH₄ emission, estimation of different components, nutrients, primary productivity of water in the Sundarbans mangrove forest.

A.3 Staffing Plan

Staffing plan for Project Management Unit (PMU) is given in the following Tables.

<table>
<thead>
<tr>
<th>Position</th>
<th>Project Director</th>
<th>Program Manager- Operation</th>
<th>Program Manager-Finance and Administration</th>
<th>Program Manager-Documentation &amp; Communication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Who is eligible</td>
<td>Should have minimum 20 years of service/experience in the relevant field.</td>
<td>Should have sound technical knowledge on coastal zone management issues/environmental management issues.</td>
<td>Should have knowledge on Financial management and general administration</td>
<td>Should have knowledge and experience in Mass Communication/Documentation (in computer) preferably on coastal management/environmental management issues</td>
</tr>
<tr>
<td>Recruitment plan</td>
<td>Recruitment to the above four positions will be either through deputation basis or through open advertisement.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salary</td>
<td>Rs. 50,000/- p.m.</td>
<td>Rs. 40,000/- p.m.</td>
<td>Rs. 40,000/- p.m.</td>
<td>Rs. 40,000/- p.m.</td>
</tr>
<tr>
<td>Tenure</td>
<td>Tenure of all positions is for a period of five years and is purely temporary. However, the continuation will be subject to annual review.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Position</td>
<td>Ecologist/Environmentalist</td>
<td>Planner/ Engineer</td>
<td>Oceanographer/ Marine Scientist</td>
<td>Fishery Specialist</td>
</tr>
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<td>-----------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Who is eligible</td>
<td>At least M.Sc. in relevant subject with at least five years of research experience in coastal environment related problems</td>
<td>Should be a graduate Engineer/ Post Graduate with specialisation in Planning and should have 5 years experience in development planning of coastal areas / design of civil (including coastal) structures</td>
<td>At least M. Sc. in relevant subject and should preferably have at least five years of research experience in coastal process studies.</td>
<td>Should be a Ph.D. in Fishery Science and should have at least 5 years experience in coastal/marine fishery monitoring and management</td>
</tr>
<tr>
<td>Recruitment plan</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Recruitment to all the above positions will be made through open advertisement</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salary</td>
<td>Rs. 35,000/- p.m.</td>
<td>Rs. 35,000/- p.m.</td>
<td>Rs. 35,000/- p.m.</td>
<td>Rs. 35,000/- p.m.</td>
</tr>
<tr>
<td>Tenure</td>
<td>Tenure of all positions is for a period of five years and is purely temporary. However, the continuation will be subject to annual review.</td>
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</tr>
<tr>
<td>Position</td>
<td>Who is eligible</td>
<td>Recruitmen plan</td>
<td>Salary</td>
<td>Tenure</td>
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</tr>
<tr>
<td>Procurement Officer</td>
<td>Should be a Graduate Engineer/ Chartered Accountant and should have at least 5 years working experience in procurement</td>
<td>Recruitment to all the above positions except that of Accounts and Administrative Officer will be made through open advertisement; for the mentioned two posts of Accounts and Administrative officers deputation from eligible state service officers will be obtained</td>
<td>Rs. 35,000/- p.m.</td>
<td>Tenure of all positions is for a period of five years and is purely temporary. However, the continuation will be subject to annual review.</td>
</tr>
<tr>
<td>Accounts Officer</td>
<td>Should be an officer of state financial service with at least 5 years experience in accounting</td>
<td></td>
<td>Rs. 35,000/- p.m.</td>
<td></td>
</tr>
<tr>
<td>Administrative Officer</td>
<td>Should be an officer of the state administrative service with at least 5 year experience in general administration</td>
<td></td>
<td>Rs. 35,000/- p.m.</td>
<td></td>
</tr>
<tr>
<td>Documentation Officer</td>
<td>Should be a Post Graduate in Mass Communication/ English and should have at least 5 years of working experience in documentation</td>
<td></td>
<td>Rs. 35,000/- p.m.</td>
<td></td>
</tr>
<tr>
<td>MIS Expert</td>
<td>Should be a Post Graduate in Computer Application/ Operation Research/ Statistics and should have at least 5 years of experience in MIS (Management Information System) or related field.</td>
<td></td>
<td>Rs. 35,000/- p.m.</td>
<td></td>
</tr>
<tr>
<td>Communication Officer</td>
<td>Should be a Post Graduate in Mass Communication/ Journalism/ English and should have at least 5 years of experience in relevant field/ event management</td>
<td></td>
<td>Rs. 35,000/- p.m.</td>
<td></td>
</tr>
<tr>
<td>Position</td>
<td>Technical Assistant I</td>
<td>Technical Assistant II</td>
<td>Technical Assistant III</td>
<td>Technical Assistant IV</td>
</tr>
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</tr>
<tr>
<td>Eligibility</td>
<td>At least honours science graduate with experience/competence in computer use; age below 40 years</td>
<td>At least bio-science honours graduate preferably with degree/diploma in environmental management; age below 40 years</td>
<td>Should have a diploma in civil engineering and at least 2 years experience in supervision of civil constructions age below 40 years</td>
<td>Should be a Honours Graduate in English/sociology and with about 2 years of experience in relevant field/event management Age below 40 years</td>
</tr>
</tbody>
</table>

Recruitment Plan
Recruitment to all the above positions will be made through open advertisement

Salary
Rs 15000 per month

Tenure
Tenure of all positions is for a period of five years and is purely temporary. However, continuation will be subject to annual review
348. In addition, two Junior Technical Attendants (JTA) with a pay of Rs 10000 per month and four General Duty Attendants (GDA) with a pay of Rs 7000 per month will be recruited for the PMU. Eligibility will be at least Higher Secondary pass in science stream for JTA with 2 years experience in a research institute/I.T. organisation and at least Matriculate for GDA with age not exceeding 30 years for both the posts. Recruitment will be made through open advertisement.

349. Staffing plan of the implementing agencies will be as per the approved DPR. Only operational staff members will be recruited by the implementing agencies with permanent departmental staff member(s) providing the lead, expert input and guidance to the pilot projects as part of their duties either on full time or part time basis as decided by the respective heads of the agencies. However, each implementing agency will name a responsible member to head the pilot project allotted to the agency responsible to the PMU for successful implementation of the pilot project.

B. Financial Management Arrangement

B.1 Financial management Framework

350. Environment Department, GOWB will be the nodal department for overseeing financial management of the ICZM project in West Bengal. Funds approved and released annually will be received directly by IESWM. The financial management of the entire fund received from World Bank will rest on PMU in IESWM. Expenditure related to functioning of the PMU and expenditure related to execution of pilot projects of ICZM by the implementing agencies will be met from funds to be allotted by the PMU.

B.2 Fund Flow and Disbursement Arrangement

351. The implementing agencies will receive their annual requirements of fund from the PMU in IESWM (upon submission of audited utilisation certificate of the fund received in the previous year) for incurring expenditure as per the approved budget in the DPR. Government departments as implementing agencies will follow the standing financial rules of the GOWB observing strictly all financial formalities for expenditure from the allotted funds. Similarly, implementing agencies such as central government departments, autonomous institutes, statutory bodies and universities will follow their respective financial rules in utilising the sanctioned amount. Each agency will maintain separate accounts for the received funds and in no case the funds received are to be clubbed with funds received from other sources. Monthly expenditure statements are required to be furnished by the implementing agencies to the PMU within 10th of the following month.
B.3 Accounting Policies and Procedures
352. Separate accounts will be maintained at the level of executing agencies for ICZM project. Cash book, ledgers, stock and store registers, etc will be maintained at each level. The entire accounting procedures will follow the general finance rules of GOWB for pilot projects being implemented by the government departments. Agencies other than government departments will follow their own approved accounting policies and procedures. Separate double entry cash book system is to be followed for receipt and expenditure account separately for the pilot projects by all implementing agencies. These cash books should be available for inspection by the funding and allocating agency. The monthly account statement to be submitted by the implementing agencies to the PMU should tally with the entries in the cash book. Supporting documents for the incurred expenditure including expenditure sanction order by the competent authority of the implementing agencies should be scrupulously maintained for inspection as and when required by the funding and fund allocating agency.

B.4 Staffing and Capacity Building
353. At the level of PMU, necessary staffing arrangement has been made (e.g Finance and Administration unit) to deal with the financial matters of the project. At the level of individual implementing agencies, the existing accounting staff shall manage the accounting matters of the project.
354. Training of the concerned accounting staff at the level of PMU as well as at the individual implementing agency level will be organised especially with regard to World Bank guidelines and procedures. The accounting staff will also be trained in computerised accounting procedure.

B.5 Financial Reporting
355. The implementing agencies will submit the statement of accounts and requisition of funds to the PMU at intervals to be decided by the funding authority. The PMU after compilation of accounts will submit the consolidated statement and utilisation certificates at required intervals to the Environment Department, GOWB for onward transmission to the funding authority. It is necessary that a fully computerised uniform accounting system is evolved at each accounting level for ease in financial data handling, processing and reporting.

B.6 Internal Control Mechanism
356. Fund will be released by PMU to the executing agencies on quarterly basis after evaluating their performance and progress (physical and financial). However, such release will be subject to achievement of mile stones in respect of each component of work by the concerned executing agencies. The senior officials of each executing agency/department as
well as the officials of PMU will conduct field inspections. Monthly review meetings between PMU and implementing agencies will be conducted to evaluate the physical and financial progress of the work as per the approved DPR.

B.7 Audit Arrangements

357. The accounts of the project as a whole will be audited by the internal audit of the state government and also by the designated Chartered Accountant/Auditors that may be engaged by the MoEF, Govt. of India and World Bank. The said audit will be conducted after the completion of each financial year, i.e after 31st March every year.

B.8 Retroactive Financing

358. There is no provision for retroactive financing at present at the level of the state government. But IESWM may seek permission from the competent authority to adopt retroactive financing with respect to procurement of goods, works and consulting services only.

B.9 User Cost Sharing Principles

359. The principle will not be followed for the present.

C. Procurement Arrangement

C.1 Procurement Responsibility

360. The NPMU/SPMU, implementing agencies and the community will be responsible for procurement such as goods, works and consulting services for the implementation of the project. The responsibility of procurement of goods, services and equipments is vested on respective executing agencies and PMU. PEAs will be responsible only for contract management, regular supervision, and certification for payments. Exceptions to the above rule are the cases of community procurement, force accounts, and procurement of small incremental operating facilities through local shopping for which all responsibilities will lie with the PEAs.

C.2 Procurement Methods

361. The methods of procurement to be followed are:

   A) International Competitive Bidding (ICB)
   B) National Competitive Bidding (NCB)
   C) Limited International Bidding (LIB)
   D) Shopping
   E) Single tender/ Direct Contracting

C.3 Procurement Thresholds

362. The following tables give the thresholds for Procurement Method for Civil Works and Goods

   Thresholds For Procurement Methods -Civil Works
C. 4 Overall Procurement Plan

363. Procurement plan includes goods/consultancies/works to be procured, their estimated value and method of procurement. Separate procurement plan shall be prepared for consultancies, goods and works. Methods of procurement to be adopted as well as review of contracts by the World Bank will be decided based on the total value of a tender rather than on the value of each individual contract/schedule/lot/slice. Procurement planning and its execution is therefore an integral part of project implementation and monitoring, which must be done and reviewed periodically to anchor the project over its life. Procurement plans prepared by SPMU and NPMU will also be shared with the World Bank. Procurement of all goods, works and services shall be undertaken in accordance with such procurement plans/schedules.

C. 5 Procurement Manual

364. A Manual on Procurement has already been prepared nationally. The purpose of the Manual is to inform the concerned staff of NPMU, SPMU and implementing agencies, the objectives of the project, guidelines for implementation of the project and to keep the officers informed about various procurement procedures applicable to this project. As the responsibility for the implementation of project, award and administration of contracts lies with the Borrower, it is important to get acquainted with the procurement procedures of the World Bank. A set of Guidelines have been published by the World Bank which need to be
understood and followed by the State Governments so as to enable them to procure ‘Works’, ‘Goods’ and ‘Consultant Services’ in conformity with these guidelines. Adoption of these procedures will ultimately result in efficient procurement and will enable the Borrower to claim reimbursement of funds spent from the Bank within the stipulated time frame.

C.6 Annual Procurement Plan

365. At State level each PEA will prepare their own contract wise annual procurement plan with assistance from SPMU. Procurement plans of each PEA will then be consolidated and approved at the State level by SPMU. Similarly, SPMU will prepare its procurement plan for services to be hired. At National Level NPMU will also prepare annual procurement plan for works, goods, and services to be procured by them during the year. However, to start with Procurement Plan has been prepared for the first 18 months of operation and include relevant information on all goods, works consulting services, training and capacity building to be undertaken under the Project as well as the scheduling of each milestone in the procurement process. The procurement plans show the step-by-step procedures and processing times for procurement including: contract packages for goods, consultant services and training; estimated cost; procurement or consultant selection method; bidding, evaluation and contract award; the activities which follow contract signature such as manufacture, shipment, delivery and installation of goods; mobilization, construction and completion of works. The implementing agencies will update periodically the sub-component procurement plans and submit them to the PMU Project Procurement Specialist to consolidate in the master procurement plan. Any update – annual or periodic to the procurement plan must be approved by the Bank before implementation. Special training on Procurement Planning would be provided to all procurement focal persons at the Implementing Agencies to build their capacity to undertake this very important exercise.

C.7 Procurement of Works

366. The methods of procurement to be followed for Works are:

A) International Competitive Bidding (ICB)
B) National Competitive Bidding (NCB)
C) Limited International Bidding (LIB)
D) Shopping
E) Single tender/ Direct Contracting

A) International Competitive Bidding (ICB)

This method is generally adopted where the supplies need import and/or foreign firms are expected to participate irrespective of the value. This method is to be adopted where the
estimated cost of the procurement of works is more than US$ 1,000,000/- equivalent for goods. Steps to be followed are:

(i) Apart from wide publicity nationally, Invitation for Bids (IFB) shall also be forwarded to embassies and trade representatives of countries of likely suppliers/ contractors of the goods and works and also to those who have expressed interest in response to the general procurement notice.

(ii) Invitation for Bids shall also be published in UNDB, dgMarket and project website.


(iv) Sale of bid documents should start only after publication of invitation for bids in newspapers and UNDB/ dgMarket.

(v) Bidding period shall be 45 to 90 days from the date of start of the sale of bid documents.

(vi) Domestic preference shall be allowed to domestic manufacturers/contractors with respect to foreign manufacturers/contractors as per procedure mentioned in the bid documents.

(vii) Other procedures for global tender/ ICB will broadly be same as that of open advertised tender in respect of bid opening, bid evaluation, notification & publishing of award of contract, complaint redressal etc.

B) National Competitive Bidding (NCB)

i) NCB is the competitive bidding procedure normally used for public procurement in the country and may be the most efficient and economic way of procuring goods or works, by their nature and scope. The procedures shall provide for adequate competition in order to ensure reasonable prices. The method to be used in the evaluation of tenders and the award of contracts shall be made known to all bidders and not be applied arbitrarily.

ii) NCB will be adopted normally where the contract value is less than the equivalent of US$ 1,000,000/- but more than the equivalent of (i) US$ 30,000 for goods and works.

iii) Various steps involved in procurement under NCB have been enumerated in detail in the prepared Manual.

C) Limited International Bidding (LIB)

Limited International Bidding (LIB), is essentially ICB by direct invitation without open advertisement. It may be an appropriate method of procurement where (a) there is only a limited number of suppliers, or (b) other exceptional reasons may justify departure from full ICB procedures. Under LIB, borrowers shall seek bids from a list of potential suppliers broad enough to assure competitive prices, such list to include all suppliers all over the world. Domestic preference is not applicable in the evaluation of bids under LIB. In all respects other than advertisement and preferences, ICB procedures shall apply, including the
publication of award of contract in UNDB online and in dgMarket and use of the Banks Standard Bidding documents.

D) Shopping

Shopping procedure is adopted where the estimated cost of procurement is less than 30000$ in case of Works and 20,000$ in case of goods.

C.8 Procurement at Community Level

367. Growing awareness of community participation in the works from planning to implementation and post implementation can help in smooth operation and maintenance and successful implementation of the project. Institutional capacity of community plays a major role for effective community participation in procurement and implementation of the program. Capacity building activities need to be undertaken in order to build and sharpen their existing skills for management and for sustaining all activities related to project implementation.

C.9 Key Procurement Guidelines

368. The key procurement guidelines cover

- key objectives of the procurement for the project;
- chosen procurement option;
- chosen procurement route (open or restricted as allowed by the procurement manual)
- key milestones (check that enough time will be allowed for various steps)
- key documents e.g. requirements, specifications, bidding documents etc.

Key factors influencing the procurement guidelines relate to the degree of complexity, innovation and uncertainty about the requirement, together with the time needed to achieve a successful outcome.

D. Environmental and Social Safeguards

D.1 Current Regulatory Framework

369. The current regulatory framework has necessary and sufficient provisions to ensure environmental and social safeguards during implementation of the State Project of ICZM through the existing Coastal Regulation Zone Notification, 1991 as amended from time to time, Water (Prevention and Control of Pollution) Act, 1974, Wildlife (Protection) Act 1972 amended in 2006, the umbrella Environment (Protection) Act, 1986, the draft Coastal Zone Management (CZM) Notification, 2008, Forest Conservation Act, 1980, Biological Diversity Act 2002 and Environmental Impact Assessment Notification, 2007 and the state level Fisheries Act. Important features and provisions of these acts and notifications have already been provided in Section I - D.1. These provisions will provide the regulatory framework for environmental and social safeguards of coastal areas during the project implementation. The environmental and social safeguard is also ensured through statutory authorisation procedures in a transparent manner for specified interventions having a potential to cause deterioration of
environmental and social conditions through formulation and implementation of approved appropriate mitigation measures against potential adverse environmental and social impacts due to intended “developmental” activities of specified nature and/or magnitude. Roles and responsibilities of regulatory agencies have been clearly spelt out in these acts and notifications so that the domains of regulatory framework are clearly understood while implementing the environmental and social safeguards.

**D. 2 Base line Environment situation**

370. A detailed enumeration of the base line environmental situation of the coastal region is perhaps outside the scope of this document. Discussion under Section – I, D. 6 on key issues in coastal zone management of West Bengal outlines the relevant aspects of base line environmental situation of the coastal zone of West Bengal. The raw data corresponding to these discussions are available with the monitoring agencies like West Bengal Pollution Control Board, Central Pollution Control Boards, etc. Specifically amongst the environmental parameters, quality of coastal water is showing deteriorating trends mainly from discharge of effluents from industries around Haldia region, discharge of untreated sewage from cities and towns present in the catchments of estuaries of the Sundarban region and from sea side resorts fringing the Digha-Sankarpur coast, pollution by pilgrims annually visiting Sagar island during the month of January, pollution from discharge from ships calling at Kolkata and Haldia ports and pollution from large scale immersion of idols especially in the Hugli river annually during the months of September-October. The impact of deteriorating water quality in many cases is reflected in the aquatic ecology with pollution resistant species far outnumbering the pollution sensitive species. Collection of fish fry in the coastal waters of Sundarban and associated destruction of reject biota are having an adverse effect on the aquatic bio-diversity. Dredging of ship channels certainly is disturbing the bottom dwellers in the Hugli estuary whose impact is largely uncharted.

371. The agencies preparing the DPRs will collect and collate the relevant base line data that are being generated by different agencies under their regular and specific activities. This base line data base will provide the necessary platform on which the initial environmental examination of each component of ICZM will be carried out, as part of the DPR, to assess the potential environmental impact including social impact and to formulate the required environmental and social mitigation measures.

**D.3 Environment Management Framework**

372. Most coastal zone management (CZM) efforts have been developed in response to crises. The CRZ notification of 1991 is the first codified effort in India in CZM but it also
evolved in response to the crises that developed following attempts to regulate coastal zone usages that began with the directive on such usage by the then Prime Minister of India to the Chief Ministers of coastal states of India. Although the CRZ notification was a historical necessity, an integrated and sustainable environment management framework for coastal environment of India has been a long felt need. Such a framework is ideally based on a stated overall policy to safeguard the coastal environment and its biodiversity from any intended action or decision by laying down the basic principles for ICZM and setting overall goals and specific objectives to guide activities and decisions affecting the coast and coastal resources. The framework is to include a well defined management strategy so that implementing agencies could achieve the stated goals and objectives. The strategy is to specifically address sensitive issues related to biodiversity conservation, coastal land use planning, resource conservation and management, coastal fisheries management, socio-economic especially livelihood development, environmental assessment, pollution control and project review. Environmental management strategy is also required to provide clear directions in the field of coastal environment education, public awareness & participation in coastal zone management, research on coastal zone management and information disclosure. A well co-ordinated institutional arrangement for the implementation of the policy statement and management strategy to address cross-sectoral issues is an integral part of the management framework. A monitoring and evaluation system to judge the efficacy of the ICZM programmes towards achieving its policies and objectives is a critical component of the environmental management framework.

373. In essence initial environmental examination of each component of ICZM will be conducted as part of the DPR preparation. The exercise will include preparation of an environmental management plan (EMP) based on the outcome of impact assessment inclusive of formulation of mitigation measures. The EMP will clearly identify the agency who will implement the worked out mitigation measures during the construction and operation phase of the projected interventions. The TEM of the PMU will be responsible for enforcing the implementation of the EMP. A first level Environmental & Social Impacts and Mitigation Measures in Priority Investigations in West Bengal has already been prepared during sanctioning of the present Project.

D.4. Environmental Monitoring Plan

374. Environmental monitoring plan requires both a clear definition of objectives of monitoring the relevant environmental parameters and of a valid scientific methodology of monitoring all parameters in an effective manner. The plan, of necessity, will comprise
individual plans of the components but eliminating duplication of monitoring the same parameters from the same area. The monitoring will also exclude actual monitoring of parameters that are being carried out separately as part of routine state or union efforts under statutory obligations and/or as part of national level programme(s).

At present, no comprehensive environmental monitoring plan related exclusively for coastal zone management exists in the state. However, sectoral monitoring of water quality, shoreline processes, biodiversity, and fishery resources are being undertaken in various scales. A brief description of such monitoring programme is discussed below.

- West Bengal Pollution Control Board monitors at regular interval the water quality of rivers and inland waters at selected points.
- Coastal Water Quality is being monitored by the Eastern Regional Office of CPCB under the COMAPS programme of Ministry of Earth Sciences.
- State Forest Department through Sundarban Biosphere Reserve Division monitors the ecological status including bio-diversity of mangrove forests in the Sundarban region
- Project Tiger of the State Forest Department (wildlife wing) monitors the tiger movements and other related activities in the Sundarban region.
- IESWM and School of Oceanography, Jadavpur University through their research programmes monitor the shoreline changes along selected stretches.

Component specific environmental monitoring plans will be prepared as part of the Detailed Project Report of each component of the State ICZM plan. The monitoring plans will include the parameters to be monitored, frequency at which monitoring is planned to be carried out, the methodology of monitoring and the agencies responsible for carrying out the monitoring as per the monitoring plan. PMU shall be responsible for enforcing the Monitoring Plan, review the monitored data and evaluate the need for any change in the monitoring plan that may be required to achieve the desired objective of monitoring.

**D.5 Institutional arrangement for Environmental management**

The Project Management Unit (PMU) shall be responsible for enforcing the implementation of the environmental management plan (EMP) by identified agencies under different components of ICZM. The component specific EMP will be drawn up as part of the Detailed Project Report after making an initial environmental examination of the potential impacts of the project activities on the environment for each component of ICZM separately. The mitigation measures with identified agencies responsible for implementing the measures
will be at the core of the EMP. The Monitoring plan will be implemented by the identified monitoring agencies as per EMP.

D.6  **Capacity Building**

378. In order that responsible agencies and institutions take appropriate steps to safeguard the environmental and social scenario during the implementation of ICZMP, a focussed capacity building programme has been included under Component M after identification of capacity gaps/needs in environmental and social safeguard areas. The Component provides for augmentation of facilities of the IESWM. As previously mentioned, trained and qualified permanent man power development and placement in the institutes currently engaged in environmental and social economic research in coastal areas will be an essential component of capacity building in environmental and social safeguard segment. The other essential activity for capacity building in the field of environmental and social safeguards is man power training through implementation of a well planned and focussed training programme. The training modules will be appropriately designed for different target groups from people living in coastal areas essentially dependent on coastal resources for their livelihood to local administrative and elected officials to scientists and technologists working on various aspects of coastal dynamics and coastal zone management. Training programmes based on a broader understanding of the coastal dynamics and associated processes in the coastal region is perhaps necessary in order to organise capacity building for environmental and social safeguards during implementation of intervention programmes related to ICZM. The areas that are generally identified in this connection include coastal erosion and deposition vis-à-vis coastal processes, biodiversity resilience in relation to biological processes and intervention by man, socio-economics of coastal region, coastal resource base and adoption and sustainability of different livelihoods by different coastal communities and finally anthropogenic activities in relation pollution of coastal environment.

D.7  **Budget**

379. The budget to adopt measures safeguarding the environmental and social aspects of the pilot programmes planned for implementation under ICZM has been included under Section-II G titled Project Costs.

**SECTION – IV   PROGRAM AND IMPLEMENTATION SCHEDULE**

A.  **Overall Program Phasing**
380. The ICZM project of West Bengal has seventeen different components (excluding the functioning of State Project Monitoring Unit, ICZM plan preparation under SPMU and capacity building of SPMU – Forest & Environment department) that can be grouped under five major heads – mitigation of coastal erosion, pollution prevention, development of livelihood options, creation of facilities to mitigate coastal hazards and capacity building. The overall phasing of all the components is given in the following Table.

B. First Year Implementation Plan

381. The first year implementation plans of all the components are indicated in the Table. The main work elements include preparation of detailed design report, preparation of tender documents, tender floatation, tender evaluation and award of contract for components involving civil constructions to be carried out through external agencies. In case of components involving mainly procurement of equipments, the first year implementation plan will include finalisation of equipment specifications, preparation of tender documents, tender floatation, tender evaluation, placement of purchase order, preparation of the site of installation, receipt of equipment, installation and calibration of received equipments. In case of components involving departmental works, the first year implementation plan will include recruitment of project staff, if provided in the project, placement of departmental staff in the project, allotment of work elements to individual or groups of persons and initiation of works, etc.
Phasing of ICZM programmes of West Bengal

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<td>Preparation of first ICZMP</td>
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<td>14</td>
<td>Component E.1 – Capacity Building of IESWM:</td>
<td>Study of the DPR</td>
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<td>Drawing up of specifications of hardware, soft ware &amp; data products, floatation of tender, tender evaluation and award of purchase order</td>
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<td>Installation of coastal monitoring equipment, hardware and software and their calibration and verification</td>
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<td>Monitoring and evaluation of the procured instruments</td>
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<td><strong>Component E.2</strong> – Capacity building of Forest Directorate and Environment Department, GoWB</td>
<td>Drawing up of specific plans and programs</td>
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<td>Implementation of the plans</td>
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<td>16</td>
<td><strong>Component E.3</strong> - Capacity Building of University of Calcutta</td>
<td>Study of the detailed project report</td>
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<td>16</td>
<td>Drawing up of detailed specifications of the instruments to be procured, tender document preparation, tender floatation, tender evaluation and award of purchase order</td>
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<td>Receipt, installation and calibration of equipments to</td>
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SECTION V - MONITORING AND EVALUATION

A. Objective

382. Monitoring has traditionally been defined as a continuous or periodic process of collecting and analyzing data to measure the performance of a program, project, or activity. As an integral and continuing part of project/program management, it provides managers and stakeholders with regular feedback on implementation and progress towards the attainment of stated objectives. Monitoring enables management to take appropriate corrective action to achieve desired results. Effective monitoring requires baseline data, as well as indicators of performance and related measurements, regular reporting, and a feedback mechanism for management decision-making.

383. Evaluation, on the other hand, is systematic and independent assessments of ongoing or completed projects or programs, their design, implementation and results, which aim to determine whether the actions taken have produced the desired results. Ideally, evaluation should be a continuous process through which measures of performance are defined and systematically compared with program goals and objectives. It may also be undertaken periodically during the lifetime of a program. In practice, evaluations are used by managers to improve their own performance (adaptive management), as well as for reporting (accountability) or as lessons learned to improve future planning.

384. The objective of Monitoring and Evaluation (M & E) of each component of State ICZMP is, therefore, to track through suitable means that the execution of the work program of each component is progressing as per schedule in terms of physical targets, allotted time
span and available financial resources. The objective of M & E is also to see that equipments, services, operation, etc that will be procured by allotted resources are of acceptable quality and in contracted quantities. One of the main objectives of M & E is also to decide on the desirability of a mid-course correction through revised resource allocation, alternative technological means, altered manpower deployment, etc. if the M & E indicate such a measure as absolutely necessary. In such a scenario the objective will be to learn from past experiences in engineering solutions, equipment performance or methodology efficacy.

B. Components of Monitoring

385. Any ICZM program will have the following five components of monitoring:

- Data acquisition
- Data management
- Information generation
- Information distribution
- Information use

386. Data acquisition covers both automated and manual data collection, as well as laboratory analysis of collected samples. Data management covers the systematic and logical organization of data. It involves physical storage, association of data with metadata, data validation and verification, ownership and access privileges definition, consistent approaches to dealing with the expected lifetime of data including obsolescence of technical solutions, data backup, and data integration with existing systems. Information generation is accomplished through processing and analysis of data. Often this is performed in conjunction with models. Generating information can be very simple (e.g. creation of a trend line), or require complex numerical modelling (e.g. predicting future morphological changes of the coastline). In order for information generation to be truly useful, it should be transparent and reproducible. Information distribution is the process of dissemination of information in a useable format to different stakeholders. It is to be noted that the key point here is that information should be clear and at the appropriate level. Information use is the process of utilising the information. Typically, this involves determining additional information needs, making decisions and taking actions. Information use often impacts monitoring. For instance, data acquisition location and frequency can change, or it can be decided that better models and processing tools need to be developed.
387. A solid data base as part of M & E system on relevant aspects of coastal zone is a pre-requisite for any program of investigation and planning of intervention on any or all aspects of sustainable development and/or use of the coastal zone of West Bengal including continued sustainability of the coastal environment. Several investigations and planning efforts can draw data from the same base and be sure about commonality of data so that any integration of results of different investigations will not suffer from uneven data quality and density at any level. The most important items that need to be inventorised include

- details of physical and biological resources of different natural subdivisions of the coastal zone
- extent and magnitude of vulnerability of different sectors of the coastal zone to natural disasters
- extent of bio-diversity and fragility of the eco-system
- details of eco-system functioning and its interaction with physical and physico-chemical processes of different sectors of the coast
- extent of pollution of the coastal environment (mainly water environment)
- current land use pattern of the coastal zone
- socio-economic condition of the coastal population including livelihood details
- management interventions that are already in place and those that are contemplated in future
- measurement of important aspects of physical processes in near shore and coastal areas

388. Preparation of data base on the above aspects will involve collection of monitored data from the accredited institutions (like water quality data from WBPCB). Some primary data can be reliably generated at the laboratory with field verifications (like land use map of the coastal zone). A large part of the data base is to be built up from ground surveys either in full or in the form of sample survey supplemented by accessing the data being collected by the grass root agencies of the government. These will include, for example, information on socio-economic condition including means of livelihood of local population in Sundarban areas available with Sundarban Development Board and in Digha-Sankarpur area available with DSDA, management measures already undertaken by Irrigation and Waterways Department at Digha to prevent coastal erosion, livelihood enhancement measures of fishermen undertaken by the Fisheries Department, improvement of agricultural purposes, development infra-structural facilities by the SDB, etc.
The data base will be used to infer on the following after the implementation of the pilot programmes:

- Status of dynamic equilibrium
- Retreat/advance/equilibrium of the coast line along the Digha-Sankarpur sector over the monitored period
- Land loss/land gain/equilibrium in the Sundarban areas inclusive of Sagar Island
- Shrinkage/addition/equilibrium of mangrove covered areas in Sundarban
- Reduction/addition/equilibrium in the population of keystone species in the Sundarban
- Near clean/polluted environment in and around Haldia and Digha-Sankarpur with water quality meeting/not meeting the required discharge standard
- Increase/decrease/equilibrium in fish catch (catch per effort) along the coast
- No report/report of dead olive ridley turtle from Sundarban
- No change/change over to multi crop agriculture with availability of grid power in Sagar Island
- Increase/decrease/equilibrium in GDP of the coastal districts of West Bengal
- Increase/decrease in the number tourists visiting Digha-Sankarpur areas

Positive response in any or all of the above indictors will point towards success and sustainability of the interventions introduced by ICMZP.

Monitoring, recording, evaluating and understanding of the physical and ecological processes operative in coastal areas is one of important aspects of coastal research forming an essential input for the contemplated management interventions and ultimately in fine tuning of the prepared ICZMP. At present process monitoring on a regular basis is being carried out by the Calcutta Port Trust. These include bathymetric survey of parts of the Hugli estuary up to the Sagar Point for navigation of approaching ships through the maze of shifting bars/shoals and for determining the extent of maintenance/capital dredging that may be required for navigability, tidal amplitude and velocity measurements in more or less the same area, wave period measurements in a small part of the sea around Haldia port, etc. But unfortunately these data have been categorized as classified and are not available for use/consultation. Daily meteorological data are available only for Sagar, Haldia and Digha.
stations. Cyclone related data are available with IMD. The above brief discussion clearly brings out that process monitoring along the West Bengal coast is inadequate and sporadic. Although geomorphological maps are perhaps available, data on dynamic form monitoring like berm, beach face and near shore bar mapping through tidal and seasonal cycles, data on near shore bathymetric survey through such cycles, near shore wave period and wave direction monitoring beyond the surf zone, estuarine form monitoring vis-à-vis estuarine process variability (like tide duration, magnitude, velocity, etc) on a daily, seasonal and larger time scale are not available. Therefore any existing synthesis leading to a form-process-material interaction model of different segments of West Bengal coast is speculative and proposed engineering intervention to manage the shore line instability problems are therefore not on required scientific base. The result is continued unpredictable shoreline instability and failure of the engineering solutions to overcome the instability manifested in coastal erosion & accretion. The monitoring of ecosystem functioning in terms of biological processes that has a bearing on functioning form-process-material interaction model. Very few data on these aspects are at present available and consequently the contemplated ICZMP will be prone to failure if such data are not collected and integrated with other data to arrive at an efficient ICZMP.

391. The proposed two part M & E system will therefore include

- creation of an appropriate data base on relevant items through data acquisition from secondary sources, primary data generation in the laboratory and sites and primary survey or sample survey and will be tailored to be used as indicators for success/failure in the coastal intervention programmes.
- process monitoring of the coastal zones having open sea and/or estuary

392. The above work plan by the PMU will provide for the development of essential tools for carrying out M & E of the proposed interventions in coastal areas of West Bengal as part of ICZMP, be it in the form of physical structures, biological shields and/or socio-economic development.

393. Information on which evaluations are based thus could come from many sources, but monitoring (observation) has a particularly important contribution in providing the basic data that should underpin the evaluation. In this regard, indicators provide a useful tool to
identify, prioritize and quantify objectives, monitor their achievement, evaluate the program and ultimately adjust it.

394. In the context of ICZM three types of indicators are of importance:

- **Governance indicators**, which measure the performance of program components (e.g., status of ICZM planning and implementation), as well as the progress and quality of interventions and of the ICZM governance process itself;

- **Ecological/Environmental indicators**, which reflect trends in the state of the environment. They are descriptive in nature if they describe the state of the environment in relation to a particular issue (e.g., loss of biodiversity or over-fishing). They become performance indicators if they compare actual conditions with targeted ecological conditions;

- **Socioeconomic indicators**, which reflect the state of the human component of coastal and marine ecosystems (e.g., economic activity) and are an essential element in the development of ICZM plans. They help measure the extent to which ICOM is successful in managing human pressures in a way that results not only in an improved natural environment, but also in improved quality of life in coastal areas, as well as in sustainable socioeconomic benefits.

395. Monitoring of key indicators and evaluation of the monitoring results will point towards the success or otherwise of the interventions which have been proposed in the State Project Report on ICZMP of West Bengal and will form the central theme of the envisaged monitoring and evaluation efforts. As have been outlined earlier the key indicators that are of relevance and are required to be monitored will include the following:

- seasonal field monitoring of retreat/advance of the coast line and beach profile along the Digha-Sankarpur and Sagar island sectors over a sufficient number of years so as to evaluate that equilibrium beach plans and profiles have been attained.

- yearly monitoring through remote sensing about erosion/growth through deposition/emergence/disappearance of coastal island systems of the Sundarban areas inclusive of Sagar Island

- yearly monitoring through remote sensing and limited check field observations on shrinkage/increase of mangrove covered areas in Sundarban
- yearly monitoring through field survey of status of bio-diversity in Digha-Sankarpur and Sagar island areas to evaluate the health of bio-diversity of the areas
- periodic and regular water quality monitoring (especially BOD and bacterial count) of coastal waters in and around Haldia and Digha-Sankarpur to evaluate that the water quality is meeting the required standard
- periodic data collection on fish catch (catch per effort) along coasts to evaluate that the health of coastal fish population is maintaining the required standard
- continuous field monitoring of coastal process through deployment of suitable field monitoring equipments
- yearly monitoring of crop and other agricultural and horticultural yield to evaluate their productivity due to the proposed interventions
- yearly monitoring and evaluation of GDP of the coastal districts of West Bengal
- monthly monitoring of movement and visit of tourist to Digha-Sankarpur and Sagar island areas

396. Positive response in any or all of the above indicators will point towards success and sustainability of the ICMZP. Most of these monitoring and evaluation will be carried out as planned under paras 387 to 392. A few of the monitoring related to water quality, GDP, fish catch, agricultural and horticultural production, fish catch etc are routinely collected by the concerned departments of the government. These data will be accessed avoiding duplication of monitoring works.

(a) Performance M & E systems

397. Performance of the M & E system will depend upon the correct choice of monitoring and evaluation items for a corresponding set of items of actions of an intervention program. It will also depend on the choice of correct methodology and equipment for the monitoring and evaluation exercise. Once these are achieved the adopted M & E system will perform satisfactorily and provide information about the efficacy of the adopted intervention program to address the chosen problem related to the ICZM.

(b) Effectiveness M & E systems
A chosen M & E system will be effective if and only if the system is operated efficiently by qualified personnel and the generated data are processed effectively to extract the required information on the efficacy of the intervention program being monitored and evaluated.

C. **Results Framework**

399. Results framework will have the following structure:

- Achievement of physical targets (e.g. progress in construction, progress in procurement of manpower and equipments, etc.)
- Financial management (fund flow and expenditure status, budget status, status of financial records and audit, etc.)
- Environmental scenario (e.g. status of water quality, bio-diversity, etc.)
- Socio-economic scenario (e.g. level of living standards, level of socio-economic vulnerability, livelihood status, etc.)

D. **Implementation Arrangement**

D1. **Arrangements for Result Monitoring**

400. The following arrangements will be made for result monitoring:

- Field visit, inspection and field measurements
- Laboratory analysis
- Reporting system
- Monthly/quarterly review meeting
- Research publications/reports
- Review meetings at the state level (half yearly)
- External monitoring and evaluation (annual)

401. While formulating the above arrangement for results monitoring, the following specific arrangements will be an integral part of the monitoring:

- A description of steps taken to achieve the Project objectives during the past one year.
- A summary of achievements relative to each objective specified in this progress report.
- A description of project outcome data collected and its interpretation.
- An assessment of progress relative to targets.
- A list of concerns about progress toward activity objectives and suggested remedial steps.
D2. Program Management Reports
402. Reports on ICZM project execution, implementation and outcome shall be generated by the concerned implementing agencies on quarterly, bi-annual and annual basis. Particularly important will be Quarterly Program Activity reports (QPAR) that will be generated quarterly based on both environmental and physical/structural monitoring and Quarterly Financial management report (QFMR) that will be provided by the implementers of the programs to be linked to program activity reports. The returns and reports of the implementing agencies shall be submitted to PMU. PMU will scrutinize the reports/returns and place them before the government for state level review.

D3. Program Operations Management Information System
403. The Program Operations Management Information System will be as follows:
   - Development of ICZM information system and database to link all data generated and interdisciplinary information
   - Preparation of ICZM page on the website including the institutional model/structure, information on individual scientist/engineer, progress and project reports on ICZM organisation, methods, practices and results as well as results of ICZM monitoring, evaluation and reporting.
   - Exchange of information with other coastal states about the implementation of the environmental conventions and the ICZM aspect.
   - International exchange/share of information about the ICZM-West Bengal activities, outcome and failures, if any.
   - Integration of cross-sectoral information into the ICZM-West Bengal MIS.
   - Development of networks to bring together those working in the same or similar line/environment/ecosystems/areas.

D4. Data Collection Tools
404. There are a number of useful tools that could aid the monitoring and evaluation process in ICZM. Data collection is but one of the important tools and is attained through various ways. Data collection tools will widely vary in conformity with the monitoring items and should provide information that allows the understanding of the coastal physical, biological, chemical and geological processes; the state of coastal health; ocean and coastal biodiversity; the functions performed by coastal ecosystems; climate variability and climate change; structure and dynamics of coastal settlements and livelihood of the inhabitants and coastal resources management. Digital analysis of remote sensing data products, field
monitoring of coastal processes, laboratory analysis of coastal water samples, field monitoring of bio-diversity, survey on coastal resources and livelihood of coastal population will be the principle tools for monitoring and evaluation. GIS platform and statistical analysis packages are important tools that will be used for data analysis, mapping, data storage and dissemination.