CHAPTER 3

STUDY AREA

3.1 LOCATION

A coastal stretch of about 50 km length, lying between 13° 03' 00" N and 13° 30' 00" N latitude and between 80° 00' 00" E and 80° 27' 30" E longitude extending from Marina Beach on the southern side of Chennai port to the inlet of Pulicat Lake along the coast of Bay of Bengal has been chosen as the study area (Figure 3.1). This area falls under Chennai district in the south and Tiruvallur district in the north bordering Andhra Pradesh state. This area has been chosen because of its typical nature, diversified coastal ecosystems and the unique presence of all kinds of complicated natural and man-made coastal features such as ports, thermal power stations, creeks, lagoons, shoals, sand barrier islands, barrier spits, inlets, etc. This area is also vulnerable to erosion and deposition due to natural and man-made phenomenon. Due to Chennai port, the north Chennai coast is under threat even though protection measures have been implemented in the past. In addition, a new port (Ennore port) has also been constructed on the same coast, which may cause significant impact on further downdrift coast. Therefore, this area is chosen to identify the impacts due to Ennore Port and to suggest management options.
Figure 3.1 Map showing study area
3.2 VARIOUS FEATURES OF THE AREA

The study area consists of following important coastal features:

Natural features

- Marina Beach
- Cooum River and its inlet
- North Chennai coast
- Ennore Creek
- Kortalaiyar River
- Ennore and Pulicat shoals
- Kattupalli Island (Barrier island)
- Pulicat Lake and its inlet
- Araniar River and
- Kalangi River

Man-made features

- Chennai Port
- Royapuram Fishing Harbour
- Ennore and North Chennai Thermal Power Stations
- Ennore Port and
- Buckingham Canal

One of the defining features of the study area is that it has growing metropolis situated adjacent to the coastline. Chennai is the fourth largest city in the country having a population of 6.5 million with a growth rate of 1.48 %
per annum and a population density of 2,207 persons/km² (ICZOMAT 2000).

The entire study area has been divided into three zones as given below and the features are explained zone wise in the following section:

Zone I : Marina Beach to Tiruvottiyur
Zone II : Tiruvottiyur to Ennore Port and
Zone III : Ennore Port to Pulicat Lake.

3.2.1 Marina Beach to Tiruvottiyur (Zone – I)

In this zone, Marina Beach, Cooum river inlet, Chennai port, fishing harbour and Royapuram coast are situated. Marina Beach is the most natural, second longest beach in the world with a width varying from 150 to 600 m and has a length of approximately 3 km. It is a famous tourist spot with more than a million tourists visiting every year (Gowri 1997). The shoreline oriented in a N-S direction. With the accretion due to port construction on the southern side, the sea began to recede. The present Marina Beach was not in existence during the 1700’s (Azariah and Azariah 1987). The Marina Beach with fine sandy foreshore and backshore, is now the pride of Chennai city.

On the northern side of Marina Beach, the river Cooum confluences with the Bay of Bengal. The Cooum river originates from the surplus waters of the Cooum tank in Tiruvallur taluk. The catchment of the river is about 290 km² studded with 140 tanks. The length of the river is about 65 km of which 18 km fall within the city limits (Sundaresan 1986). The Cooum river runs through Chennai city from west to east almost bisecting the city. This river is totally polluted within the city limits and is used as open sewer due to innumerable outfalls of sewer-storm water interconnections. About 0.252 MLD of industrial
effluents carrying heavy metals and about 69.3 MLD of domestic sewage are released into the Cooum river (Nammalwar and Pakshirajan 1995). The construction of an artificial Chennai harbour, just north of Cooum river, has obstructed the sediment transport of the Bay of Bengal which resulted in the erosion of seacoast on the northern side of the harbour and deposition on the southern side. This results in the mouth of Cooum river almost always choked up by shoal formation.

The Chennai port, located on the northern side of Cooum river is one of the 12 major ports of India handling a variety of products from iron ore to containers. The coastline along the present Chennai harbour was in dynamic equilibrium in the pre harbour period 1862 – 1876 (IHH Report 2000). History reveals that in the year 1876 a jetty projecting into the sea was constructed at Chennai for unloading of cargo. Later, breakwaters were constructed on either side of the jetty (with the harbour entrance located on the eastern side), to protect the facility from wave disturbance, without realising the effect of east entrance on tranquility in the harbour basin. Subsequently the entrance to the harbour was shifted to the north and the harbour expanded further parallel to the coast for operational reasons.

The inner harbour has a land area of 441 acres and the outer harbour has about 146 acres. The water spread area in both the harbours is 220 acres and 200 acres respectively. The length of southern breakwater is 2.2 km and northern breakwater is 1.2 km. It handles 36 million tons of cargo every year.

Due to the construction of Chennai harbour, erosion has taken place on the northern side and Royapuram Bay was formed on the Royapuram coast (CWPRS 1996). Advantage of erosion has been utilized to locate a fishing
harbour in the Royapuram Bay in the year 1975 to station the fishing boats and trawlers operating in the north Chennai area. The fishing harbour has a northern breakwater of 0.7 km and southern breakwater of 1.05 km long. This coast is affected by all kind of pollution due to the movement of vehicles carrying containers, solid waste disposal on the highway, discharging of municipal sewage into the sea, etc. (ICZOMAT 2000).

3.2.2 Tiruvottiyur to Ennore Port (Zone – II)

The north Chennai coast stretches in a North-Northeast direction. The north Chennai coast is oriented along 15° - 195° bearing. A 6 km stretch of the coast north of fisheries harbour is susceptible to severe erosion. This coast is severely affected due to sea erosion and several coastal hamlets have been swallowed by the sea in the past. A coastal highway (Ennore Highroad) running parallel to the coast has been damaged several times and the highway has been shifted at least three times in the past. Many attempts have been made by the government agencies to protect the coast from erosion by constructing sea walls and by other temporary measures.

A huge number of major industries are located in this area at Manali and Ennore such as metallic and non-metallic industries, rubber, plastic, coal and petrochemical industries, refineries, thermal power stations, food and beverages industries, etc. In total these industries discharge 2,200 kld of sewage and 1,31,000 kld of trade effluents per day posing a serious threat to the quality of human life and local biodiversity (ICZOMAT 2000). This has also made this coast more vulnerable to pollution. The coastal area near Ennore is very flat and has vast expanse of backwater including saltpans.
The river Kortalaiyar, flowing in the direction of west to east, confluences with Bay of Bengal at Ennore passing through the Ennore creek. The Ennore creek is the estuary of the river Kortalaiyar and also serves as an outlet for the surplus water from the Poondi Reservoir, where water is being stored for the city (Chennai) water supply. The Ennore creek flows west to east and opens into the Bay of Bengal at Ennore. The Buckingham Canal flowing north to south parallel to the coast joins at Ennore creek and flows further south. All the effluents discharged by the Ennore industrial complex as well as the effluents of the North Chennai Thermal Power Station are discharged into the Ennore creek (Sanjeeva Raj 2000).

The coastal stretch near Ennore creek, at a distance of about 13 km from Chennai harbour is not experiencing any coastal erosion. Restoration of natural sediments along this coast by the waves caused the bar formation. As the inlet is the only source of sea water supply to the creek, its maintenance became imperative for the operation of neighbouring power stations, such as Ennore Thermal Power Station (ETPS) and North Chennai Thermal Power Station (NCTPS) which obtain their cooling waters from this creek and it is also important for local population as it supports a good fishery. Dredging of the inlet is a daily routine and dredged spoil is disposed in the neighbourhood.

The orientation of the north Chennai coast has changed from N 15° E to N 10° W at Ennore (Haskoning 1995). Extensive shallows (Ennore shoals) are formed at this place and they extend up to Pulicat. The coastal area near Pulicat is very flat and has vast expanse of backwater including saltpans. Inlets of Ennore and Pulicat are joined by Buckingham canal, which runs parallel to the coast.
3.2.3 Ennore Port to Pulicat Lake (Zone – III)

The 25 km stretch of coastline, from the Ennore creek in the south up to the Pulicat Lake mouth in the north is a highly threatened coastal ecosystem of India today, in view of the several developmental interventions that are coming up in this stretch of coastal zone (Sanjeeva Raj 1999). The major ecological components of this integrated ecosystem are the Ennore creek in the south, the Buckingham canal on the west, the Pulicat Lake in the north and the inshore waters in the east and all water bodies enclosing the Kattupalli Island in the south and the Pulicat sand strip in the north. The area north of Ennore port, up to the Pulicat Lake, is relatively undeveloped.

The Ennore satellite port, located in the immediate north of Ennore creek, has been constructed recently, as an unloading port in order to meet the required coal to the two thermal power stations situated at Ennore. This project has been developed in an area of 1052 ha (2600 acres) of land, due to insufficient capacity at the existing Chennai port for cargo handling. The estimated quantity of coal to be handled at the Ennore port will be about 16.12 million tonnes per year (Kanakasabai 1999). The two breakwaters of the port are aligned in such a way that the entrance to the harbour is located in the southeast quadrant. The length of south breakwater is 1.2 km aligned in the east-west direction and is almost perpendicular to the shoreline. The north breakwater extends for a distance of 3.2 km and its tip is located in a water depth of about 11 m. The Ennore satellite port has started functioning in the year 2001.

Ennore shoals are located about 5 km North-Northeast direction of the Ennore creek at Latitude 13° 17' N and Longitude 80° 22' E. From the
bathymetry charts, it is seen that depth contours are nearly parallel along the coast. 5 km and 10 km contours are about 250 m and 750 m away from the coast indicating a nearshore slope of 1:50 and offshore slope of 1:75.

Ennore port and NCTPS are situated on the Kattupalli Island. This island is spindle shaped and is about 14 km north to south and is about 4 km east to west at its broadest point. It is chiefly a sandy island, but alluvial patches near the water springs allow a crop of paddy, particularly during the monsoon. The aquifers on this island are uniquely superficial and they are the source of abundant clean drinking water to the local population. Kattupalli is a multi-ecosystem island. It is unique for its huge 12 m high sand dunes. Within this small island, there is a diversity of vegetation types, such as mangroves, tropical dry evergreen, cultivated vegetation, etc. There are five villages on this island, two of tribals, two of dalits and one of fisherfolk, all with a total population of 2000 (Sanjeeva Raj 1999). Kattupalli beach is a nesting site for the protected sea-turtle, Olive Ridley (Sanjeeva Raj 2000).

The Pulicat sand strip in the north is eight kilometer long north to south and is about two kilometers east to west at its broadest point. This strip is exclusively sandy, situated between the Bay of Bengal in the east and the Buckingham canal in the west. Studded with Palmyra trees and casuarina groves, this is heavily populated with nearly 15 fishing villages and with a total population of about 12 thousand people. Three or four of these villages were already displaced once from the Sriharikota island in the north by the Sriharikota Rocket Launching Station during 1975-80 (Sanjeeva Raj 1999).

In the extreme north of the study area, the Pulicat Lake is situated at a distance of about 20 km from Ennore port. Pulicat Lake is the second largest
brackish water lake in India. It opens through a narrow opening into the Bay of Bengal at the southeastern end near the Pulicat town, which is located 40 km north of Chennai city by sea. Pulicat Lake is lying almost parallel to the Bay of Bengal and covers an area of about 461 sq. km. The lake extends to about 59 km in a north-south direction with a maximum width of 19 km in the east-west direction in the northern sector of the lake with an average depth of about 1.5 metres (IOM Report 2001). The coastal waters of the Bay of Bengal on this stretch of coastal zone are shallow and are connected to the inland waters at two points, through Ennore creek mouth and Pulicat Lake mouth. Thus, all these water bodies are interconnected. (Sanjeeva Raj 1999).

The River Kalangi and River Kaleru drain from northwestern part of the lake and join the Pulicat Lake near Tadakuppam in Andhra Pradesh state. The Kalangi river mixes into the northwest corner of the lagoon at 13° 40' N latitude. The river Araniar flows west to east on the southern side of the lake and branches out into two distributaries. One joins at north of Pulicat town near Jameelabad and the other joins at the southern side of the Pulicat town near Sattankuppam.

The Buckingham canal (East Coast Canal) was built as a saltwater navigation canal in 1806. It stretches for about 315 km north of Chennai and 103 km south of Chennai, parallel to the east coast between Kakinada (Andhra Pradesh) and Cuddalore (Tamil Nadu). Since the canal runs less than 1 km away and parallel to the coast, there are numerous points where the backwaters from the sea flows into the canal (Appasamy and Lundqvist 1993). The Buckingham canal runs parallel to the lake right from the northern end towards south along the western margin of the Sriharikota Island, which separates the Bay of Bengal and the lake. Buckingham canal enters into the Pulicat Lake at...
the Moosamani Lock and it emerges out from the lake after a distance of 1.5 km at Kottaikuppam Lock. Between Pulicat and Ennore, this canal spreads out into vast open stretches of shallow waters. It runs parallel to the coast towards south and cuts perpendicularly the Ennore creek and proceeds further towards south.

3.3 ENVIRONMENTAL CONDITIONS OF CHENNAI COAST

3.3.1 Wind and Wave Conditions

The geographical position of the coast makes the Chennai region to experience the northeast monsoon between October and January and the southwest monsoon from June to September. Wave is the main driving factor for the littoral transport off Chennai. During northeast monsoon, the waves approaches the coast from northeast direction and during southwest monsoon it approaches mostly from southeast. Since almost 60 – 75% of the year, the waves are driving the sediments from south to north, the net annual transport is from south to north only (Rajendran 1999). The wind and wave conditions that prevail in deepwater during the monsoons are presented in the Table 3.1.

<table>
<thead>
<tr>
<th>Monsoon</th>
<th>Wind Speed (m/s)</th>
<th>Wind Direction</th>
<th>Wave Height</th>
<th>Wave Direction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northeast</td>
<td>5.8 – 7.5</td>
<td>49°–87° with respect to North</td>
<td>2.5 – 3.0 m</td>
<td>About 60° with respect to North</td>
</tr>
<tr>
<td>Southwest</td>
<td>2 - 12</td>
<td>153° - 263° with respect to North</td>
<td>2.0 – 2.5 m</td>
<td>About 135° with respect to North</td>
</tr>
</tbody>
</table>

(Source: ICMAM Report 2002)
3.3.2 Tides

Characteristics of the tides observed in the offshore of Chennai by the Chennai port are given below:

- Highest high water spring tide: 1.50 m
- Mean high water spring tide: 1.10 m
- Mean high water neap tide: 0.80 m
- Mean sea level: 0.54 m
- Mean low water neap tide: 0.40 m
- Mean low water spring tide: 0.10 m

3.3.3 Meteorological and Hydraulic Conditions

The annual rainfall in the study area is extremely variable. The total annual rainfall varies as much as from 500 to 1500 mm per year. More than 60% falls during the northeast monsoon. The average monthly air temperatures vary from 37° C in May and June to 29° C during December and January. The average minimum monthly temperatures vary between 28° C in May and June and 21° C in January and February.

Thunderstorms occur throughout the year. From May to August they normally occur in the early evening and for the rest of the year they usually occur in the early morning or late at night. Some of the thunderstorms are accompanied by wind gusts of up to 130 kmph. Tropical depressions and cyclones are a recurrent phenomenon, usually occurring in the months of October and November. Cyclonic disturbances originating in the Bay of Bengal track westward towards the Indian coastline. Wave heights associated with
these cyclones can be as high as 5 to 8 m (Haskoning 1995). The study area experiences a high humidity. The average maximum monthly values of the relative air humidity remain high of above 90% throughout the year. The average minimum monthly values are between 25% in May and 48% in November.

Visibility in the study area is generally very good and more than 20 km for the major part of the year. The average visibility is between 4 and 10 km on 40 days per year and less than 4 km on 4 days per year (Haskoning 1995).

### 3.4 IMPORTANCE OF THE PRESENT STUDY

As discussed in this chapter and previous chapters, the Chennai coast is experiencing hectic shoreline changes after the construction of Chennai port. There are enough studies have been conducted on the impacts of Chennai port on Chennai coast. But the Ennore Port has been commissioned only during 2001 and no detailed study has been conducted so far about the impacts of Ennore Port. Under section 3.2, the study area has been divided into three zones and explained briefly. All the studies so far conducted are only on the Zone – I and therefore in the present study, Zone – II and III are concentrated and given more importance and detailed study has been made to identify the impacts of Ennore port.

With the background information on Chennai port and its impacts, in order to fill the gaps and to have the understanding on coastal dynamics of the north Chennai coast, an effort has been made to collect data on environmental parameters such as waves, tides, current, sediment characteristics, bathymetry, etc. In order to identify the impacts, beach profile survey and shoreline survey
has also been conducted. The methods adopted and results obtained are presented and discussed in detail in the following Chapters. These results will help to work out the measures with the combination of inputs from the earlier studies.