CHAPTER 7

COASTAL PROCESSES (BEACH PROFILE AND SHORELINE CHANGES)

7.1 INTRODUCTION

Changes in beach and nearshore profiles are a result of cross-shore and longshore sediment transport. If the longshore gradients in the longshore component can be considered small, it is possible, through the continuity equation, to infer the volumetric cross-shore transport from two successive profile surveys (CEM, 1998). Beach and nearshore profiles are the major sources of data for engineering studies of beach changes. Sometimes littoral transport can be estimated using these profiles. Usually, beach and nearshore profiles are measured at about the same time, but using different techniques. The nearshore profile is usually measured from a boat or amphibious craft, using an echo sounder or from a sea sled, etc. (Kolessar and Reynolds, 1966; Reimnitz and Ross, 1971). Beach profiles are usually surveyed by standard levelling and taping techniques (SPM, 1984).

It is being a proven fact that along the East coast of India, wherever coastal structure such as breakwaters are constructed, the behavior of coast line changes and it leads to accretion on the South side and erosion on the Northern side of the structure. On the East coast of India, the net long shore sediment transport is to the extent of 1 million m^3 and the movement is in the northern direction. Obstruction of this movement by the construction of breakwaters leads to coastal erosion in the north due to lack of sediment load by the incoming waves and accretion in the south due to sudden obstruction and reduction in the velocity of transport to carry the sand.

7.2 BEACH PROFILE SURVEY

In order to quantify the impacts of port on the Pulicat Lake and to arrive amicable options between natural and man made developmental activity, a pilot study has been taken up between Pulicat Lake mouth to Ennore creek region with the guidance and

support of ICMAM-DOD research group. In the first phase during April 2000, 7 transects were identified between South of Ennore creek to Pulicat Lake mouth (Fig.7.1). Details of the position of the transects are given in the Table. 7.1. Beach profile survey have been carried out up to water depth of 4 m for seven transects using dumpy level/KGPS and wave sled.

Table 7.1 Positions of the beach profile transects

Transect No.	Latitude (N)	Longitude (E)	Remarks
Transect 1	13°31’17.0”	80°19’38.1”	South of Ennore Creek near EID Parry factory
Transect 2	13°15’07.5”	80°20’06.2”	South of south breakwater of Ennore Port
Transect 3	13°17’31.8”	80°20’43.4”	South of Kattupalli kuppam village (North of Ennore Port)
Transect 4	13°25’20.0”	80°19’37.2”	Near Pulicat Lighthouse (South of Pulicat Lake bar mouth)

Schematic diagram of the beach profile survey carried out in seven transects is given in Fig.7.2. After the first phase of measurements in April 2000, along the same seven transects, beach profile (on land side only) survey were carried out during 2001 using Dumpy Level and KGPS to know the changes in shoreline from the fixed reference benchmark. Detailed mapping were done for the Pulicat Mouth region for Pre-monsoon season 2000 (November) using KGPS to know the changes around inlet.

7.2.1 BEACH PROFILES

The elevation and contours of a shoreline are a response to the forcing of waves, winds and currents and depend on the supply of sediment to the beach. By measuring the dimensions of a beach repeatedly, the amounts of erosion or accretion can be determined

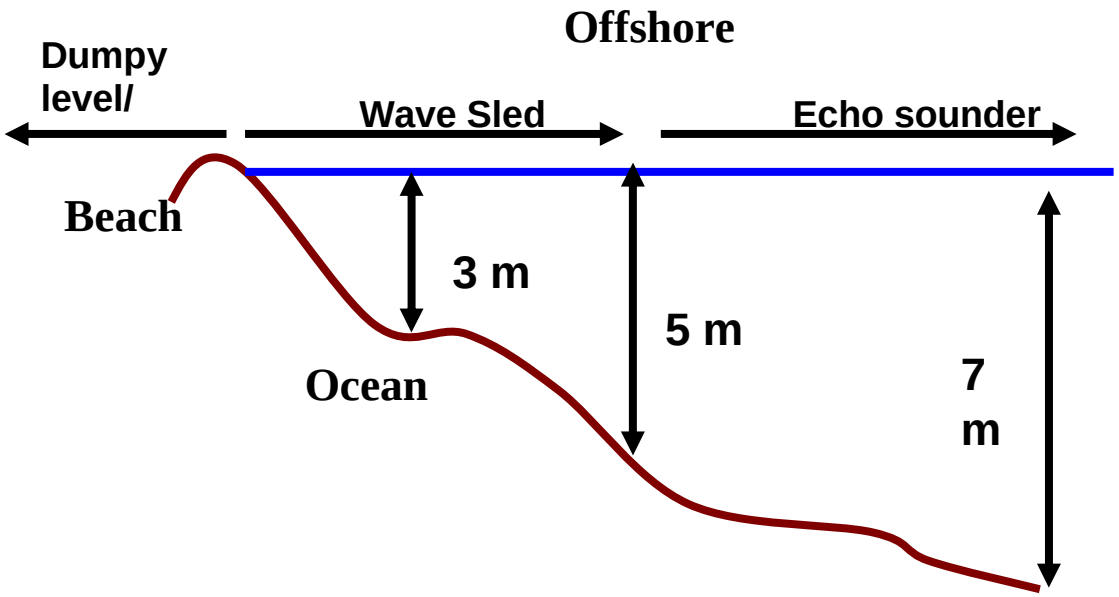
over the period of the surveys as well as some indications of where the material may be going.

Beach profiles vary with time, both seasonally as the wave climate changes over the long term, in response to the pressures of erosion or accretion. Beach profiles measured at the same location over a period of time can provide details about the behavior of the entire beach. By taking a series of profiles along a beach and then repeating the profile measurements at later times, the behavior of the entire beach can be examined in terms of shoreline recession and volumetric sand loss; moreover an overall sand budget (sources and sinks of sand) can be determined. Complete beach profiles extend from the dry beach (landward expected storm damage) and extend offshore to depths beyond which the bottom does not change significantly with time. Typical procedures entail two separate surveys, an offshore survey using boat and inshore survey that involves level and transit survey equipment.

For the present study offshore profiles were surveyed using wave sled. Wave sled is pulled over the offshore profile using beach landing small boats. Using leveling equipment offshore profile depths were noted for every 5 m. On the shore survey was completed up to the fixed bench mark, after taking out the wave sled from the sea. Global positioning system was used to for better accuracy of the measurements.

For the present study beach profiles survey was carried out during the month of May 2000 and 2001 using graduated wave sled and beach levels with RTK. All levels were adjusted to mean sea level and related to the phase of the tide. The location of transects were fixed with RTK through established permanent reference station at Ennore south breakwater. In total four transects were taken for comparative study and long term

monitoring. Transects were fixed at EID Parry (PF1), South of south breakwater of Ennore port (PF3), North of North breakwater of Ennore port near Kattupalli (PF5) and Pulicat Light House (PF6). The consolidated results of the beach profile of the four transects are given in the Table 7.3.



Schematic diagram of Beach profile survey

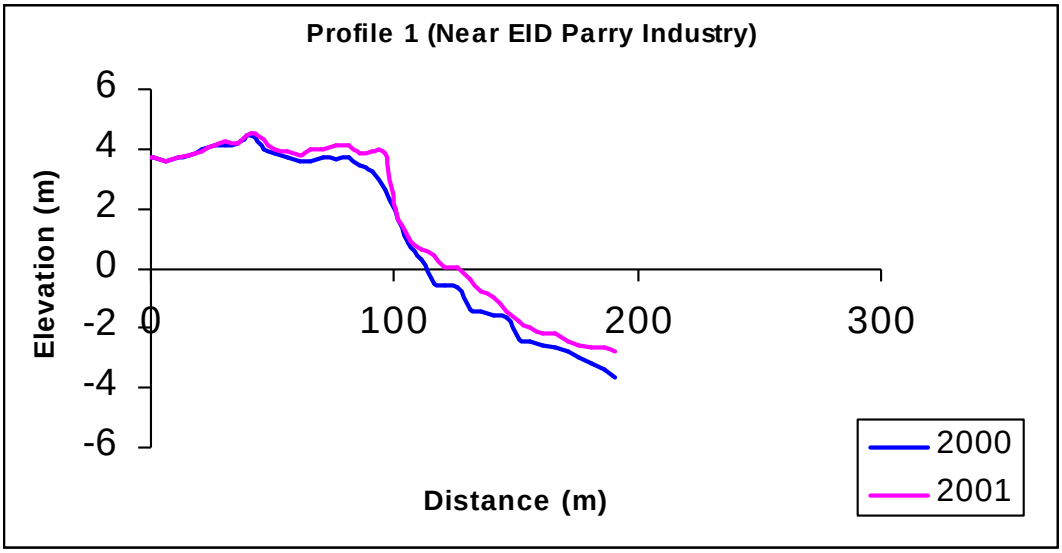
7.4.2 Observations of the field measurements

1. Beach profiles data indicate that the entire area is having a steep slope varying 1:20 to 1:30 in the surf zone and off shore bar formation is noticed in Transects 4 &5.
2. Transects 4 & 5 which are in the northern side of the northern breakwater show a gentle slope may be because of the presence of Ennore and Pulicat shoals and beach fill carried out by port.
3. Results from the beach profiles data of the northern Chennai coast for the period from 2000-2001 were given in the Table 7.2 a, b & c and Figure 7.3 a-g (April 2000), 7.4 a-g (October 2000) and 7.5 a-d (January 2001)

The beach profiles survey carried out during 2000 indicate the accreting shoreline in Transects of 2, 3 and 5. Transects 2 and 3 are on the southern side of the south breakwater and due to obstruction of the transported sediments by the breakwater, the sediments are deposited and showing the accreting coastline. Transect 5 is on the northern side of the north breakwater. In the normal condition, it should be eroding shoreline. But because of the beach fill materials, which are loose sediments adjacent to the north breakwater these sediments are being transported and deposited in further north at the Transect 5. This might be the reason for the accretion in Tr.5. Hence in the present scenario erosion is not started in the Kattupalli island coastal region. The shoreline of the Transect 7 show eroding coastline. Almost 30 meters of shift has been observed at this transect near the Pulicat mouth region. Results observed in each of the transect is explain in detail along with sketches below.

Profile 1 (EID Parry)

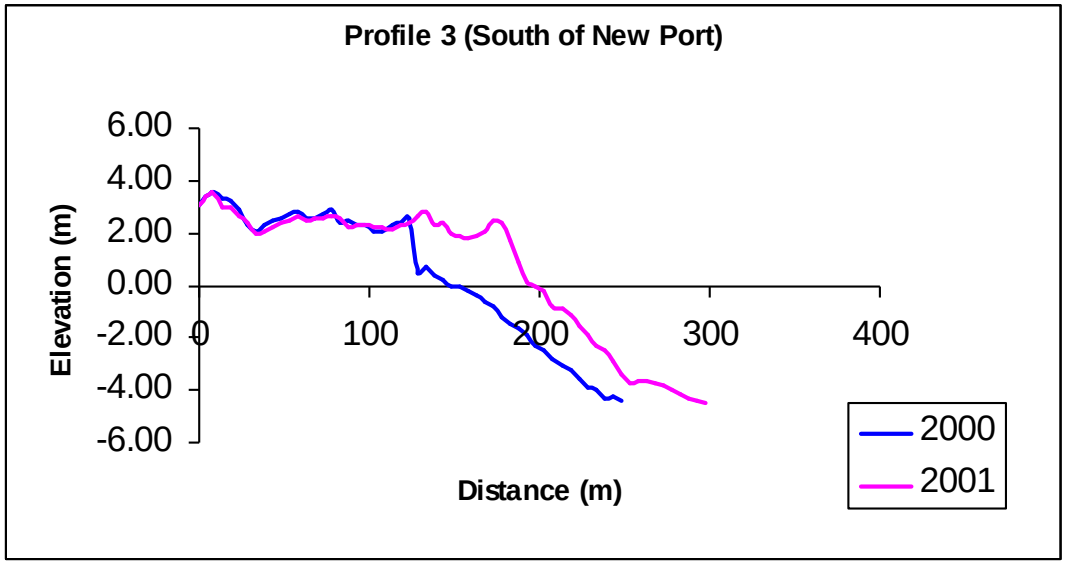
Bench mark of the PF1 is located at Latitude 13º31'17.0"N and Longitude 80º19'38.1"E on the compound wall north of EID parry industrial complex. Comparative profile diagram is given in following figure.



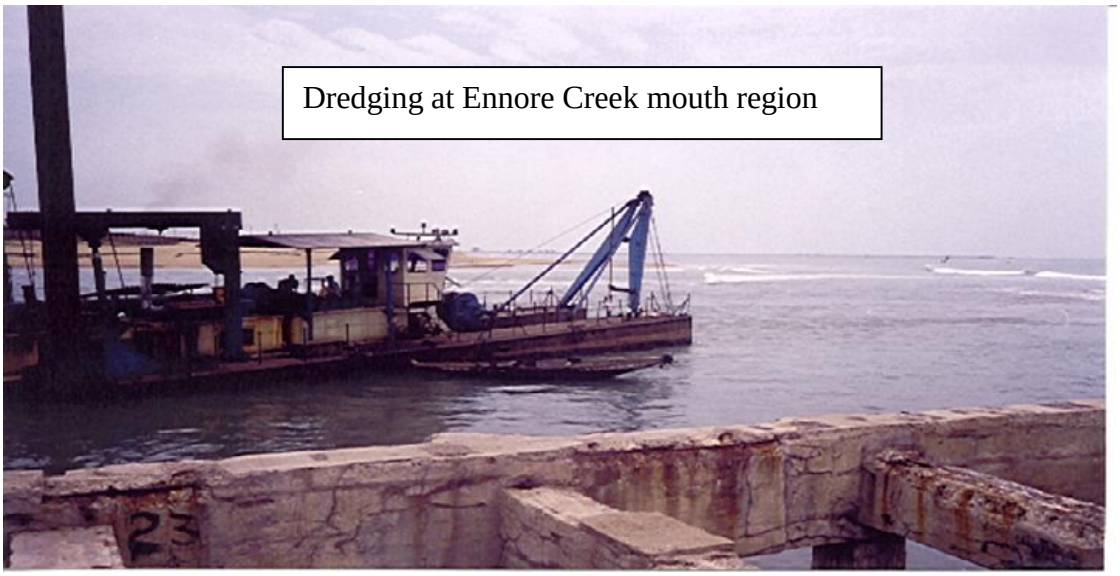
The results indicate gradual accretion in the offshore and inshore profile in the study region. Even though the southern part at a distance of more than 1km are experiencing coastal erosion problems at the Periyakuppam and Chinnakuppam region, the present profile show accretion may be due to the influence of southern breakwater of Ennore port. Total quantity of the sediment accretion in the study region is 30 cu m/m above the datum and 45 cu m/m below datum with horizontal shoreline change of 13 m.

Profile 3 South of Ennore Port

Profile 3 is located at Latitude 13°14’45.4” N and 80°20’ 06.2”E at 500 m distance south of the Southern breakwater of Ennore Port. Bench Mark is located in the compound wall of North Chennai Thermal Power station. Changes in the profile characteristics are given in the following figure.

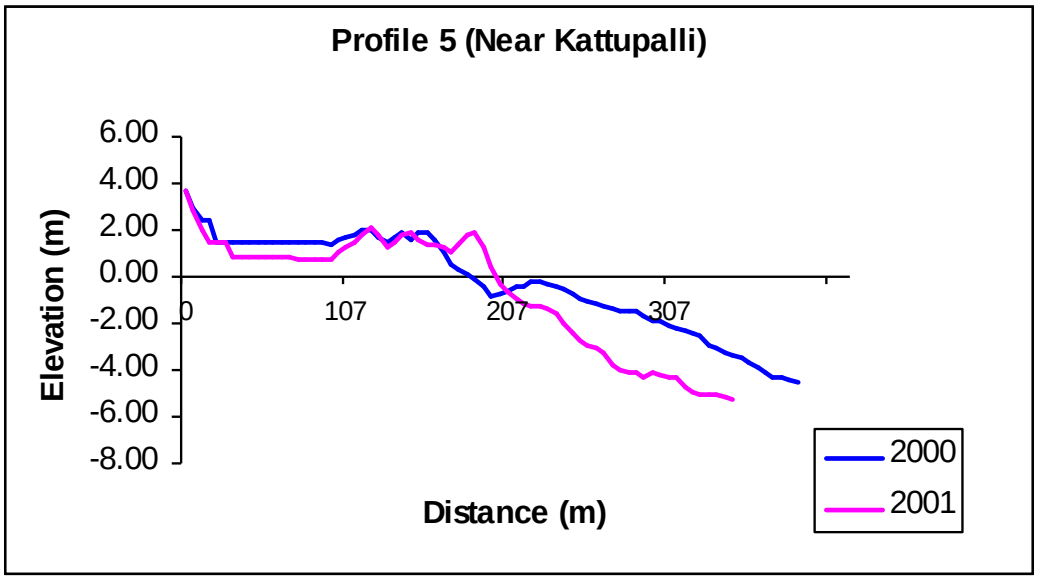


Above figure clearly shows the accretion nature of the profile. On the east coast of India almost eight months period sediments are being transported towards north, due to the obstruction by the Southern breakwater accretion is taking place on the southern side of the breakwater. Total volume of accreted sediments above the datum is 114 cu m/m and below the datum is 145 cu m/m with a horizontal shoreline shift of 44 m towards east. Accretion due to the southern breakwater is causing closing of Ennore creek and to keep the mouth open for water intake to the coolant system of Thermal Power plant by 24 hours dredging activity at the mouth region by the Tamil Nadu Electricity board (Fig.)



Profile 5 (North of Ennore Port)

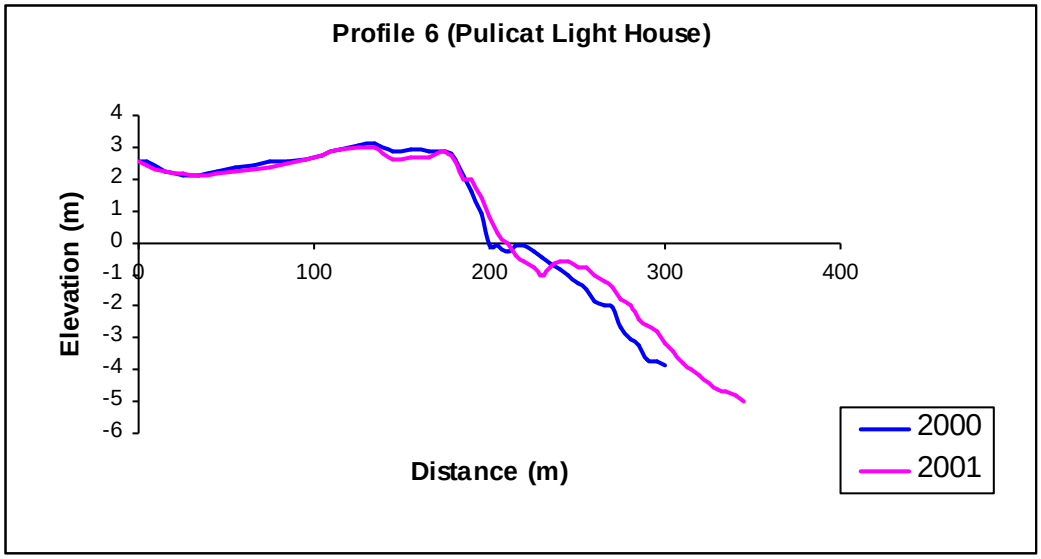
Profile is located at Latitude 13°17’31.8” N and Longitude 80°20’43.4” E at a distance of 500m north of the beach fill dump on the northern side of north break water. Bench marck is located on an oval shaped sign board south of Kattupalli village. Observed profile for the period 2000 and 2001 is given in Figure.



The results on the surface level show accreting shore line with an advancement of 13 m towards east. Offshore profiles clearly show the erosion activity in the study region. Almost 259 cu m/m of sediments were eroded during one year period below the datum level. The profile pattern show changes from the gentle to steeper slope in offshore profile and indicating erosion phenomena. Beach fill sumps for the 1.5 sq.km region is presently controlling the erosion activity and the presence of shoals controls the wave energy in this region. Recent survey on shoreline (April 2002) further confirmed the changing shoreline pattern of the study region. The results of the shoreline survey in this region are discussed in the subsequent chapter on shoreline changes. Erosional behaviour of this transect is of importance to the proposed TIDCO petrochemical park by the state government at the Kattupalli island regions.

Profile 6 (Pulicat Light House)

Profile is located at Latitude 13°25’20” N and Longitude 80°19’37.2”E north of Pulicat Light house. Bench mark is fixed at a house compound wall of Lighthouse Kuppam. The result from the beach profile observation is given in the figure.



This profile is having wide beach region of almost 200 m. The results indicate not much changes in the shape of the profile and indicating erosion with 48 cu m/m of above datum sediments and 20 cu m/m of below datum sediments were eroded during the one year period. But the overall offshore profile trend is accretion at the bottom with steep slope.

Koraikuppam and Sattankuppam are the villages (south of PF6) located on the

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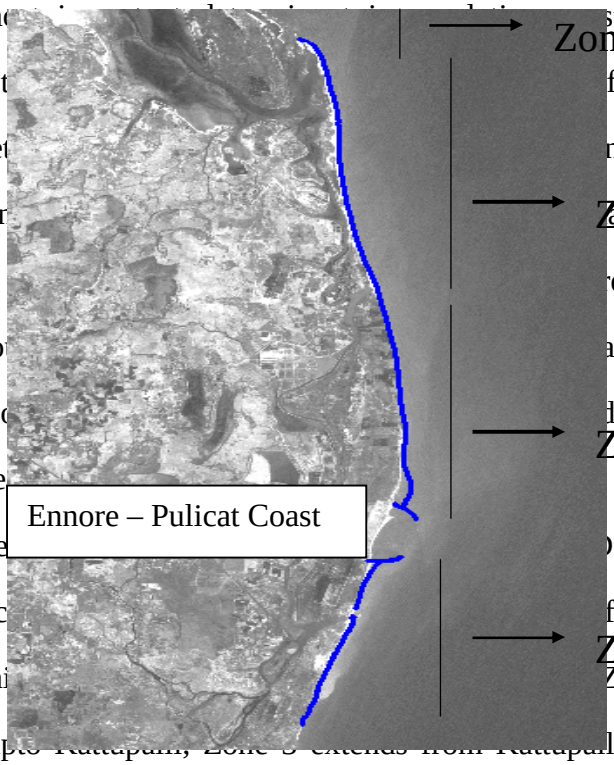
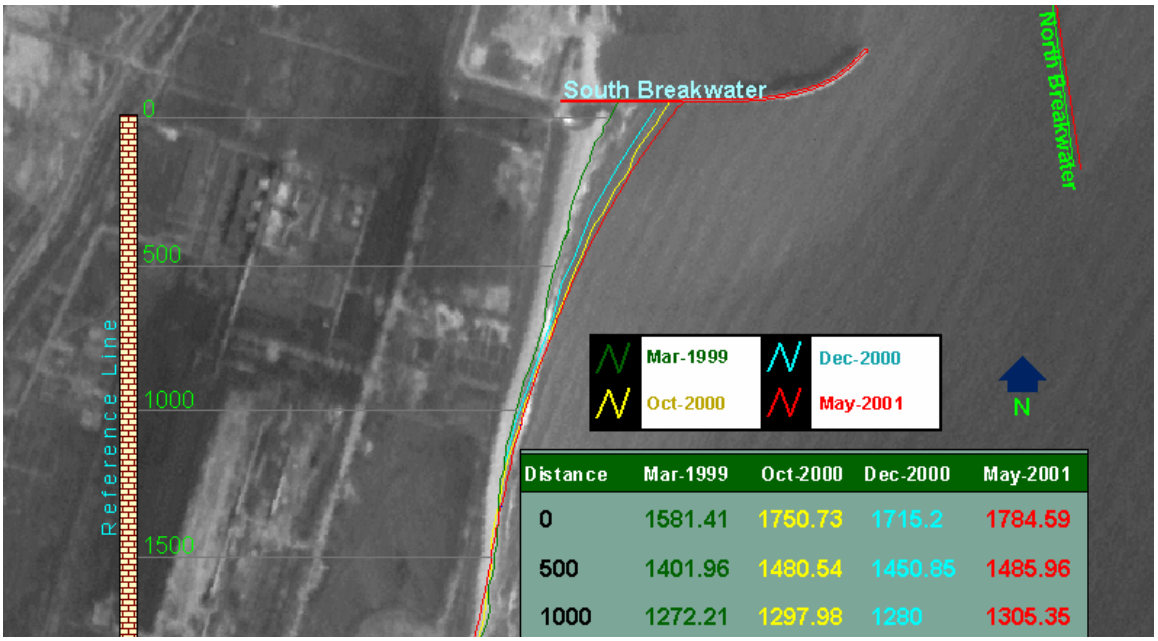
1	EID Parry	90	1:13
2	South of Ennore Port	120-180	1:17
3	North of Ennore Port	190	1:30
4	Pulicat Light House	190	1:23

7.3 SHORELINE CHANGES IN THE STUDY REGION

The m stal construction along the shoreline is t f shoreline trend include establishing se ng whether and, if so, under what conditio ure of the coastal environmental region from Ennore creek to the Pulicat mo anges using Kinematic Real Time GPS. Al l coordinates were recorded for different se on shore line changes. This shoreline were (1999) and changes were clearly demarc fferent zones to discuss the results in deta Zone 2 comprises North of Ennore port up li to Koraikuppam, Zone 4 from Koraikuppam to Pulicat Light house and Zone 5 is the Pulicat lake mouth region (shown in Figures 7.5 to 7.9).

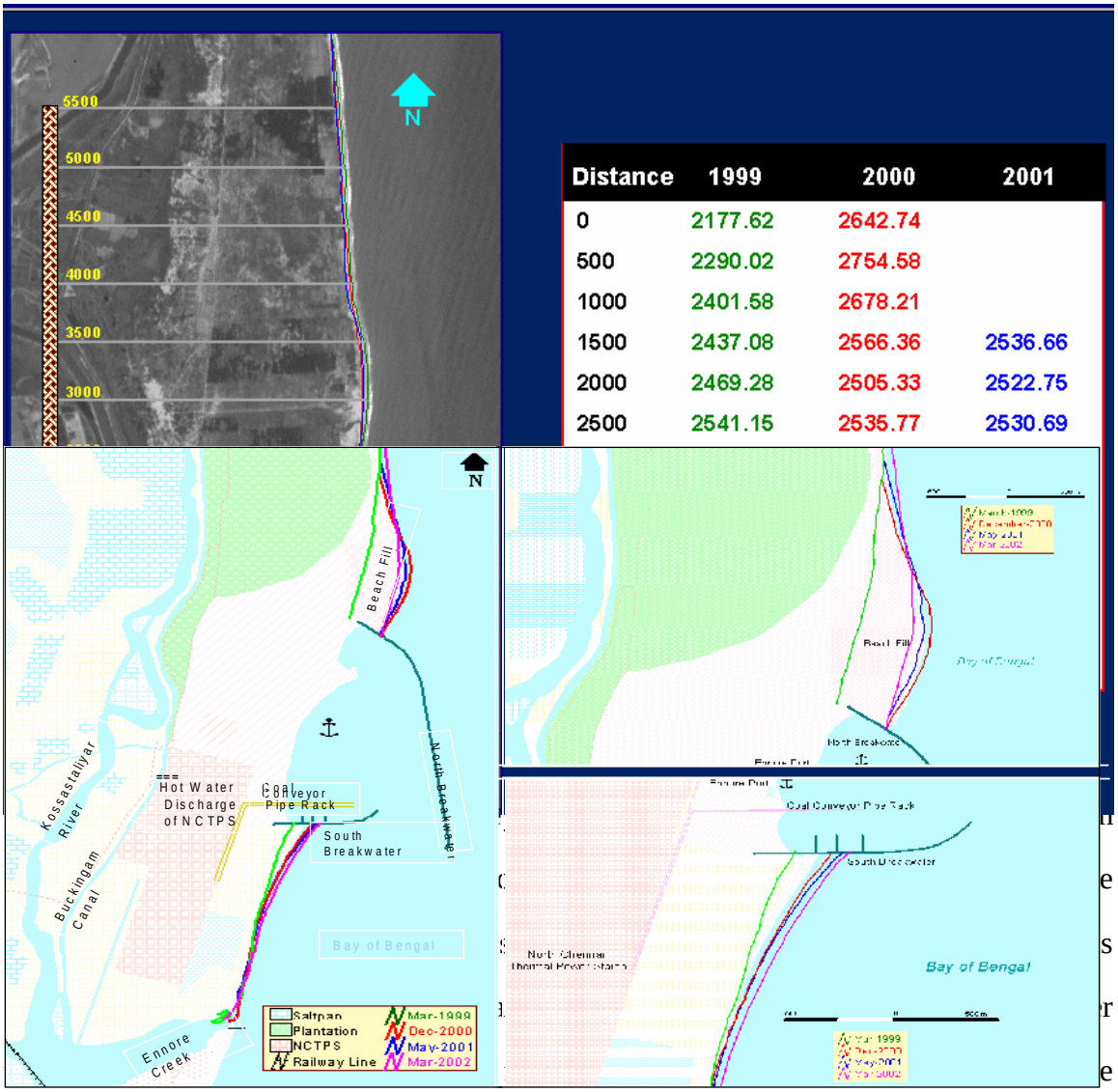


Zone 1 (Ennore creek to South Breakwater)



satellite IRS 1D Pan imagery. Since the shoreline survey carried out using the Leica model KGPS, the results are of 1cm accuracy.

Zone 2 (North Breakwater to Kattupalli)



Distance	1999	2000	2001
0	2177.62	2642.74	
500	2290.02	2754.58	
1000	2401.58	2678.21	
1500	2437.08	2566.36	2536.66
2000	2469.28	2505.33	2522.75
2500	2541.15	2535.77	2530.69

port.

Zone 3 and Zone 4 (Kattupalli to Pulicat Lighthouse)

Zone 3 and 4 extends from Kattupalli Kuppam to Pulicat Light house covering 12km distance. Zone –3 and 4 is almost a stable coastline and started showing erosion signature on the southern side while advancing shoreline is seen on northern side. At the northern side of Kattupallikuppam village erosion has started to take place (Figure 7.7). From Table 3, it is clearly seen that a 3 km coastal stretch near Kattupallikuppam village is subjected to erosion. From Figure 7.7, it is seen that maximum erosion of 40.60 m has taken place north of Kattupallikuppam and a minimum of 11.13 m has taken place north of Kalanji village between 1999 and 2001. This is quite natural that if any coastal structure is constructed on the east coast definitely there will be erosion on the northern side (SUNDAR, 1999). Interestingly, in this case erosion has not started in the immediate north of north breakwater compared to Chennai port, but it took place after a distance of 3.5 km. Presence of beach fills is the reason for this changing trend on the Ennore coast. In Kattupalli Island, starting from north of Kalanji village up to Pulicat Lake mouth, the width of the sand bar is very narrow. Particularly near Kalanji and Koraikuppam villages the width of the sand bar between the lake (channel) and the sea is only about 100 m. If erosion starts in this region or even if a big storm strikes, this vulnerable zone may disappear and the possibility of these villages getting washed away by the sea cannot be ruled out. It may also lead to the merger of the Pulicat Lake into the Bay of Bengal and the disappearance of the brackish water ecosystem of the lake resulting in severe ecological and social problems (SANJEEVA RAJ, 1999).

It is observed that accretion to the tune of 14.54 m noticed during 1999 to 2000 has been reverted back to erosion of 3.65 m during 2000-2001 near Koraikuppam

village with overall accretion of 10.89 m during 1999 to 2001. From Koraikuppam village upto the end of the zone the shoreline is accreting to the distance of 13.56 m, 20 m and 17.49 m during 1999 to 2001 near Sattankuppam, Vairankuppam and Nadukuppam respectively. North of Pulicat Lighthouse, accretion at a rate of 45.69 m per year has taken place. But after the introduction of the port the shoreline is obtaining some equilibrium and behaving as an accreting coastline. Thus the shoreline in this coastal stretch is oscillating ± 20 m with almost a stable coastline set up.

Zone 5 (Pulicat Lake mouth region)

Zone-5 represents northern end of the study area comprising bar mouth region of Pulicat Lake with a distance of 5 km (Fig. 7.9). The Pulicat inlet is generally recognized as a small scale water way that connects an inland body of water with the ocean. Pulicat inlet serves as conduits for the exchange of waters during the tidal cycle between the coastal waters and large tidal water body. Sediments are brought into the lagoon during flood tides and the flows into the inlet draw sediment laden water from the surf zone as well as from the offshore. Flood tidal deltas are observed near the tidal inlets of Pulicat Lake due to the reduced velocity of ebb. The fluctuations in the tidal flows are caused by the water level difference of ocean and lagoon. Figures and Table clearly reveal that the entire zone is prone to accretion during the period of study. At the southern end of the zone, the length of accretion is 20 m and at the southern side of the mouth it is around 40 m during 1999 to 2001. At the southern edge of the mouth about 200 m of accretion has taken place during 1999 to 2001 and at the mouth about 170 m of accretion has taken place during 2000 to 2001 alone. Tidal inlet of Pulicat Lake was closed from April 2001 until the start of northeast monsoon period (November 2001) due to failure of monsoon

during preceding years and accretion at mouth by the long shore sediment transport. The closure of bar mouth has taken place after a gap of 26 years since 1975 as reported by RAMAN et al. (1977). This has caused the choking of the mouth, which is the only active opening to the entire Pulicat Lake for the exchange of water with the Bay of Bengal.

Pulicat mouth region changes are dealt as inlet dynamism in the study region. It is to be noted that the tidal inlets are the prevalent morphologic features along the coastline. These serve as extremely important conduits for the exchanges of water and sediment between bays, lagoons or estuaries and the continental shelf. Because of the interruption in the uniformity and continuity of coastal processes and sediment transport tidal inlets exert a tremendous influence on shoreline erosion/deposition trend, sediment budgets and migration history.

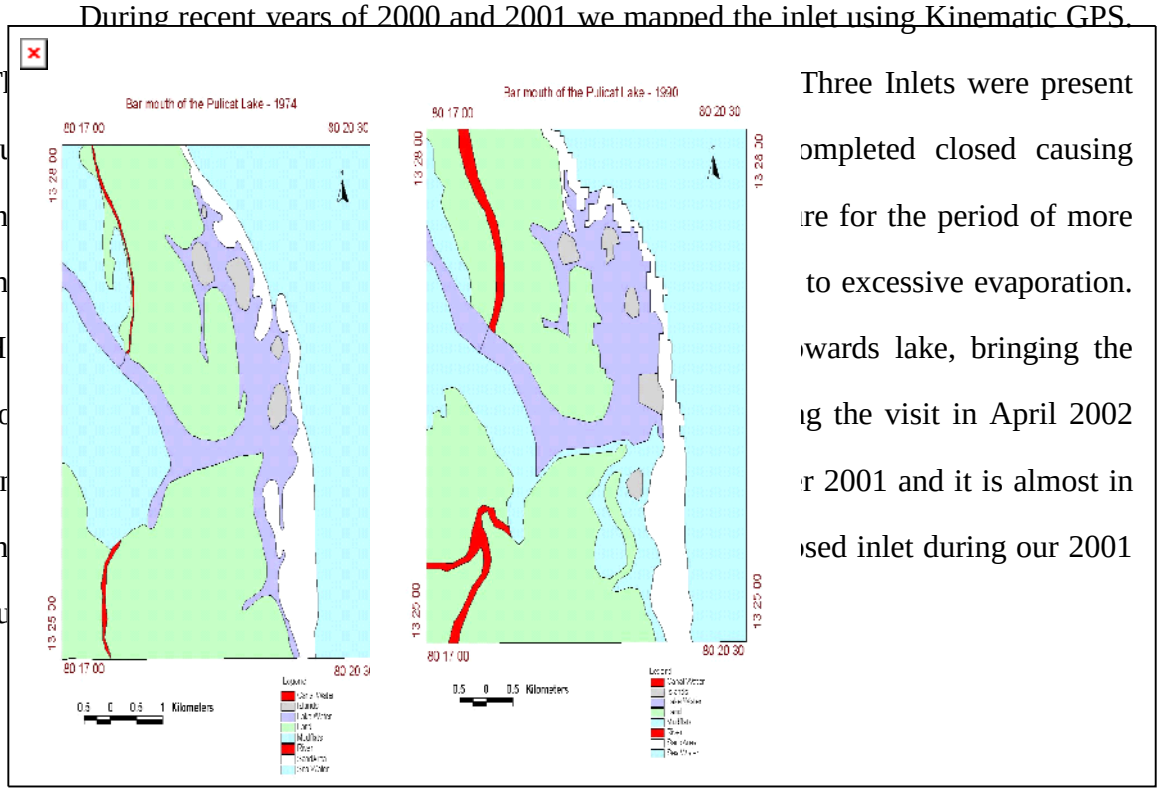
Pulicat inlet was formed by the development of the spit from the south towards northern direction. Formation of spit from two headlands, grown towards each other to the center of embayment eventually the tidal currents in the inlet (flowing between the ocean and the embayment during the tidal cycle) had become stronger and stronger because of the decreased width of the inlet cross section. During the growth of the spits the tidal currents force a balance with the littoral drift of material of the inlet and a final equilibrium inlet cross section resulted. Due to reduced fresh water flow in the Pulicat Lake system in the recent years the tidal currents are not strong enough to keep the sand out of the inlet leading to the inlet closure permitting the bay mouth barrier to form.

The Pulicat inlet is generally recognized as small scale water way that connects an inland body of water with the ocean. Pulicat inlet serve as conduit for the exchange of waters during the tidal cycle between the coastal waters and large tidal water body.

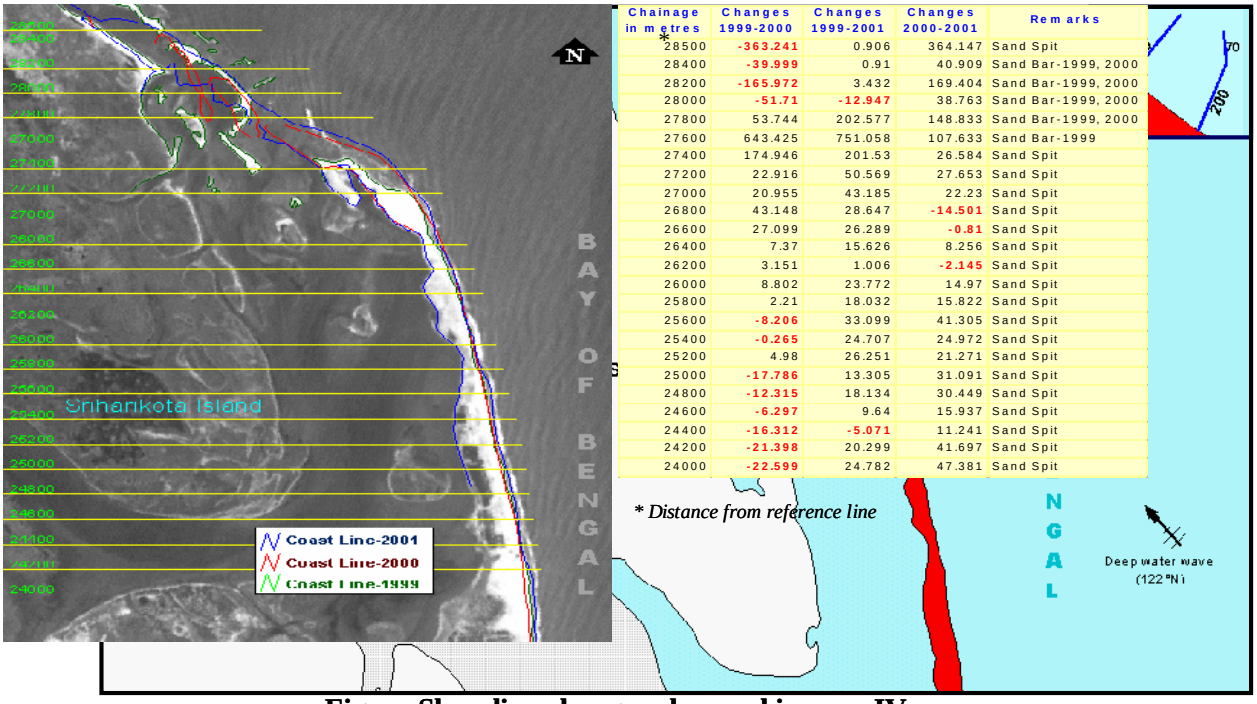
Sediments are brought into the lagoon during flood tides and the flows into the inlet draw sediment laden water from the surf zone as well as from the offshore. Flood tidal deltas are observed near the tidal inlets of Pulicat Lake due to the reduced velocity of ebb. These fluctuations in the tidal flows are caused by the water level difference of ocean and lagoon. In general the Pulicat inlet tends to migrate in the direction of the long shore sediment transport which is mostly towards north.

In recent years Pulicat region is experiencing reduced rain fall and almost no freshwater flow in to the lagoon. Hence the water level in the lake system became very low. This resulted in the closure of the inlet mouth during last year from May 2001 to almost up to August 2001. After November rainfall the mouth got opened and it is migrating in faster rate towards north and expecting closure during this summer, if rainfall fails. Long term changes in the inlet dynamism were prepared using Remote sensing and GIS techniques. The results were given for the period 1974, 1990 and 1998.

During recent years of 2000 and 2001 we mapped the inlet using Kinematic GPS.



Three Inlets were present
ompleted closed causing
re for the period of more
to excessive evaporation.
wards lake, bringing the
g the visit in April 2002
r 2001 and it is almost in
sed inlet during our 2001

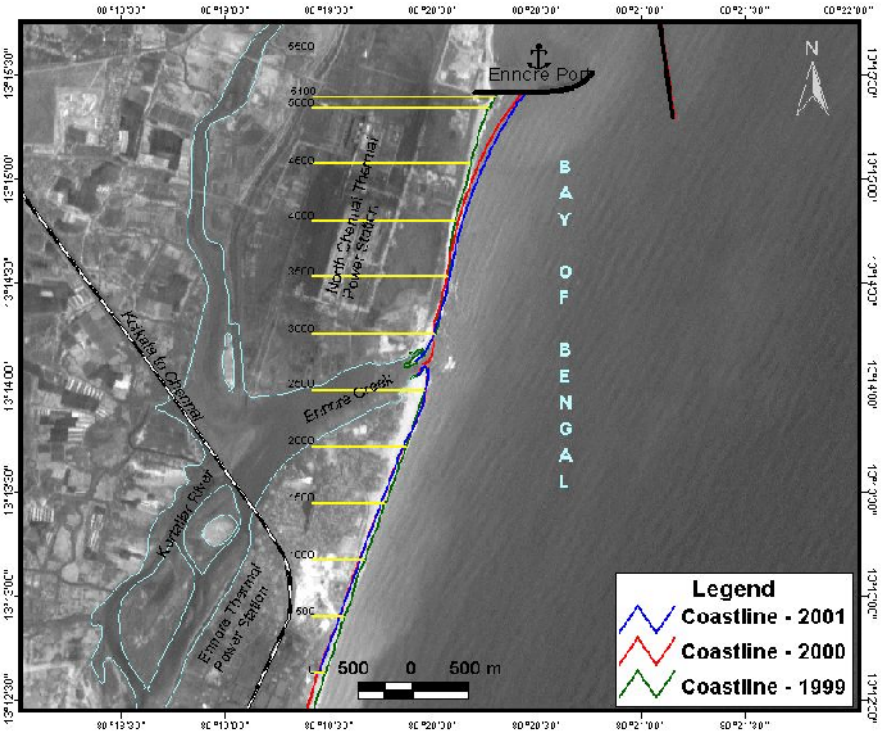


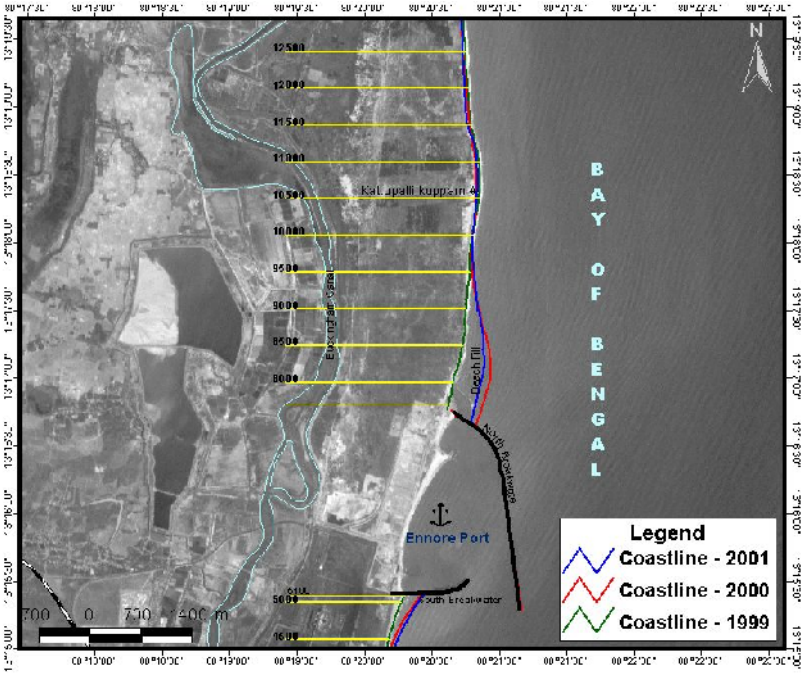
Chainage in metres *	Changes 1999-2000	Changes 1999-2001	Changes 2000-2001	Remarks
28500	-363.241	0.906	364.147	Sand Spit
28400	-39.999	0.91	40.909	Sand Bar-1999, 2000
28200	-165.972	3.432	169.404	Sand Bar-1999, 2000
28000	-51.71	-12.947	38.763	Sand Bar-1999, 2000
27800	53.744	202.577	148.833	Sand Bar-1999, 2000
27600	643.425	751.058	107.633	Sand Bar-1999
27400	174.946	201.53	26.584	Sand Spit
27200	22.916	50.569	27.653	Sand Spit
27000	20.955	43.185	22.23	Sand Spit
26800	43.148	28.647	-14.501	Sand Spit
26600	27.099	26.289	-0.81	Sand Spit
26400	7.37	15.626	8.256	Sand Spit
26200	3.151	1.006	-2.145	Sand Spit
26000	8.802	23.772	14.97	Sand Spit
25800	2.21	18.032	15.822	Sand Spit
25600	-8.206	33.099	41.305	Sand Spit
25400	-0.265	24.707	24.972	Sand Spit
25200	4.98	26.251	21.271	Sand Spit
25000	-17.786	13.305	31.091	Sand Spit
24800	-12.315	18.134	30.449	Sand Spit
24600	-6.297	9.64	15.937	Sand Spit
24400	-16.312	-5.071	11.241	Sand Spit
24200	-21.398	20.299	41.697	Sand Spit
24000	-22.599	24.782	47.381	Sand Spit

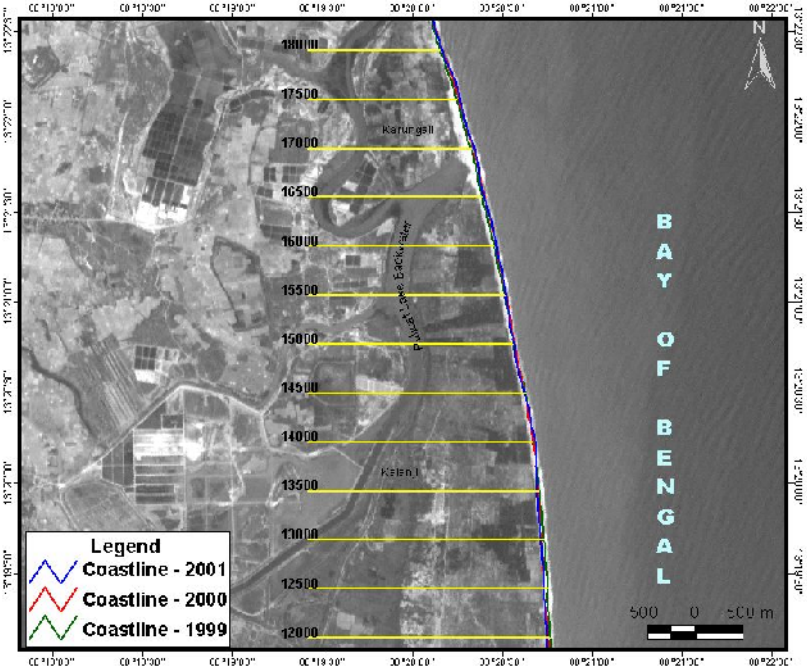
** Distance from reference line*

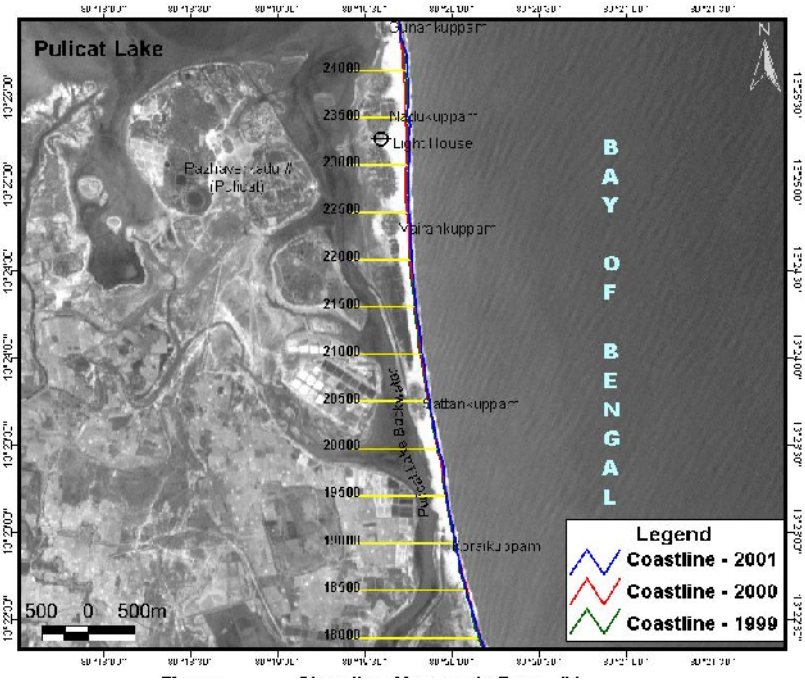
Figure Shoreline changes observed in zone IV

Figure Wave refraction pattern at the Pulicat Mouth


Ennore Port
N
BAY OF BENGAL
North Chennai Thermal Power Station
Kosathalai River
Ennore Creek
Kosathalai Channel
Ennore Thermal Power Station
500 0 500 m
Legend
Coastline - 2001
Coastline - 2000
Coastline - 1999


N
BAY OF BENGAL
Beach fill
North Breakwater
Ennore Port
South breakwater
Legend
Coastline - 2001
Coastline - 2000
Coastline - 1999


Legend
Coastline - 2001
Coastline - 2000
Coastline - 1999
BAY OF BENGAL
N
18000
17500
17000
16500
16000
15500
15000
14500
14000
13500
13000
12500
12000
Karungali
Kalenji
500 0 500 m


Pulicat Lake
Light House
BAY OF BENGAL
Legend
Coastline - 2001
Coastline - 2000
Coastline - 1999
500 0 500m
N

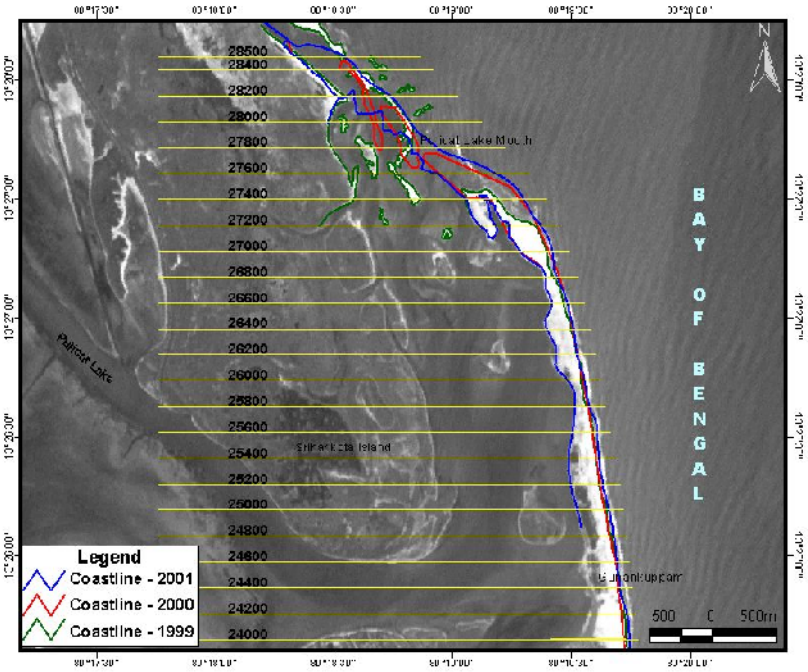

N
BAY OF BENGAL
Pulicat Lake
Pulicat Lake Mouth
28500
28400
28200
28000
27800
27600
27400
27200
27000
26800
26600
26400
26200
26000
25800
25600
25400
25200
25000
24800
24600
24400
24200
24000
Legend
Coastline - 2001
Coastline - 2000
Coastline - 1999
500 0 500m

Table Shoreline Changes Observed During 1999 to 2001

Chainage in metres	Shore line-1999*	Shore line-2000*	Shore line-2001*	Changes 1999-2000	Changes 1999-2001	Changes 2000-2001	Remarks
0	120.535	58.793	57.146	-61.742	-63.389	-1.647	EID Parry Factory
500	291.916	248.906	244.010	-43.010	-47.906	-4.896	
1000	460.815	418.378	422.375	-42.437	-38.440	3.997	
1500	641.938	606.691	602.577	-35.247	-39.361	-4.114	
2000	825.450	800.696	796.996	-24.754	-28.454	-3.700	
2500	985.320	993.993	990.624	8.673	5.304	-3.369	Ennore Creek
3000	1078.193	1059.904	1064.609	-18.289	-13.584	4.705	Ennore Creek
3500	1185.399	1173.588	1200.713	-11.811	15.314	27.125	
4000	1251.310	1278.452	1316.040	27.142	64.730	37.588	
4500	1384.432	1453.994	1502.728	69.562	118.296	48.734	
5000	1544.307	1733.051	1766.758	188.744	222.451	33.707	
5100	1596.821	1806.365	1839.641	209.544	242.820	33.276	
8000	2241.650	2729.999	2617.255	488.349	375.605	-112.744	Beach Fill
8500	2373.641	2713.937	2652.256	340.296	278.615	-61.681	Beach Fill
9000	2417.907	2587.845	2577.012	169.938	159.105	-10.833	Beach Fill
9500	2467.549	2506.772	2526.800	39.223	59.251	20.028	Beach Fill
10000	2508.587	2509.518	2509.654	0.931	1.067	0.136	
10500	2586.879	2550.090	2558.944	-36.789	-27.935	8.854	Kattupalli Kuppam
11000	2589.350	2543.837	2558.634	-45.513	-30.716	14.797	Kattupalli Kuppam
11500	2479.978	2467.633	2440.361	-12.345	-39.617	-27.272	Kattupalli Kuppam

*Distance from reference line

Continued…

Note: From 5100m to 7500 -Ennore Port Area

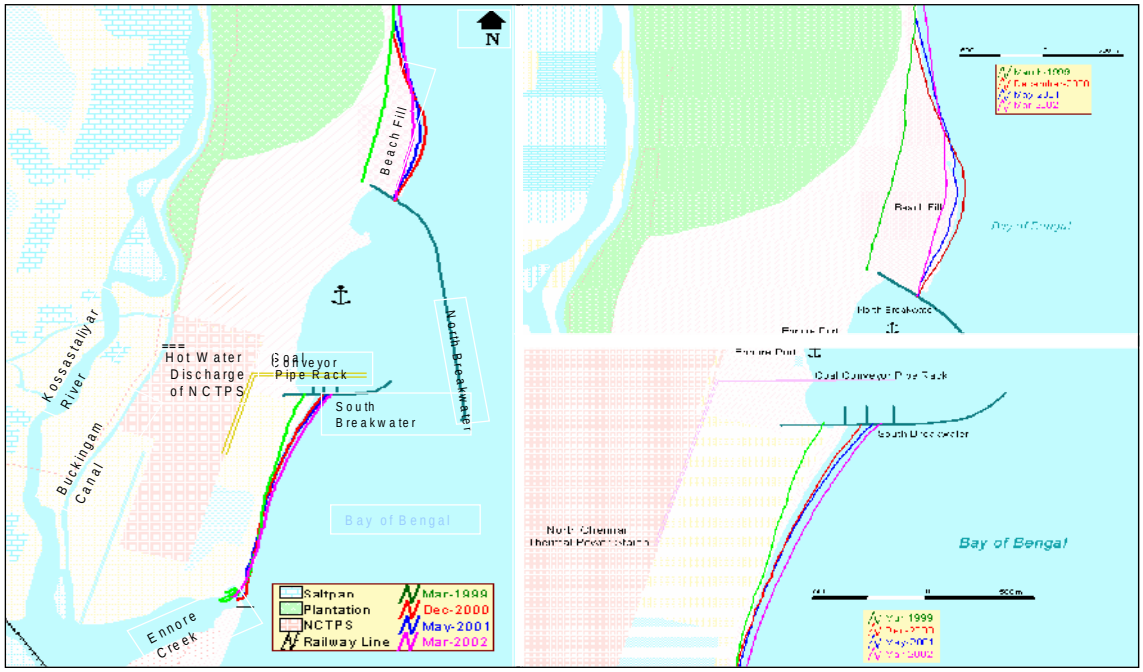
Table Shoreline Changes Observed During 1999 to 2001

Chainage in metres	Shore line-1999*	Shore line-2000*	Shore line-2001*	Changes 1999-2000	Changes 1999-2001	Changes 2000-2001	Remarks
12000	2441.174	2419.151	2405.161	-22.023	-36.013	-13.990	Kattupalli Kuppam
12500	2415.873	2379.048	2375.245	-36.825	-40.628	-3.803	Kattupalli Kuppam
13000	2370.648	2349.100	2343.713	-21.548	-26.935	-5.387	Kattupalli Kuppam
13500	2329.947	2316.447	2307.466	-13.500	-22.481	-8.981	Kattupalli Kuppam
14000	2272.052	2266.391	2286.163	-5.661	14.111	19.772	
14500	2189.368	2180.288	2178.240	-9.080	-11.128	-2.048	
15000	2069.013	2079.904	2076.785	10.891	7.772	-3.119	
15500	1981.924	1994.978	1990.229	13.054	8.305	-4.749	
16000	1874.905	1895.872	1898.286	20.967	23.381	2.414	
16500	1757.714	1781.711	1770.778	23.997	13.064	-10.933	
17000	1645.546	1667.723	1676.684	22.177	31.138	8.961	
17500	1499.640	1524.310	1529.871	24.670	30.231	5.561	
18000	1331.332	1355.499	1356.319	24.167	24.987	0.820	
18500	1203.014	1218.150	1208.764	15.136	5.750	-9.386	
19000	1085.337	1099.881	1096.228	14.544	10.891	-3.653	Korai Kuppam
19500	988.862	999.144	1001.080	10.282	12.218	1.936	
20000	904.326	911.081	915.688	6.755	11.362	4.607	
20500	809.372	819.115	822.937	9.743	13.565	3.822	Sattan Kuppam
21000	732.913	743.917	751.394	11.004	18.481	7.477	
21500	668.734	683.809	687.585	15.075	18.851	3.776	
22000	618.938	628.154	642.274	9.216	23.336	14.120	
22500	593.705	590.791	613.726	-2.914	20.021	22.935	Vairan Kuppam
23000	591.848	589.808	610.517	-2.040	18.669	20.709	
23500	586.635	577.189	604.123	-9.446	17.488	26.934	Nadu Kuppam
24000	573.672	550.920	596.608	-22.752	22.936	45.688	

Table Shoreline Changes Observed During 1999 to 2001

Chainage in metres	Shore line-1999*	Shore line-2000*	Shore line-2001*	Changes 1999-2000	Changes 1999-2001	Changes 2000-2001	Remarks
24000	3570.498	3547.899	3595.280	-22.599	24.782	47.381	Sand Spit
24200	3555.592	3534.194	3575.891	-21.398	20.299	41.697	Sand Spit
24400	3524.822	3508.510	3519.751	-16.312	-5.071	11.241	Sand Spit
24600	3491.524	3485.227	3501.164	-6.297	9.64	15.937	Sand Spit
24800	3455.049	3442.734	3473.183	-12.315	18.134	30.449	Sand Spit
25000	3422.611	3404.825	3435.916	-17.786	13.305	31.091	Sand Spit
25200	3364.588	3369.568	3390.839	4.98	26.251	21.271	Sand Spit
25400	3339.685	3339.420	3364.392	-0.265	24.707	24.972	Sand Spit
25600	3315.721	3307.515	3348.820	-8.206	33.099	41.305	Sand Spit
25800	3271.687	3273.897	3289.719	2.21	18.032	15.822	Sand Spit
26000	3226.913	3235.715	3250.685	8.802	23.772	14.97	Sand Spit
26200	3194.381	3197.532	3195.387	3.151	1.006	-2.145	Sand Spit
26400	3152.155	3159.525	3167.781	7.37	15.626	8.256	Sand Spit
26600	3093.918	3121.017	3120.207	27.099	26.289	-0.81	Sand Spit
26800	3014.695	3057.843	3043.342	43.148	28.647	-14.501	Sand Spit
27000	2959.379	2980.334	3002.564	20.955	43.185	22.23	Sand Spit
27200	2866.883	2889.799	2917.452	22.916	50.569	27.653	Sand Spit
27400	2592.234	2767.180	2793.764	174.946	201.53	26.584	Sand Spit
27600	1830.659	2474.084	2581.717	643.425	751.058	107.633	Sand Bar-1999
27800	1933.503	1987.247	2136.080	53.744	202.577	148.833	Sand Bar-1999 and 2000
28000	1934.770	1883.060	1921.823	-51.71	-12.947	38.763	Sand Bar-1999 and 2000
28200	1769.781	1603.809	1773.213	-165.972	3.432	169.404	Sand Bar-1999 and 2000
28400	1529.345	1489.346	1530.255	-39.999	0.91	40.909	Sand Bar-1999 and 2000
28500	1428.583	1065.342	1429.489	-363.241	0.906	364.147	Sand Spit

*Distance from reference line


N
Beach Fill
North Breakwater
Kossastaliyar River
Buckingam Canal
Hot Water Discharge of NCTPS
Coal Conveyor Pipe Rack
South Breakwater
Bay of Bengal
Ennore Creek
Saltpan
Plantation
NCTPS
Railway Line
Mar-1999
Dec-2000
May-2001
Mar-2002
Beach Fill
North Breakwater
Coal Conveyor Pipe Rack
South Breakwater
Bay of Bengal