2.1 **INTRODUCTION:**

The coastal margin of West Bengal is unique, formed by the combined effect of fluvial and marine action. It forms part of the largest and Active Delta of the world - The Ganges Delta. The district of South Twenty four Parganas comprises of the extreme limit of the state and lies between 21°.32' and 22°.40' North latitudes and between 88°.05' and 89°.06' East longitudes; thus comprising of the littoral deltaic part. The district is bounded by the Calcutta Metropolitan District in the North West, North 24 Parganas district to the North; the international boundary of Bangladesh in the East and South-East and Medinipur District of West Bengal in the West. The southern limit of the district consist of the famous Sundarban tidal mangrove swamps and forests, much indented and washed by the Bay of Bengal. The total area covered by the district is 6,388 sq. km. supporting a total population of 5.8 million (1991). This chapter deals primarily with the Geographical and Ecological information used primarily as a basework for carving the Geo-Ecological subregions required for the settlement study.
2.2 **GEOLOGY, TECTONICITY AND EVOLUTIONARY HISTORY:**

The deltaic district of South Twenty Four Parganas is a composite landmass, the origin of which is due to a series of geologic and geomorphic events like upheaval and subsidence coupled with gradual deposition of alluvial silts brought from distant Himalayas by the Ganga-Brahmaputra river complex.

Hooker (1854) and Theobald (1881) stated that the whole of 'Lower Bengal' was originally an estuary. Historical evidences elucidate the fact that the tidal swamp once extended upto the Rajmahal Hills.\(^1\) In the later part of the Tertiary Period (35 million years ago), this was filled up by the Himalayan drainage from the North. J. Fergusson (1863)\(^2\) was of the opinion that during the early Pleistocene, shallow marine water condition prevailed in this part of the Bengal Basin, it was only in the late Pleistocene that sea receded completely from this area. Older sediments began to be covered with thick river borne alluvium. Very precisely Oldham\(^3\) (1893) states, the whole area including the Sundarbans, lying between the river Hugli in the West and Meghna (Bangladesh) in the East, is only the delta caused by the deposition of the debris carried down by the river Ganga, Brahmaputra and their tributaries. This is further substantiated by the fact that there is no trace of any marine deposits even much below the ground; but some
estuarine fossils were traced at a depth of 290 meters (950 ft.) while digging a tubewell at Garden Reach under Calcutta Municipality. Oldham also suggested that this part of the Gangetic plains were formed by the sinking of the crust due to the weight of the alluvium brought down by the rivers from the Himalayas. The whole of the lower Gangetic delta as such remained somewhat trough land till today. 4

The geologic history of the district, therefore, lies in subsidence in this part of the country followed by deposition in comparative recent times. Similar results were also obtained from the bore operation at Fort William (Calcutta) upto a depth of 140 metres. There was no trace of marine deposits proving thereby that the whole bore comprises of alluvial brackish water deposits. This view was supported by colonel Gastrell (1868) and by Hunter (1875).

The depositional history of the region has been emphasized by the excavations of the Metro Railway Project in Calcutta, and the Second Hugli Bridge Project. Clauson (1940) 5 stated that these alluvial strata (comprising alterations of clay, sand and silt) were formed due to simultaneous depressions and elevations proved by the occurrence of alternating peat beds (a dark brown humus formed by the partially decomposed mass of Marsh vegetation) and Kankar beds. The distinct deposition of a layer of 0.50 m to 1.20
m thick peat was recorded 5 m below the surface, being about the mean sea level. In the excavations of the Metro Railway Project a second layer of peat has been recorded for the first time 12 m below the surface, being 7 m below the mean sea level. The sequence of sediments with two distinct layers of peat and an intermediate layer of soft grey clay with decayed stumps of Sundari trees (typical of present Sundarban vegetation) has been found at several stations (Jatin Das Park, Bhowanipur and Esplanade) of the Metro Railway. As early as in June 1889 "The Calcutta Review" has also recorded: Stumps of Sundari trees embedded near Seal-dah (Calcutta) and at Canning (South 24 Parganas) 30 feet below the ground.6

The palaeogeography of the district is thus associated with brackish water plants like Heritiera, Sonneratia, Avicennia, Caerisps, along with leaves, stems, radicle, mioflora and mollusc shells of Neritina, Telescopuim, etc. Radio carbon dating on some of these materials suggests that they belong to a period around 7000 years of age.

Fresh water plant deposits of pteridophytic, angiosperm and mioflora along with remnants of leaves and stems of both, some Monocotyledons and Dicotyledons have also been recovered from the older strata. The molluscan genera like Pila, Indo Planorobis Segmentina, Lamellidens etc. have also been studied and carbon dating experiments show that they
were hardly about 4000 years old. All these studies reveal an ecological succession of phases like tidal mangrove, followed by sudden cessation of tidal influx, marine, and salt tolerant fresh water vegetation in conformity with the Eastward tilting of South Bengal some 300 years ago.

There is a great natural depression called "Swatch of No Ground" in the Bay of Bengal, south of the Raimangal Estuary and this figures in navigation charts. The surrounding waters which are around 20 metres, change almost suddenly to 500 m in depth. Fergusson's theory is that the sediments is carried away from the spot and deposition is prevented by the strong currents produced by a meeting of tides from the East and West coasts of the Bay of Bengal. Another theory attributes the depression to a local sinking. Thus the unstable condition of the area opine Oldham, Beveridge and Fergusson result in periodic subsidence, earthquakes, etc. is related to the "Swatch of no ground", the origin of which is still shrouded in mystery. Subsidence and earthquakes together with other natural hazards have been common to the region.

2.3 GEOMORPHIC CHARACTERISTICS

South 24 Parganas District lies within the limits of the Gangetic delta, the main channel from the Himalayas being splitted into several small channels to take the
present shape of innumerable creeks and channels; to form a low flat country, little of which is raised above flood level, and a few metres rise in sea level can drown the entire landmass including Calcutta. However, 2 broad natural divisions in the district are now noticeable:

(a) The more or less Stable Delta towards the North forming higher ground hardly affected by tidal action and

(b) the most dynamic and Active Delta in the southern sea-board popularly called the low lying Sundarbans. This was delineated as a special forest area by Dampier and Hodges known as the Dampier and Hodges Line of Tidal Forest, and at present only the Eastern part of the River Matla now exists as the true core area of this dwindling mangrove forest.

The northern inland tract of the Stable Delta is a land of sluggish rivers comprising of large amounts of clay occasionally enclosing peat beds and forming monotonous plains with a very low gradient towards the sea.

The Sundarbans, on the other hand, are a network of tidal channels, rivers, creeks and islands\(^8\). Gupta (1957) studied the physiography of the area in relation to tidal action. He stated that the area being subject to tidal
action, a back rush of silt from the Bay occurs. The silts carried down to the sea are pushed back to the Moribund channels and get deposited there due to tidal action. The bed of the channel thus gets steadily raised ultimately blocking the flow of water and a small island is thus gradually evolved. This is the basic geographical history about the origin of innumerable islands of the region. Ray Choudhury et al (1963) have discussed much about the reactions of sea water in the continental shelf after analysing silts from the rivers and creeks. They also stated that the deposits of Ganga alluvium going to the sea are turned back by tides and redeposited in the estuarine region and this alluvium is enriched with various salts. The silt and clay loads carried down into the sea beyond the delta undergo partial transformation due to exchange reaction with Sodium Chloride (NaCl) of sea water. During tides, this constituent, on suspension, rushes back through the numerous tidal creeks in the coastal region and gets partially deposited due to gravitational force which is greater than the force of suction exerted by ebb water, in the flat plain situated inland. They also opined that the Active Delta of the Sundarbans is still under formation. Presence of many small islands bear ample testimony to this condition of new land formation. Recent detection of well publicised new Moore
Island (Purbasha) emphasises the fact. The coastal area of the Sundarbans comprising of broad undulating indented coast line of South Twenty-Four Parganas consist of a varied morphoecological features such as mudflats, shifting sand banks, complex dune ridges and flats and mangrove swamps. Two of the most conspicuous geomorphological features of the area can be treated in greater detail.

(A) **The Sundarban Mudflats**

Mudflats are found at the estuaries and on the deltaic islands of the Sundarbans where the sheltered spots marked by low velocity of river and tidal currents occur. (Map No. 2.1) Suspended sediments of finer quality get time to settle down in the sheltered areas where the disturbance of tidal currents and waves are minimized, and thus the mudflats are developed on the islands and estuarine banks. The thick mud substratum is richer in organic content and is ideal for penetration by plant roots. The flats are exposed in the low tides and are submerged in the high tides, and thus the unstable mud flat changes morphologically even in one tidal cycle. The littoral parts of the mudflats have characteristic flat slopes, a resultant factor of higher velocity of tidal currents, and is thus devoid of vegetation, unlike the interior parts - that are the magnificent home of the luxu-
Location Of Mud-Flats And Sand-Flats In The Sundarbans

Map No. 2.1

Source: Paul and Bandyopadhyay
riant Mangroves. Besides, the extended mudflats of estua­rine environment are important feeding grounds for marsh and estuarine birds. The mudflats are roughened by the algae mat in the monsoon and postmonsoon periods. The activities of benthic fauna on the flats develop microtopographical variations on different islands of the Sundarbans.

The composition of the mudflat is of fine silt and clay which stick together in the sea water and generally deposited on the sandy bottom. The thick mud substratum is extremely loose and open in structure and it contains large amount of water with air gaps. The morphological features of the Sundarban mudflats has a developed profile. The profile of a shallow estuarine mudflat shows a prominent mid-tidal break of slope, almost a slopeless flat in the low velocity area, densely vegetated high mudflats or the mangrove swamps and the high velocity creek bed which is composed of solid grains of larger size. The tidal and riverine depositions are accelerated by the pneumatophores and the dense branching roots in the mangrove swamps. The morphology of the swamps is characterised by the occurrence of salt pans, ditches and banks with a thick substratum of decomposed organic matter. Most of the swamp floor is totally submerged by the spring tides; and as the ebb tide starts from the highest level, the general slope of the
The micromorphology of the coastal mudflats is characterised by the location of peculiar mud-mounds and holes. The mounds and holes are created by the activities of a typical mud-dweller (Scylla Serrata) of the Sundarban marshes. The growing mounds and holes obstruct the flow-tide and lead to the formation of tiny swirls and eddies or sheltered patches in between these structures which favour extensive sedimentation on the floor. Some of the mudflats in this coastal area possess a pronounced break of slope at the position of the breaking waves which is marked as the beach step. The mud ridge and the microholes are the other morphological features of the coastal mudflats. The microholes of the dense mudflat are the resultant features of the activities of crustaceans in the coastal flat.

Thus the Sundarban mudflats control the food chain in estuarine ecosystem, but excessive reclamation, however poses the greatest single threat to the shallow estuarine mudflats of the Western and Northern Sundarbans as it destroys forever the natural habitat and ecosystem.

The only exception to the monotonous flat plains of fluvio-marine deposits of the Sundarbans are the complex
dune ridges and flats on the isolated islands of the South Western Sundarbans.

(B) **Coastal Dune Systems**

Coastal dune systems are located on somewhat higher areas in the S. Western Sundarbans as for example in Sagar Island, Jambudwip, Chuksar, Fraserganj - Bakkhali Islands, Lothian and Tat Islands. Dunes are the product of sea deposition on the coast in which wave and wind processes play dominant role in the formation of dunes. The dune landscape in the Sundarbans comprises a system of low ridges parallel to the coast, separated by large dry and wet sand-flats.

Dune formation in the Sundarbans is controlled by the following four major factors:

1. Insufficient source of sand on the beaches,
2. Absence of long dry season with strong wind speed (20 to 50 Km per hour) on the shores,
3. High sub-surface moisture and
4. Rapid growth of vegetation on the sandy shores.

On the island of Chuksar, Jambu and Lothian, the dunes are still growing and are younger in age. The embryonic dunes, dune humps and dotted dunes (small ridges) are the special features of the dune morphology of these islands. Most of the dunes are deformed due to South West and North
East winds. The dunes on these islands are mostly vegetated by heaths and grasses, height varying in between a few centimetres to 5 metres.

The dunes of Sagar Island, (Map No. 2.2), Fraserganj, Bakkhali and Tat Island, are mature and largely developed. In altitude these range to over 5 metres. Eight stages of dune development have been observed (Paul and Bandyopadhyay 1987) on the Sagar Island, where the dune morphology and its development are controlled by the ecology of some halophytic plants. At Bakkhali, the dunes are more or less stabilized because they are largely managed through planting casurina trees. Dune areas of Tat Island are heavily settled and cultivated.

The seaward faces of the coastal dunes of these islands are now being engulfed by the encroaching sea waves with the activities of cyclones on the low lying coast. The isolated dotted dune, eroded primary dune, mobile dunes and wide bare sandflats are the important features of Sagar Island and Fraserganj coasts. The Fraserganj coast is almost destroyed by the longshore current attack from the West. Now the drier dunes are advancing inland causing damage to agricultural fields. Again, at present, the rate of coastal erosion is high on the coast of Fraserganj, Bakkhali and Sagar. Thus, the wide beaches of these coasts are gradually being

69
Location of Sand Dunes And Sand Flats in Sagar Island

Sand dunes Of Sundarban

Map No. 2.2.

Source: Topographical Sheets
narrowed and the seaward dunes are being directly attacked by the high sea waves.

A variety of dune landscape types with their associated geomorphology and vegetational types can be discernable in South Western Sundarbans that provide functions such as protection of hinterland, water storage, biotic resources and recreation.

**TABLE 2.1**

<table>
<thead>
<tr>
<th>Type of dunes</th>
<th>Altitude M.S.L. (in M)</th>
<th>Geomorphology Above</th>
<th>Stability</th>
<th>Vegetation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Embryo dunes</td>
<td>1 - 2</td>
<td>Dotted dunes</td>
<td>Stable</td>
<td>Dune heaths</td>
</tr>
<tr>
<td>Fore dunes</td>
<td>3 - 5</td>
<td>Parallel dunes</td>
<td>Stable</td>
<td>Dune scrubs</td>
</tr>
<tr>
<td>Dune stacks</td>
<td>1 - 1.5</td>
<td>Wet hollows</td>
<td>Stable</td>
<td>Dune grass</td>
</tr>
<tr>
<td>Dune humps</td>
<td>2 - 3</td>
<td>Rounded dune top</td>
<td>Stable</td>
<td>Dune herbs</td>
</tr>
<tr>
<td>Dune flat</td>
<td>4 - 6</td>
<td>High dune flats</td>
<td>Stable</td>
<td>Wood lands</td>
</tr>
<tr>
<td>Primary dune complex</td>
<td>2 - 3.5</td>
<td>Semi-barkhans</td>
<td>Unstable</td>
<td>Bare dunes (mobile)</td>
</tr>
<tr>
<td>Dry sand-flat</td>
<td>2.5 - 4</td>
<td>Dry shore flats</td>
<td>Unstable</td>
<td>Bare flats (mobile)</td>
</tr>
</tbody>
</table>

The littoral tract of South Twenty four Parganas is therefore the product of interaction of innumerable geomorphic and geoecological processes, highlighted by tidal action rather than the lone effect of waves on the seaboard. The complexity of this region, thus according to many scholars, owes its origin due to uprising of the basement complex (Pleistocene times) and consequent recession of the sea from the lower part of the Bengal basin. Thus the Geologic and various other physiographic conditions of different regional components of this delta require a complex set of analysis of tectonicity rather than depending solely on the age old hypothesis of riverine alluvial deposition.

2.4 FLUVIAL CHARACTERISTICS

The Geography of South Twenty Four Parganas is intimately linked up with that of ever changing river courses and so the drainage pattern constitutes the underlying factor in shaping the settlement pattern of the district.

The rivers of the district (Map No. 2.3) were formerly distributaries of the Ganga, (i.e. they were channels by which Ganga waters were distributed and ultimately discharged into the sea); but the main current of that river got deflected eastward\(^2\) and hence these ceased to be effective drainage channels; though a large volume of water is conveyed through the Hugli. Hence most of the rivers of the area are essentially tidal.
The Ecogeography of this deltaic coast is totally dependent on this tidal effect. There are two flow tides (in flow) and two ebb tides (out flow) daily. The intertidal zone (or the tidal limitation daily and between seasons) in the estuarine rivers ranges between 3 - 5 metres. However, there is a wide gap in the tidal fluctuation between the Western Bay estuaries than in the East (3m - 5m Vs 1.52 m - 2.13 m respectively); and this can be attributed due to a lack of fresh water drainage through Indian rivers. Moreover, the strength of the tidal current varies with the slope of the sea-bed and season. The maximum recorded velocity of tide in the Hugli estuary had been of the order of 200 cm/sec.

The main rivers of the area, most of which are estuaries are (i) the Hugli, (ii) Piyali - Bidyadhari, (iii) Muri Ganga, (iv) Saptamukhi, (v) Thakuran, (vi) Matla, (vii) Gosaba and (viii) Harinbhanga.

(i) Hugli - The Hugli (for origin see Appendix II.3) forms the western boundary of the district, by which the waters of the Ganges enter the Bay of Bengal. Entering the district from the North - East, it flows almost due South, receiving the Damodar opposite the Falta Point and Rupnarayan opposite the Hugli Point.
These great tributaries deflect the stream to the East for about 13 km. and have set up in it, the dreaded moving shoals known as James and Mary Sands. Navigation in the Hugli has become difficult on account of rapid currents, shoals and shifting sandbanks. However, with some dredging operations, the river has been maintained navigable to large liners and is the gateway for the foreign trade of Eastern India.

After Diamond Harbour, the river resumes a southerly direction, until it debouches into the Bay of Bengal, its breadth at the point of junction being about 26 km., its mouth being locally known as the Burha Mantreswar. The tide of the Hugli is occasionally so strong that it gives rise to a phenomenon known as a bore\textsuperscript{13}. This is the name given to the headwave which is formed when an unusually high tide is checked by the narrowing of the river channel.

(ii) The Bidyadhari and the Piyali - The Bidyadhari flows a very circuitous course and in the Northern portion of the district has nearly been silted up (in Bhangar Block) and comprises of an outfall channel for the storm-water and sewerage of Calcutta. However south eastwards, the river widens, being joined by the Karatoya and Atharabanka and falls into the Matla river in Canning Block. The Piyali leaves the Bidyadhari 14
kms. below Bamanghata (Tiljala) and flows South and South-West till it joins the Matla about 32 kms. below Canning city.

(iii) **Muri Ganga** - The Hugli before joining the Bay of Bengal bifurcates with another easterly channel passing east of the Sagar Island, the largest of all the Sundarban Islands. This channel is called the Baratala River or the Channel Creek; but is locally known as the Muri Ganga. It is fed by several subsidiary channels or creeks and merges with the Bay to the East of Dhoblat (Sagar Island).

(iv) **Saptamukhi** - This is also an estuarine river, originating near Sultanpur, flows between the Kulpi and Mathurapur Blocks. It has connection with Muri Ganga and Deogra Khal and falls to the sea with a wide mouth after traversing about 80 Kms.

(v) **Thakuran** - Originating near Jaynagar (Jaynagar Block) the Thakuran, another tidal estuarine river takes the name of Jamira. It has a number of connections with the Saptamukhi and forms the boundary between Mathurapur and Jaynagar Blocks.

(vi) **Matla** - The Matla is considered one of the most important river of South Twenty Four Parganas due to its largest and deepest navigable channel used
throughout by the ocean going vessels upto Port Canning, near which it is joined by the Bidyadhari. This river also ends up in an estuary in a wide opening to the Bay of Bengal.

(vii) Gosaba - This river is formed by the confluence of the Raimangal and Matla river and forms a broad estuary to the sea.

(viii) Harinbhanga - The Harinbhanga river forms the International Boundary of the district and is connected with the Bangladesh river Jamuna through River Kalindi in the East.

These estuarine rivers are all formed by the junction of smaller rivers, all having a general southerly course towards the sea. They are separated from one another by numerous islands, few of which are inhabited. From West to East these islands are, the largest of all, the Sagar Island (between the Hugli and the Channel Creek), the Mecklenberg Island or Fraserganj (West of Saptamukhi), Lothian Island (in the mouth of the Saptamukhi), the Bulcherry Island (between the Jamira and the Matla), the Halliday Island (in the Matla), the Dalhousie Island (between the Matla and Gosaba) and finally the Bangaduni Island (at the mouth of Gosaba).

Between the large estuaries and rivers, there are innumerable streams and water courses called "Khals", form-
ing a perfect network of channels, drawing water from every block of land. Each block is like a saucer with high ground along the bank of the Khals surrounding it with one or more depressions and is drained off by little creeks and Khals into the larger khals and ultimately into the rivers. Many of the "Khals" connect two larger ones and as a result tide flows into them through both ends. Such Khals are called 'do-aniya khals'\textsuperscript{14} They offer communication between the larger khals, but get silted up gradually at the point where the two tides meet because the water is stagnant there.

2.5 **CLIMATIC CHARACTERISTICS**

South Twenty Four Parganas District is characterised by a typical tropical Monsoon Climate (as typical for the rest of India) but with excess of humidity and a little less of northern winter due to its maritime influence.

<table>
<thead>
<tr>
<th>TABLE 2.2</th>
<th>TEMPERATURE &amp; RAINFALL OF SOUTH 24 PARGANAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Particulars</td>
<td>Normal 1983</td>
</tr>
<tr>
<td>Annual Rainfall in millimetre.</td>
<td>1579</td>
</tr>
<tr>
<td>Temperature in °C (Dum Dum) Maximum</td>
<td>39</td>
</tr>
<tr>
<td>Minimum</td>
<td>9</td>
</tr>
</tbody>
</table>

Source: 1. Agri, Meteorologist, Directorate of Agri: West Bengal.
2. Directorate of Regional Meteorological Centre, Calcutta.
The climatological picture is more flattened out towards the southern seaboard, and here extreme climatic conditions do not prevail even though the region is close to the Tropic of Cancer. This is because of its locational advantage of its proximity of the sea and the constant flushing of landscape by innumerable tidal creeks and rivers. Here the maximum average temperature of 29°C is felt during June and a minimum of 20°C is recorded in December-January. The average rainfall is around 1800 mm.

The so-called summer in this area prevails from middle of March to middle of June (pre-monsoon). Monsoon starts from the middle of June and prolongs up to September, sometimes extending into the middle of October. The south-west wind brings monsoon in this area.

From mid-October to November (Post-Monsoon) the cyclonic storm occasionally touches the area accompanied with high waves and tides (near the sea), which sometimes cause great disasters. The winter months are December, January and February; winds from North and North East blow from mid-October to the middle of March. The rivers become calm and quiet during this period and is the best part of the year.

In late March to May (pre-monsoon period), violent and frequent thunderstorms occur in this district, generally known as the "Norwesters" (as they approach the land from North-Westerly direction). Hailstorms also occur accompany-
ing the thunderstorms. Locally known as 'Kalbaishakhi', these thundersqualls are short lived, rapid shifting winds with rain and thunder accompanied by a sudden fall of temperature. The wind speed in these storms varies from 64 to 80 Km. per hour and sometimes may even reach a velocity of 160 Km./hour.

Therefore, the early rains of this district is mainly due to the norwesters. They are line squalls bringing thunder and lightening and intense precipitation often in the form of hail, the line regenerating several times, the down draught from the first line promoting enough turbulence, specially downward to provoke a second and so on. They are commonly associated with divergence related to the westerly Jet Streams, or to westerly disturbances in the Upper Troposphere, sometimes intensified by 'inphase superposition' of a wave in the Upper Troposphere Easterlies and develop, given an association of favourable conditions: (1) low level convergence, (2) Upper air divergence, (3) sufficient inflow of moist air at low level and (4) unstable lapse rates - often provided through cold air advection aloft¹⁵.

In the early hot weather, too, as well as in the late monsoon period, cyclonic storms (Map No. 2.4) or tropical cyclones occurs in the Bay that affect the district some-
Bay of Bengal Cyclones
times severely causing tidal bores and storm surges. Heavy rains associated with a storm have been known to cause floods of no mean dimensions\(^{16}\). (Appendix II.1)

### TABLE 2.3

**FREQUENCY OF CYCLONIC STORMS IN THE BAY OF BENGAL 1831-1960**

<table>
<thead>
<tr>
<th>Month</th>
<th>J. F. M. A. M.</th>
<th>J.</th>
<th>J.</th>
<th>A.</th>
<th>S.</th>
<th>O.</th>
<th>N.</th>
<th>D.</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less</td>
<td>4 1 4 18 28 34 38 25 27 53 56 26 314</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Severe</td>
<td>1 1 2 7 18 4 7 1 8 19 23 9 100</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Directorate of Regional Meteorological Centre, Calcutta.

2.6 **SOIL CHARACTERISTICS**

The natural soil associations (Map No. 2.5) found in this deltaic district has been formed both as a result of physical phenomena, climate, watersheds (abiotic components) as well as by the action of organic constituents (biotic components).

In general the soils of the district are derivatives of fine Gangetic deltaic alluvium borne out of terrestrial materials of the Himalayas viz. (1) The Ganga alluvium and (2) Salinized Ganga alluvium\(^{17}\). The soil of this area can be well differentiated into 4 major divisions according to
SOUTH TWENTY-FOUR PARGANAS
SOILS
Alluvial Sub Recent or Deltaic Alluvium

INDEX

- Non Saline Soils
- Saline Soils
- Non Saline Alkali Soils
- Saline Alkali Soils
- Alkali Soil degraded
- Saline Soils degraded
the factors affecting their genesis - (i) Along the Hugli and in the Northern part of the district heavy textured silty clay loams, with about 45% clay and the rest silt with very little percentage of sand, organic content being less than 1%. Infiltration rate is low being about 0.20 cm per day and in the monsoon this improves to about 3 cm/day.

In the Active Delta 3 other soil types are noticeable (2) Sandy clays and loams and sand dunes are noticeable in the western estuarine parts with higher percentages of sand, organic matter and infiltration rates (3) Some organic and peaty deposits have been noticeable in central parts and finally (4) Swampy and marshy soils occur in the Eastern littoral also called the Mangrove Soil.

The whole district consists of newer alluvium but the soils of the Stable Deltaic areas are not inundated whereas in the active estuarine deltaic areas are being renewed. This results in a variation of soil texture. The silts (and clays) deposited in this fashion are mostly palebrown, sometimes grey to greyish - black, with deposits of mica, very often mixed with loamy calcareous clays, and are devoid of carbonate (Kankar) segregations. Sand is available along the sea face, (specially in part of the west depleted of the original vegetation); a result of tidal action and strong winds.
The soil profile of the region portrays a grey to greyish black upperlayer whereas grey clay with traces of sands alongwith different kinds of silts are found in the subsoil. After a certain depth medium to fine sands having grey to bluish grey colour are noticeable. Occasionally at certain depths peat is also noticeable. The Sundarban forest proper comprises of the mangrove soil that is comparatively young and low in oxygen content. Besides humus it contains good quality of shells of forminifera, mollusca and other organisms from marine source. Calcium salts from the molluscan shells are released, related by the activity of sulphur bacteria. This is the cause of higher alkalinity (pH) of the silt. Mere deposition of alluvium does not always make a productive soil, complex biological process is necessary to make the soil suitable to be utilised by plants and other associates. Many organisms such as bacteria, blue-green algae, diatoms and green algae play very important role in this process. Nitrifying bacteria and sulphate reducing bacteria also have significant role (The local soil terminologies of the district is given in Appendix II.4).

The soil chemistry of the region have been studied by various scholars. Roy Choudhury et al\textsuperscript{18} (1963) states that nitrogen of the soil ranges from 0.05 to 0.9%, phosphate varies from 0.1 to 0.15% (0.06 to 0.1% varies inside the
forest), pH varies from 7.0 to 8.9%. Potash varies from 0.3 to 1.0% calcium oxide ranges from 0.6 to 3.0% and carbon varies from 0.50 to 1.0%. Blasco (1977) states that about 40 to 60% of the soil of this region is silts; organic matter varies between 1% to 1.5%, pH is about 8 (alkaline) and exchangeable bases high. (Ca++, Mg++,K+,Na+). In areas of heavy rain and rapid drainage the nitrogen content of the soil decreases and the organic component increases.

The salinity of the surface soil and the adjoining water bodies change to a great extent throughout the year and is governed mainly by the quantity of fresh water flow. Monsoonal rainfall is also another affecting factor. On the basis of salinity in the soil, the soil types of the district can be categorised as (1) Saline Soil is formed where there is inundation or flushing of brackish water and is found in the flood plains of the river and creeks. Saline soils have three phases (a) Inundated Phase, (b) Phase rich in Calcite (CaCo3), and (c) Phase rich in dolomite (CaCo3, MgCo3) (2) Saline Alkali Soils is formed when the sodium salts flood a fresh low land enriched with alkali and sodium ions. Sometimes rain water completely removes the salt and makes the soil of the region (3) Non-Saline Alkali. Hence Saline Alkali Soils may have tidal or non-tidal phases. Saline alkali soils also have 3 phases (a) Rain water washed phase, (b) Sea water washed phase and, (c) Active Delta
forming phase (4) Degraded Saline Alkali soils or Saline Turf soil is formed in the presence of decomposed organic matter. Organic acids and high salt content form saline unsaturated soils. These soils too have 3 phases (a) Inundated forest phase, (b) Cultivated area (above sea level) phase, and (c) cultivated area (below sea level) phase. (The physico-chemical characteristics of coastal soils of the district is given in the Appendix II.5).

Bhattacharjee\textsuperscript{19} (1972) has studied the soil samples of the district. Saline soils have been noticeable in the blocks of Falta, Jaynagar, Mathurapur, whereas Saline Alkali Soils are found in the Sagar Island, Kakdwip and in Namkhana - Fraserganj. Limited amounts of Saline - Alkali soils is also noticeable in part of Kulpi, Mathurapur and in Canning.

Non-Saline Alkali soils have been traced in patches in Mathurapur and degraded alkali soils in the vicinity of Port Canning.

2.7 FLORA AND FAUNA

The flora or natural vegetation of the district today is confined only to the forested tracts of the Active Delta, popularly known as the Mangrove Tidal Forests of the Sundarban Delta; with noted halophytic conditions. (Appendix II.6).
Salinity, sandy soil, nutrients, weather hazards, cyclones, floods and above all human interference have all obstructed plant survival in this area. Therefore, only those species that have adapted themselves with high salinity, fine clayey soils and tidal currents have thrived best. The Mangrove community is characterised by (a) the stilt roots which both support the plants and their means of respiration. The Garjan (Rhizophora apiculata), Genwa (Excoecaria agollocha) and Jelegaren (ceriaps decandra) are examples of such plants. (b) Another noticeable feature is the presence of pneumatophores (breathing roots) of plants such as the Kalabaen (Avicennia Marina), Keora (Sonneratia Apetala), Sundari and Passur (Xylocarpus mekongensis), (c) Plants such as the Khalsi (Aegeceras Carniculatum), Tora (Aegialitis rotundifolia) and Kala baen have salt - excretory glands, (d) The cell sap develops high osmotic pressure which helps the plants to draw water from the concentrated soil solution, (e) All these plants have Viviparous germina-
tion (no time gap between the formation of seed and the development of the embryo).

A wide group of the grasses, shrubs and sedges native to the initial vegetation after land evolution in these parts are also associated with the mangroves. The "Dhani" grass (Porterasia Coarctata) and the Baruna grass (Sesuvium
portula castrum) grow on fresh deposits of silt alongside the forests on freshly formed islands in the middle of rivers. Herbaceous growth is strangely absent. Plants of Genwa and Jelegaran species account for about 70% of the plant species.

The Mangrove forests are adapted to a special kind of 'ecological niche' studied widely by various scientists. Prain (1903) arranged the Sundarban forests mainly into 3 categories (1) Southern coastal area with dominant mangroves (2) Central zone dominated by the Sundari and (3) North Eastern part dominated by grasses. Curtes (1933) classified the forest cover into (1) Fresh water forest, (2) Moderately salt water forests and (3) Salt Water Forests. Champion (1936) divided the forests into 4 types, (1) Low Mangrove forests, (2) Tree mangroves, (3) Salt water and (4) fresh water forests. Champion and Seth (1968) modified this division into 5 types as (1) Mangrove scrub, (2) Mangrove forest, (3) Salt water mixed forest, (4) Brakish water forests and (5) Palm swamps. Rao and Sastry (1972, 74) proposed a modification of the former classification; dividing the Mangroves firstly into 2 broad groups as (1) Euestuarine and (2) Proestuarine. The proestuarine group has again been divided into (i) Tidal mangrove, (ii) Euhyline and (iii) Prohyline zones according to the topography and other edaphic factors. Chakravarty (1979) has divided the
forest into (1) High tide, (2) Above the general tide level, (3) Frequently inundated by salt water and (4) Below tide level. Naskar and Guha Bakshi (1982) have grouped the plant species into 4 major forms (1) Sea face or Beach forest, (2) Formative island flora, (3) Flora of the reclaimed and lowlying cultivated zone and (4) Swamp forests.

In general therefore the normal pattern of vegetation in an estuarine delta, distribution of mangrove communities on tidal flats depends on the tidal intensity, the type of sediments and salinity. Three distinct zones of vegetation therefore can be recognised as (a) A true estuarine zone, comprising the estuarine banks along the mouths of the rivers is mainly, dominated by the 'Kala Bean', 'Tora' and 'Krippa'. These species tolerate high salinity and submergence either by developing salt excreting glands or by increasing water storage tissues in their leaves, and develop soft and porous pneumatophores (b) A middle estuarine zone dominated by Garjan, Jelegaran and the taller Keora. Here salinity is lower than the true estuarine mouth, but the tidal current passing through the narrow creeks and channels is higher. Mangroves adjust to these habitats by producing stilt roots; and pneumatophores are soft and porous. (c) An inner estuarine or riverine zone comprising elevated areas with less aerated soil and more fresh water flow, is domi-
nated by the Sundari, Genwa, Kankra (Bueguiera Sexangula) and the Golepata (Nypa fruiticans). These species usually prefer more fresh water and develop hard pneumatophores to adjust to less aerated soil. This original zonation is sometimes lost due to erosional undercutting causing exposure of inner estuarine types along the mouth.

The flora of those forests has been facing tremendous exploitation. Over the years the "Sundari" trees (from which according to some scholars the Sundarban derive its name), noted for its valuable timber has been over-exploited. Secondly the greater part of the inner estuarine zone has become more saline due to lack of fresh water (though some of Ganga fresh water is received by the Hugli from the Farakka Barrage) and the Sundari, which prefer less saline soil, do not proliferate these days.

Of the forest products, golepata is used as roofing material for rural houses; Sundari and Passur as also Dhundul, Garjan, Tora and Mathgaran is used for house posts. Garan, Tora, Garjan, Kankra and Hental (Phoneix paludosa) are used as rafters. Branches of Garan are used for wattle. Sundari wood is good for making boats. The most favoured fuels are Garan, Khalsi, Baen and Singara. In addition some mangrove trees of the region give shelter to migratory rock bees from the Himalayas to build many beehives. On an average 500 quintals of honey and 30 quintals of wax are
been collected from these forests.

The fauna of these forests play generally **amphibious role**. The food-chain (Map No. 2.6), of the Sundarbans brings into focus the factor that the famous Royal Bengal Tiger is at the apex of the hierarchy of terrestrial as well as aquatic animals. Here the tiger's prey includes pig, deer, monkey, water monitor, bird, crab and fish.

The Sundarbans is one of the tiger reserves having the largest tiger population of India and where Project Tiger (Appendix II.7) was launched in 1973 to save the tiger from extinction. The Sundarbans Tiger Reserve covering 2585 Sq.km. over the whole of South Twenty four Parganas had 135 tigers at that time, has 264 (1984 Census) at present, the annual rate of growth being 8.7% \(^{21}\). There are also two more Sanctuaries at Halliday and Lothan Islands. There are no major co-predators to share the source of food with the tiger even adapted to swimming and drinking honey from the beehives.

The jungle cat (Felis chaus) and the civet cat (Viverra zibatha) and the fishing cat (Felis Viverina) are found in plenty. The chital or the axis deer (Cervus axis) has been estimated to be 30,000 in the forest. Besides the rhesus monkey, barking deer, wild pig, otter, water monitor are also prominent.
Food Chain In The Mangrove Ecosystem

[Diagram showing the food chain in the mangrove ecosystem, including organisms like tiger, lesser cats, herbivores (monkey, deer, pig), crocodiles, birds, predator fish, crustaceans, mollusks, insects, chelonids, zooplankton, phytoplankton, organic detritus, and mangrove vegetation.]

Map No. 2.6. Source: Coast Zone Management, West Bengal.
The fluvial habitats of the region are utilized by the estuarine crocodile (now also being reared here in the crocodile project) sharks, dolphins and crabs. Of the snakes, the king cobra, common cobra, banded krait, russel's viper and some sea snakes are venomous while the python is the most prominent non-venomous snake of the forest.

The Sajnekhali Bird Sanctuary is alive with birds specially during the monsoon. The open bill stork, little egret, large egret, grey heron, purple heron, night heron and cormorant are the local birds whereas the pelican is migratory. Besides these forests are also the abode of local birds as the stork, lapwing, dove, parakeet, cuckoo, etc. Fishes abound in the nutrient enriched creeks and so prawn farming and fishing are very important activities.

2.8 GEO-ECOLOGICAL REGIONS

The regional concept though based on mental judgement has long been regarded as "inherently geographic work"22. Much debate has been undertaken right from Hettner, Whittlesey to more recent scholars like Woolridge and East, C.C. Carter, I.G. Joerg, K. Young, Stamp and Baker, Mathieson, Roger Minshull23 and Indian authors like K.S. Ahmad, Pithawala, Asok Mitra, and R.L. Singh24, on this topic. In view of the above national complexities the present regionalization scheme has been attempted to incorporate the
various distinguishing and meaningful regional factors and assess their role in different subregions in this area.

Based on the physical and ecological parameters an attempt has been made here to classify South Twenty Four Parganas (a part of the Ganges-Hugli Delta), into different regions. (Table 2.4)

I. **The Stable Delta of the North**; comprising of slight higher elevations and the land of sluggish rivers and depressions\(^2\text{5}\) in contrast to the

II. **The Active Delta of the Southern part**; comprising a composite of tidal channels, rivers, creeks, islands. (Map No. 2.7)

Each of these two broad divisions can be further subdivided based on micro variations as (I) The stable Delta of the North can be divided into (i) **The Western Hugli Side Flats**; comprising a narrow strip of flat alluvial land along the stretch of the Hugli in the west, (ii) **The Mature Delta of the Hugli** in the Middle bordering the Hugli Side Flats, sloping southwards, and (iii) **The Piyali - Bidyadhari Plains** in the East also forming a plain area with land sloping to the south. This region is also characterised by swamps and marshes of which Salt water Lake (Dhapa) is one of the best examples.

II. The Active Delta of the South (known popularly as the Sundarbans), lying to the South of the Stable Delta can
again be classified into 3 subregions.

(iv) The **Western Sundarban Margin**, comprising of the Active Mouth of the Hugli; exposed under a set of different ecological factors. (v) The **Middle Sundarbans** and the Fringes of the Active Delta (Bordering the Mature Delta of the North) and finally the (vi) **Eastern or Interior Sundarbans** comprising of dense forested tracts and saline soils lying in juxtaposition with the international boundary (Bangladesh); and separating the Bangladeshi Sundarbans from the Indian counterpart.

<table>
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<tr>
<th>TABLE - 2.4</th>
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<tr>
<td><strong>A GEO-ECOLOGICAL CLASSIFICATION OF SOUTH 24 PARGANAS</strong></td>
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The Ganga Delta

<table>
<thead>
<tr>
<th>I. The Stable Delta of the North</th>
<th>II. The Active Delta of the South or the Sundarbans</th>
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<tr>
<td>(i) Western Hugli Side Flats</td>
<td>(ii) Middle Hugli Maturc Delta</td>
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<tr>
<th>(iv) The Western Sundarbans Margin</th>
<th>(v) Middle Sundarbans Comprising Fringes of the Active Delta</th>
<th>(vi) Eastern Sundarbans of Dense Tidal Forested Tracts.</th>
</tr>
</thead>
</table>

(Classification is based on physical and ecological factors)
For simplicity and data computation, the regional divisions consist of separate blocks of the district given as follows -

(i) The Western Hugli Side Flats consist of blocks of (1) Thakurpukur-Metiaburuz, (2) Maheshtala, (3) Budge Budge, (4) Falta, (5) Diamond Harbour and (6) Kulpi;


(iii) The Piyali Bidhyadhari Plains of the Eastern part of the district falls in the (13) Bhangar and (14) Canning blocks;

(iv) The Western Sundarban Margin consists of 3 blocks of (15) Sagar Island, (16) Kakdwip and (17) Namkhana;

(v) The Middle Sundarbans consist of again (18) Mathurapur and (19) Patharpratima and finally

(vi) The Eastern Sundarbans also comprises of 3 blocks of (20) Kultali, (21) Basanti and (22) Gosaba.

In total the Hugli Deltaic South 24 Parganas cover 22 blocks of 1991 census, or former police stations of 1981 census.
The characteristics and attributes of area, population and settlements of the District has been portrayed in Table 2.5 which depicts a marked contract between the Stable and the Active Delta or the Sundarbans. The Middle Mature Hugli Delta is the largest subregion in areal extent exemplified by contributing 20.91% of the total area, and also contributes the highest proportion of human numbers i.e.
33.92% in 1991. Within the Active Delta, the Western Sundarbans depicts the largest areal size i.e. 19.06% but the lowest population size of 8.21% only.

Population density figures reveal the highest 1991 density of 1914/Sq.Km in the Western Hugli Side Flats and the lowest i.e. 393/Sq.Km again in the Western Sundarbans. The highest growth rate of population is seen in the Piyali-Bidyadhari Plains having a 1981-1991 growth rate of 36.58%. The Eastern Sundarbans reveal the lowest rate of 19.70%. Sex -Ratio figures in general are in the favour of males but lower figures are noticeable in the Stable Delta.

The total number of settlements of the district has exhibited a rise from 2124 in 1981 to 2151 in 1991. The highest number or 803 settlements occur in the Middle Mature Hugli Delta, followed by 618 settlements of the Western Hugli Side Flats. The lowest number of settlements, all villages, 122 in number are seen in the Western Sundarbans.
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<tr>
<th>GEO-ECOLOGICAL REGION</th>
<th>NAME OF THE BLOCK</th>
<th>AREA (Sq.Km)</th>
<th>PROPORTION OF AREA OF VILLAGES (inhabited)</th>
<th>NUMBER OF VILLAGES</th>
<th>NUMBER OF TOWNS</th>
<th>TOTAL NO. OF SETTLEMENTS (Sq.Km)</th>
<th>AVERAGE AREA PER SETTLEMENT (Sq.Km)</th>
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| TOTAL                 |                  |              |                                           |                   |                |                                 |                                  |

| DISTRICT TOTAL        |                  |              |                                           |                   |                |                                 |                                  |
|------------------------|----------------------|--------------------|------------------------------------|------------------------------|--------------------------|
| Stable Delta           |                      |       |       |       |       |       |       |       |       |       |       |       |       |
| (I) The Western        |                      |       |       |       |       |       |       |       |       |       |       |       |       |
| Hugli-Side             | Thakurpukur - Metiaburuz Flats | 110.606 | 176.456 | 2.51  | 3.03  | 3655  | 5514  |      |      |      |      |      |      |
|                        | Maheshtala           | 194.094 | 331.142 | 4.41  | 5.68  | 3655  | 5514  |      |      |      |      |      |      |
|                        | Budge Budge          | 295.350 | 342.924 | 6.71  | 8.88  | 2073  | 2406  |      |      |      |      |      |      |
|                        | Falta                | 161.181 | 199.596 | 3.66  | 4.32  | 1188  | 1471  |      |      |      |      |      |      |
|                        | Diamond Harbour      | 229.167 | 288.601 | 5.21  | 9.95  | 1167  | 1470  |      |      |      |      |      |      |
|                        | Kulpi                | 167.640 | 211.851 | 3.81  | 3.63  | 669   | 669   |      |      |      |      |      |      |
| TOTAL                  |                      | 1,158.038 | 1,550.570 | 26.32 | 26.60 | 1429  | 1914  |      |      |      |      |      |      |
| (II) The Middle        | Sonarpur             | 241.434 | 346.520 | 5.49  | 5.94  | 1414  | 2030  |      |      |      |      |      |      |
| Mature Delta           | Bishnupur            | 287.811 | 357.253 | 6.54  | 6.13  | 1349  | 1624  |      |      |      |      |      |      |
| Of The Hugli           | Baruipur             | 230.238 | 312.071 | 5.23  | 5.35  | 1073  | 1455  |      |      |      |      |      |      |
|                        | Mograhat             | 318.136 | 419.464 | 7.23  | 7.19  | 1247  | 1644  |      |      |      |      |      |      |
|                        | Nandi Bazar          | 126.947 | 159.585 | 2.89  | 2.74  | 1082  | 1360  |      |      |      |      |      |      |
|                        | Jay Nagar            | 254.478 | 382.823 | 5.78  | 5.67  | 698   | 845   |      |      |      |      |      |      |
| TOTAL                  |                      | 1,459.043 | 1,977.716 | 33.16 | 33.92 | 1093  | 1481  |      |      |      |      |      |      |
| (III) The Piali-Biyadhari Plains (East) | Sonarpur | 248.071 | 330.613 | 5.64  | 5.67  | 1414  | 2030  |      |      |      |      |      |      |
|                        | Canning              | 248.754 | 347.930 | 5.65  | 5.97  | 1414  | 2030  |      |      |      |      |      |      |
| TOTAL                  |                      | 496.825 | 678.543 | 11.29 | 11.64 | 632   | 863   |      |      |      |      |      |      |
| Active Delta           |                      |       |       |       |       |       |       |       |       |       |       |       |       |
| (IV) The Western       | Sagar Island         | 115.228 | 154.190 | 2.62  | 2.64  | 198   | 265   |      |      |      |      |      |      |
| Sundarbans             | Kakdwip              | 166.777 | 227.692 | 3.79  | 3.91  | 350   | 473   |      |      |      |      |      |      |
| Margin                 | Namkhana             | 74.156  | 96.750  | 1.69  | 1.66  | 464   | 605   |      |      |      |      |      |      |
| TOTAL                  |                      | 356.161 | 478.632 | 8.09  | 8.21  | 293   | 393   |      |      |      |      |      |      |
| (V) The Middle         | Mathurapur           | 244.609 | 314.870 | 5.56  | 5.40  | 400   | 515   |      |      |      |      |      |      |
| Sundarbans             | Pathar Pratima       | 197.866 | 245.821 | 4.49  | 4.22  | 408   | 507   |      |      |      |      |      |      |
| TOTAL                  |                      | 442.295 | 560.691 | 10.05 | 9.62  | 403   | 511   |      |      |      |      |      |      |
| (VI) The Eastern       | Kultali              | 147.147 | 156.450 | 3.34  | 2.68  | 407   | 433   |      |      |      |      |      |      |
| Interior               | Basanti              | 172.353 | 226.974 | 3.92  | 3.89  | 421   | 554   |      |      |      |      |      |      |
| Sundarbans             | Gosaba               | 168.335 | 200.514 | 3.82  | 3.44  | 453   | 540   |      |      |      |      |      |      |
| TOTAL                  |                      | 487.835 | 583.938 | 11.09 | 10.01 | 427   | 511   |      |      |      |      |      |      |
| District Total         |                      | 4,400.197 | 5,830.090 | 100   | 100   | 689   | 913   |      |      |      |      |      |      |

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<tr>
<th>GEO-ECOLOGICAL REGION</th>
<th>NAME OF THE BLOCK</th>
<th>SEX RATIO (NO. OF FEMALES PER 1000 MALES)</th>
<th>AVERAGE POPULATION PER SETTLEMENT</th>
<th>PROPORTION OF SCHEDULED CASTES TO TOTAL POPULATION 1981</th>
<th>PROPORTION OF SCHEDULED TRIBES TO TOTAL POPULATION 1981</th>
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<tbody>
<tr>
<td>1. Thakurpukur - Metiaburuz FLATS</td>
<td>1. Thakurpukur - Metiaburuz FLATS</td>
<td>20 21</td>
<td>22 23</td>
<td>24 25</td>
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<td>930 933</td>
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**ACTIVE DELTA**

| THE WESTERN SUNDARBAN | 15. Sagar Island | 950 946 | 2119 3352 | 26.67 28.44 | 0.36 0.35 |
| 16. Kakdwip | 948 1017 | 3475 4744 | 29.10 33.74 | 0.68 0.49 |
| 17. Namkhana | 947 947 | 2648 3455 | 25.22 26.28 | 0.47 0.55 |
| TOTAL | 948 979 | 2968 3923 | 27.51 30.32 | 0.53 0.46 |
| THE MIDDLE SUNDARBANS | 18. Mathurapur | 932 927 | 2022 2519 | 29.00 35.25 | 1.06 0.99 |
| 19. Pathar Pratima | 944 952 | 2299 2731 | 23.95 25.92 | 0.78 0.75 |
| TOTAL | 937 938 | 2137 2608 | 29.91 31.16 | 0.93 0.89 |
| THE EASTERN SUNDARBANS | 20. Kultali | 937 943 | 2885 3068 | 48.53 50.27 | 2.69 2.81 |
| 21. Basanti | 947 950 | 2652 3388 | 41.48 41.75 | 6.26 6.00 |
| 22. Gosaba | 934 941 | 3368 4010 | 64.13 65.04 | 9.71 9.82 |
| TOTAL | 939 945 | 2939 3476 | 51.42 52.03 | 6.37 6.46 |
| DISTRICT TOTAL | 929 937 | 2047 2658 | 34.71 33.93 | 1.30 1.21 |

**SEX RATIO**

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In general the highest number of villages, 789 in number, occur in the Middle Mature Delta, whereas the lowest i.e. 122 occur in Western Sundarbans. The Active Delta in general has no town or cities. Within the Stable Delta the highest number of towns i.e. 27 in number occur in the Western Hugli Side Flats. Again average area per settlement is greater in general in the Active Delta, being largest in the Western Sundarbans, being 9.98 Sq.Km. in 1991 and smallest in the Stable Delta, being 1.31 Sq.km. in the Western Hugli Side Flats. The average population per settlement also portrays a similar picture.

The Scheduled Castes and Tribes are more concentrated in the Active Delta, the Eastern Sundarbans depict the highest i.e. 52.03% of Scheduled castes in 1991, and 6.46% of the Scheduled tribes in 1991. The lowest proportions of castes and tribes in 1991 are noticeable in the Western Hugli Side Flats and the Middle Mature Hugli Delta respectively. Literacy figures of 1991 reveal the highest in the Western Hugli Side Flats, being 50.62% and the lowest in the Piyali-Bidyadhari Plains i.e. 32.98%. Again the work participation rates reveal higher rates in the Active Delta in comparison to the Stable Delta; the highest rate of 1991 being seen in the Western Sundarbans i.e. 33.05%.
In terms of area, population growth rates, settlements and literacy, the Middle Mature Delta of the Hugli and the Western Hugli Side Flats constitute two important subregions of the Stable Delta that stand ahead of others.

2.9 CONCLUSION:

From the above study it can therefore be concluded that the Geo-Ecological characteristics of South 24 Parganas are responsible for regional contrasts in the district. The coastal area is a typical littoral type with deltaic estuarine and tidal complicacies. Recently, the entire area of the Sundarbans, south of the Dampier - Hodges line has been declared as a "Biosphere Reserve" - the fifth one in the country. From the margin of the coast towards the interior of the district, changing natural environments and ecosystems are observed. The littoral margin has high salinity, periodic inundations, storms, forests and wild animals. Even within this region, micro contrasts arise from the west to the East. All these factors contribute to marked variation in the characteristics of settlements in the region.

REFERENCES


6. ibid., pp. 8-9.


8. **Mitra Ashok** (1951) Census of India, op.cit. pp. IV and V.


14. ibid, pp. VII - VIII.


18. ibid., pp. 19-22.


20. ibid., pp. 38-41.


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