Chapter-III

Description of Study Area
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Goa the smallest state in India with a geographical area of 3702 km², is the prime tourist destination of the world often called as “Rome of East” because of its picturesque beauty. It has coastline that extends up to about 105 km, more than 70 km comprise of sandy beaches located at Latitude14°54’33”N and Longitude74°47’27”E (Southern Border) and Latitude15°43’30”N and Longitude73°40’43”E (Northern Border) N on the west coast of India. It is bounded by the Sindhudurga districts of Maharashtra in the North, Belgaum & Dharwad districts of Karnataka along the East, Uttara Kanada in the south and Arabian Sea to the West. Goa is broadly divided into three main sub regions.

1. Mountainous regions of the Western Ghats towards the East
2. The Interior Highlands
3. The Coastal Plains towards West.

Of these, the Coastal Plains is the most sensitive region in the State.

The coastal strip is highly indented with sea cliff, notches and promontories alternating with rivers, sandy beaches, separated rocky shores, and estuaries. The pre-Cambrian dharwar and cuddapah rocks occupy a large coastal area. Climatologically this region shows three season pre monsoon (Feb-May), monsoon (June-Sept) & post monsoon (Oct-Jan). Annual rainfall is 100cm-200cm along the Goa coast which causes heavy erosion followed by accreditation at most river mouth, Tropical climate prevails and air temperature varies from 18 to 34°C. Humidity ranges between 75% and 95%. The tidal amplitude is noticed in all the rivers. The impact of wave action is moderate to strong.

There are 10 rivers out of which seven are major dynamic rivers, most with mouth devoid of any mangroves as a result of rocky substratum, strong wave action and currents. These conditions are unfavorable for the establishment of mangrove seedlings and three minor rivers with luxuriant mangrove patches and
Kumarjua canal is the only connection between Zuari and Mandovi River. Most of the rivers which cut across hinterland formations, originate in the Western Ghats.

**Terekhol estuary:** The Terekhol River runs about 27 km in length covering approximately 349 hectares of water area in Goa territory. Salinity influences in this river was seen 20 km from river mouth region up to Naybag. The mangrove vegetation of this estuary covers about 45 hectares, i.e. approximately 12.89 % of the total water area of the river.

**Chapora River:** The River originates from a small village in Maharashtra called Hajgoli near Belgaum and then it flows through the Tilari Ghat and enters Goa. It divides North Goa talukas Pernem and Bardez. The river flows into Arabian Sea of the Indian Ocean. At the estuary to the south is situated the popular tourist destination Vagator Beach. To the north is the village Morjim. The Chapora River is approximately 30km in length with total; water area of about 711 hectares. The mangroves have occupied about 145 hectares i.e. 20% of the total water area. Mangrove vegetation appears approximately 1.5 km from the estuary mouth. The salinity influence is observed beyond colvale which is 18-20 km from the mouth.

**Baga River:** Baga River has its source in the dense mixed jungles of Assagao. This 12 km long river system has 7 hacters of fringing type mangrove on ether side of river bank i.e. 58% of the total water area. The River flows finally into the Arabian Sea at Baga.

**Mandovi estuary:** The Mandovi River is the largest river in Goa. This is also known as Mahadayi or Mhadei River. It is described as lifeline of Goa. The river has a length of 77 kilometers, 29km in Karnataka and 52 kilometers in Goa, It originates from a cluster of 30 springs at Bhimgad in the Western Ghats in the Belgaum district, Karnataka. The river has 2032 sq km catchment area in Karnataka while 1,580 sq km catchment area in Goa. The Mandovi enters Goa from the north via the Sattari Taluka with its five tributatries and eventually
pouring into the Arabian Sea. This estuary is about 3 km wide at the mouth with sandy beaches on either banks at Miramar and Verem. The effect of salinity gradually decreases upstream towards Savaiverem. Mandovi joins with the Zuari at a common point at Cabo Aguada, forming the Marmogoa harbour and the Cumberjum Canal links both rivers. Three large freshwater island; Divar, Chorao and Vashee are present in the Mandovi near the town of Old Goa. The island of Chorao with mangroves is home to the Salim Ali Bird Sanctuary. The salinity influence is notice upto Savaiverem, b e y o n d w h i c h mangroves are absence. The estimated mangroves area of this estuary is about 934 hectares. Mapusa River is a tributary of the River Mandovi. The river originates from the jungles of Dumarem and Amthane, meanders eastward and then southward before it drains itself in the Mandovi River at Penha de Franca. The Mapusa River has separated Corjuem from mainland Aldona.

**Zuary estuary:** Zuari has a total length of 64 km. The Zuari originates at Hemad-Barshem in the Western Ghats. It flows in the southern-western direction through the talukas of Sanguem, Quepem, Salcete, Ponda, Tiswadi and Mormugao. The Zuari Bridge connects villages of Agaciam, on the north of river bank and to Cortalim on the southern bank of Zuari River. It has water spread area of 5790 hectares, out of which 1175 hectares have been occupied by mangroves. The mouth region is about 6-7 km wide while the upstream region narrows down to less than 0.5km. Zuari is a negative estuary with more freshwater influx. The effect of salinity is marked upto Savordem, which is around 28 km from the estuary mouth; beyond which fresh water environment results in the absence of mangroves. The first 5-6 km of the estuary from Dona Paula to Siridao head and from Vasco to St Jacinto Island on the northern and southern banks respectively is devoid of mangroves because of strong wave action, currents and rocky substratum. Beyond Siridhone (Santana), both the sides of river banks have beautifull patches of mangrove vegetation.

**Cumberjua canal:** Cumberjua canal connects the Mandovi and Zuari estuaries. It is approximately 15 km in length and 30 to 400 m in width. It has about 375
ha of water area. Cumbarjua canal on the either side has mud flats with fringing mangroves. Mangrove area found along this canal is about 248 ha, which around 66.13% of total water area. The mangrove vegetation is quite thick at the end of cumbarjua canal towards the Zuari estuary. Seedling establishment is more common along the canal because of feeble wave action, current and suitable substratum. The intertidal expanse of muddy nature ranges from 5-15 m along the Cumbarjua canal.

**Sal River:** The River opens near Cavelossim. It passes through Margao, Navelim, Dramapur, Chinchinim, Assolna and drains itself into the Arabian Sea at Betul, Goa. Sal River is the third largest river with 35 km length out of which 45% area is occupied by mangroves; it is the only river that follows a North-South direction before meeting the Arabian Sea at Betul.

**Saleri:** It has water area of 11 ha and 8 km in length. The thick mangrove patches are seen at the river mouth and on river bank which cover an area of 5 ha that is 45% of total area, which has its origin at Karmal Ghat, Western Ghats and winding its way to the Arabian Sea.

**Pallolem:** Pallolem River is the smallest river of Goa and it has mangrove coverage of 3 ha with water area of 7 ha and the total length of 5 km and on southern side it touches world famous pallolem beach and on the northern side with lusky green patch of terrestrial forest.

**Tolpona:** Talpona River is about 19 km in length and has occupied the water area of 50 hectares, mangrove vegetation has covered about 14 ha which is about 28% of the total water cover.

**Galgibaga:** Galgibaga River is about 16.5 km in length and has approximately 28 ha of water area. The mangrove vegetation has occupied about 23 ha which comes to 82.14% of the total water coverage. Even though this is the smaller estuary, mangrove vegetation was quite dense, as compared to mangrove cover in other estuaries of Goa.
Table 1: Latitude and longitude of substations studied under each station.

<table>
<thead>
<tr>
<th>STATIONS</th>
<th>Substation 1 (Lat. and long.)</th>
<th>Substation 2 (Lat. and long.)</th>
<th>Substation 3 (Lat. and long.)</th>
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<tbody>
<tr>
<td>Terekhol</td>
<td>15°43'44.68''N &amp; 73°42'44.68''E</td>
<td>15°43'18.42''N &amp; 73°43'40.58''E</td>
<td>15°44'04.34''N &amp; 73°44'14.86''E</td>
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<td>Chapora</td>
<td>15°37'27.73''N &amp; 73°44'57.71''E</td>
<td>15°39'00.65''N &amp; 73°47'43.40''E</td>
<td>15°38'59.53''N &amp; 73°50'11.53''E</td>
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<td>Baga</td>
<td>15°33’51.43’’N &amp; 73°45’01.14’’E</td>
<td>15°33’58.77’’N &amp; 73°45’05.49’’E</td>
<td>15°34’08.06’’N &amp; 73°45’18.13’’E</td>
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<td>Mandovi</td>
<td>15°31’28.47’’N &amp; 73°51’32.45’’E</td>
<td>15°30’30.35’’N &amp; 73°54’42.41’’E</td>
<td>15°31’43.85’’N &amp; 73°58’13.63’’E</td>
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<td>Cumbarjua</td>
<td>15°22’19.06’’N &amp; 73°55’35.71’’E</td>
<td>15°27’38.25’’N &amp; 73°57’13.47’’E</td>
<td>15°30’53.34’’N &amp; 73°57’01.51’’E</td>
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<td>Zuari</td>
<td>15°24’26.76’’N &amp; 73°53’32.23’’E</td>
<td>15°22’19.13’’N &amp; 73°57’33.21’’E</td>
<td>15°20’06.17’’N &amp; 74°00’18.13’’E</td>
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<td>Sal</td>
<td>15°10’23.80’’N &amp; 73°57’40.38’’E</td>
<td>15°11’25.70’’N &amp; 73°58’40.13’’E</td>
<td>15°12’02.45’’N &amp; 73°58’09.66’’E</td>
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<td>Saleri</td>
<td>15°03’18.09’’N &amp; 73°58’53.65’’E</td>
<td>15°03’16.21’’N &amp; 73°59’02.14’’E</td>
<td>15°03’19.95’’N &amp; 73°59’02.50’’E</td>
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<td>Pallolem</td>
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<td>15°01’06.89’’N &amp; 74°01’03.67’’E</td>
<td>15°01’03.41’’N &amp; 74°01’05.59’’E</td>
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<td>Tolpona</td>
<td>14°59’11.16’’N &amp; 74°02’50.99’’E</td>
<td>14°59’16.81’’N &amp; 74°03’18.89’’E</td>
<td>14°59’37.35’’N &amp; 74°03’30.95’’E</td>
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<td>Galgibaga</td>
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<td>14°58’05.74’’N &amp; 74°03’28.87’’E</td>
<td>14°58’17.94’’N &amp; 74°03’46.70’’E</td>
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Plate 1: Terekhol River

a) Map of Terekhol River.

b) Mangrove Island at Substation 2 of Terekhol River.
Plate 2: Chapora River

a) Map of Chapora River.

b) Mangrove Island at mouth of Chapora River.
Plate 3: Baga River

a) Map of Baga River.

b) Substation 3 of Baga River.
Plate 4: Mandovi river, Cumbarjua canal and Zuari river.

a) Mandovi River (Northern side), Zuari River (Southern side) and Cumbarjua canal (Connecting both the rivers).

b) Substation 2 of Mandovi River.
Plate 5: Substations of Cumbarjua canal and Zuari River.

a) Substation 2 of Cumbarjua canal.

b) Substation 2 of Zuari River.
Plate 6: Sal River

a) Map of Sal River.

b) Substation 3 of Sal River.
Plate 7: Saleri River

a) Map of Saleri River.

b) Substation 2 of River Saleri.
Plate 8: Pallolem River

a) Map of Pallolem River.

b) Substation 1 of Pallolem River.
a) Map of Tolpona River.

b) Substation 1 of Tolpona River.
Plate 10: Galgibaga River

a) Map of Galgibaga River.

b) Thick patch of mangroves near Railway Bridge at Galgibaga River.