CHAPTER 3

3.0 COASTAL GEOMORPHOLOGY

3.1. GENERAL STATEMENT

The coast is the interface between sea and land where constant changes have been taking place ever since the commencement of exogenic processes around the Earth’s surface. These changes include marine transgression and regression, sediment erosion and accretion, and shifting of confluences/mouths/openings between sea and the connected inland water bodies. The coast is vulnerable to natural hazards such as river floods of varying intensity and cyclones of varying intensity and tsunamis taking place rarely. Coastal areas are marked by variety of ecosystems such as barrier spits and islands, coastal estuaries/lagoons, confluences/mouths/openings between sea and inland water bodies, mudflats, and sandy shores.

The mouths in this transitional environment allow for movement of seawater and sediments into the coastal water bodies during high tides/cyclones/tsunamis leading to closure of the existing mouths; and movement of inland waters/sediments from coastal water bodies into sea during low tides/river floods leading to opening of new mouths.

To understand coastal geomorphology, an understanding of tidal changes is necessary. Tides are the rise and fall of sea levels of different amplitudes at different times and are influenced by the alignment of the Sun and Moon, rotation of the Earth, the pattern of tides in the deep sea, various types of water circulations within the sea, the shape of the coastline and near-shore bathymetry. Some shorelines experience semi-diurnal tide with two almost equal high tides and two low tides each day. Some locations experience only diurnal tide with one high and one low tide each day. Some locations experience mixed tide with uneven tides. This data could be used meaningfully in conjunction with the Google Earth images if only
Google Earth provides in the public domain the exact time of capturing of satellite images together with the date of capture. The local fishermen living for generations at the same place near coast however possess a good knowledge on these tidal changes to plan their fishing operations safely for obtaining good catch.

For the purpose of studying the coastal geomorphology of the study area, the study area is divided into the following five regions.

1. Buckingham Canal linking Kandaleru River in the north and Swarnamukhu River in the south and passing towards west of the coast at a maximum distance of 4 km,

2. The region bordered by the Swarnamukhi River mouth in the south,

3. The region marked by the Kandaleru River mouth in the north,

4. The region marked by extensive development of barrier islands-cum-lagoons north of the Swarnamukhi River mouth, and

5. The barren region south of Kandaleru River mouth and north of barrier islands-cum-lagoons.

An effort has been made in this chapter to describe these coastal features in a greater detail.

3.2. BAY OF BENGAL

The Bay of Bengal, the largest bay in the world connected with the Indian Ocean and surrounded by India, Bangladesh, Thailand, Myanmar, Indonesia, Malaysia and Sri Lanka, has long gently sloping shelves with shallow water depths. It has a maximum length of 2,090 km, maximum width of 1,610 km, surface area of over 2.17 million sq km, maximum depth of 4,694 m and average depth of 2,600 m. The sea currents flow towards north to northeast in
a clockwise circulation pattern known as "East Indian Current" from January to August. In the remainder of the year, the flows are towards south to southwest in a counter-clockwise pattern known as “East Indian Winter Jet” that experience occasional severe cyclones and storm surges (Murty and Flather, 1994), which in turn bring cloudburst rains and flash floods in the rivers Kandaleru and Swarnamukhi for a few days in a year.

It is noted that the height of a storm surge near a point where the cyclone crosses the coast depends on the elevation of that point, intensity of the cyclone (i.e., very high pressure gradient and consequent high wind velocity) and timing of the cyclone in relation to astronomical high tide with peak surge occurring when a cyclone crosses at the time of high tide. According to the Regional Meteorological Centre of Mumbai, the coast between Ongole in Andhra Pradesh towards north to Nagapattinam in Tamil Nadu towards south that includes the entire study area is less vulnerable to high storm surges (http://www.imdmumbai.gov.in/scripts/detail.asp?releaseId=E0000CY5).

The topography of India is such that most rivers of India such as the rivers Ganga, Brahmaputra-Meghna, Godavari, Krishna, Cauvery, Pennar and intervening minor rivers including Arani river flow from west to east to join the Bay of Bengal. It has been estimated by the Central Ground Water Board (CGWB) that around 1205.8 cu km of surface water and 366.5 cu km of groundwater flow into the sea annually. In contrast to this, the rivers flowing from east to west to join the Arabian Sea include Indus, Narmada, Tapi, Cambay, Kutch-Saurashtra-Luni and Western Ghats’ rivers. As a result, around 317.5 cubic kilometres of surface water and 85.7 cubic kilometres of groundwater flow into the sea annually (Jagadiswara Rao, 2009).

The surface water flowing into the sea carry enormous sediment composed of sand, silt and clay in varying amounts in large amounts. Under the influence of sea currents,
cyclones, tsunamis, floods, high tides and low tides, the sediments entering the sea get deposited mostly in the form of barrier islands and barrier spits near the sea coast. As the sediments received by the Bay of Bengal are expected to be around four times the sediments received by the Arabian Sea, there is greater scope for the sediments to get deposited and exposed as barrier islands and barrier spits along the east coast rather than along the west coast of India. These barrier islands and spits often cover the river mouths joining the sea. They often cover Kandaleru River from north to south and Swarnamukhi River from south to north.

3.3. NORTH BUCKINGHAM CANAL

The 316-km long North Buckingham canal extending from Peddaganjam in Andhra Pradesh to Chennai in Tamil Nadu along the east coast is part of Kakinada-Pondicherry stretch of canals meant for navigation. It was constructed between 1806 and 1897 and became operational since 1878. This waterway, also known as the National Waterway number 4 (NW-4), became navigable in 1878 for transportation of commodities such as rice, salt and firewood, but became unusable since 1964 owing to poor maintenance and lack of demand. With the passage of the Inland Vessels (Amendment) Bill, 2005 in 2007 and the National waterways Bill, 2006 in 2008, the Inland Waterways Authority of India (IWAI) has taken up the reconstruction of the Buckingham canal with a width of 32 m and depth of 1.8 m (WAPCOS, 2010).

This canal is a tidal lock-in-canal with extensive provision for passing upland discharge so as to retain a surface water level in the canal approximately up to the highest prevailing tide to facilitate inland navigation. The flood gates/locks were provided in various sea mouths to prevent silting caused under the influence of high and low tides caused by diurnal variation, besides creating impounding facility for retaining high water levels during
low tides and when sea bars are closed due to wave action. Because of the permanent closure of the flood gates/locks of the dilapidated Buckingham canal now in disuse, river floods cause enormous flood damage resulting in the inundation of nearby settlements and agricultural lands. Under the influence of high tides, the canal provides saline water for some distance along the canal for pumping into the nearby salt pans to make sea salt and aquaculture farms to grow shrimp. The sources of canal water include seawater entering the canal during high tides, flood flows from the inland rivers joining the sea via canal through leaks, and large flow of fresh groundwater from either side of the canal in large amounts.

A 15-km stretch of Buckingham canal passes right across the study area in a south to north direction parallel to and at a distance of 1.3 to 4 km west of the sea coast. The canal enters the study area by crossing Swarnamukhi River (SR) at 75.5 km-stone in the south and emerges out of the study area by crossing Kandaleru River (KR) at 90.5 km-stone. Figures 3.1 to 3.3 are pictures of the canal in the study area. As the alignment of the canal was along clay-dominant coastal sediments rather than sandy sediments to ensure stability of its embankments, availability of canal water has resulted in luxuriant growth of *Prosopis juliflora* – a weed plant – along the banks of the canal (Figure 3.1). In contrast to this, any vegetation bordering the canal near Krishnatnam Port had to be removed by the Port administration for widening and deepening the canal (Figure 3.2).

The feature noted in Figure 3.1 is also seen in the satellite image captured on 29 Apr 2000 where Buckingham canal is covered with luxuriant vegetation of *Prosopis juliflora* all along its banks (Figure 3.3).

Noting the abundant availability of fresh groundwater at shallow depth along the banks of the Buckingham canal, the local farmers have found it advantageous to reclaim the bank of the canal at places to grow water-intensive paddy crop by removing *Prosopis*
FIGURE 3.1: A view of the Buckingham canal carrying abundant water and bordered on either side by luxuriant vegetation of Prosopis juliflora. Apart from availability of abundant water, thick vegetation bordering the canal is because of its alignment along clay-dominant coastal sediments supporting vegetation rather than sand-dominant sediments that supports no vegetation.

FIGURE 3.2: Another view of the Buckingham canal close to the right bank of the Kandaleru River with a bridge constructed across it to provide access between the newly-built bridge across Kandaleru River and the right groin of Kandaleru River. During the widening and deepening of the canal by the Krishnapatnam Port administration, any vegetation bordering the canal had to be removed.
FIGURE 3.3: A Google Earth image captured by GeoEye satellite on 29 Apr 2000 showing the Buckingham canal bordered on either side by luxuriant vegetation underlain by clay-dominant coastal sediments. The sand-dominant soils on either side of the canal are devoid of any vegetation.
*juliflora* and growing in its place water-intensive paddy crop. The Google Earth image captured by DigitalGlobe satellite on 18 Oct 2009 and shown in Figure 3.4 demonstrates this feature.

In order to know the chemical quality of canal water flowing in the study area, the total dissolved solids (TDS) of the canal water was determined in the field with a Eutech CON 400 Waterproof Hand-held Conductivity/TDS Meter by collecting 17 canal water samples at 1-km intervals starting from Swarnamukhi River (SR) in the south to Kandaleru River (KR) in the north. The salinity of the water was 35 ppt in the vicinity of Swarnamukhi River at 76 km-stone, which got steeply reduced to 4 to 5 ppt at 79 km-stone. The salinity remained more or less constant till the 87 km-stone and steeply increased to 35 ppt at the 88 km-stone and 40 ppt at the 90 km-stone near Kandaleru River. Figure 3.5 is a profile showing the TDS of canal water along the 15-km stretch of the Buckingham canal. The extremely low salinity of 4 to 5 ppt in a nine-km stretch of canal water clearly indicates loss of a very large quantity of fresh groundwater into the canal on a continuing basis. In the absence of the Buckingham canal, the large groundwater lost would have provided substantial water for irrigation.

The east coast of the Bay of Bengal was severely affected by a tsunami stuck between 9 AM and 10:30 AM on 26 Dec 2004 due to an earthquake near the west coast of Sumatra in Indonesia measuring 8.9 in the Richter scale (Gupta, 2005). Ramalingeswara Rao (2005) and Ramalingeswara Rao et al. (2005) claim that the manmade Buckingham canal constructed parallel to the coast was responsible in reducing the havoc played by the 2004 tsunami. Absence of any damage to the ISRO-owned Sriharikota Island where Buckingham canal was located west of the island far away from the sea dispels the contention that the canal reduced the havoc caused by the tsunami. The author opines that the conditions that favoured the
FIGURE 3.4: A Google Earth image captured by DigitalGlobe satellite on 18 Oct 2009 showing the Buckingham canal bordered on either side by luxuriant vegetation underlain by clay-dominant coastal sediments. The sand-dominant soils away from the canal are devoid of any vegetation. In addition, the left bank of the canal is bordered by crops grown by farmers with local spring-channel water flowing from east to west.
FIGURE 3.5: Profile showing the Total Dissolved Solids (TDS) of the waters of the Buckingham Canal flowing between Swarnamukhi and Kandaluru Rivers. Although the canal waters in close proximity to the Kandaluru and Swarnamukhi estuaries bordering the sea shows salinity near to that of seawater, major part of the canal flowing in the study area shows salinity of as low as fresh water owing to large-scale flow of fresh groundwater within the dune sands on either side of the canal.
formation of the Kothapatnam-Chennai Barrier Island rather than the Buckingham canal were responsible in the mitigation of the effect of tsunami. The canal has no doubt reduced the effect of tsunami in the vicinity of river mouths such as Kandaleru and Swarnamukhi Rivers with the waves generated by tsunami entering not only into the river but also towards either side of the canal to dissipate the energy of the tsunami to a greater extent and thereby reduce the damage.

It may be noted in this connection that Russell (1898), the British Chief Engineer who supervised the digging of the Buckingham Canal (East Coast Canal) expressed “It was a costly error to have designed a canal on the east coast of south India, which was prone to severe floods, soil-erosion and siltation”. According to him, Ennore Lake and several water bodies in the vicinity of Buckingham canal had disappeared owing to excessive siltation caused by the canal construction. Reconstruction of the Buckingham canal by increasing its width and depth would result in higher loss of groundwater into the canal. To this extent, the canal would be detrimental to the interests of the local farming community in making less groundwater available to them. In the light of the observations made by Russell that the canal caused environmental disaster and the present observation that the canal in its present is also depriving farmers much-needed groundwater on a continuing basis, there is need on the part of the Government of India to review the decision taken to reconstruct the Buckingham canal by the Inland Waterways Authority of India (IWAI).

3.4. REGION BORDERED BY SWARNAMUKHI MOUTH

The surface and underground runoff of a river joins ultimately sea at a confluence (also called mouth or opening). In some cases, there can be more than one mouth. A mouth can be closed owing to its choking by deposition of sediment brought about sea waves during high tides, cyclones and tsunamis. When the river experiences flood, the floodwater has to
find a new mouth for the expulsion of floodwater into the sea. If a river has a straight course perpendicular to the sea coast just before joining the sea, the new mouth opened will be nearly at the same place as the old mouth. But when the river course makes an angle with the coastline, the floodwaters force themselves to get discharged from a new mouth away from the old mouth. When the river slants towards its left bank, the new mouth will be towards north of the old mouth. In contrast to this, the new mouth will be towards south of the old mouth, when the river slants towards its right bank. This closure of old mouth and opening of new mouth result in the development of a barrier spit parallel to the coast. The barrier spit so formed covers a mouth by spreading from south to north when the river course slants towards its left bank and from north to south when it slants towards its right bank.

Swarnamukhi River marks the southern boundary of the study area, while Pulicat Lake lies further south of the study river. During most of the geological history of Swarnamukhi River, its river course was slanting towards its left before joining the sea. In some geological past, Swarnamukhi River was discharging its entire surface and underground runoff into the northern Pulicat Lake through a confluence, which allowed the whole lake to remain perennial. Gradual shifting of the river course towards north deprived the lake from the runoff of Swarnamukhi River. This has led to the near drying of the northern half of Pulicat Lake.

The 18th century historic map of d'Anville (1753) indicated that Swarnamukhi River was flowing close to Armagon (also called Dugarajapatnam) village where there was an ancient lighthouse. In course of time, there was a shift of the river mouth to a distance of around 11 km when again a port by name Dugarajapatnam was built. The place where the lighthouse was constructed continued to remain at Armagon village. Even now, the Directorate General of Lighthouses and Lightships of Government of India maintains a
lighthouse at this place. In the latest Google Earth image captured on 22 Jun 2012 and shown in Figure 3.6, the present mouth of the Swarnamukhi River to the sea is at a distance of 21 km north of the lighthouse.

Figures 3.7 to 3.10 are the Google Earth images available in the public domain and captured on 28 Apr 2000, 12 Apr 2002, 18 Oct 2009 and 22 Jun 2012 of Swarnamukhi River joining the sea. Except for the image captured on 28 Apr 2002 showing two openings, images captured on other dates show only one opening. Figure 3.11 is same as that of Figure 3.10, but for showing the locations of all the mouths seen in all the dates. Although Swarnamukhi River has a tendency to shift its mouth from south to north, the reverse can also happen. For example, the mouth of Swarnamukhi River in the image captured on 28 Apr 2000 was at extreme north, while that captured on 12 Apr 2012 had one of its two mouths at extreme south. These shifts in the position of these mouths are illustrated in Table 3.1 with reference to the southern-most opening in the image captured on 12th Apr 2002.

The shifting of the mouths of Swarnamukhi River has led to creation of a barrier spit parallel to the coast which has been getting disturbed frequently due to closures and openings of mouths and remaining barren of vegetation that cannot be reforested through growth of mangrove plantations. Shifting of the river course will cause shifting of the river course in the upstream inundating settlements and agricultural land and thereby causing enormous hardship to the people living along the banks of rivers for several kilometres upstream of the river mouth. There is need to arrest this shifting of the river course by understanding the root problem for such shifting.

The best way to prevent such changes in the river course would be to protect the confluence from getting covered by a barrier spit by the action of sea waves. This can be achieved by creating a 100-m long new opening by trenching along the red line at N
FIGURE 3.6: A Google Earth image captured by Digital Globe satellite and data collected from SIO, NOAA, U.S. Navy, NGA and GEBCO showing the Swarnamukhi River joining the Bay of Bengal and its ancient course passing near Dugarajupatnam when it was flourishing as a port during the 18th century. The date of capture of image is not shown as it was a composite image prepared by merging images captured on different dates.
FIGURE 3.7: A Google Earth image of the Swarnamukhi River captured by DigitalGlobe satellite on 28 Apr 2000 with data from NASA showing its mouth with the Bay of Bengal located at N14°04'59" E80°08'19" at sea level. Owing to formation of a barrier spit bordering the coast, the river waters had to flow from the original mouth along a narrow channel for over 1.5 km towards north before joining the sea.
Figure 3.8: A Google Earth image of the same shown in Figure 3.10 captured by DigitalGlobe satellite on 12 Apr 2002 with the old mouth closed and opening of two new mouths with northern mouth located at N14°04'44” E80°08’24” at sea level and the southern mouth at N14°04’44” E80°08’24” at sea level.
FIGURE 3.9: A Google Earth image of the same in Figure 3.10 captured by the DigitalGlobe satellite on 18 Oct 2009 showing the closure of the old mouths and opening of a new mouth located at N14°04’49” E80°08’25” at sea level.
FIGURE 3.10: A Google Earth image of the same in Figure 12 captured by the DigitalGlobe satellite on 22 Jun 2012 together showing closure of old mouths shown in Figures 9, 10 and 11 and opening of a new mouth located at N14°04’49” E80°08’18” at sea level.
FIGURE 3.11: A Google Earth image of the same in Figure 13 captured by the DigitalGlobe satellite on 22 Jun 2012 together with the mouths shown in Figures 10, 11, 12 and 13. To avoid periodic closure and opening of mouths, it is recommended to create a 100-m long new opening by trenching along the red line shown.
<table>
<thead>
<tr>
<th>No.</th>
<th>Date</th>
<th>Distance from the Southern Mouth as on 12 Apr 2002</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>28-Apr-2000</td>
<td>853 m towards N</td>
</tr>
<tr>
<td>2</td>
<td>12-Apr-2002</td>
<td>317 m towards N</td>
</tr>
<tr>
<td>3</td>
<td>18-Oct-2009</td>
<td>195 m towards N</td>
</tr>
<tr>
<td>4</td>
<td>22-Jun-2012</td>
<td>585 m towards N</td>
</tr>
</tbody>
</table>
14°04’51” E 80°08’21” shown in Figure 3.11, besides taking up maintenance work to prevent future closure of the new trench by another barrier spit.

3.5. REGION BORDERED BY KANDALERU MOUTH

From what has been stated in Section 3.5, the course of Swarnamukhi River slants steeply towards its left bank before joining the sea resulting in the development of a barrier spit covering its mouth and thereby resulting in a significant shift of its confluence from south to north. Although Kandaleru River shows extreme meandering before joining the sea, its course before joining the sea for a distance of around 5 km is almost straight. As such, there is no much scope for a shift of its mouth over time. But, as the straight course of the river shows a slight slant towards its right bank, a barrier spit trying to close its mouth is seen developing from north to south in a Google Earth image captured by DigitalGlobe satellite on 1 Apr 2005 (Figure 3.12). Because of the efforts by the old Krishnapatnam Port administration functioning in this river, periodic dredging used to be taken up to prevent the barrier spit from completely closing the river’s mouth.

With the implementation of the decision of the State Government to form the Krishnapatnam Port Company Limited (KPCL) to develop the previous minor port into modern, deep water and high productivity port, on BOST (Build–Operate-Share-Transfer) concession basis for 50 years in Sep 2004, the new company has taken up dredging operations to remove the barrier spit covering the Kandaleru mouth. In addition, a northern breakwater (groin or bund) for a distance of 750 m and southern breakwater for a distance of 1500 m were constructed to extend into the Bay of Bengal. In addition, the port administration has taken up maintenance in the river to prevent any development of barrier spits covering the mouth. The Google Earth images captured by DigitalGlobe satellite on 10 Apr 2009 and 23 Jun 2012 (Figures 3.13 and 3.14) show the excellent condition in which the
FIGURE 3.12: A Google Earth image captured by DigitalGlobe satellite on 1 Apr 2005 showing the shallow nature of the mouth of the Kandaleru River with the mouth covered by a barrier spit extending from north to south.
FIGURE 3.13: A Google Earth image captured by DigitalGlobe satellite on 10 Apr 2009 showing groins constructed parallel to the left and right banks of Kandaleru River to prevent any barrier spit from covering the mouth to enable the Krishnapatnam Deep Port to function. The left bank groin was constructed for a length of 750 m and the right hand groin constructed for a length of 1500 m.
FIGURE 3.14: A Google Earth image captured by DigitalGlobe satellite on 23 Jun 2012 showing further improvements to the estuary and the port.
Kandaleru mouth is kept by the port administration. Because of this, there is little scope for any shifting of the Kandaleru Mouth in the coming years.

3.6. REGION BORDERING BARRIER ISLANDS AND LAGOONS

The entire coastland in the study area is a more or less level land at a height of a few metres above the mean sea level covered by unconsolidated sediments and devoid of any rocky terrain as found in certain other coasts.

In order to understand what has happened to coastal land of the study area in the historic past, a map of the Coromandel Coast prepared by d'Anville (1753), a French Surveyor, is found to be quite useful (http://en.wikipedia.org/wiki/Buckingham_Canal). His map was not drawn correct to scale. The spellings of several words used make it difficult to identify them with the existing place names. The map shows no longitude, but shows only 14° north latitude, which roughly coincides with 13°56’ north latitude in the Google Earth image. The traverses used for chain surveys in the preparation of the map are mostly confined near to the coast. As such, the coastal features shown in the map can be considered to be reasonably accurate. A study of this map indicated the existence of about 116-km long barrier island extending south of minor stream near Kothapatnam in the study area in the north to Triplicane in Chennai in the south (Figure 3.15). This barrier island bulged to a maximum of 8.5 km in width to form Sriharikota Island. Once forestland, Sriharikota Island is now under the possession of the Indian Space Research Organisation (ISRO) to house the Satish Dhawan Space Centre for launching satellites. Swarnamukhi River was then flowing near Armagon or Duggarajupatnam (Dugarajapatnam) to join the sea by cutting across the barrier island.

The map of d'Anville (1753) also reveals the existence of a 116-km long narrow coastal lagoon bulging to a maximum of 20 km to form Pulicat Lake west of Sriharikota
FIGURE 3.15: A map of a portion of the Coromandel Coast showing the 116-km long Kothapatnam-Chennai barrier island bulged in the middle as Sriharikota Island and bounded by the Bay of Bengal on the east and by an equally long lagoon bulged in the middle as the Pulicat Lake on the west (Modified after d'Anville, 1753).
Island. The Wikipedia – the most popular web-based, free-content encyclopaedia reports this lagoon as Buckingham canal (http://en.wikipedia.org/wiki/Buckingham_Canal). It may be noted in this connection that the map of d'Anville (1753) was constructed in the 18th century, while the Buckingham canal was constructed in the 19th century. It is erroneous to consider the lagoon looking similar to a canal shown in a map prepared in the 18th century as Buckingham canal constructed in the 19th century. This article in Wikipedia is erroneous and has to be corrected.

A study of the relevant topographic maps and most recent satellite images available in the Google Earth public domain revealed that this barrier island further extends by about two km further north of Kothapatnam. Figures 3.16 and 3.17 are satellite images showing a portion of these barrier islands occurring along the southern portion of the study area. These high-resolution images show the same region in two different dates, of which Figure 3.16 was captured on 19 Oct 2009 and Figure 3.17 on 23 Jun 2012. In the intervening period of around three years, there has been a significant difference in the shapes, sizes and dispositions of the barrier islands.

As no barrier island with a length of over 116 km was reported from anywhere in India so far, the Kothapatnam-Chennai Barrier Island becomes the first India’s longest barrier island. Its formation indicates a wave-dominated micro-tidal coast with a relatively low gradient shelf, ample sediment supply, constancy of sea levels and a tidal range of less than 2 m and is responsible in creating a unique environment of relatively low energy protecting multiple wetland systems. The work of Stone and McBride (1998) has clearly indicated that barrier islands play a profound influence in protecting coastal wetlands from the fury of storm surges and tsunamis.
FIGURE 3.16: A Google-Earth image captured by the GeoEye satellite on 19 Oct 2009 showing a number of elongated barrier islands in the southern portion of the study area bordered by sea on the east and lagoons connected to the sea on the west.
FIGURE 3.17: A Google-Earth image of the same area as in Figure 3.2 captured after a gap of around three years by the DigitalGlobe satellite on 23 Jun 2012 showing significant differences in the shapes and sizes of the barrier islands.
Although Ramalingeswara Rao (2005) and Ramalingeswara Rao et al (2005) report that the manmade Buckingham canal between Peddaganjam and Chennai constructed parallel to the east coast was responsible in reducing the havoc played by the tsunami of 26 Dec 2004, the conditions that favoured the formation of the Kothapatnam-Chennai barrier island must have actually protected the coast from the tsunami. This is documented from the observation that Sriharikota Barrier Island with Buckingham Canal located towards its west escaped the fury of the tsunami to the same extent as the bordering areas where Buckingham Canal is very close to the coast.

3.7. REGION BORDERING PLAIN COAST

Although high tides, occasional storm surges and rarely occurring tsunamis damage the region bordering the mouths of Swarnamukhi and Kandaleru Rivers as well as that bordering the barrier spits and the associated lagoons in some degree or other, they are found to only result in some immediate damage requiring some maintenance work. But, in the long run, these processes allow for the accumulation of sediments they bring for long-range protection to the coast. The only damage they cause at best is closure of the existing mouths requiring dredging for opening them once again. The region free of river mouths and barrier spits/lagoons characterised by plain coast are prone for more severe damages as a result of high tides, storm surges and tsunamis. Such region is found in the study area to extend for a distance of about 11 km south of the mouth of Kandaleru River and north of the region bordered by barrier spits and lagoons.

Special mention is made here on the severe tsunami that got stuck in the Bay of Bengal in the forenoon of 26 Dec 2004 due to an earthquake that struck near the west coast of Sumatra in Indonesia measuring 8.9 in the Richter scale (Gupta, 2005). As a result of this tsunami, the damages caused to the regions bordered by river mouths, Buckingham canal,
barrier spits and lagoons in the study area are quite negligible. The region in the study area occupied by the plain coast was however worst affected by the tsunami. The damages caused however are not that significant owing to absence of habitations, cultivated land, communications and industries close to the coast in the study area. The only exception relates to complete destruction of some aquaculture farms. Pictures of an aquaculture farm, which got completely damaged owing to the tsunami are shown in Figures 3.18 and 3.19. Because the site where the aquaculture farm was constructed is not suitable for the purpose, the owner of the aquaculture farm has abandoned his project.
FIGURE 3.18: A view of an abandoned aquaculture farm along beach in the study area destroyed by the Sumatra-Andaman earthquake or tsunami that occurred on 26 Dec 2004

FIGURE 3.19: Another view of the same abandoned aquaculture farm