

# National Assessment of Shoreline Changes along Indian Coast

R.S. Kankara, M.V. Ramana Murthy & M. Rajeevan

Status Report for

26

years

1990-2016



सत्यमेव जयते

Ministry of Earth Sciences  
National Centre for Coastal Research  
Chennai-600100

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## 4. Status of shoreline changes along the Indian coast

### 4.1 Status of coastal erosion along the Indian mainland

About 6632km long shoreline (in 1:25000 scale) distributed among nine coastal states and two union territories was analyzed for the period 1990-2016 to estimate the shoreline change i.e., erosion, accretion and stable. Coastal erosion has become one of the most alarming threats in varying pockets along the Indian coast. Shoreline length used in the analysis is the shoreface length (excluding the interior parts of river / creeks) obtained from Resourcesat-2, LISS-IV satellite data (by zooming in 1:15000 scales). The shoreline analysis suggests that 34% of coast is eroding, 28% is accreting and 38% is in stable state (Table 5).

**Table 5: Summary of shoreline changes along the Indian coast**

SI No	States		Shoreline used for mapping (in km)*	Status of the coast					
				Erosion		Stable		Accretion	
				km	%	km	%	km	%
1	West Coast	Gujarat, Daman & Diu	1701.78	524.84	31	741.98	43	434.96	26
2		Maharashtra	739.57	178.26	24	472.67	64	88.64	12
3		Goa	139.64	16.82	12	95.58	68	27.24	20
4		Karnataka	313.02	70.02	22	151.16	48	91.84	30
5		Kerala	592.96	263.04	45	201.52	34	128.40	21
6	East Coast	Tamil Nadu	991.47	407.05	41	353.56	36	230.86	23
7		Pondicherry	41.66	23.80	57	14.63	35	3.23	8
8		Andhra Pradesh	1027.58	272.34	27	320.98	31	434.26	42
9		Odisha	549.50	153.80	28	113.52	21	282.18	51
10		West Bengal	534.35	336.52	63	68.78	13	129.05	24
Total			6631.53	2246.49		2534.38		1850.66	
%				34		38		28	

\* Length of shoreline estimated from imageries(1:25000 scale) excluding river /creek mouths etc.

The state-wise analysis suggests that in the West Bengal (63%) and Pondicherry (57%) coasts, erosion exceeds more than 50%, followed by Kerala (45%) and Tamil Nadu (41%). Odisha (51%) is the only coastal state which is having more than 50% of accretion, followed by Andhra Pradesh with 42%. Apart from Kerala coast, coasts in other states on the west coast of India fall in stable condition. More than 50% of West Bengal and Pondicherry coasts are under erosion, followed by Kerala (45%) and Tamil Nadu (41%). Odisha is the only coastal state which has more than 50% accretion followed by Andhra Pradesh with 42%. The state-wise details of shoreline change status are given in Tables 6 & 7.



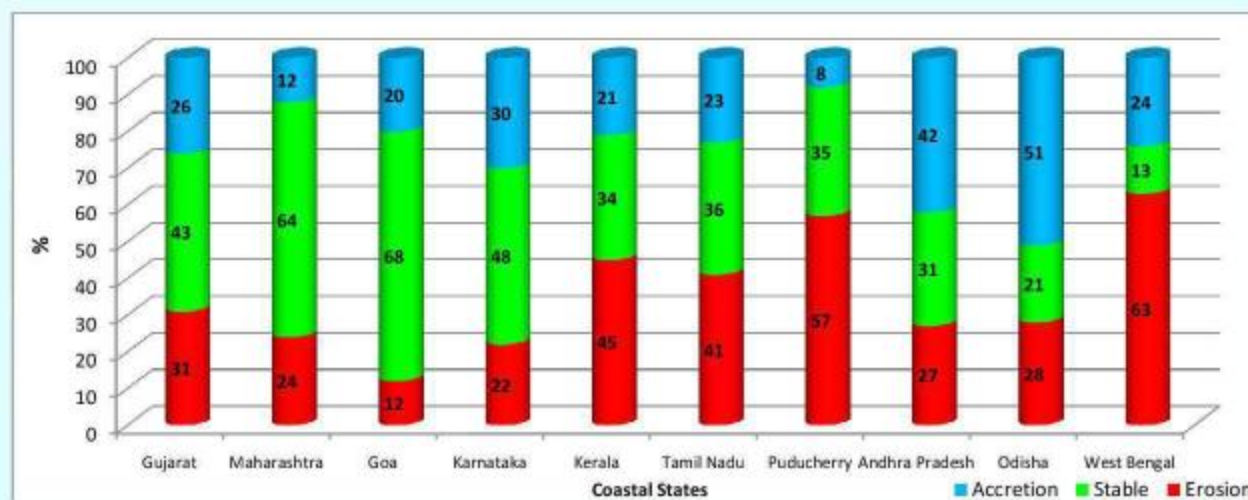


Figure 6: Shoreline change status of Indian coastal states in percentage

Table 6: Erosion-stable-accretion status along the west coast of India

SL No	State	Coast Length (in km)	Coast length (in km)						
			High Erosion	Moderate Erosion	Low Erosion	Stable	Low Accretion	Moderate Accretion	High Accretion
1	Gujarat, Daman and Diu	1701.78	30.96	46.04	447.84	741.98	357.64	50.06	27.26
2	Maharashtra	739.57	2.54	9.38	166.34	472.67	78.22	5.38	5.04
3	Goa	139.64	0.08	1.46	15.28	95.58	23.00	3.52	0.72
4	Karnataka	313.02	2.20	4.46	63.36	151.16	81.64	8.12	2.08
5	Kerala	592.96	5.30	8.98	248.76	201.52	96.50	14.68	17.22
<b>Total</b>		<b>3486.97</b>	<b>37.62</b>	<b>74.48</b>	<b>850.82</b>	<b>1662.392</b>	<b>727.44</b>	<b>78.04</b>	<b>56.18</b>
		<b>%</b>	<b>1</b>	<b>2</b>	<b>24</b>	<b>48</b>	<b>21</b>	<b>2</b>	<b>2</b>

Table 7: Erosion-stable-accretion status along the east coast of India

SL No	State	Coast Length (in km)	Coast length (in km)						
			High Erosion	Moderate Erosion	Low Erosion	Stable	Low Accretion	Moderate Accretion	High Accretion
1	Tamil Nadu	991.47	14.66	36.65	355.74	353.56	194.27	23.96	12.63
2	Puducherry	41.66	0.00	0.32	23.48	14.63	1.45	1.78	0.00
3	Andhra Pradesh	1027.58	101.50	32.78	138.06	320.98	273.58	67.18	93.50
4	Odisha	549.50	68.26	30.50	55.04	113.52	138.94	45.60	97.64
5	West Bengal	534.35	173.64	51.96	110.92	68.78	56.26	19.80	52.99
<b>Total</b>		<b>3144.56</b>	<b>358.06</b>	<b>152.20</b>	<b>683.24</b>	<b>871.47</b>	<b>664.51</b>	<b>158.31</b>	<b>256.76</b>
		<b>%</b>	<b>11</b>	<b>5</b>	<b>22</b>	<b>28</b>	<b>21</b>	<b>5</b>	<b>8</b>

## 4.2 Status of land loss and land gain due to shoreline changes

Land loss and gain due to shoreline changes were quantified in square kilometres (sq. km) by geoprocessing shorelines of 1990 and 2016 in GIS environment (Figure 7). The results elucidate significant amount of land either gained or lost during the above time frame. It can be seen that the coastal states of Gujarat, Andhra Pradesh, Odisha and West Bengal have undergone drastic change in the past 26 years. Land gain of greater than 60 sq.km is observed along the states of Gujarat and Odisha. In Andhra Pradesh, Kerala and Tamil Nadu both land gain as well as loss is seen to have occurred simultaneously in significant amounts. Land gain is slightly higher than land loss in Andhra Pradesh and Kerala; however in case of Tamil Nadu it's reverse (land loss is more than gain). States in the Konkan sector along the west coast of India viz., Maharashtra, Goa and Karnataka are seen to exhibit very less changes. Land gain and loss in these states are of the order of 0.55 and 5.84 sq. km respectively. Of all the states maximum land loss is in West Bengal, 99.05 sq. km is seen to have lost by erosion. Over all during 1990 to 2016, about 231.50 sq. km of land is gained by accretion and 234.25 sq. km land is lost by erosion along the Indian mainland.



Figure 7: Land loss/land gain distribution along Indian coast.

## 4.3 List of Shoreline change maps in 1:25000 scale

The shoreline change maps for both long and short term were prepared in 1:25,000 scale and shall be hosted on NCCR website. These maps are being updated every subsequent year. The details state-wise maps are listed in Table 8 and Gird wise information is listed in **Annexure-1**.

Table 8: Total number of 1:25,000 scale maps along the Indian coast

East coast of India		
Sl. No	State	Number of maps( 1:25,000)
1	Tamil Nadu & Puducherry	80
2	Andhra Pradesh	89
3	Odisha	46
4	West Bengal	29
West coast of India		
5	Kerala	55
6	Karnataka & Goa	32
7	Maharashtra	45
8	Gujarat and Daman & Diu	150
<b>Total Numbers</b>		<b>526</b>



Considering the maximum and minimum values of the shoreline change rate, the shoreline is divided into seven categories as low erosion, moderate erosion, high erosion, stable, low accretion, moderate accretion and high accretion (Figure 8). The status of the shoreline change along with infrastructure details, assessment of erosion, locations likely factor of erosion ports, industries, anthropogenic activities, will also be provided the shoreline change maps. The map will be updated every year. The overall distribution of shoreline change rate along the Indian coast for 1990-2016 is shown in Figure 6.

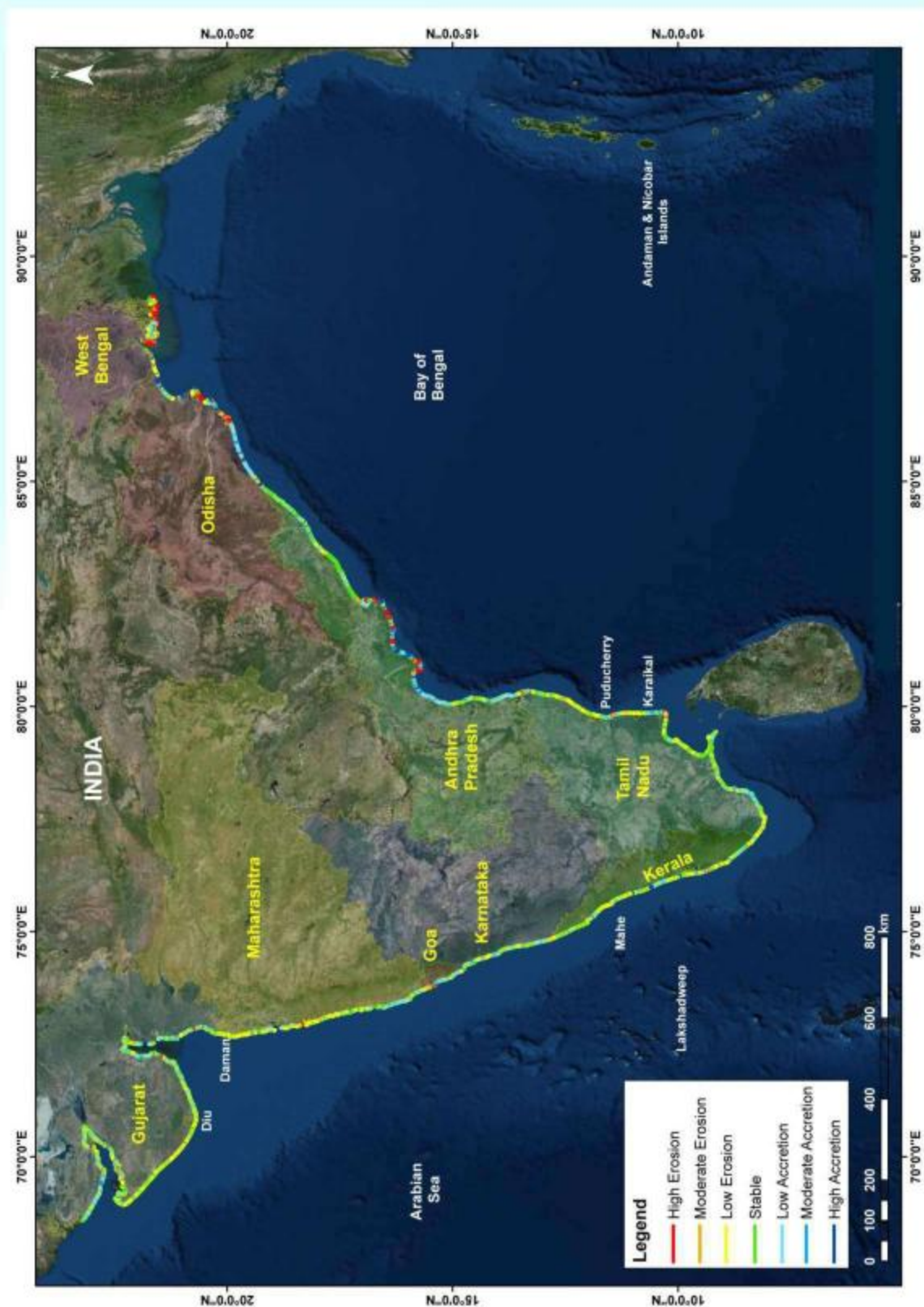


Figure 8: Shoreline change map along Indian coast (1990-2016)



### 4.3.1 Gujarat, Daman & Diu

The Coastal state of Gujarat is on the western end of Indian peninsula. It is endowed with long coastline of varying geomorphic features, and based on the varied physiographic features, geomorphology, coastal processes and river discharge the coast can be broadly classified into five regions (1) The Rann of Kachchh (2) Gulf of Kachchh (3) The Saurashtra coast (4) Gulf of Khambhat and (5) The south Gujarat coast. The coastlines of the Gulf of Khambhat and Kachchh are tide dominated with tidal mudflats, salt flats, mangroves and salt marshes prevalent all along the stretch. Major rivers like Narmada, Tapti, Mahi and Sabarmati drain into the Gulf of Khambhat to form an estuary. Tidal variation of 8-11m is observed in the coast with strong tidal currents influencing the landforms. Wave dominance can be seen along Saurashtra coast. Sandy beaches, rocky terrace, cliffs, coastal plains and estuary are few of the geomorphic features of the Saurashtra sector. Coral reefs and coral islands in the Gulf of Kachchh are another remarkable aspect of the coast, around 37 species of corals are found here. Human intervention in the form of developments of structure plays a major role in influencing the shoreline change system. Gujarat, because of its strategic location near the Middle East, Africa and Europe is dotted with 49 ports which include 1 major port at Kandla and 48 minor ports. Apart from this, other industrial and developmental activities such as salt industry, cement industry and aquaculture also the landuse and catalyse shoreline changes.

Coastal length of the state constituting 14 coastal districts and 2 union territories is measured to be approximately 1701 km from 2016 satellite imagery. The 1990 to 2016 shoreline change assessment result shows that 43% of the coast is stable, 31% is eroding and remaining 26% is accreting. It is observed that south Gujarat districts of Valsad, Navsari, Bharuch and district of Kachchh exhibit all three (stable, accretion and erosion) conditions. Bhavnagar and Surat coasts are dominated by stable and accretion conditions. Districts of Anand and Ahmedabad in the Gulf of Khambhat are dominated by stable conditions with 57% and 69% of their respective coastal lengths remaining stable. In the Saurashtra sector, viz. Amreli, Girsomnath, Porbandar, DevbhumiDwaraka and Jamnagar, erosion and stable conditions are prevalent. About 66% of Junagadh coast faces erosion. In the case of Union Territory of Daman and Diu are erosion and stable trends are recorded respectively. Erosion hot spots are identified along Bhat, Onjal and Borsri of Navsari district, Bhagwa of Surat and along Degam, Isanpur, Devla and Dhej of Bharuch district. In the Saurashtra sector, erosion is observed along Jaspara, Mithi, Viradi, Thalsar and Gogha of Bhavnagar and in Adri, Navapara of Girsomnath. Regions around Mundra and Kandla, where leading ports operate, are also observed to be eroding. Notable accretion is seen along Nada of Bharuch district and Bhavnagar.

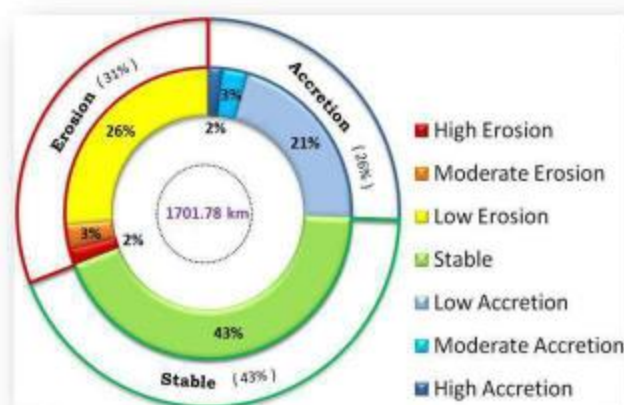


Figure 9: Percentage of shoreline change rate along Gujarat coast.



**Table 9:** Erosion-stable-accretion status of Gujarat coastal districts

SL No	District	Coast Length (in km)	Coast length (in km)						
			High Erosion	Moderate Erosion	Low Erosion	Stable	Low Accretion	Moderate Accretion	High Accretion
1	Valsad	75.46	2.36	3.90	24.78	25.76	14.34	2.44	1.88
2	Navsari	43.32	1.18	3.86	7.20	18.40	9.38	0.66	2.64
3	Surat	42.48	0.00	0.42	4.82	17.62	13.62	5.40	0.60
4	Bharuch	77.32	1.84	4.54	16.64	29.70	20.96	2.56	1.08
5	Anand	59.88	0.28	1.08	13.12	34.18	9.02	1.52	0.68
6	Ahmedabad	77.52	0.64	0.62	3.00	53.32	17.56	1.34	1.04
7	Bhavnagar	173.66	6.04	3.30	27.92	67.40	56.94	9.30	2.76
8	Amreli	57.00	0.16	0.88	22.40	18.68	14.50	0.34	0.04
9	Gir Somnath	114.40	1.42	2.56	46.70	44.72	17.64	0.92	0.44
10	Junagadh	42.98	0.08	4.64	23.48	11.20	3.48	0.10	0.00
11	Porbandar	112.60	0.02	0.38	52.70	54.70	4.48	0.08	0.24
12	Devbhumi Dwarka	228.60	5.26	6.36	80.40	95.54	35.22	3.14	2.68
13	Jamnagar	177.38	5.22	4.68	34.70	87.60	31.48	8.44	5.26
14	Kachchh	386.64	6.42	7.92	78.38	169.66	103.58	12.76	7.92
15	Diu	18.18	0.00	0.82	9.54	5.96	1.82	0.04	0.00
16	Daman	14.36	0.04	0.08	2.06	7.54	3.62	1.02	0.00
<b>TOTAL</b>		<b>1701.78</b>	<b>30.96</b>	<b>46.04</b>	<b>447.84</b>	<b>741.98</b>	<b>357.64</b>	<b>50.06</b>	<b>27.26</b>

**Figure 10:** Shoreline change map of Gujarat coast (1990-2016).



Figure 11: Coastal districts of Gujarat



Kachchh



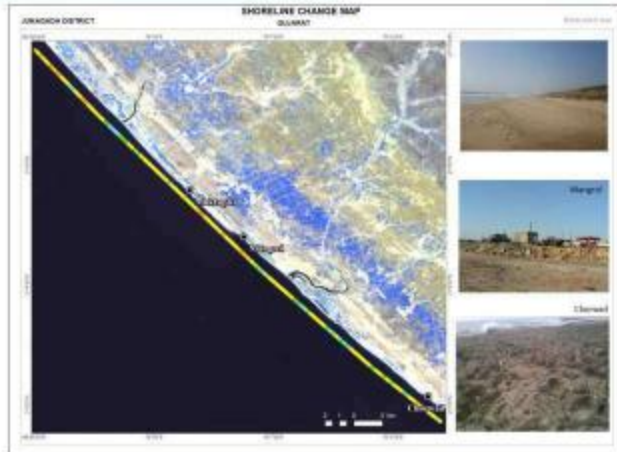
Jamnagar



Dev Bhumi Dwarka



Porbandar



Junagadh



Gir Somnath



Amreli



Bhavnagar





**Ahmedabad**



**Anand**



**Bharuch**



**Surat**



**Navsari**



**Valsad**



**Diu**



**Daman**



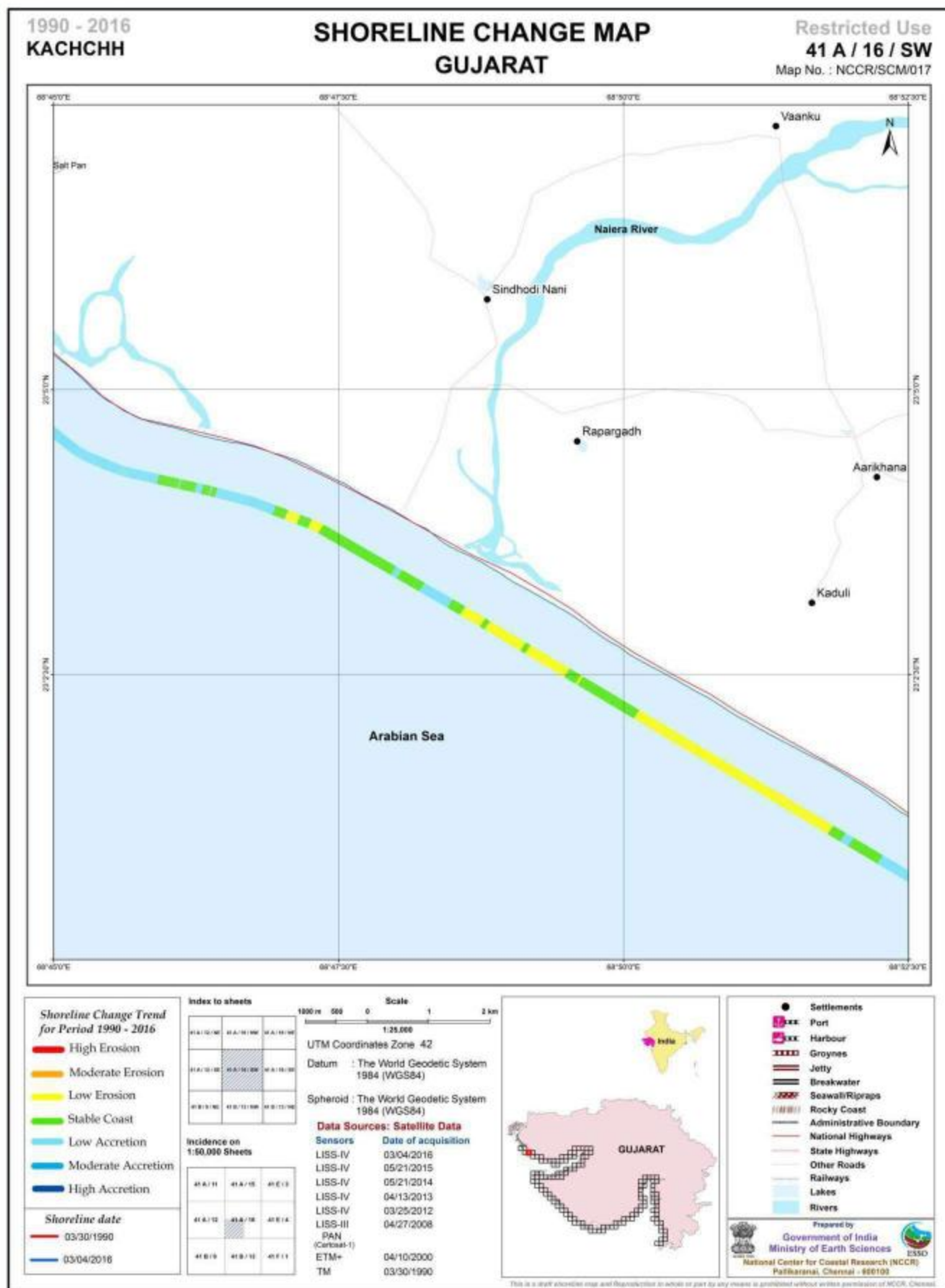


Figure 12: 1:25,000 scale map of Kachchh district, Gujarat.



### 4.3.2 Maharashtra

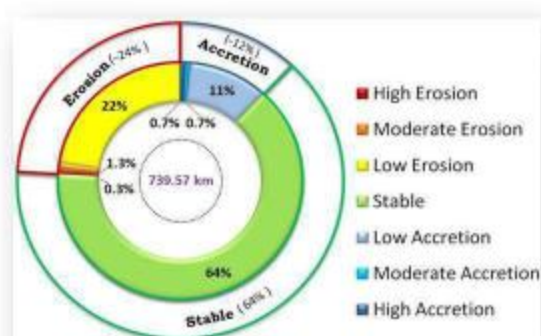
The coastline of Maharashtra is more or less N-S oriented and is bound by Arabian Sea in the west and Western Ghats in the east, with narrow coastal tract. Rivers like Terekhol, Karli, Savitri, Vashi, Shastri, Patalganga, Kundalika, Ulhas and Vaitarna and 5 major creeks are reported along the coast. The drainage pattern is parallel to sub parallel structurally controlled by joints and faults. Rocky coast, sandy shores, muddy and mangrove shore are the coastal types prevalent here with the occasional presence of patches of corals in places like Malvan. Rivers, creeks and outcrops from foot hills of Sahyadri highly dissect the coast and contribute to the diversified coastal configuration and beaches along this stretch. The coastal stretch constitutes 7 districts, viz., Sindhudurg, Ratnagiri, Raigad, Mumbai city, Mumbai suburban, Thane and Palghar.

Coastal length of the state is estimated to be approximately 740 km from 2016 satellite imagery. Shoreline change analysis carried out along the 740 km of coast from 1990-2016 elucidates that around 24% of the coast is eroding, 12% is accreting and 64% remains in stable condition. It is seen that Sindhudurg, Ratnagiri and Raigad districts of the state is dominated by stable coast with a few pockets of low erosion and accretion. Upon moving north of Thane creek, from Mumbai to northern end of the state in Thane district, erosion is evident. Coastal protection measures taken in the form of ripraps, seawall etc., can be observed along the districts of Palghar, Thane and Mumbai.

Accretion is observed along Malvan, Tarkarli, Gad River, Girye, Devgad, Undi, Ambolagad, Velas, Revadanda, Alibag, Akshi and Aksa regions. Above mentioned places are seen to accrete naturally. Artificial land reclamation of 20.23 ha is observed north of Mahim bay in Mumbai. Rocky coast of the state constitutes to about 331.08 km, which remains in stable condition. Coast of Shiroda and Anjarle are also found to exhibit stable condition. Beach in Arvai, Vengurla, Mirya, Velshwar, Dabhol, Murud, Shrivarshan, Diveaga, Kihim, Erangal, Manori, Gorai, Bordi, Kelva&Shrigaon are observed with erosion.

**Table 10:** Erosion-stable-accretion status of Maharashtra coastal districts

SL No	District	Coast Length (in km)	Coast length (in km)						
			High Erosion	Moderate Erosion	Low Erosion	Stable	Low Accretion	Moderate Accretion	High Accretion
1	Sindhudurg	137.02	0.04	0.20	6.50	82.00	46.88	1.02	0.38
2	Ratnagiri	258.93	0.78	1.08	36.32	203.39	15.80	0.82	0.74
3	Raigad	134.83	0.58	2.90	42.98	81.73	5.16	0.70	0.78
4	Mumbai city	41.02	0.00	0.00	1.34	38.36	1.32	0.00	0.00
5	Mumbai suburban	41.15	0.02	0.22	17.54	18.77	2.78	0.58	1.24
6	Palghar & Thane	126.64	1.12	4.98	61.66	48.44	6.28	2.26	1.90
<b>TOTAL</b>		<b>739.57</b>	<b>2.54</b>	<b>9.38</b>	<b>166.34</b>	<b>472.67</b>	<b>78.22</b>	<b>5.38</b>	<b>5.04</b>



**Figure 13:** Percentage of shoreline change rate along Maharashtra coast.



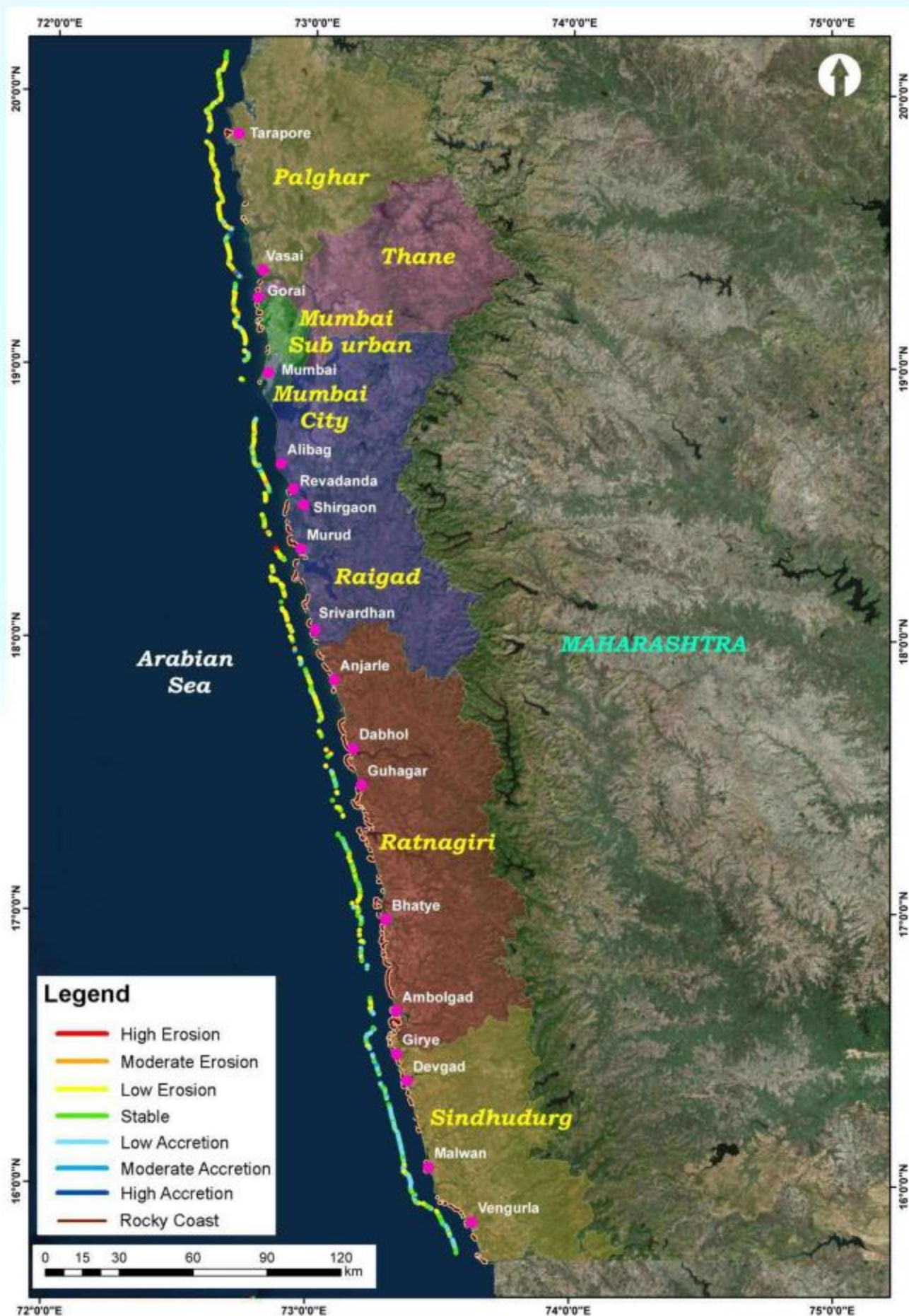
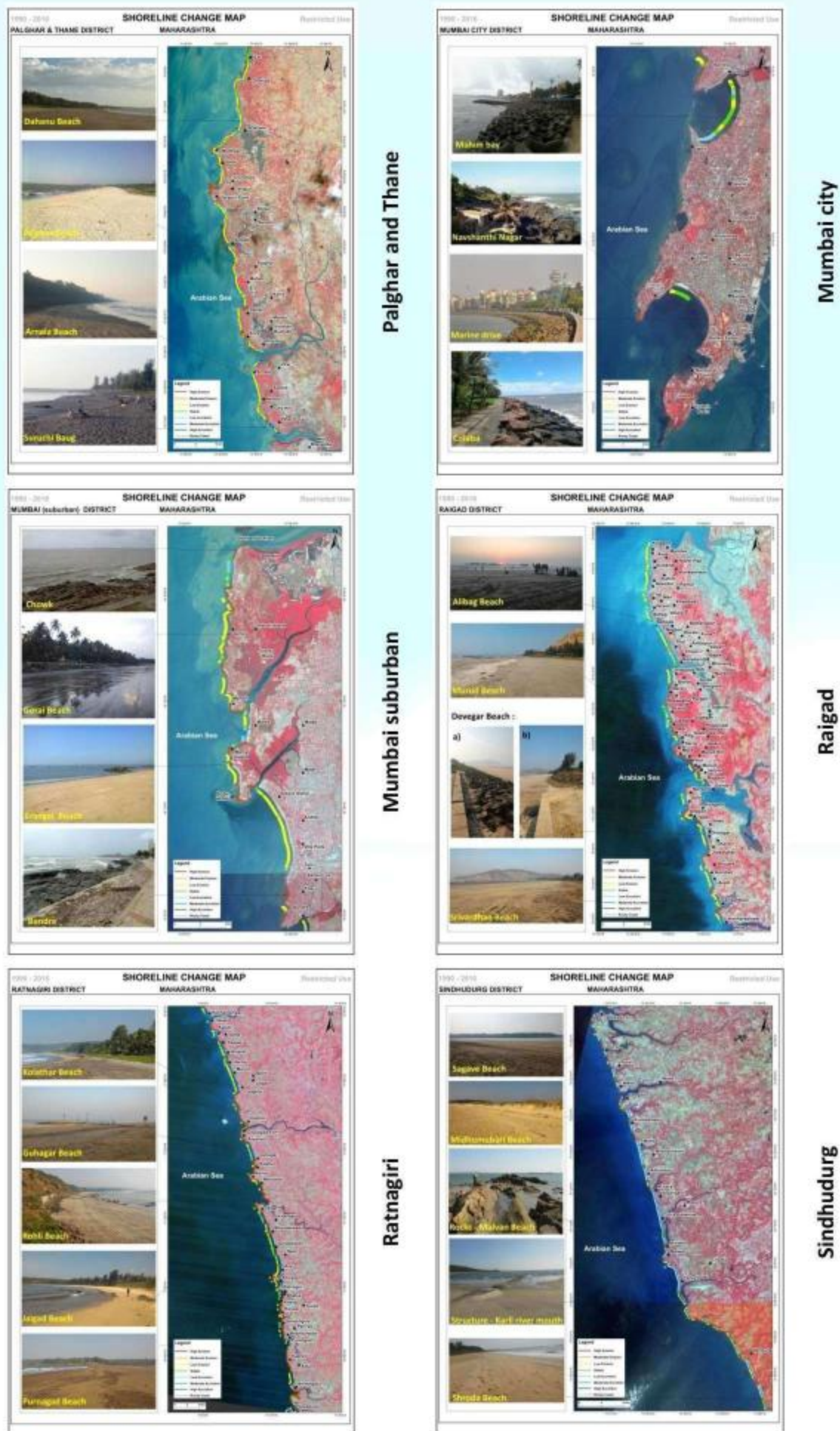


Figure 14: Shoreline change map of Maharashtra coast (1990-2016).



Figure 15: Coastal district of Maharashtra





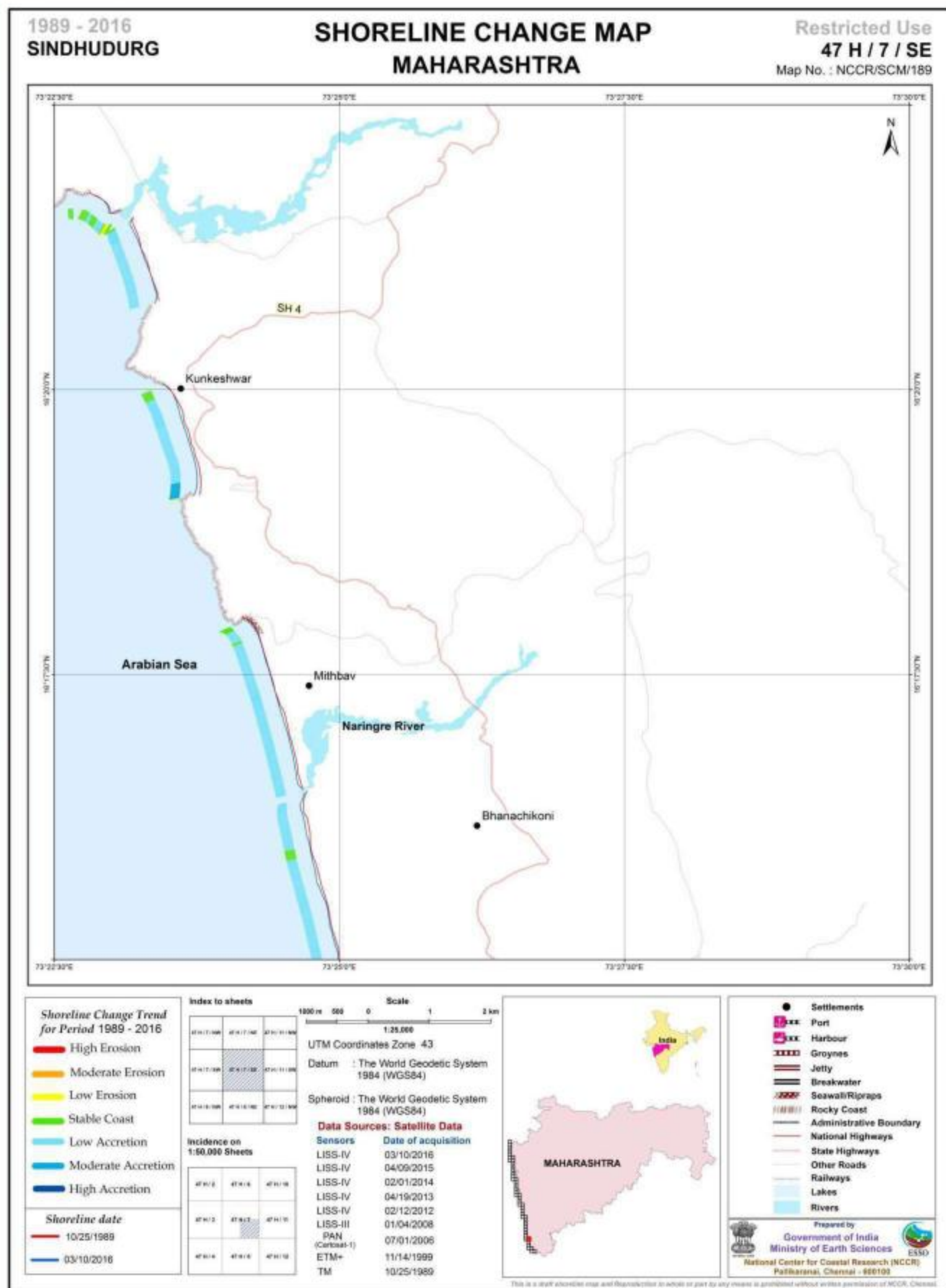


Figure 16: 1:25,000 scale map of Sindhudurg district, Maharashtra.



### 4.3.3 Goa

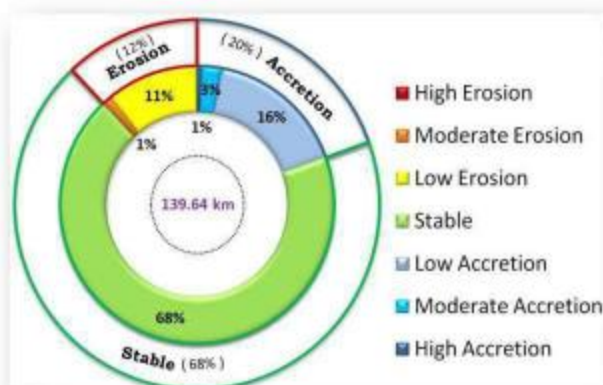
Geomorphologically the coast of Goa can be divided into three sections - long, linear and wide beaches of north, central bay area around Aguada & Mormagao and rocky cliff with pocket beaches of south. Zuari, Mandovi, Chapora, Talpona and Galgibag are a few of the important rivers flowing through the state. These rivers drain into Arabian Sea forming estuary at their mouth region. About 12 species of mangroves are found along the estuaries in the state. Morjim beach found north of Chapora river is nesting site of endangered olive ridley sea turtles. Picturesque beaches along the coast attract international tourists and promote economy of the coastal belt through tourism. Port in Mormagao bay of the state is one of the biggest natural ports of south Asia.

Coast length of Goa is about 140 km as measured from 2016 satellite imagery. Shoreline analysis of the state from 1990 - 2016 shows that around 68% of the coast is in stable condition, 20% is accreting and 12% is eroding. The coast of North Goa district is stable with a few pockets of erosion and accretion regions. It's observed that 29% of North Goa district is eroding. South Goa is also dominated by stable coast with about 20% of the coast showing accretion. Major portion of the Goa coast which comes under stable category constitutes rocky cliff, headlands and promontories of basaltic origin which are resistant to wave action. Headlands and promontories occurring in the stretch play an important role in controlling the morphology of the beach adjacent to them. Sediments along the pocket beaches get circulated within the headland, bounding their ends depending on season.

In Figure 18, we find that accretion is observed in Majorda, Velsao, Arossim, Utorda, Colva, Morbor, Betul regions of South Goa and northern part of Calangute beach, northern bank of Chapora river and along coastal stretch from Harmal to Mandrem of North Goa. Erosion is seen in the coast of Keri, Vagotor, southern part of Calangute, Mandrem to Morjim, Candolim in North Goa and Palolem, Talpona, north of Galgibaga and region from Varca to Cavelossim in South Goa.

**Table 11:** Erosion-stable-accretion status of Goa coastal districts

SL No	District	Coast Length (in km)	Coast length (in km)						
			High Erosion	Moderate Erosion	Low Erosion	Stable	Low Accretion	Moderate Accretion	High Accretion
1	North Goa	36.40	0.06	1.36	9.18	19.46	6.08	0.22	0.04
2	South Goa	103.24	0.02	0.10	6.10	76.12	16.92	3.30	0.68
<b>TOTAL</b>		<b>139.64</b>	<b>0.08</b>	<b>1.46</b>	<b>15.28</b>	<b>95.58</b>	<b>23.00</b>	<b>3.52</b>	<b>0.72</b>



**Figure 17:** Percentage of shoreline change rate along Goa coast.



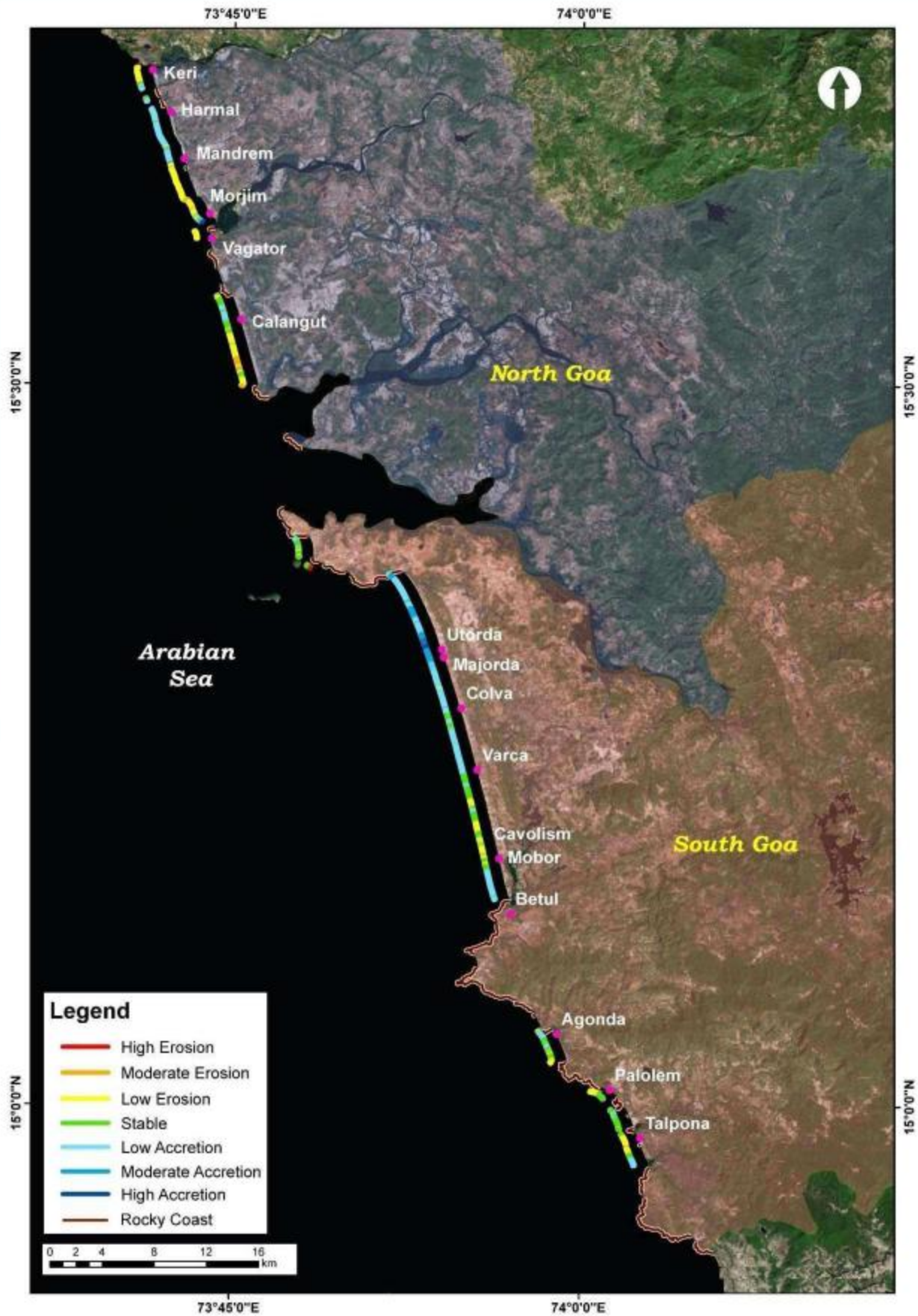


Figure 18: Shoreline change map of Goa coast (1990-2016).



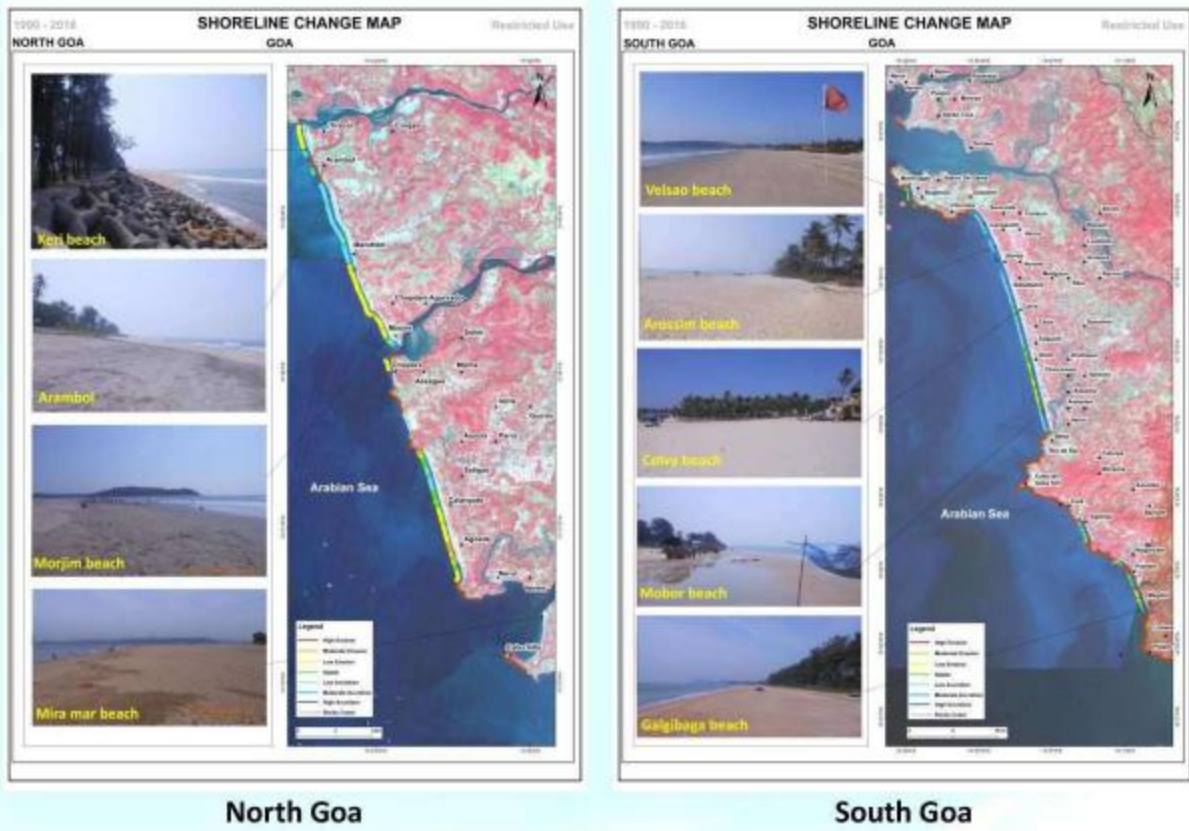


Figure 19: Coastal district of Goa

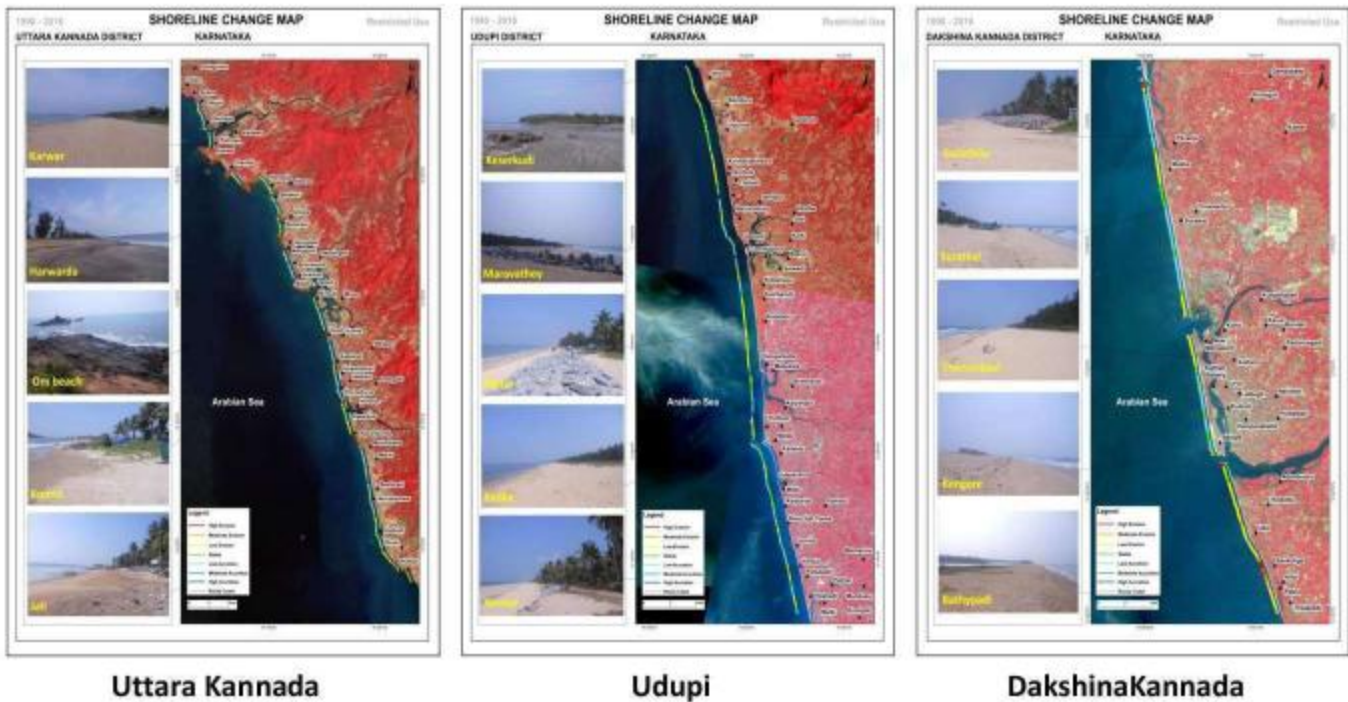


Figure 20: Coastal district of Karnataka



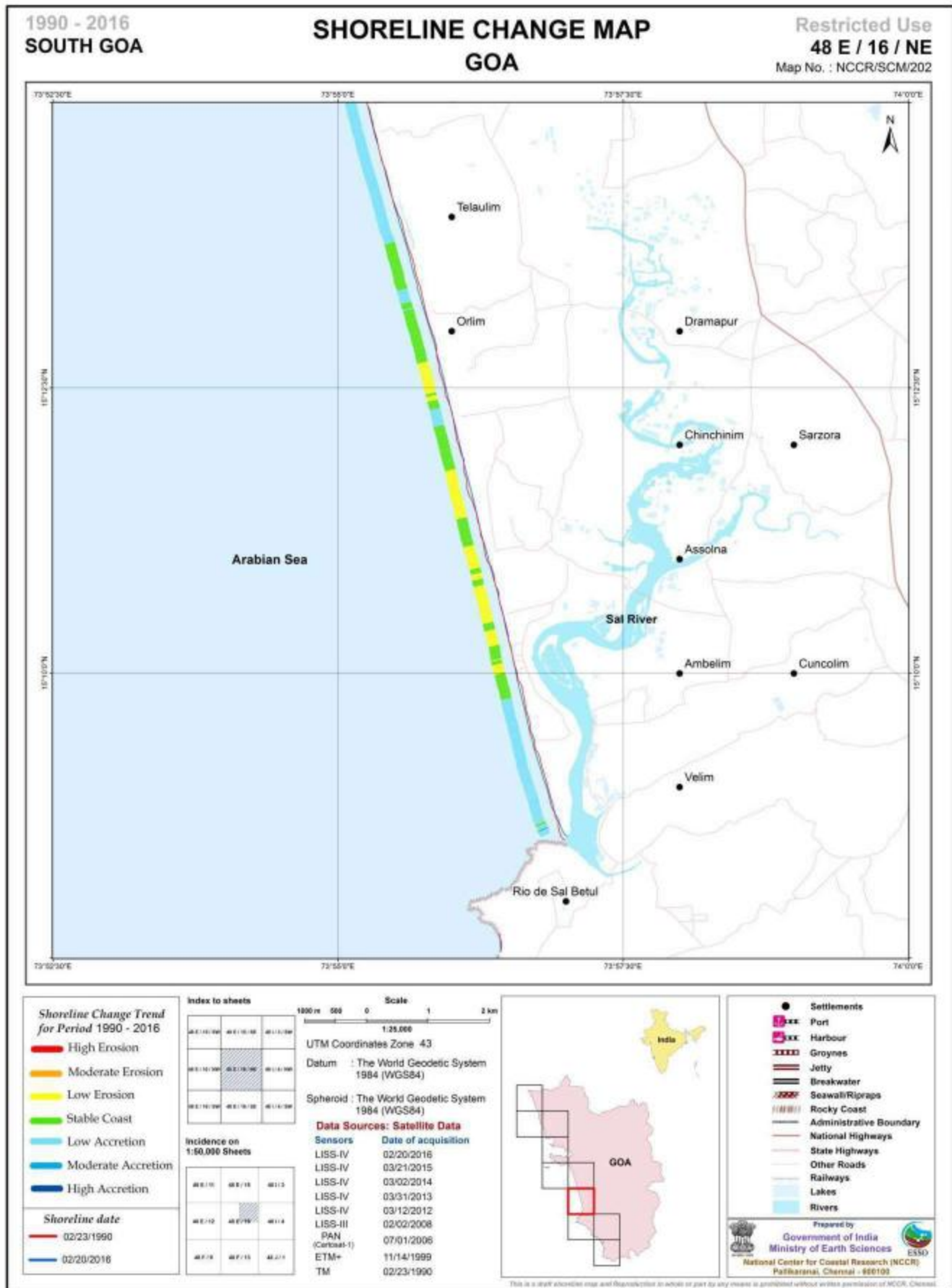


Figure 21: 1:25,000 scale map of South Goa district, Goa.



### 4.3.4 Karnataka

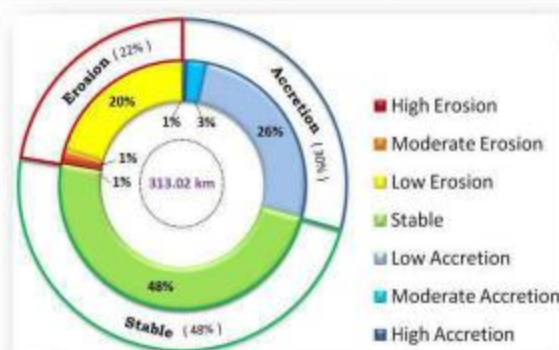
The coastal plain of the state is narrow, except at estuaries. Netravati and Sharavathi are the major west flowing rivers in the region. Rocky headlands, promontories and sea cliff are present along the northern part of the state with the prevalence of pocket beaches. Long, narrow and straight beaches are observed in the central and southern parts of the state (eg. Suratkal, Panamburu and near Coondapur). Estuaries, spit, shallow lagoons and mudflats are some of the geomorphic features found on the coast. Patches of Mangroves are present along the estuaries of Mulki, Sita, Kali, Swarna, Chakra, Haldi, Kolluru and Agnashani. Major port at New Mangalore and 10 other minor ports in Belkeri, Tadadi, Honnavar, Bhatkal, Malpe, Kundapura, Hangarakatta and Padubidri contribute to the economy of the coastal districts. Sand mining, petrochemical, fertilizer and allied industries are seen along the coast.

The coastal length of the state is about 313 km as estimated from 2016 satellite imagery. Shoreline analysis of the coast from 1990-2016 shows that 30% of the coast is accreting and 22% is eroding and 48% in stable state. It is observed that 45% of Dakshina Kannada district is relatively affected by erosion and Uttara Kannada is dominated by stable condition with a few pockets of erosion and accretion. Stable and erosion conditions are prevalent along the Udupi coast with a few sectors of accretion.

Eroding coastal stretches are Mukka, Ullal, Thalapadi, north of Thannirbavi and Bathypadi in Dakshina Kannada District and Malpe, Mulur, Yermal, Kirimanjeshwara, Hejmadi, Pithrody, Kinara, Maravathey, Koravadi and Kaipunjil regions of Udupi. Though Uttara Kannada District of the state is dominated by low accretion and stable coast, erosion is observed in Apsarakonda, Harwarda, Kasarkod and about 11 km from Keserkudi to Jali. Accretion is observed along Bengere, south of Thannirbavi and Chitrapura in the southern end of the state and along Kadke, Udyavara and Beejadi in Udupi district. Regions of Murudeshwar, Pavinakurve, Gokarna, Majali, Devbag and Karwar beaches are observed to exhibit accretion.

**Table 12:** Erosion-stable-accretion status of Karnataka coastal districts

SL No	District	Coast Length (in Km)	Coast length (in Km)						
			High Erosion	Moderate Erosion	Low Erosion	Stable	Low Accretion	Moderate Accretion	High Accretion
1	Dakshina Kannada	36.66	1.08	2.36	13.18	7.72	12.08	0.22	0.02
2	Udupi	100.71	0.32	0.98	34.92	35.69	25.44	2.36	1.00
3	Uttara Kannada	175.65	0.80	1.12	15.26	107.75	44.12	5.54	1.06
<b>TOTAL</b>		<b>313.02</b>	<b>2.20</b>	<b>4.46</b>	<b>63.36</b>	<b>151.16</b>	<b>81.64</b>	<b>8.12</b>	<b>2.08</b>



**Figure 22:** Percentage of shoreline change rate along Karnataka coast.



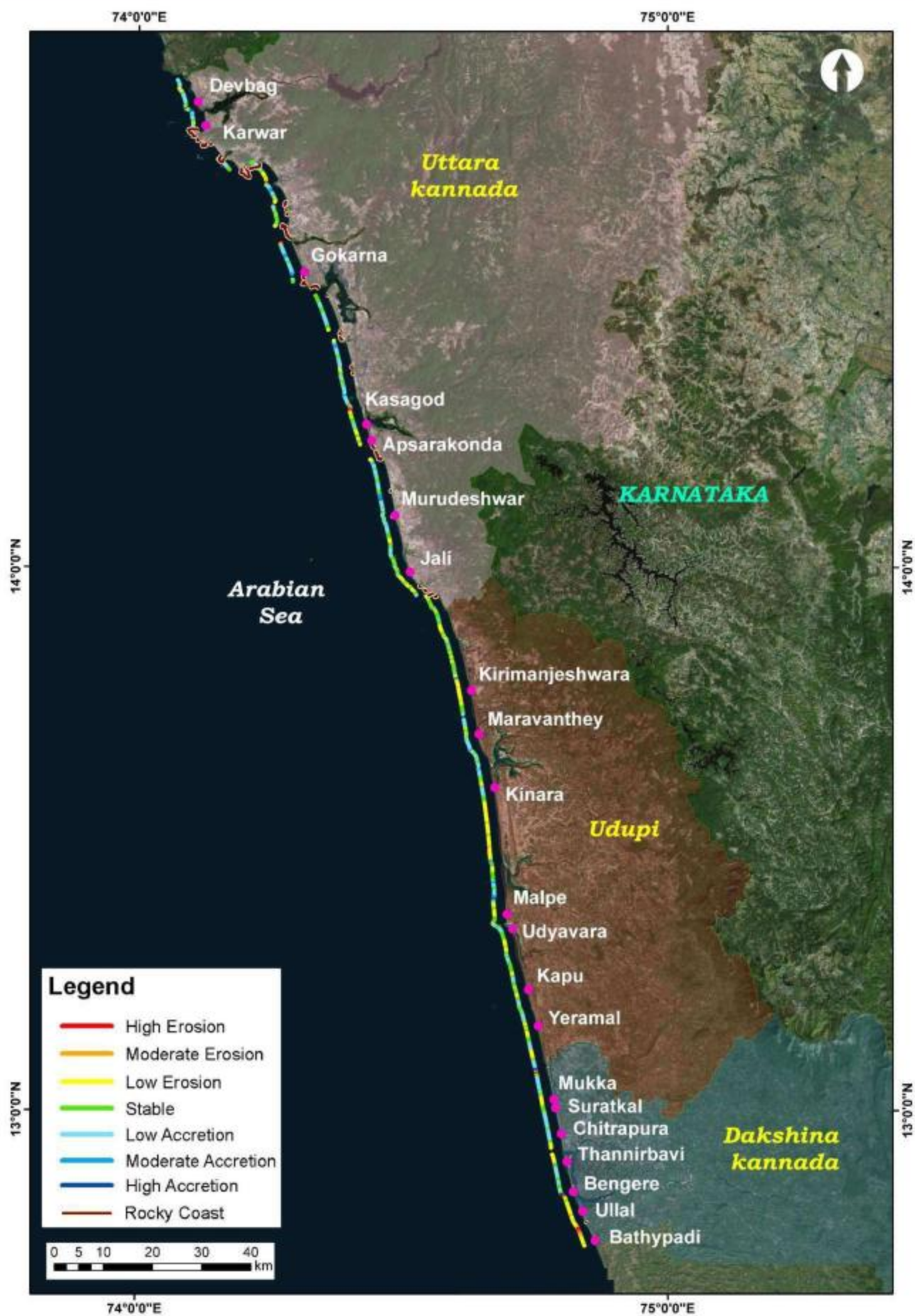


Figure 23: Shoreline change map of Karnataka coast (1990-2016).



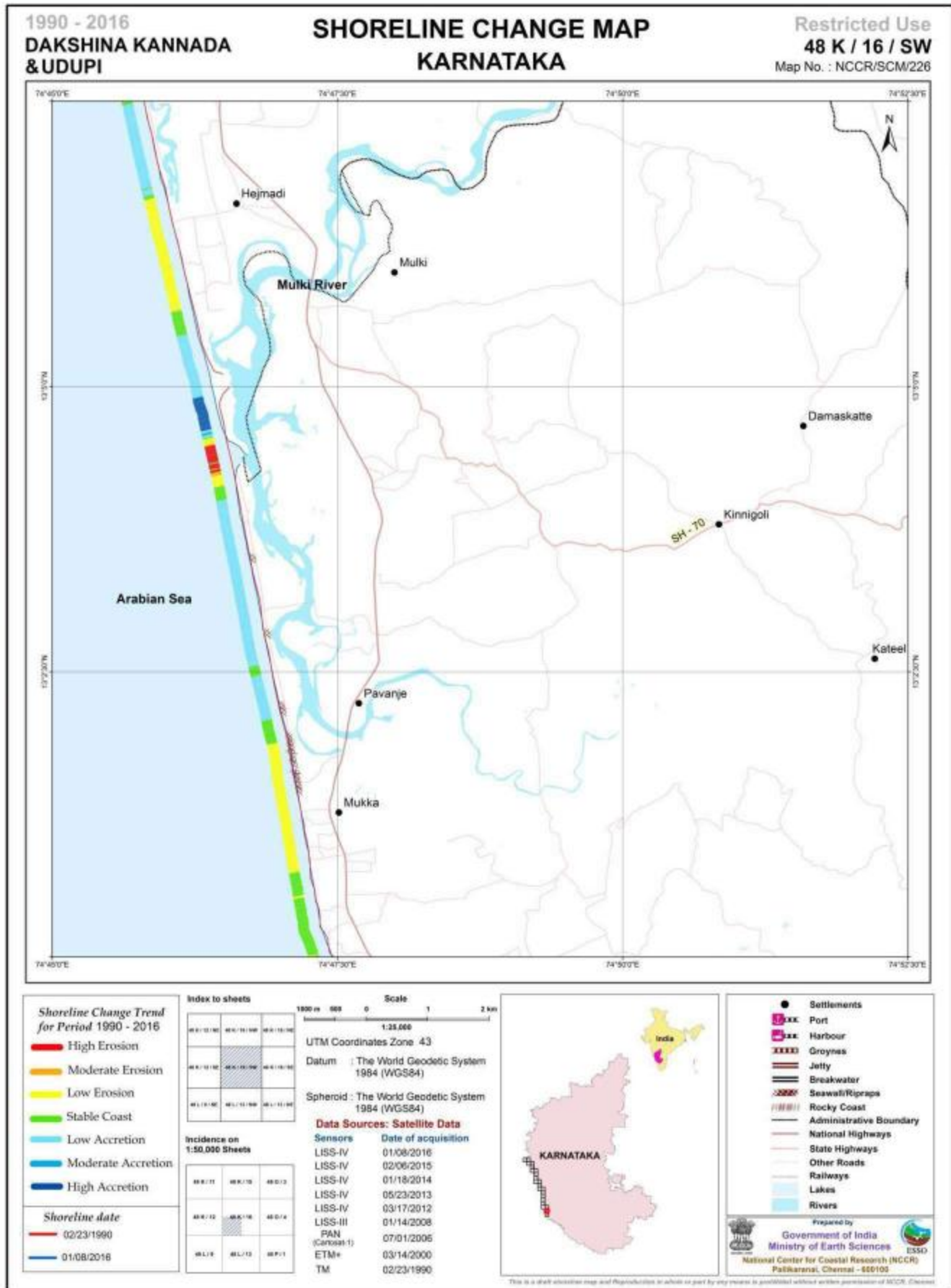


Figure 24: 1:25,000 scale map of Dakshina Kannada and Udupi district, Karnataka.



### 4.3.5 Kerala

The coastal state of Kerala is in the southern end of Indian peninsula, with its low lying coastal plain fringing into the Lakshadweep Sea. The coastline is generally straight trending NNW-SSE with minor variations. Physiographically the state can be divided into three sections viz., 1) Coastal plains 2) Laterite plateaus of midland and 3) Highland - Western Ghats. The width of the coastal plain varies from 5-29 km, with the maximum width observed at Cherthala. In many places like Bekal, Ezhimala, Azhikode and Kadalur of north Kerala and Vizhinjam, Varkala and Tangasseri of south Kerala coastal plain is void with rocky laterite midlands extending up-to the shoreline. These promontories, along with 41 east flowing rivers of the state make the shoreline discontinuous. Periyar, Bharathapuzha and Pamba are a few of the prominent west flowing rivers while Kabini, Bhavani and Pambar are the only east flowing rivers of the region. The west flowing rivers originating from western ghats drain into either backwater system or Arabian Sea. The state has one of the largest backwater networks in the country with Vambanad being the largest backwater lake in that network. Water way transport being operated in these backwaters attract many tourists and thereby add economic dimension to the coast. Landforms such as beach, lagoons, barrier islands, beach ridges, paleo strandlines, alluvial plains, marshy plains, spits, mangroves and islands locally called as 'thuruths' are observed along the coast. Dharmadam Island seen north of Kerala has mangrove vegetation. Another striking feature of the coast is high population density of the narrow coastal belt. This has aggravated human interference in shoreline change system. Construction of structures such as fishing harbours, ports, groins, seawall and beach sand mining for monazite ores has highly altered the nature of coastline and induced changes.

9 coastal districts from Kasaragod in the north to Thiruvananthapuram in the south attribute the coast belt of the state. The coastal length is measured to be approximately 592 km from 2016 satellite imagery. Shoreline change analysis carried out for a span of 26 years (1990-2016) indicates that 45% of the coast is eroding, 34% is stable and 21% is accreting. Further, it may be seen from Table 13, that the coasts of Kasaragod, Kannur, Malappuram, Ernakulam and Kollam are dominated by both erosion and stable condition with a few pockets of accretion. The only district showing accretion trend is Thrissur, about 50% of its length shows accretion. As far as Thiruvananthapuram is concerned erosion, accretion and stable conditions are observed in equal amounts.

**Table 13:** Erosion-stable-accretion status of Kerala coast.

SL No	District	Coast Length (in km)	Coast length (in km)						
			High Erosion	Moderate Erosion	Low Erosion	Stable	Low Accretion	Moderate Accretion	High Accretion
1	Kasaragod	83.60	0.02	0.18	28.48	40.20	12.64	0.44	1.64
2	Kannur	69.05	0.04	0.14	28.04	27.85	9.92	2.60	0.46
3	Kozhikkode	78.03	0.46	0.84	47.56	24.93	3.74	0.24	0.26
4	Malappuram	50.85	0.22	1.06	23.70	18.45	7.10	0.18	0.14
5	Thrissur	61.50	0.00	0.34	17.58	12.76	18.72	6.08	6.02
6	Ernakulam	45.04	0.00	0.30	20.80	16.76	3.32	0.72	3.14
7	Alappuzha	83.56	2.12	5.08	40.66	15.84	13.08	2.68	4.10
8	Kollam	45.72	1.64	0.20	16.88	19.42	6.52	0.30	0.76
9	Thiruvananthapuram	75.61	0.80	0.84	25.06	25.31	21.46	1.44	0.70
<b>TOTAL</b>		<b>592.96</b>	<b>5.30</b>	<b>8.98</b>	<b>248.76</b>	<b>201.52</b>	<b>96.50</b>	<b>14.68</b>	<b>17.22</b>



Noticeable erosion is seen at Kappil, Mahe, southPonnani, Veliancode (Puthuponnani), Thannithura, Ramanthali, Choottad, Chombala, Kolavipalam, Pakkayil, Moodai, Chettikulam, Kappad, Calicut, Thekkepuram, Kozhikode, Beypore, Cherai (Vypin), Kuzhupilly, Anyail, Narakkal, Malippuram, Kannamaly, Thalakadavu, Chellanam fishing harbor, kodamthuruth and Kochi port to Chellanam (Figure 10). Whereas coastal belts of Kanhangad, Valiyaparamba, Trikannad, Bekal, Mattool, Azheekkal, Meenkunnuchal, Kadikkad, Chavakkad, Nakshatra, Samithi, Mararikulam to Chethy, Kackary to Ayiramthai, Chavara, Anjuthengu, Perumathura, Pallithura and Veli are noticed with accretion.

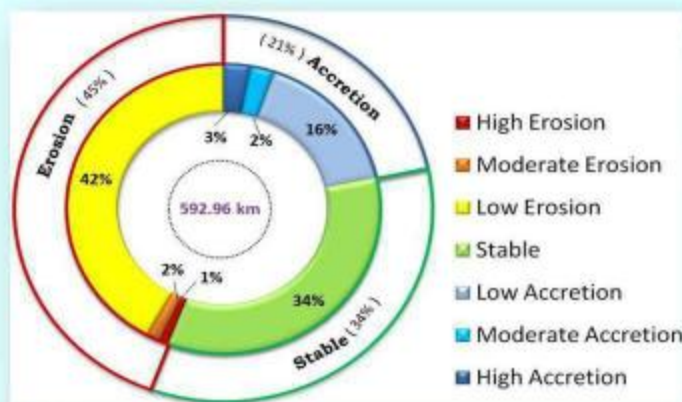


Figure 25: Percentage of shoreline change rate along Kerala coast.

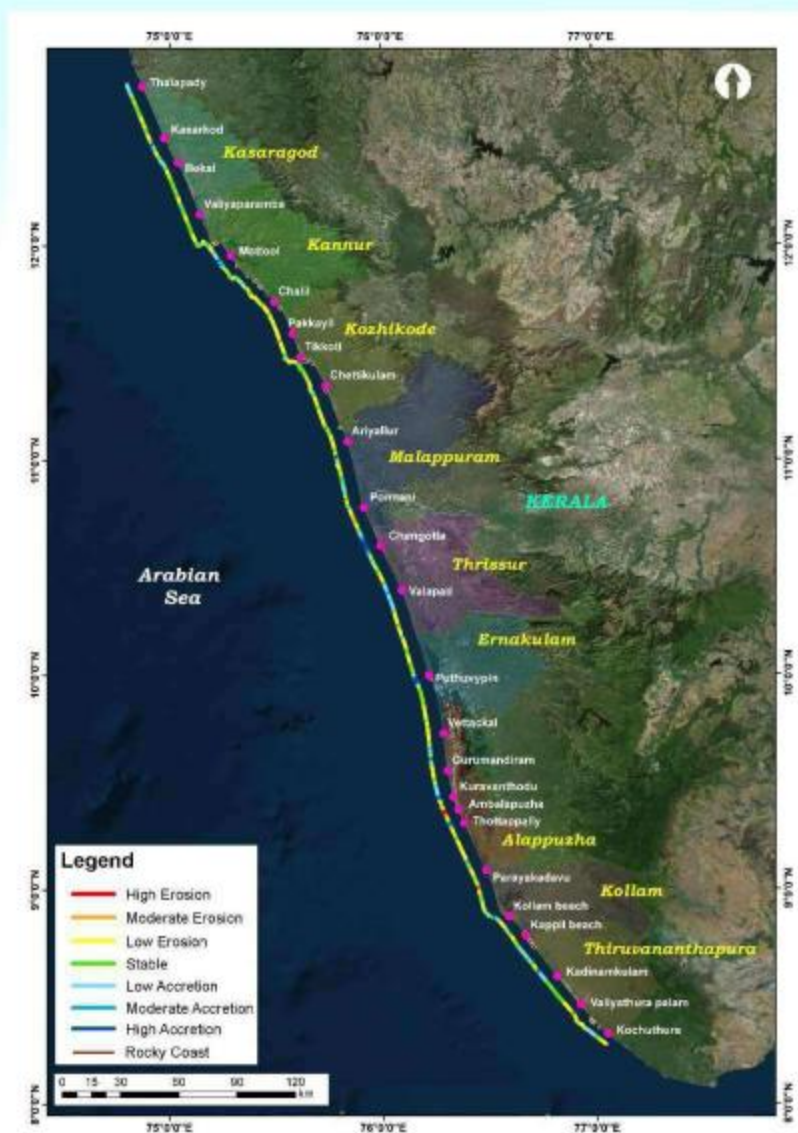
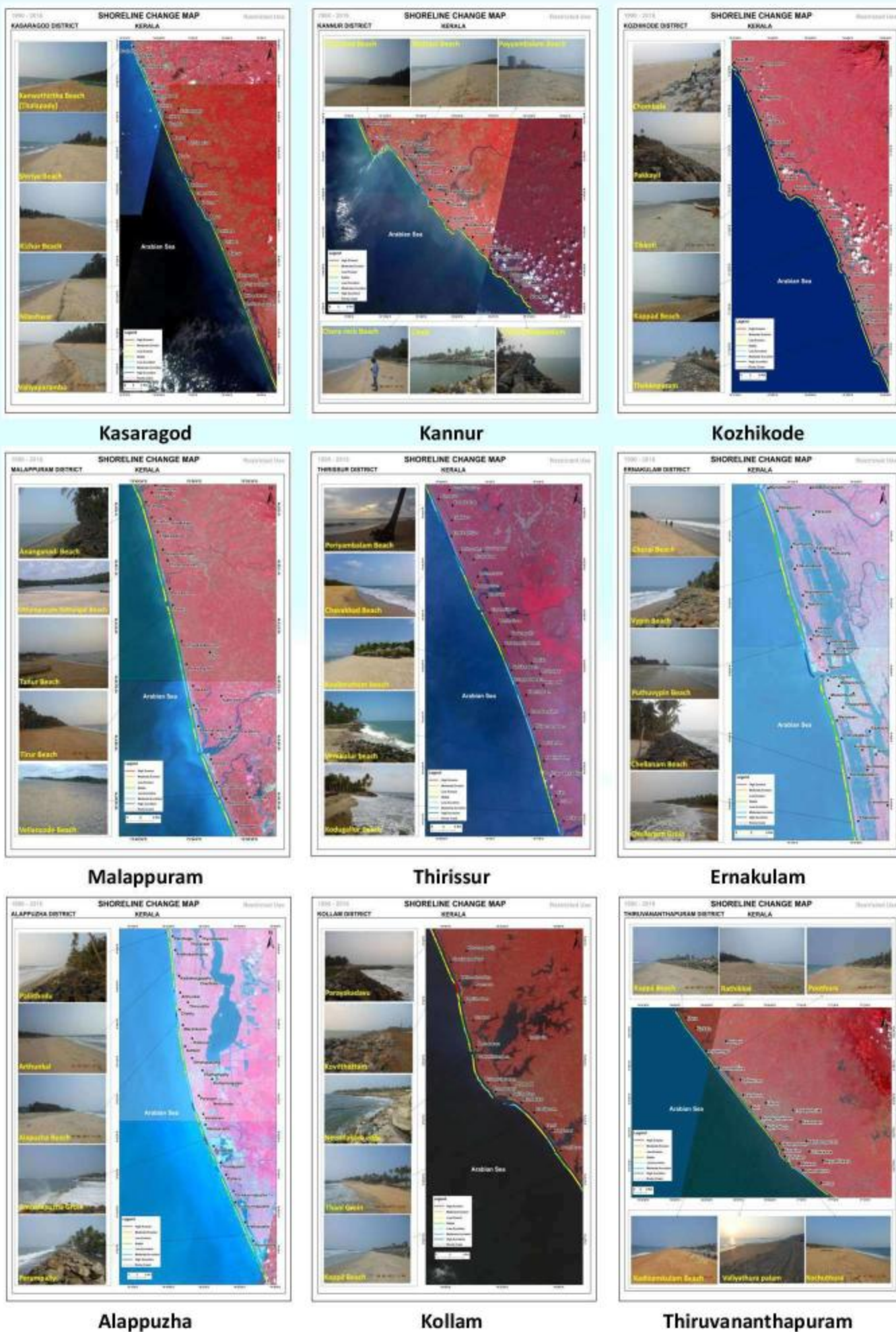


Figure 26: Shoreline change map of Kerala coast (1990-2016).



Figure 27: Coastal districts of Kerala





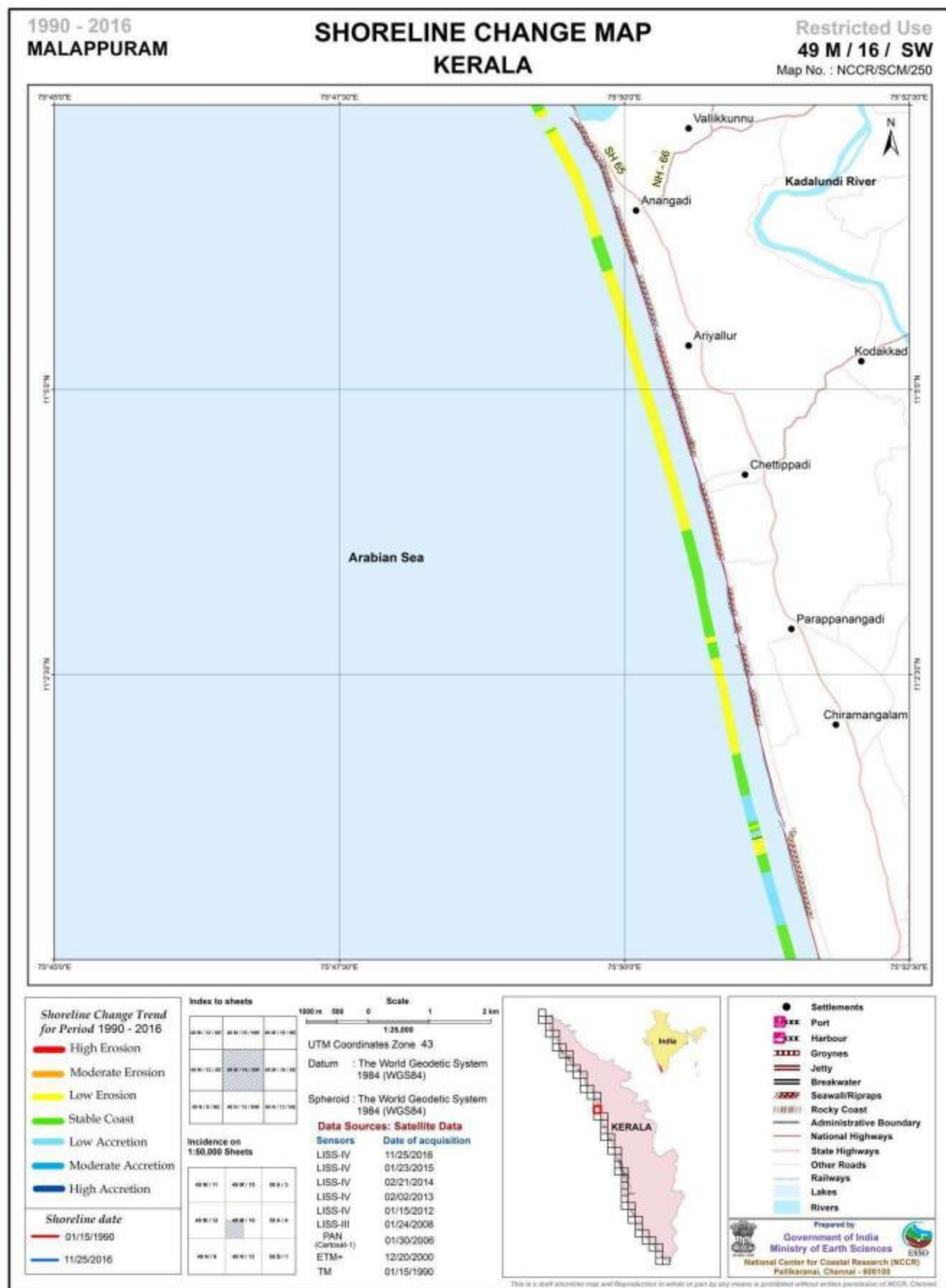


Figure 28: 1:25,000 scale map of Malappuram district, Kerala.

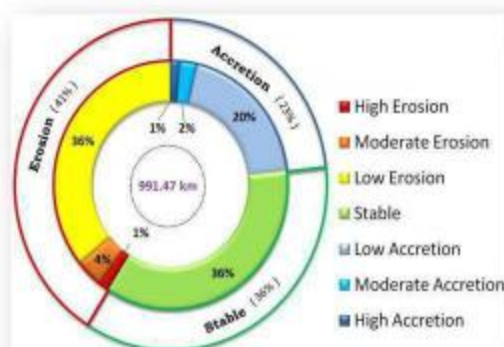
### 4.3.6 Tamil Nadu

The coastal state of Tamil Nadu is in the southern part of India, bound by Bay of Bengal in the east. The coastal length is dissected by a number of rivers, streams and by varying geomorphic features. Cauvery, Palar, Vaigai, Noyyal, Cheyyar, Bhavani and Thamirabarani are a few of the prominent rivers flowing through the state. Mudflats, beaches, spits, coastal sand dunes, lagoons, estuaries, beach ridges, strand features and rocky coasts are some of the geomorphic features identified along the coast. Pulicat found north of the state is the second largest lagoon of India. Coastal dunes stabilized by casuarinas and coconut plantations are observed along Ennore, Mahabalipuram, Manakkanam to Puducherry, Cuddalore to Pichavaram, Karaikal to Velangani, Vedaranniyam to Manamelkudi and Pudupattanam to Tondi. Two major ports are located along the coast. Madras Port and Tuticorin Port. Ports, fishing harbours and industries add economic aspect to the coast. The Gulf of Mannar Biosphere Reserve, Point Calimere Wildlife Sanctuary, mangrove forests at Pichavaram, Muthupet and coral reefs at Thothukudi show the significance of the sector.

Coastal length of the state consisting of thirteen coastal districts starting from Thiruvallur at north and Kanyakumari district at the south is estimated to be approximately 991 km from 2016 satellite imagery. Cumulative shoreline change analyzed for the past 26 years (1990-2016) shows that, about 41% of the coast is falling in erosion category, 23% is in accretion category and remaining 36% in stable category. District-wise interpretation of the results as shown in Table 14 elucidates that the coastal length of Kancheepuram, Villupuram, Thiruvarur and Kanyakumari are dominated by erosion. On the other hand, accretion of greater than 50% is observed in the districts of Thirunelveli and Thoothukudi. Along the Tamil Nadu coast, both natural coastal processes and human intervention in the form of artificial structures play a major role in shaping the coastline.

Erosion hot spots are identified along the coast of Thiruvottiyur, KasikovilKuppam, Chinnakuppam, Periyakuppam, Nadukuppam, Oyalikuppam, Bommiyarpalayam, ChinnamudalaiyarChavadi, PeriyamudalaiyarChavadi, Pettodai, Periyakuppam, Kodiakarai, Pombuhar, Kaveripattinum, Tharangapadi, Kilathotam, Tiruchendur, Thengapattanam, Midalam, Vaniakudi, Pillayarkovil, Puthenthurai, Murungavilai, Manakad, Melmidalam, Poonthurai, Colachel, Manavalakuruchi and Kovalam.

Accretion are noticed at the following places: Marina beach, between Ennore port and Korattalaiyar River, Thanthiriyankuppam, Vellingarayapettai, Pudukuppam, Samiyarpettai, Annappanpettai, Ayyampettai, Kodiakarai, Vedharanyam, Manamelkudi, Pillaiyartidal, Vallinokkam, Manapadu, Muthaipuram, Periyatalai, Pulianmarudar, Kunchiyapuram, Kuttam, Koodavallai, Kudutalai, Kuttappandi and Muttam.



**Figure 29:** Percentage of shoreline change rate along Tamil Nadu coast.



**Table 14:** Erosion-stable-accretion status of Tamil Nadu coastal districts.

SL No	District	Coast Length (in km)	Coast length (in km)						
			High Erosion	Moderate Erosion	Low Erosion	Stable	Low Accretion	Moderate Accretion	High Accretion
1	Thiruvallur	40.97	1.66	3.12	9.22	17.22	6.54	0.61	2.60
2	Chennai	24.87	0.00	0.00	3.08	14.31	7.13	0.35	0.00
3	Kancheepuram	84.41	1.30	3.54	44.56	27.74	7.27	0.00	0.00
4	Villupuram	34.52	0.00	0.31	24.83	8.39	1.00	0.00	0.00
5	Cuddalore	43.35	2.47	2.21	13.06	9.93	12.08	3.60	0.00
6	Nagapattinam	125.65	3.48	14.46	43.84	17.70	33.92	8.65	3.60
7	Thiruvarur	24.39	3.08	0.99	11.01	6.84	2.38	0.06	0.02
8	Thanjavur	52.36	0.20	0.77	16.84	20.05	13.36	1.01	0.13
9	Pudukkottai	46.74	0.04	0.28	22.67	18.98	4.66	0.11	0.00
10	Ramanathapuram	272.01	1.27	3.48	99.55	125.95	37.81	1.97	1.99
11	Thoothukudi	121.43	1.05	3.27	17.48	46.99	44.05	6.33	2.26
12	Thirunelveli	51.70	0.00	0.00	9.40	21.60	19.26	0.41	1.03
13	Kanyakumari	69.06	0.12	4.24	40.20	17.86	4.79	0.85	1.00
<b>TOTAL</b>		<b>991.47</b>	<b>14.66</b>	<b>36.65</b>	<b>355.74</b>	<b>353.56</b>	<b>194.27</b>	<b>23.96</b>	<b>12.63</b>

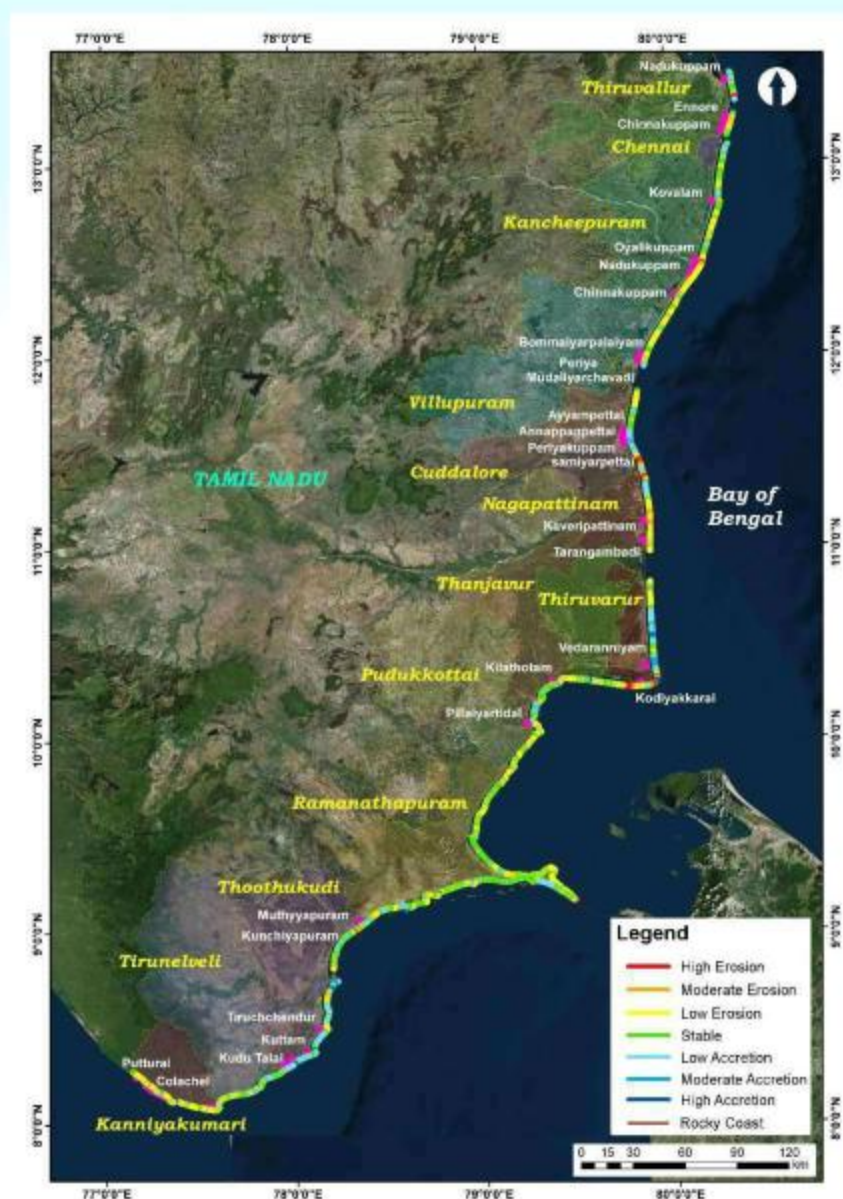
**Figure 30:** Shoreline change map of Tamil Nadu coast (1990-2016).



Figure 31: Coastal Districts of Tamil Nadu



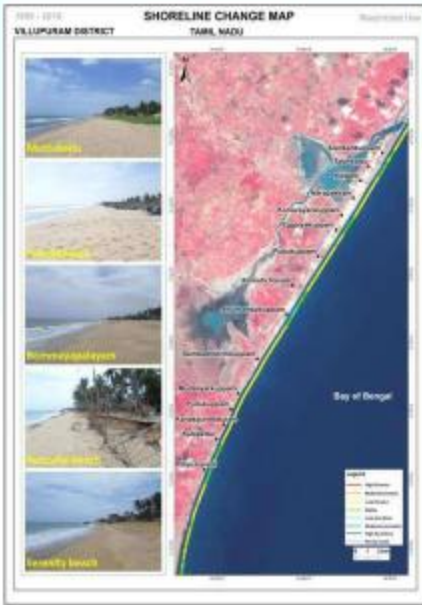
Thiruvallur



Chennai



Kancheepuram



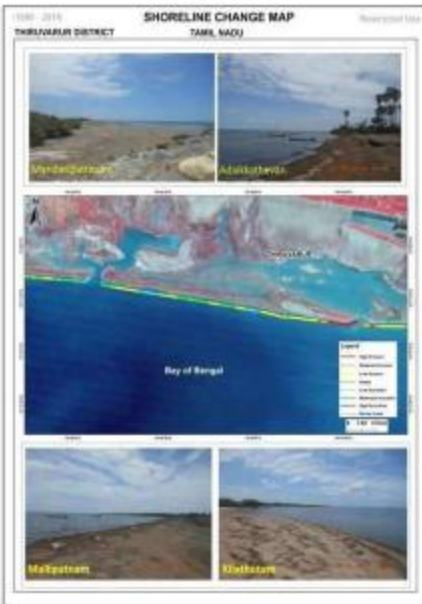
Villupuram



Cuddalore



Nagapattinam



Thiruvarur



Thanjavur



Pudukottai





Ramanathapuram



Thothukudi



Thirunelveli



Kanyakumari



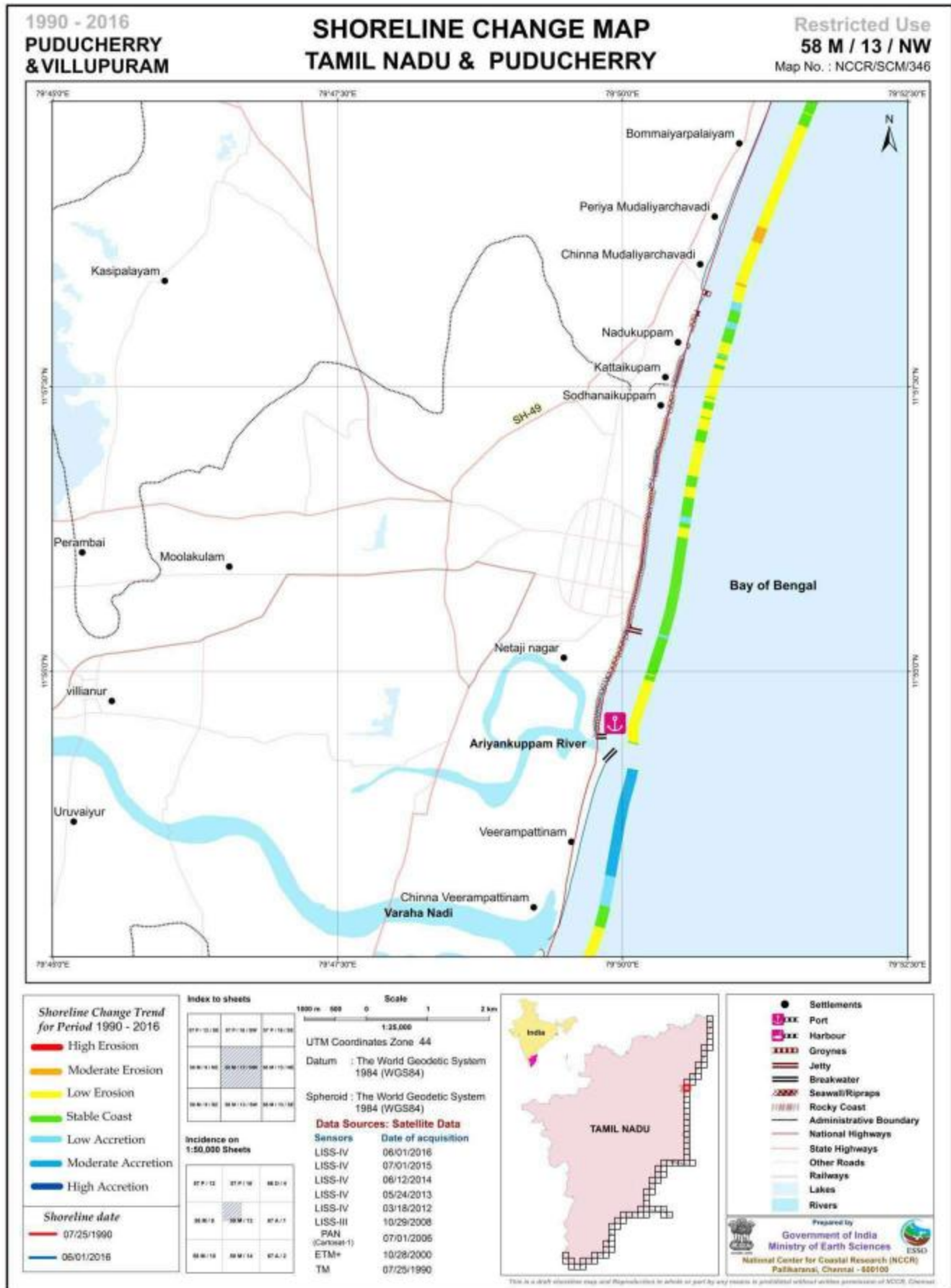


Figure 32: 1:25,000 scale map of Puducherry and Villupuram district, Tamil Nadu.



### 4.3.7 Puducherry and Karaikal

Puducherry is one of the Union Territories (UT) of India, located in the southern part of the Indian Peninsula. Puducherry, Karaikal, Yanam and Mahe districts together constitute Puducherry UT. Puducherry district and Karaikal district are bound by the state of Tamil Nadu in the deltaic region of Cauvery, While Yanam district and Mahe district are enclosed by the states of Andhra Pradesh and Kerala, respectively. Gingee and Ponnaiyar are the two major rivers flowing along the coast of Puducherry. In Karaikal, Arasalar, Tirumalarajanar and Vettar are the rivers draining into Bay of Bengal. About 5.2 km is protected with big boulder all along the north of Puducherry coast. Seawall extending for about 2 km can be observed 27 feet above the mean sea level in the Puducherry city. This wall is constructed by the French in the year 1735 to protect the city from direct wave action.

The coastal length of Puducherry and Karaikal is 23.48 km and 18.16 km, respectively, together it is about 42 km. Long term cumulative shoreline analysis of the coast from 1990 to 2016, indicates that 57% of the coast is in eroding condition, 35% in stable condition and only 8% under accreting condition. Erosion is one of the major concerns along these coasts. Artificial structures play a major role for erosion along these coasts.

North of the Puducherry port i.e., Thengaithithu, coastal villages of Pudukuppam, Pannithittu, Nallavadu, Kalapettai and ChinnaKalapettai are noticed to undergo erosion. Accretion is noticed at Virampattinum and ChinnaVirampattinum. Majority of the Karaikal coast is experiencing erosion. Along karaikal coast, erosion is observed in the coastal villages of Akkampettai, Kasakkudimedu, Kilinimedu and Pattanacheri.

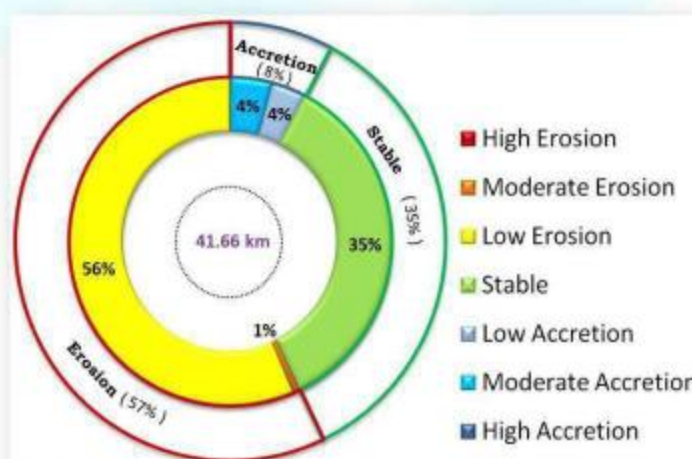


Figure 33: Percentage of shoreline change rate along Puducherry coast.

Table 15: Erosion-stable-accretion status of Puducherry coastal districts

SL No	Union Territory	Coast Length (in km)	Coast length (in km)						
			High Erosion	Moderate Erosion	Low Erosion	Stable	Low Accretion	Moderate Accretion	High Accretion
1	Puducherry	23.50	0.00	0.00	9.61	11.55	0.61	1.72	0.00
2	Karaikal	18.16	0.00	0.32	13.87	3.07	0.84	0.06	0.00
<b>TOTAL</b>		<b>41.66</b>	<b>0.00</b>	<b>0.32</b>	<b>23.48</b>	<b>14.63</b>	<b>1.45</b>	<b>1.78</b>	<b>0.00</b>



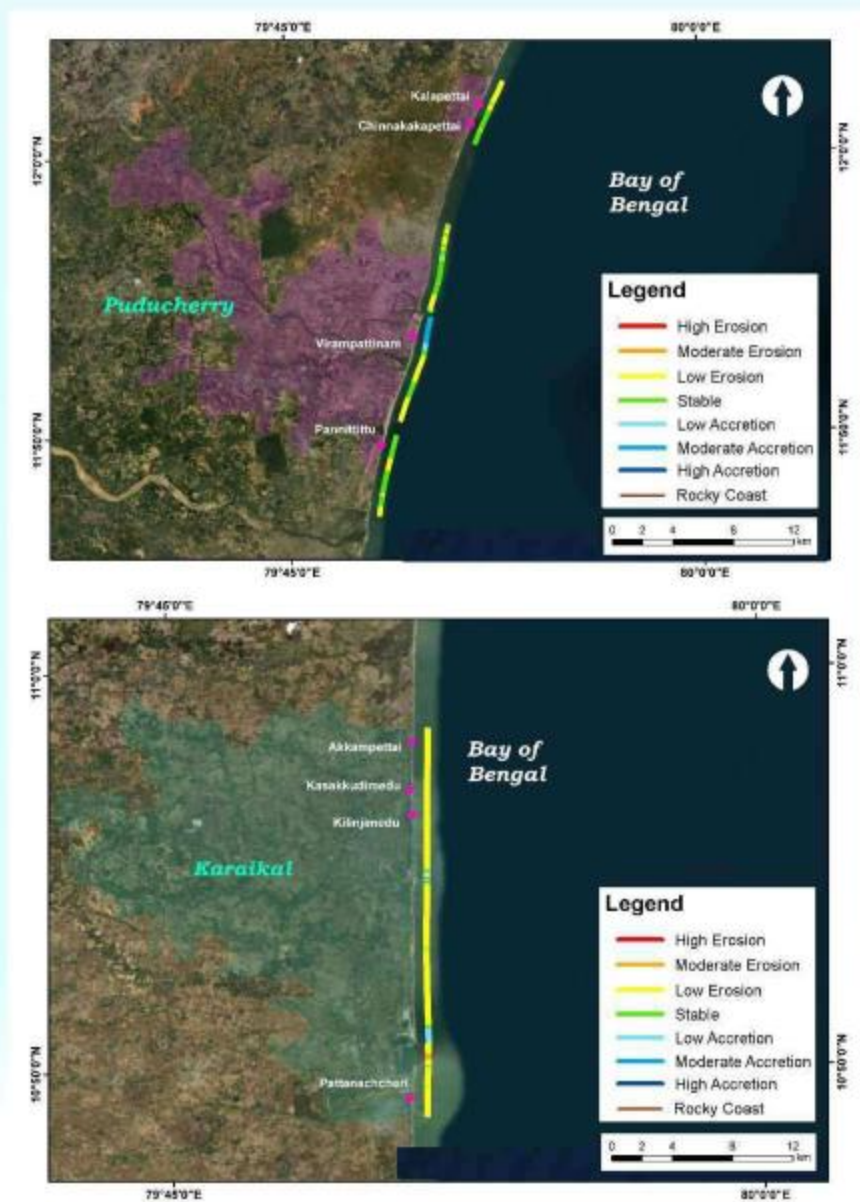


Figure 34: Shoreline change map of Puducherry coast (1990-2016).

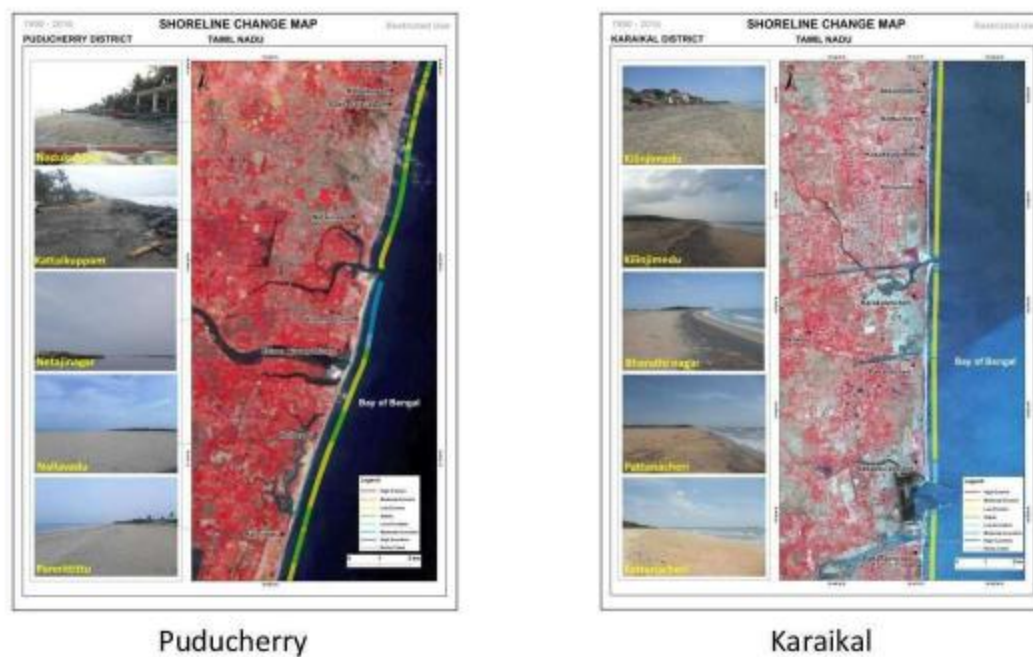


Figure 35: Coastal Districts of Puducherry



### 4.3.8 Andhra Pradesh

The Coastal stretch of Andhra Pradesh on the western side of Bay of Bengal is the second longest coast after Gujarat. It extends from Ichchapuram of Srikakulam district in the north to Tada of Nellore district in the south. Coastal geomorphic features like deltas, dune system, red sediments, beach rock, etc are prominent along this sector. Godavari and Krishna rivers, form the two important deltas of the region, influence the landforms occurring in the stretch. Stabilized and well developed sand dunes are observed north of Visakhapatnam. Mangroves are seen in the districts of Prakasam, Guntur, West Godavari and East Godavari. Region of the coast above Guntur is dotted with industries like cement, oil terminals, etc. About 10 ports including the major port in Visakhapatnam boost the economy of the coastal belt. During northeast monsoon the coast is often ravaged by tropical cyclones originated in the Bay of Bengal basin. Natural calamity and developmental activities together exert pressure on the coastal system and induce coastal changes.

From 2016 satellite imagery, coastal length of the state spread across 9 districts, is measured to be about 1027 km. Cumulative shoreline change analysis from 1990 to 2016 indicates that 27% of the coast is eroding, 31% is stable and 42% is accreting. Nellore district shows accretion trend with a few pockets of erosion and stable condition. In the districts of Prakasam, Guntur and West Godavari, accretion is observed to be dominating the coast. Delta regions of Krishna and East Godavari show alternating band of accretion and erosion. Visakhapatnam, Vizhianagaram and Srikakulam districts are observed to exhibit stable condition.

Regions like Korakupalaiyam, Pallikuppam, Toppalappalaiyam, Virrasettitanippandal, Vatturupallipalem (above the Upputeru River), Ramulapatisangam, Binginipalle, Rayaduruvu, Peddaboyanapalem, Ullapalem and Uppada are identified as erosion prone areas. Visakhapatnam is found to be the most stable in the Andhra coast as it is protected with Kailasa and Yarada ranges. Accretion is seen along Pattapupalem, Pallepalem, Kesavapalem and Gundamala. In the northern part of the coast, from Ichchapuram to Beemunipatanam, no significant change is observed. These areas are covered with sand dunes and sandy beach.

**Table 16:** Erosion-stable-accretion status of Andhra Pradesh coastal districts

SL No	District	Coast Length (in km)	Coast length (in km)						
			High Erosion	Moderate Erosion	Low Erosion	Stable	Low Accretion	Moderate Accretion	High Accretion
1	Nellore	172.10	5.36	3.16	41.72	50.36	62.22	7.14	2.14
2	Prakasam	107.18	3.20	4.72	15.38	19.70	53.64	7.18	3.36
3	Guntur	64.24	0.84	0.00	1.72	9.54	26.06	13.78	12.30
4	Krishna	133.36	40.30	6.18	8.64	17.86	21.02	10.18	29.18
5	West Godavari	17.98	5.52	0.72	0.98	1.04	2.74	1.98	5.00
6	East Godavari	189.84	45.92	13.84	19.54	25.60	33.10	18.22	33.62
7	Vishakhapatnam	136.98	0.34	2.24	12.36	102.74	17.78	1.34	0.18
8	Vizhianagaram	32.78	0.00	0.00	11.96	12.54	7.66	0.00	0.62
9	Srikakulam	173.12	0.02	1.92	25.76	81.60	49.36	7.36	7.10
<b>TOTAL</b>		<b>1027.58</b>	<b>101.50</b>	<b>32.78</b>	<b>138.06</b>	<b>320.98</b>	<b>273.58</b>	<b>67.18</b>	<b>93.50</b>





Figure 36: Percentage of shoreline change rate along Andhra Pradesh coast.

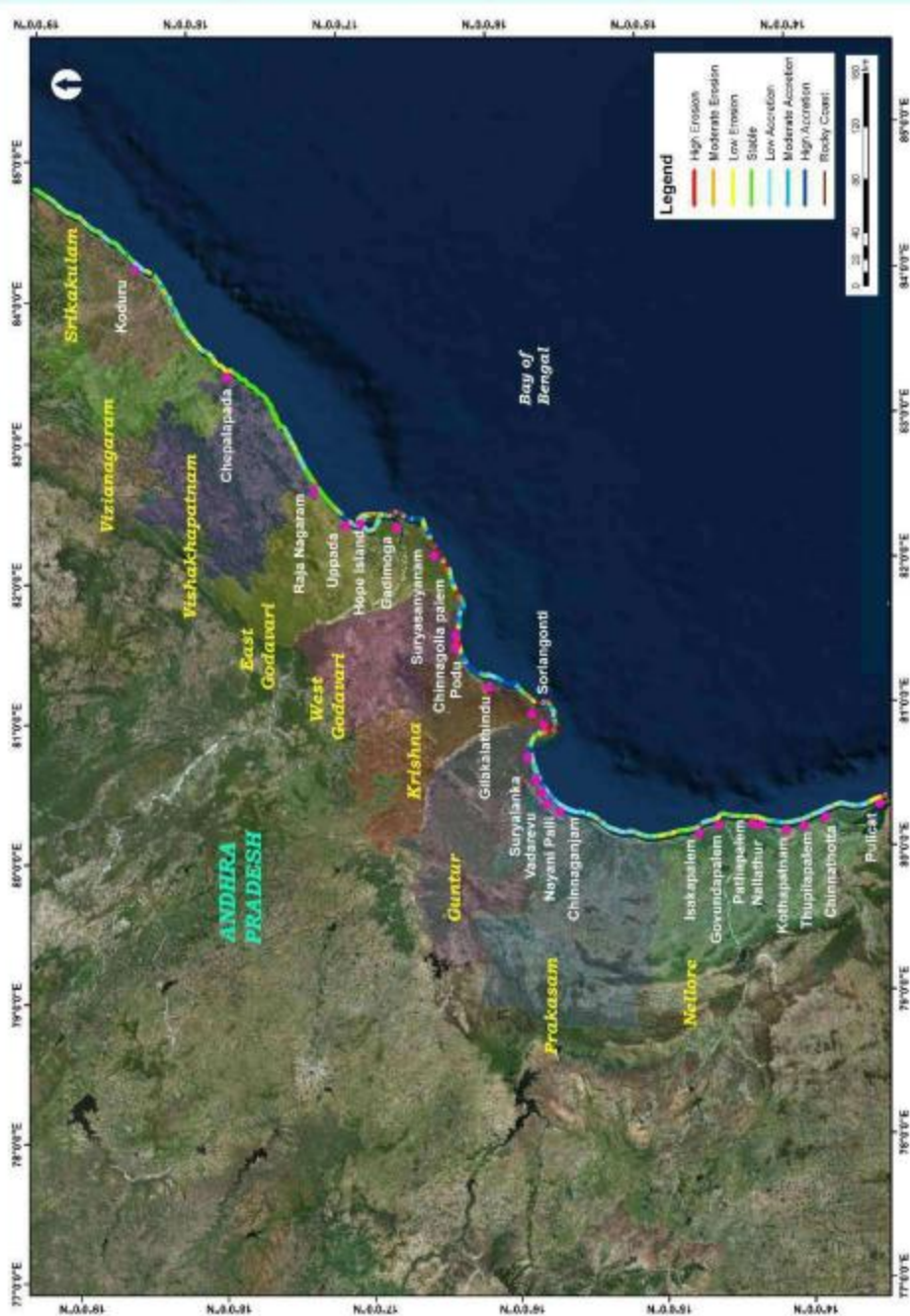


Figure 37: Shoreline change map of Andhra Pradesh coast (1990-2016).



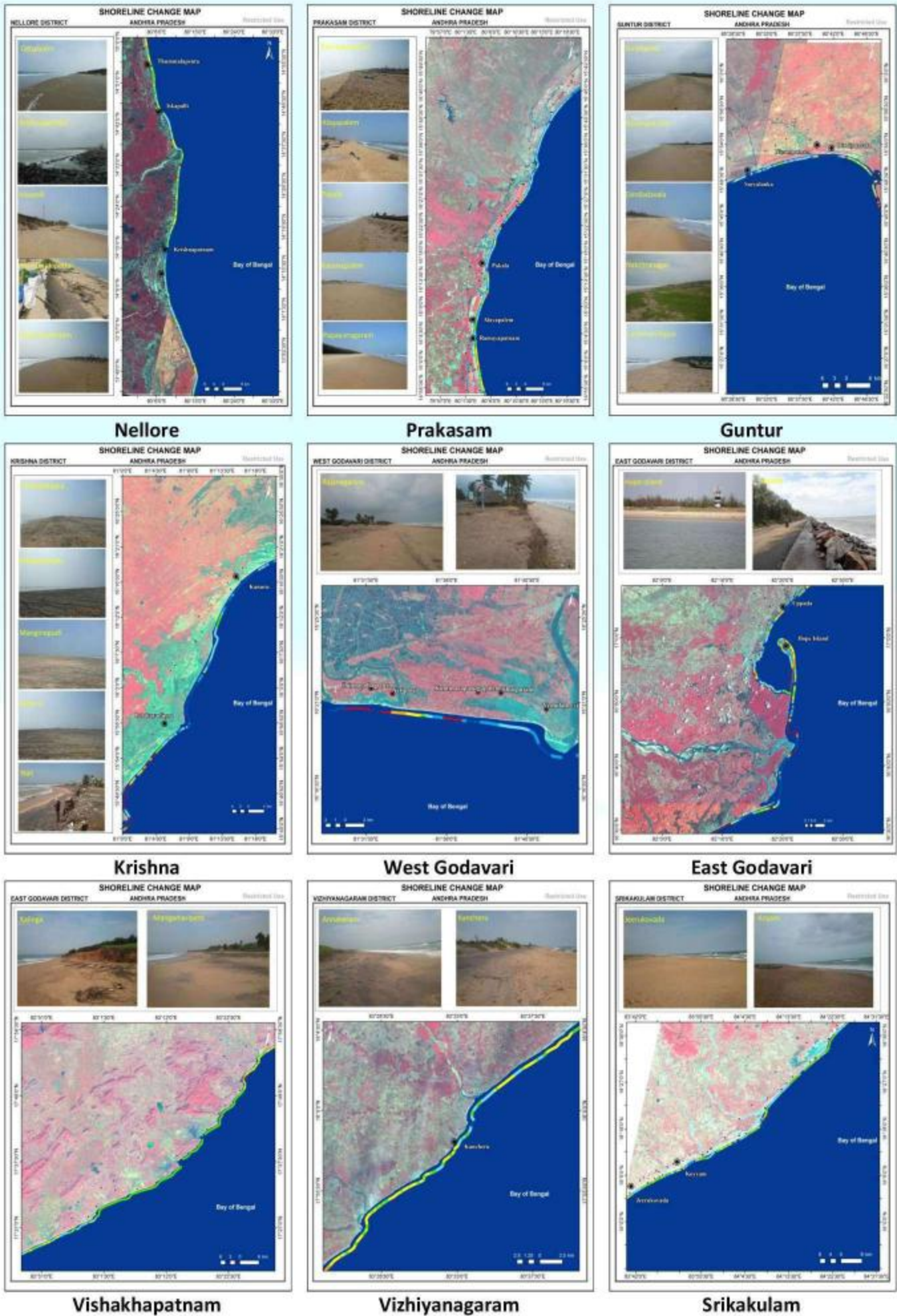


Figure 38: Coastal district of Andhra Pradesh



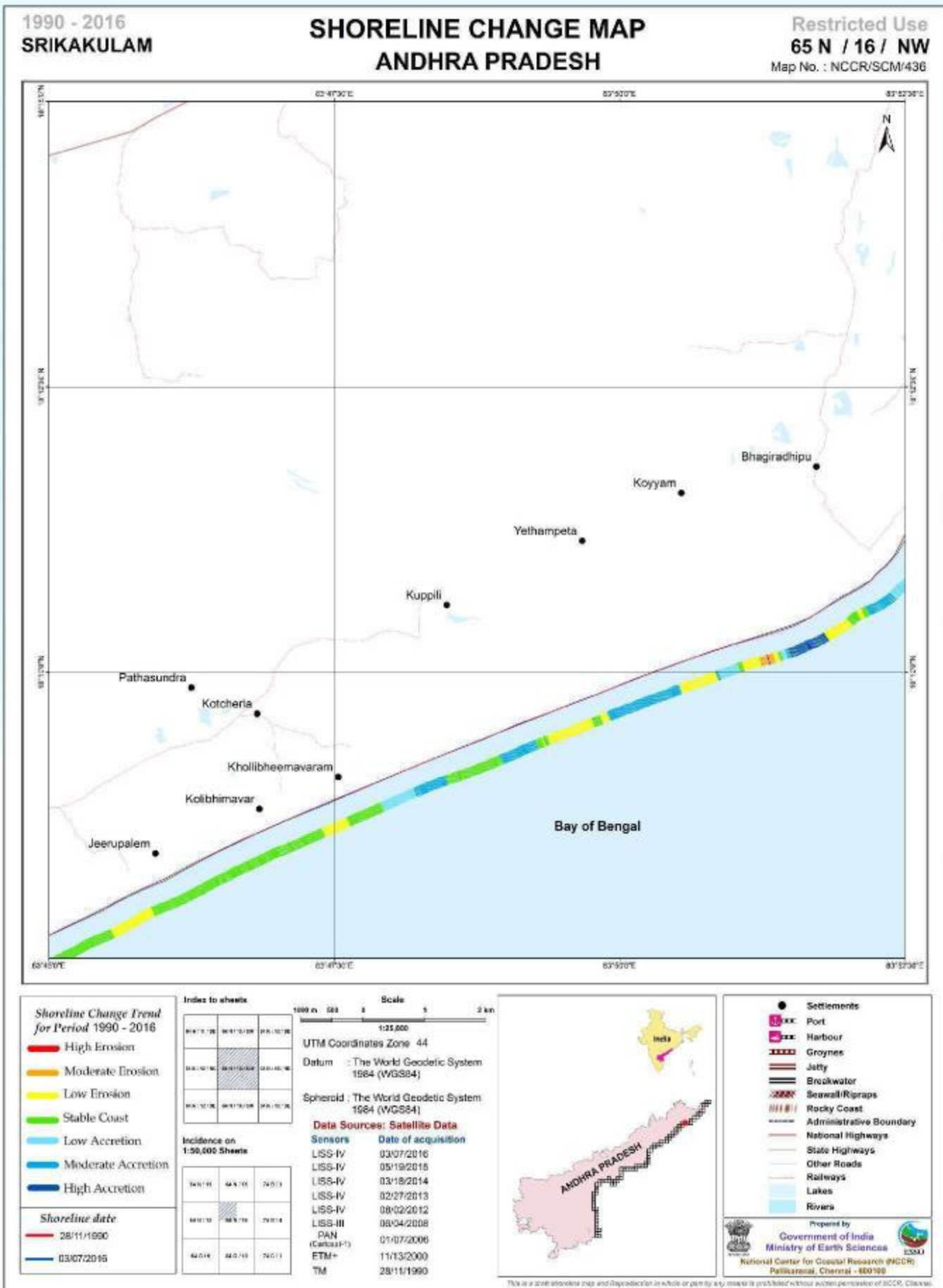


Figure 39: 1:25,000 scale map of Srikakulam district, Andhra Pradesh.



### 4.3.9 Odisha

Odisha located in the north-eastern coast of India, is a maritime state with immense potential in natural resources. The coastal plain of the state is a combination of several deltas of varied sizes and shapes formed by the major rivers the Subarnarekha, the Budhabalanga, the Baitarani, the Brahmani, the Mahanadi and the Rushikulya. The coast is characterized by several depositional geomorphic features like beach ridges, deltas, tidal flats, sand spits, and barrier spits, etc. Sandy beaches enriched with many rare earth minerals are observed in the southern part of the state from Rushikulya River mouth to Devi River mouth, while in the northern part subtidal mudflats are prevalent. The coast is of great ecological significance too. Asia's largest brackish water lagoon Chilika is located along the coast. World's largest known nesting site of olive ridley turtles is observed along the coast of Gahrim and Rushikulya. Mangrove vegetation is seen along the creek network of Mahanadi, Brahmani and Baitarani. The mangrove of Bhitarkanika is the second largest mangrove formation in the Indian subcontinent. Apart from this, the coast is vulnerable to natural disaster tropical cyclone. Further, increase in population and developmental activity along the coastal belt in the recent years has induced coastline changes.

The coastal length of state with 6 districts constitute to about 550 km. Long-term shoreline analysis from 1990 to 2016 indicates that 28% of the coast is eroding, 21% is stable and 51% is accreting. Districts of Puri, Badhrak and Baleshwar to show accretion trend; more than 50% of their respective coastal length is accreting. Jagatsinghpur district found to exhibit erosion; about 58% of its coast is eroding. In the districts of Ganjam and Kendrapara, erosion, accretion and stable conditions are observed.

From figure 18 it is noted that north of the Gopalpur port and Rushikulya river mouth exhibit erosion. The seasonal movement of sand bars plays an important role in shoreline configuration. In Jagatsinghpur district, major erosion zone starts from Devi River mouth and continues further 25 km north. Southern part of Paradip port is noticed with accretion. Spit observed north of Paradip port in 1973 has totally eroded and a new spit Hukitola is observed to grow north of Mahanadi River. It is noted that Hukitola spit is accreting at a higher rate in the tip, along Kendrapara district. Erosion is seen in the coastal villages of Pentha, Kanhupur, Satbhaya, Gairmatha and Habalikhuti. Wide mud flats with inter tidal zone of more than 0.5 km are observed in the Baleshwar district.

**Table 17:** Erosion-stable-accretion status of Odisha coastal districts

SL No	District	Coast Length (in km)	Coast length (in km)						
			High Erosion	Moderate Erosion	Low Erosion	Stable	Low Accretion	Moderate Accretion	High Accretion
1	Ganjam	62.90	3.84	1.92	8.30	18.46	22.10	1.84	6.44
2	Puri	140.04	6.68	4.34	10.38	9.18	73.72	23.66	12.08
3	Jagatsinghpur	58.72	14.58	7.76	11.88	9.24	5.18	0.88	9.20
4	Kendrapara	135.82	31.02	8.72	9.22	54.26	11.26	5.02	16.32
5	Bhadrak	59.88	6.64	3.44	3.48	4.14	4.58	6.66	30.94
6	Baleshwar	92.14	5.50	4.32	11.78	18.24	22.10	7.54	22.66
<b>TOTAL</b>		<b>549.50</b>	<b>68.26</b>	<b>30.50</b>	<b>55.04</b>	<b>113.52</b>	<b>138.94</b>	<b>45.60</b>	<b>97.64</b>



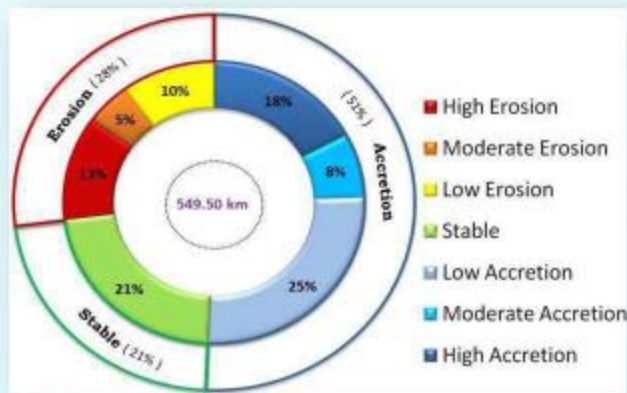


Figure 40: Percentage of shoreline change rate along Odisha coast.

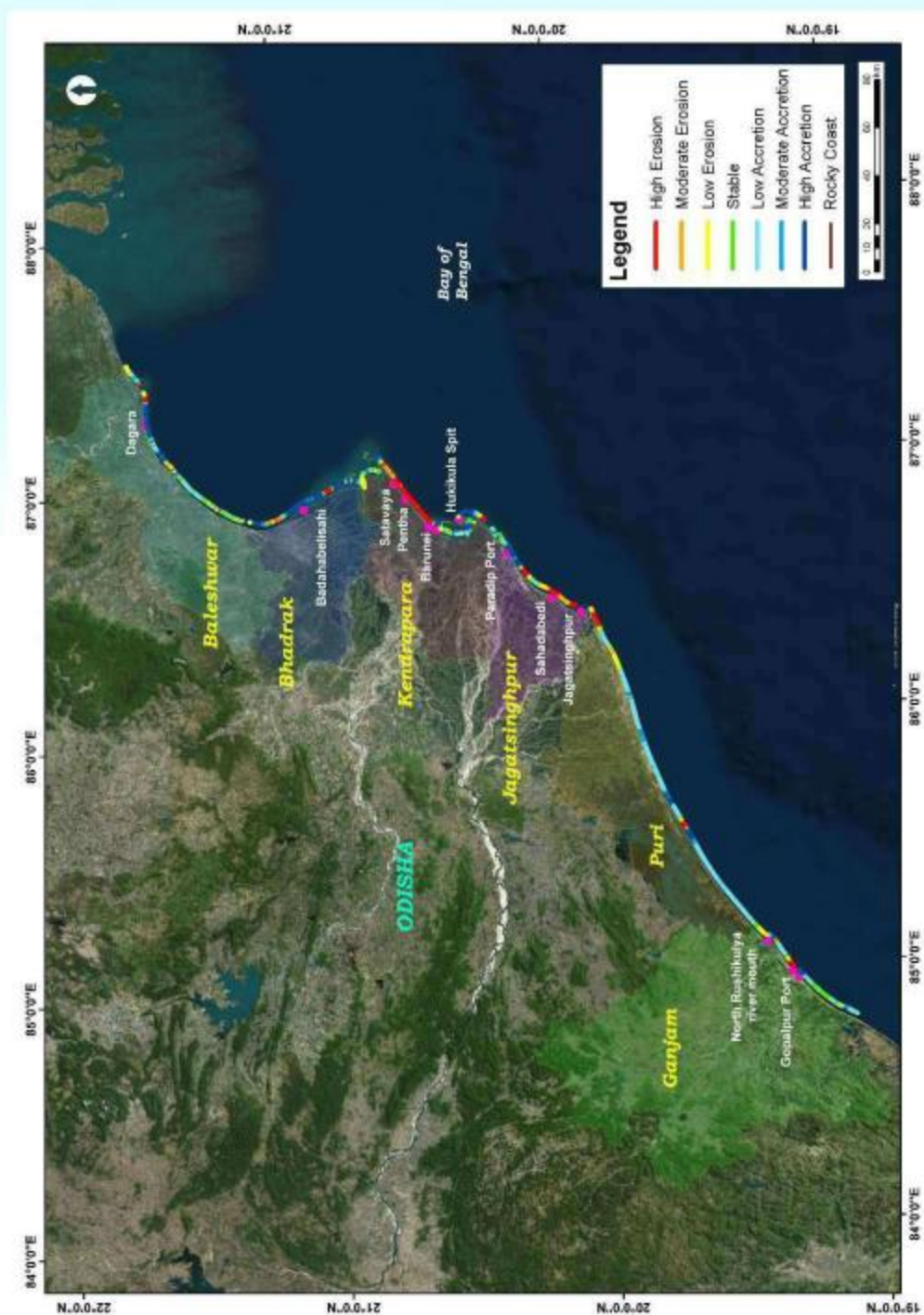
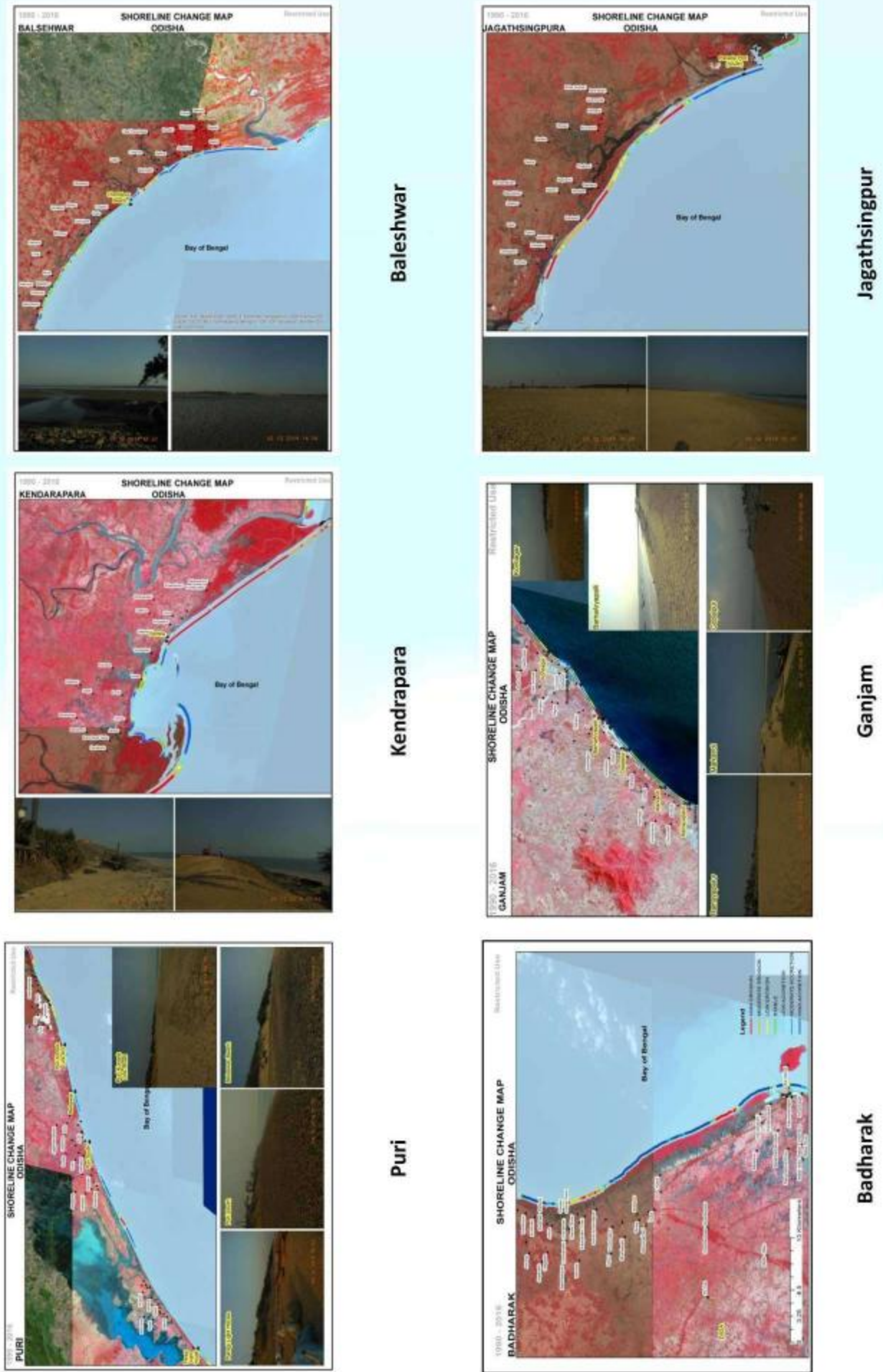


Figure 41: Shoreline change map of Odisha coast (1990-2016).



Figure 42: Coastal districts of Odisha





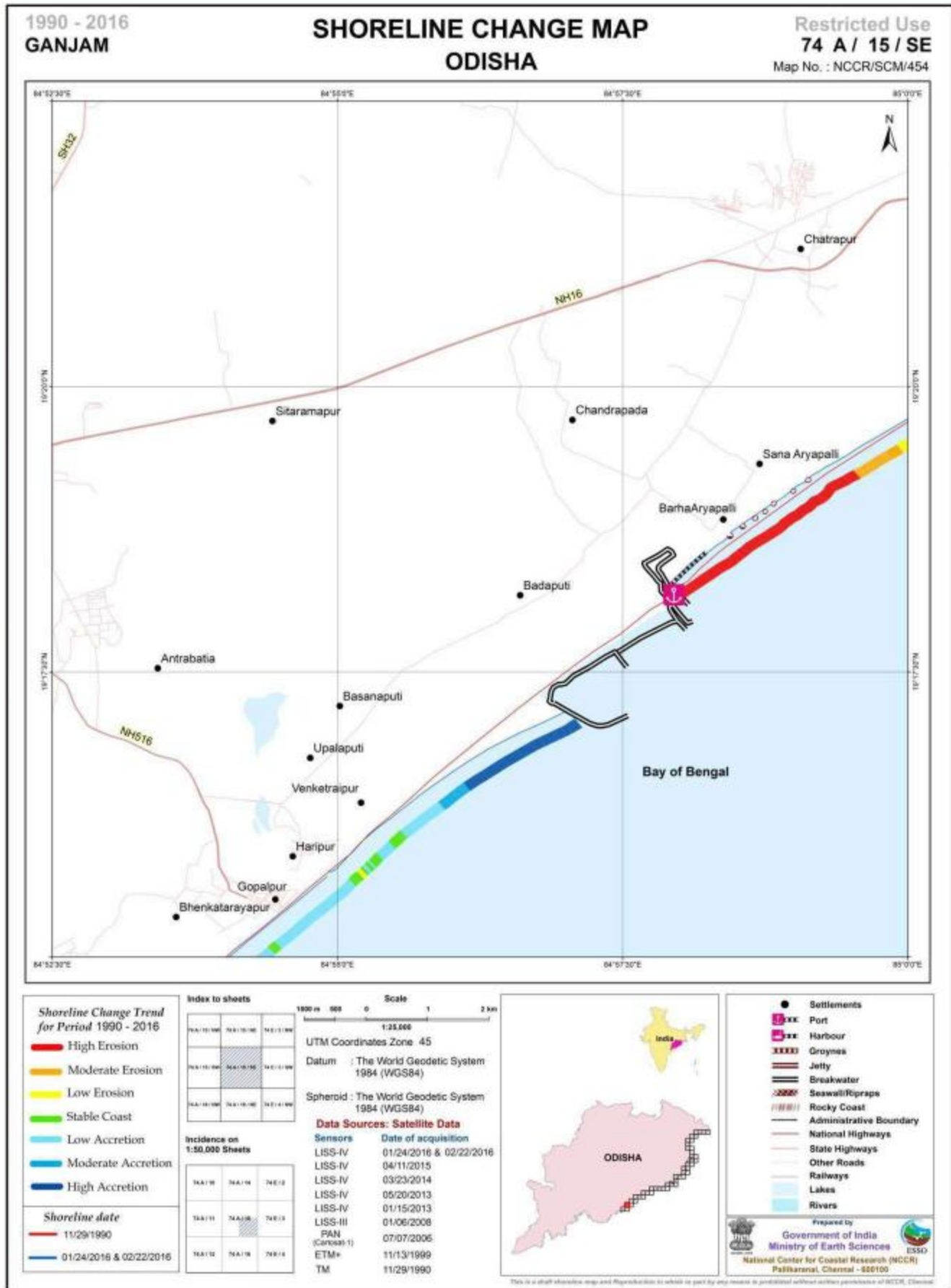


Figure 43: 1:25,000 scale map of Ganjam district, Odisha.

### 4.3.10 West Bengal

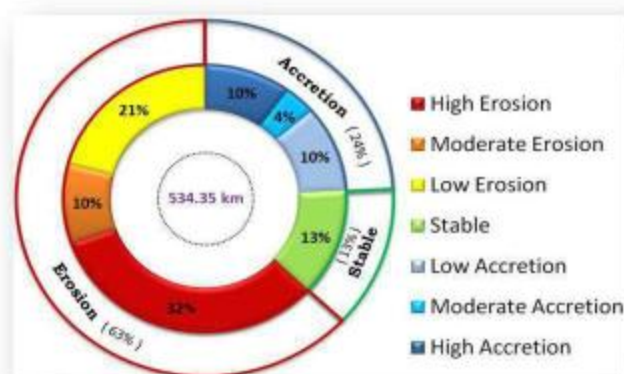
The coastal stretch of West Bengal is located in the eastern end of Indian Peninsula, bordering Bangladesh. The coast is one of the largest deltaic regions in the world. The Ganges, Damodar, Silali, Kasai and Hooghly are a few of the prominent rivers of the state draining into Bay of Bengal, forming the funnel shaped Hooghly estuary. Upper reaches of the creeks and coastal plain are composed of sand and mud, deposited by rivers and winds. Beaches, creeks, mangrove swamps, mudflats, coastal dunes and sand flats are some of the geomorphic features of the coastal area. It is observed that most of the sand dunes and marshy lands occur parallel to the coast. The Digha dunes lie nearest to the Bay of Bengal while the Kanthi dune is farthest from it. The Sundarban delta complex spread in the north and south Pargana districts is fed by numerous rivers and has the largest single block of tidal halophytic mangroves of the world. These regions are affected by tides, tropical cyclones and storm surges. The Sundarban has a link to the tectonic Bengal basin; a huge thickness of tertiary marine sediments is actively subsiding here. Natural processes and human interference such as salt pan, aquaculture, port construction and other developmental activities highly influence the coastline and cause changes.

Coastal length of the state is measured to be about 534 km from 2016 satellite imagery. Shoreline change analysis from 1990-2016 indicates that 63% of the coast is eroding, 13% is stable and remaining 24% is accreting. All the coastal districts of East Midnapore, South twenty-four Parganas and North twenty-four Parganas exhibit erosion with a few pockets of accretion and stable condition.

In the East Midnapore district, Old Digha, Jamra, Shyampur, Mandarmani and Bankiput beaches face erosion. In South 24 Parganas district, southeast and west of Sagar Island face severe erosion. Chumkur Island with the area of 133 hectares had gradually decreased and washed out in the span of 26 years. Same trend is observed in the case of Jumbudweep Island. Kusumtala (Baliara coast), Hendry Island, Gobardhanpur, Bulcherry and Sundarban area which fall between Gobardhanpur, Bulcherry and Kalash Island are severely eroded especially at the shore face.

**Table 18:** Erosion-stable-accretion status of West Bengal coastal districts.

SL No	District	Coast Length (in Km)	Coast length (in Km)						
			High Erosion	Moderate Erosion	Low Erosion	Stable	Low Accretion	Moderate Accretion	High Accretion
1	East Midnapore	55.35	6.44	5.49	15.92	8.09	9.12	2.78	7.51
2	South 24 Parganas	332.93	98.74	28.26	66.84	44.22	39.98	15.94	38.94
3	North 24 Parganas	146.07	68.46	18.21	28.16	16.47	7.16	1.07	6.54
<b>TOTAL</b>		<b>534.35</b>	<b>173.64</b>	<b>51.96</b>	<b>110.92</b>	<b>68.78</b>	<b>56.26</b>	<b>19.80</b>	<b>52.99</b>



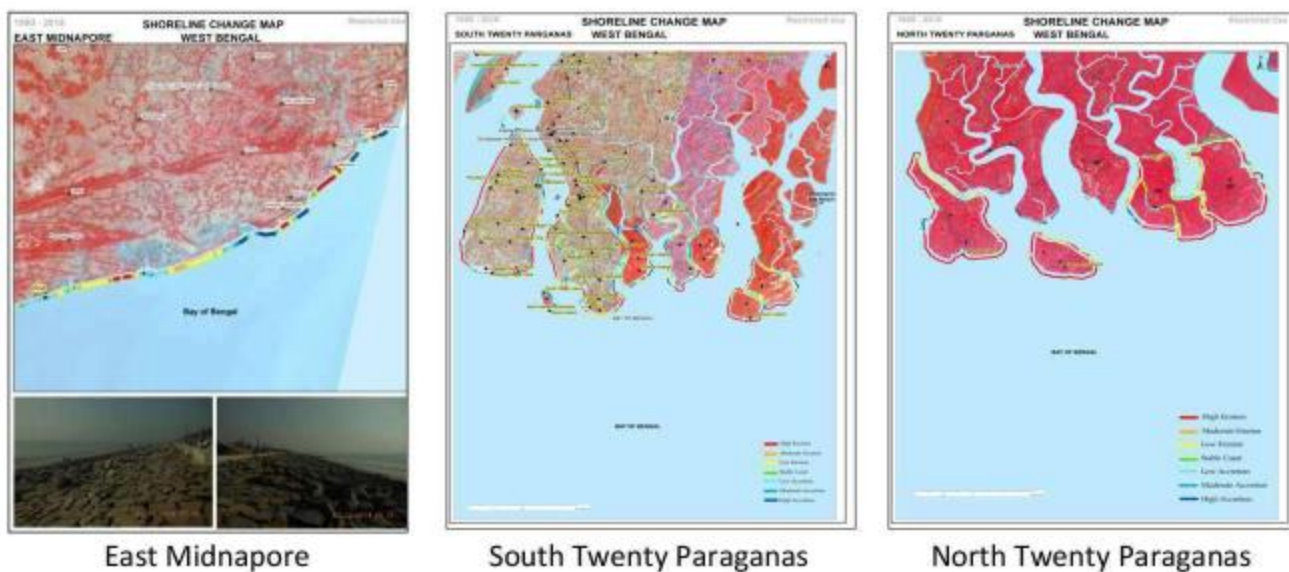
**Figure 44:** Percentage of shoreline change rate along West Bengal coast.





Figure 45: Shoreline change map of west Bengal coast (1990-2016).

Figure 46: Coastal district of West Bengal



East Midnapore

South Twenty Parganas

North Twenty Parganas

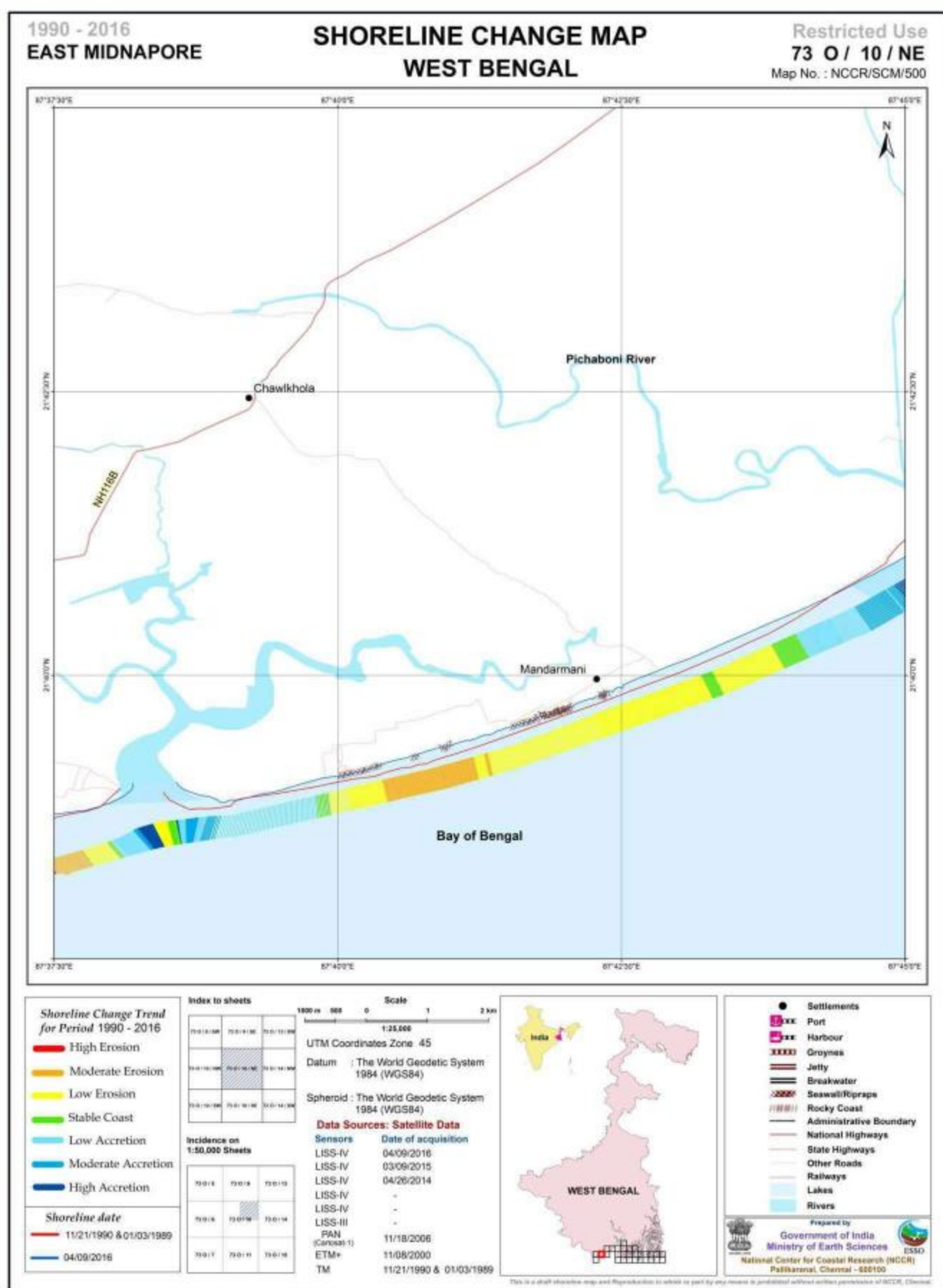


Figure 47: 1:25,000 scale map of East Midnapore district, West Bengal.



#### 4.4 Data products

The shoreline thus analysed from satellite imageries serves different data products to depict the output. Each map has different applications and used for different management purposes. These maps will be updated for every successive year. Below are the data products which are derived from final results.

##### 1:25,000 scale maps

Indian mainland is bounded with 526 numbers of 1:25,000 scale maps at coastal region. This map will have information such as shoreline change rate with seven categories as low erosion, moderate erosion, high erosion, stable, low accretion, moderate accretion and high accretion. It also carries other particulars such as shoreline surveyed date, infrastructure details, ports, fishing harbours and industries.



Figure 48: 1:25,000 scale map.

**District maps**

Indian coastal regions have sixty coastal districts and four union territories (Puducherry, Karaikal, Mahe, Daman & Diu districts). Each district map depicts shoreline change rate along with field photographs.



**Figure 49:** District map.



**State maps**

India is comprised of 9 coastal states and 2 union territories. Each state map will have information's such as shoreline change rate with seven categories as low erosion, moderate erosion, high erosion, stable, low accretion, moderate accretion and high accretion.

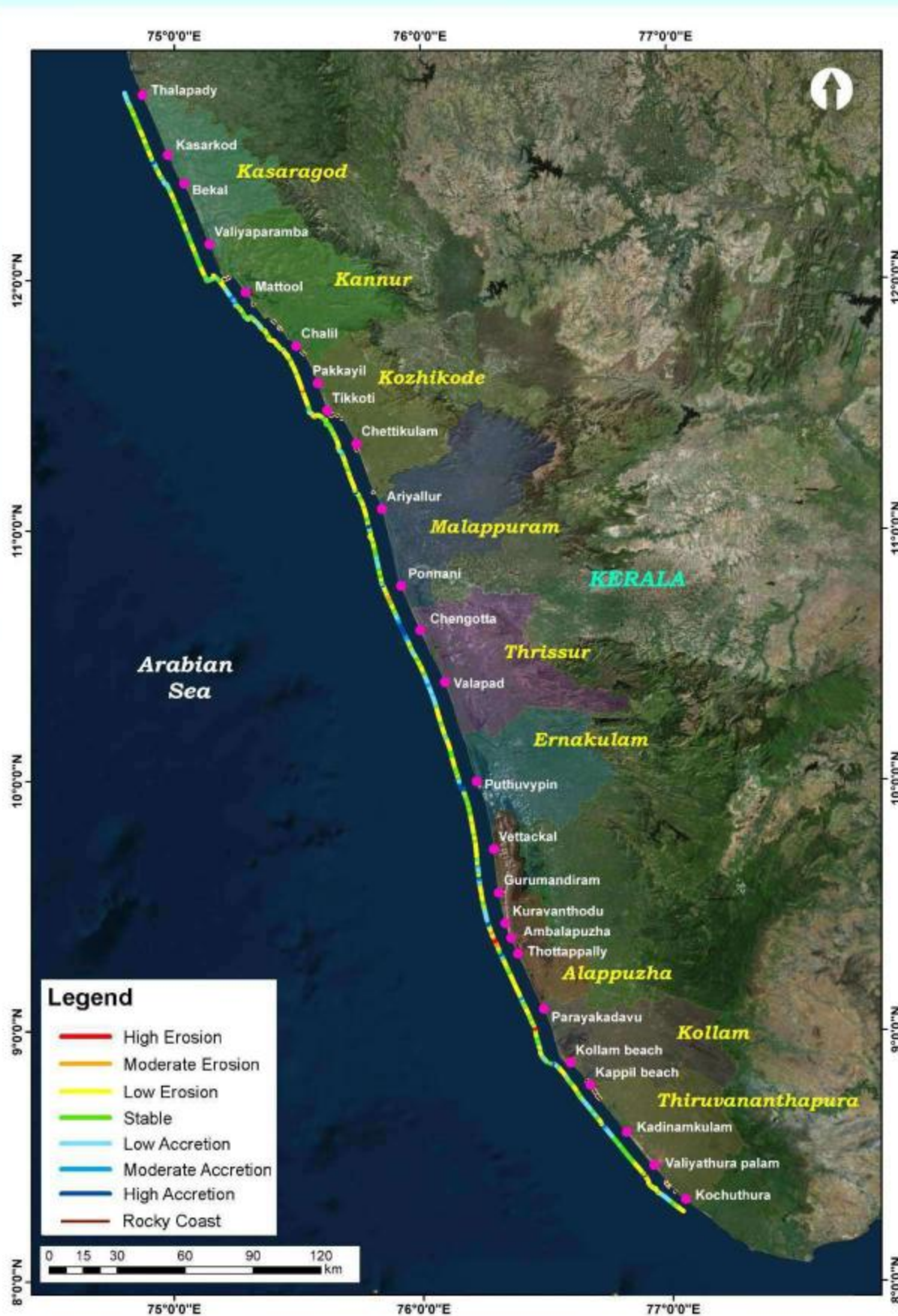


Figure 50: State map.



Hot spot locations overlaid with satellite images

From shoreline results, hot spot regions were identified for each state separately. The hot spot locations were overlaid with satellite imagery to give a clear picture of accretion/erosion change.

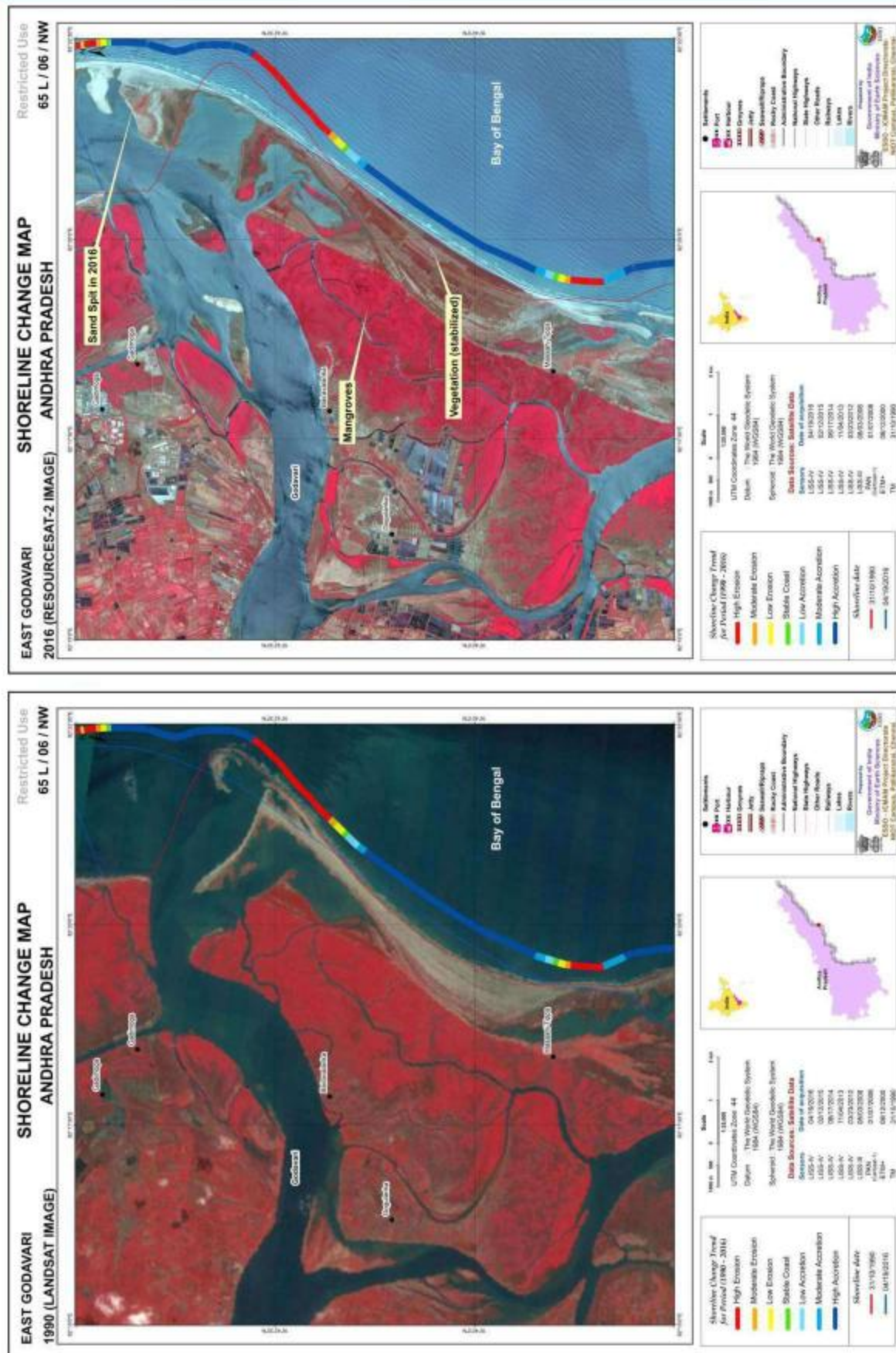


Figure 51: Hot-spot map.



## 5.0 References

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## 6.0 Publications made from this work

- ④ S. Chenthamil Selvan, R. S. Kankara, Vipin J. Markose, B. Rajan and K. Prabhu, 2015. *Shoreline change and impacts of coastal protection structures on Puducherry, SE coast of India. Natural Hazards, (Springer), 83(1), 293-308. DOI10.1007/s11069-016-2332-y.*
- ④ Vipin J. Markose, B. Rajan, R. S. Kankara, S. Chenthamil Selvan and Dhanalakshmi.2016. *Quantitative analysis of temporal variations on shoreline change pattern along Ganjam district, Odisha, east coast of India. Environmental Earth Sciences, Vol. 75, No. 10, 75:929 DOI 10.1007/s12665-016-5723-1.*
- ④ S. Sathish, R. S. Kankara, S. Chenthamil Selvan, M. Umamaheswari, K. Rasheed. *Wave–beach sediment interaction with shoreline changes along a headland bounded pocket beach, West coast of India. Environmental Earth Sciences (2018) 77:174.*
- ④ R.S. Kankara, S. Chenthamil Selvan, Vipin J. Markose, B. Rajan&S. Arockiaraj. *(Estimation of long and short term shoreline changes along Andhra Pradesh coast using Remote Sensing and GIS techniques). Procedia Engineering Vol 116, 2015 Pages 855–86.*
- ④ Sathish S, R.S. Kankara, S. Chenthamil Selvan, Manikandan M, Arockiaraj S &Rajan B. *(Textural Characterization of Coastal Sediments along Tamil Nadu coast, East coast of India). Procedia Engineering Vol 116, 2015 Pages 794–804.*
- ④ R.S. Kankara, S. Chenthamil Selvan, B. Rajan&S. Arockiaraj. *(An adaptive approach to monitor the Shoreline changes in ICZM framework: A case study of Chennai coast). Indian Journal of Marine Sciences Vol. 43(7), July 2014, pp 1271-1279.*
- ④ S. Chenthamil Selvan, R.S. Kankara& B. Rajan. *(Assessment of shoreline changes along Karnataka coast, India using GIS & Remote sensing techniques). Indian Journal of Marine Sciences Vol. 43(7), July 2014, pp 1293-1298.*



## Annexure - I

## LIST OF SHORELINE CHANGE MAPS (1990-2016) in 1:25000

## GUJARAT

SL NO	DISTRICT	GRIDS	SL NO	DISTRICT	GRIDS
1	Kachchh	41 A / 2 / NE	51	Jamnagar	41 J / 2 / SW
2	Kachchh	41 A / 2 / SE	52	Jamnagar	41 F / 14 / SE
3	Kachchh	41 A / 6 / SW	53	Jamnagar	41 F / 15 / NE
4	Kachchh	41 A / 6 / NW	54	Jamnagar	41 F / 15 / SW
5	Kachchh	41 A / 6 / NE	55	Jamnagar	41 F / 15 / NW
6	Kachchh	41 A / 9 / SW	56	Dev Bhumi Dwarka & Jamnagar	41 F / 11 / NE
7	Kachchh	41 A / 9 / SE	57	Dev Bhumi Dwarka & Jamnagar	41 F / 11 / SE
8	Kachchh	41 A / 10 / NW	58	Dev Bhumi Dwarka	41 F / 11 / SW
9	Kachchh	41 A / 10 / SW	59	Dev Bhumi Dwarka	41 F / 7 / SE
10	Kachchh	41 A / 6 / SE	60	Dev Bhumi Dwarka	41 F / 7 / SW
11	Kachchh	41 A / 11 / NW	61	Dev Bhumi Dwarka	41 F / 3 / SE
12	Kachchh	41 A / 11 / SW	62	Dev Bhumi Dwarka	41 F / 3 / NE
13	Kachchh	41 A / 11 / SE	63	Dev Bhumi Dwarka	41 F / 3 / NW
14	Kachchh	41 A / 12 / NW	64	Dev Bhumi Dwarka	41 B / 15 / NE
15	Kachchh	41 A / 12 / NE	65	Dev Bhumi Dwarka	41 B / 15 / SE
16	Kachchh	41 A / 12 / SE	66	Dev Bhumi Dwarka	41 B / 16 / NE
17	Kachchh	41 A / 16 / SW	67	Dev Bhumi Dwarka	41 F / 4 / NW
18	Kachchh	41 A / 16 / SE	68	Dev Bhumi Dwarka	41 F / 4 / SW
19	Kachchh	41 B / 13 / NE	69	Dev Bhumi Dwarka	41 F / 4 / SE
20	Kachchh	41 F / 1 / NW	70	Dev Bhumi Dwarka	41 G / 1 / NE
21	Kachchh	41 F / 1 / NE	71	Dev Bhumi Dwarka	41 G / 5 / NW
22	Kachchh	41 F / 1 / SE	72	Dev Bhumi Dwarka	41 G / 5 / SW
23	Kachchh	41 F / 5 / SW	73	Porbandar & Dev Bhumi Dwarka	41 G / 5 / SE
24	Kachchh	41 F / 5 / SE	74	Porbandar	41 G / 6 / NE
25	Kachchh	41 F / 9 / SW	75	Porbandar	41 G / 10 / NW
26	Kachchh	41 F / 10 / NW	76	Porbandar	41 G / 10 / SW
27	Kachchh	41 F / 10 / NE	77	Porbandar	41 G / 10 / SE
28	Kachchh	41 F / 9 / SE	78	Porbandar	41 G / 11 / NE
29	Kachchh	41 F / 13 / NW	79	Porbandar	41 G / 15 / NW
30	Kachchh	41 F / 13 / SW	80	Porbandar	41 G / 15 / SW
31	Kachchh	41 F / 13 / SE	81	Junagadh & Porbandar	41 G / 15 / SE
32	Kachchh	41 F / 13 / NE	82	Junagadh & Porbandar	41 G / 16 / NE
33	Kachchh	41 J / 1 / NW	83	Junagadh & Porbandar	41 K / 4 / NW
34	Kachchh	41 I / 4 / SW	84	Junagadh	41 K / 4 / SW
35	Kachchh	41 J / 1 / NE	85	Junagadh	41 K / 4 / SE
36	Kachchh	41 I / 4 / SE	86	Gir Somnath & Junagadh	41 L / 1 / NE
37	Kachchh	41 I / 4 / NE	87	Gir Somnath	41 L / 5 / NW
38	Kachchh	41 I / 8 / NW	88	Gir Somnath	41 L / 5 / NE
39	Kachchh	41 I / 8 / NE	89	Gir Somnath	41 L / 5 / SE
40	Kachchh	41 I / 12 / NW	90	Gir Somnath	41 L / 9 / SW
41	Morvi & Kachchh	41 I / 12 / NE	91	Gir Somnath	41 L / 9 / SE
42	Morvi	41 I / 12 / SE	92	Gir Somnath	41 L / 10 / NE
43	Morvi	41 I / 12 / SW	93	Gir Somnath	41 L / 14 / NW
44	Jamnagar & Morvi	41 J / 9 / NW	94	Diu & Gir Somnath	41 L / 14 / NE
45	Jamnagar & Morvi	41 J / 5 / NE	95	Diu & Gir Somnath	41 P / 2 / NW
46	Jamnagar	41 J / 5 / SE	96	Gir Somnath	41 P / 1 / SW
47	Jamnagar	41 J / 6 / NE	97	Diu & Gir Somnath & Amreli	41 P / 1 / SE
48	Jamnagar	41 J / 6 / NW	98	Amreli	41 P / 5 / SW
49	Jamnagar	41 J / 2 / NE	99	Amreli	41 P / 5 / SE
50	Jamnagar	41 J / 2 / SE	100	Amreli	41 P / 5 / NE



SL NO	DISTRICT	GRIDS	SL NO	DISTRICT	GRIDS
101	Amreli	41 P / 9 / NW	126	Bharuch & Anand	46 B / 12 / NW
102	Amreli & Bhavnagar	41 P / 9 / NE	127	Bharuch	46 B / 12 / SW
103	Amreli & Bhavnagar	41 O / 12 / SE	128	Bharuch	46 C / 9 / NW
104	Bhavnagar	41 O / 16 / SW	129	Bharuch	46 C / 9 / SW
105	Bhavnagar	41 O / 16 / SE	130	Bharuch	46 C / 9 / SE
106	Bhavnagar	41 O / 16 / NE	131	Bharuch	46 C / 10 / NE
107	Bhavnagar	46 C / 4 / NW	132	Bharuch	46 C / 10 / NW
108	Bhavnagar	46 C / 3 / SW	133	Bharuch	46 C / 10 / SW
109	Bhavnagar	46 C / 3 / SE	134	Bharuch	46 C / 10 / SE
110	Bhavnagar	46 C / 3 / NE	135	Surat & Bharuch	46 C / 11 / NE
111	Bhavnagar	46 C / 7 / NW	136	Surat	46 C / 11 / SE
112	Bhavnagar	46 C / 6 / SW	137	Surat	46 C / 11 / SW
113	Bhavnagar	46 C / 6 / NW	138	Surat	46 C / 12 / NE
114	Bhavnagar	46 C / 2 / NE	139	Surat	46 C / 12 / SW
115	Bhavnagar	46 C / 1 / SE	140	Navsari & Surat	46 C / 12 / SE
116	Bhavnagar & Ahmadabad	46 C / 1 / NE	141	Navsari	46 D / 9 / NE
117	Bhavnagar & Ahmadabad	46 B / 4 / SE	142	Navsari	46 D / 13 / NW
118	Ahmadabad	46 B / 8 / SW	143	Valsad & Navsari	46 D / 13 / SW
119	Ahmadabad	46 B / 8 / NW	144	Valsad	46 D / 14 / NW
120	Ahmadabad	46 B / 4 / NE	145	Valsad	46 D / 14 / NE
121	Anand & Ahmadabad	46 B / 7 / SW	146	Valsad	46 D / 14 / SE
122	Anand & Ahmadabad	46 B / 7 / SE	147	Daman & Valsad	46 D / 15 / NE
123	Anand	46 B / 11 / SW	148	Daman & Valsad	46 D / 15 / NW
124	Anand	46 B / 11 / SE	149	Valsad	46 D / 15 / SW
125	Bharuch & Anand	46 B / 12 / NE	150	Valsad	46 D / 11 / SE

## MAHARASHTRA

SL NO	DISTRICTS	GRIDS	SL NO	DISTRICTS	GRIDS
1	Thane	46 D / 12 / NE	26	Ratnagiri	47 G / 2 / NW
2	Thane	46 D / 12 / SE	27	Ratnagiri	47 G / 2 / SE
3	Thane	47 A / 10 / NE	28	Ratnagiri	47 G / 3 / NE
4	Thane	47 A / 10 / SE	29	Ratnagiri	47 G / 3 / SE
5	Thane	47 A / 11 / NE	30	Ratnagiri	47 G / 4 / NE
6	Thane	47 A / 14 / SW	31	Ratnagiri	47 G / 8 / NW
7	Thane	47 A / 15 / NW	32	Ratnagiri	47 G / 8 / SW
8	Thane & Mumbai	47 A / 15 / SW	33	Ratnagiri	47 H / 5 / NW
9	Mumbai	47 A / 16 / NW	34	Ratnagiri	47 H / 5 / SW
10	Mumbai	47 A / 16 / SW	35	Ratnagiri	47 H / 6 / NW
11	Thane	47 A / 9 / NE	36	Sindhudurg & Ratnagiri	47 H / 6 / SW
12	Thane	47 A / 9 / SE	37	Sindhudurg	47 H / 7 / NW
13	Mumbai	47 B / 13 / NW	38	Sindhudurg	47 H / 7 / SE
14	Raigarh	47 B / 13 / SW	39	Sindhudurg	47 H / 7 / SW
15	Raigarh	47 B / 14 / NE	40	Sindhudurg	47 H / 8 / NE
16	Raigarh	47 B / 14 / NW	41	Sindhudurg	47 H / 8 / SE
17	Raigarh	47 B / 14 / SE	42	Sindhudurg	48 E / 5 / NE
18	Raigarh	47 B / 15 / NE	43	Sindhudurg	48 E / 9 / NW
19	Raigarh	47 B / 15 / SE	44	Sindhudurg	48 E / 9 / SE
20	Raigarh	47 B / 16 / NE	45	Sindhudurg	48 E / 9 / SW
21	Raigarh	47 B / 16 / SE			
22	Raigarh	47 F / 4 / SW			
23	Raigarh & Ratnagiri	47 G / 1 / NW			
24	Ratnagiri	47 G / 1 / SW			
25	Ratnagiri	47 G / 2 / NE			



**GOA AND KARNATAKA**

SL NO	DISTRICTS	GRIDS	SL NO	DISTRICTS	GRIDS
1	North Goa & Sindhudurg	48 E / 10 / NE	17	Uttara Kannada	48 J / 7 / NE
2	North Goa	48 E / 10 / SE	18	Uttara Kannada	48 J / 7 / NW
3	North Goa	48 E / 14 / SW	19	Uttara Kannada	48 J / 7 / SE
4	South Goa & North Goa	48 E / 15 / NW	20	Uttara Kannada	48 J / 8 / NE
5	South Goa	48 E / 15 / SE	21	Uttara Kannada	48 J / 8 / SE
6	South Goa	48 E / 15 / SW	22	Udupi	48 K / 10 / NE
7	South Goa	48 E / 16 / NE	23	Udupi	48 K / 10 / SE
8	South Goa	48 E / 16 / SE	24	Udupi	48 K / 11 / NE
9	South Goa	48 I / 4 / SW	25	Udupi	48 K / 11 / SE
10	Uttara Kannada & South Goa	48 J / 1 / NW	26	Udupi	48 K / 12 / NE
11	Uttara Kannada	48 J / 1 / SE	27	Udupi	48 K / 16 / NW
12	Uttara Kannada	48 J / 1 / SW	28	Dakshina Kannada & Udupi	48 K / 16 / SW
13	Uttara Kannada	48 J / 12 / SW	29	Udupi & Uttara Kannada	48 K / 9 / NW
14	Uttara Kannada	48 J / 2 / NE	30	Udupi	48 K / 9 / SE
15	Uttara Kannada	48 J / 6 / NW	31	Udupi	48 K / 9 / SW
16	Uttara Kannada	48 J / 6 / SW	32	Dakshina Kannada	48 L / 13 / NW

**KERALA**

SL NO	DISTRICTS	GRIDS	SL NO	DISTRICTS	GRIDS
1	Kasaragod	48 L / 13 / SW	29	Thrissur	58 B / 3 / NW
2	Kasaragod	48 L / 14 / NE	30	Thrissur	58 B / 3 / SE
3	Kasaragod	48 L / 14 / NW	31	Thrissur	58 B / 3 / SW
4	Kasaragod	48 L / 14 / SE	32	Thrissur & Ernakulam	58 B / 4 / NE
5	Kasaragod	48 L / 15 / NE	33	Ernakulam	58 B / 4 / SE
6	Kasaragod	48 P / 3 / NW	34	Ernakulam	58 C / 1 / NE
7	Kasaragod	48 P / 3 / SW	35	Alappuzha & Kollam	58 C / 12 / SW
8	Kannur & Kasaragod	48 P / 4 / NE	36	Ernakulam & Alappuzha	58 C / 5 / NW
9	Kasaragod	48 P / 4 / NW	37	Ernakulam & Alappuzha & Kottayam	58 C / 5 / SW
10	Kannur & Kasaragod	48 P / 4 / SE	38	Alappuzha	58 C / 6 / NW
11	Kannur	48 P / 8 / SW	39	Alappuzha	58 C / 6 / SW
12	Kozhikode	49 M / 10 / SW	40	Alappuzha	58 C / 7 / NW
13	Kozhikode	49 M / 11 / NE	41	Alappuzha & Pathanamthitta	58 C / 7 / SE
14	Kozhikode	49 M / 11 / NW	42	Alappuzha	58 C / 7 / SW
15	Kozhikode	49 M / 11 / SE	43	Alappuzha	58 C / 8 / NE
16	Kozhikode	49 M / 15 / SW	44	Alappuzha & Kollam	58 C / 8 / SE
17	Malappuram & Kozhikode	49 M / 16 / NW	45	Thiruvananthapuram	58 D / 10 / NE
18	Malappuram	49 M / 16 / SW	46	Thiruvananthapuram	58 D / 14 / NW
19	Kannur	49 M / 5 / NW	47	Thiruvananthapuram	58 D / 14 / SE
20	Kannur	49 M / 5 / SE	48	Thiruvananthapuram	58 D / 14 / SW
21	Kannur	49 M / 5 / SW	49	Thiruvananthapuram	58 D / 15 / NE
22	Kannur	49 M / 6 / NE	50	Thiruvananthapuram	58 D / 15 / SE
23	Malappuram	49 N / 13 / NE	51	Kollam	58 D / 9 / NW
24	Malappuram	49 N / 13 / NW	52	Kollam & Thiruvananthapuram	58 D / 9 / SE
25	Malappuram	49 N / 13 / SE	53	Kollam	58 D / 9 / SW
26	Malappuram & Thrissur	49 N / 14 / NE	54	Kannur & Kozhikode & Mahe	49 M / 10 / NW
27	Thrissur	49 N / 14 / SE	55	Thiruvananthapuram & Kanyakumari	58 H / 3 / SW
28	Thrissur	58 B / 2 / SW			



## TAMIL NADU

SL NO	DISTRICTS	GRIDS	SL NO	DISTRICTS	GRIDS
1	Cuddalore	58 M / 14 / NW	41	Ramanathapuram	58 K / 15 / SE
2	Cuddalore	58 M / 14 / SW	42	Ramanathapuram	58 K / 15 / SW
3	Cuddalore	58 M / 15 / NW	43	Ramanathapuram	58 K / 16 / NE
4	Kancheepuram	57 P / 16 / SE	44	Ramanathapuram	58 K / 16 / NW
5	Kancheepuram	66 D / 1 / SE	45	Ramanathapuram	58 K / 8 / NE
6	Kancheepuram	66 D / 2 / NE	46	Ramanathapuram	58 K / 8 / SE
7	Kancheepuram	66 D / 2 / SE	47	Ramanathapuram	58 O / 7 / SW
8	Kancheepuram	66 D / 3 / NE	48	Ramanathapuram	58 O / 2 / NW
9	Kancheepuram	66 D / 3 / NW	49	Ramanathapuram	58 O / 3 / SE
10	Kancheepuram	66 D / 3 / SW	50	Ramanathapuram	58 O / 3 / SW
11	Kancheepuram	66 D / 4 / NW	51	Ramanathapuram	58 O / 8 / NE
12	Kancheepuram	66 D / 5 / NW	52	Ramanathapuram	58 O / 8 / NW
13	Kancheepuram	66 D / 5 / SW	53	Ramanathapuram&Thoothukudi	58 K / 8 / SW
14	Kanniyakumari	58 H / 12 / SW	54	Thanjavur	58 N / 4 / NE
15	Kanniyakumari	58 H / 3 / SE	55	Thanjavur	58 N / 7 / SW
16	Kanniyakumari	58 H / 4 / NE	56	Thanjavur	58 N / 8 / NW
17	Kanniyakumari	58 H / 8 / NW	57	Thiruvallur	66 C / 7 / SW
18	Kanniyakumari	58 H / 8 / SE	58	Thiruvallur	66 C / 8 / NW
19	Kanniyakumari	58 H / 8 / SW	59	Thiruvallur	66 C / 8 / SW
20	Karaikal	58 N / 13 / NW	60	Thiruvarur	58 N / 11 / SW
21	Nagapattinam	58 M / 15 / SW	61	Thiruvarur&Thanjavur	58 N / 7 / SE
22	Nagapattinam	58 M / 16 / NW	62	Thoothukudi	58 L / 1 / SE
23	Nagapattinam	58 M / 16 / SW	63	Thoothukudi	58 L / 1 NE
24	Nagapattinam	58 N / 14 / NW	64	Thoothukudi	58 L / 2 / NE
25	Nagapattinam	58 N / 14 / SW	65	Thoothukudi	58 L / 2 / SE
26	Nagapattinam	58 N / 15 / NW	66	Thoothukudi	58 L / 2 / SW
27	Nagapattinam	58 N / 15 / SE	67	Thoothukudi	58 L / 3 / NW
28	Nagapattinam	58 N / 15 / SW	68	Thoothukudi	58 L / 3 / NE
29	Nagapattinam&Karaikal	58 N / 13 / SW	69	Thoothukudi	58 L / 3 / SW
30	Nagapattinam&Thiruvarur	58 N / 11 / SE	70	Thoothukudi	58 L / 5 / NW
31	Pudukkottai	58 N / 4 / SE	71	Thoothukudi& Tirunelveli	58 H / 15 / SE
32	Pudukkottai	58 N / 8 / SW	72	Thoothukudi& Tirunelveli	58 H / 15 / SW
33	Pudukkottai	58 O / 1 / NE	73	Tirunelveli	58 H / 12 / NE
34	Pudukkottai	58 O / 1 / NW	74	Tirunelveli	58 H / 16 / NW
35	Pudukkottai &Ramanathapuram	58 O / 1 / SW	75	Tirunelveli &Kanniyakumari	58 H / 12 / NW
36	Ramanathapuram	58 K / 12 / NE	76	Villupuram	57 P / 16 / SW
37	Ramanathapuram	58 K / 12 / NW	77	Villupuram & Kancheepuram	57 P / 16 / NE
38	Ramanathapuram	58 K / 14 / NE	78	Cuddalore& Puducherry	58 M / 13 / SW
39	Ramanathapuram	58 K / 14 / SE	79	Puducherry & Villupuram	58 M / 13 / NW
40	Ramanathapuram	58 K / 15 / NE	80	Thiruvallur& Nellore	66 C / 7 / NW



**ANDHRA PRADESH**

SL NO	DISTRICT	GRIDS	SL NO	DISTRICT	GRIDS
1	Nellore	66 C / 6 / SW	46	East Godavari	65 L / 3 / NW
2	Nellore	66 C / 2 / SE	47	East Godavari	65 L / 3 / NE
3	Nellore	66 C / 2 / NE	48	East Godavari	65 L / 2 / SE
4	Nellore	66 C / 5 / SW	49	East Godavari	65 L / 6 / SW
5	Nellore	66 C / 1 / SE	50	East Godavari	65 L / 6 / NW
6	Nellore	66 C / 1 / NE	51	East Godavari	65 L / 5 / SW
7	Nellore	66 B / 4 / SE	52	East Godavari	65 L / 5 / NW
8	Nellore	66 B / 4 / NE	53	East Godavari	65 K / 8 / SW
9	Nellore	66 B / 3 / SE	54	East Godavari	65 K / 8 / SE
10	Nellore	66 B / 3 / NE	55	East Godavari	65 K / 8 / NE
11	Nellore	66 B / 2 / SE	56	East Godavari & Vishakhapattinam	65 K / 12 / NW
12	Nellore	66 B / 2 / NE	57	Vishakhapattinam	65 K / 11 / SW
13	Nellore	66 B / 2 / NW	58	Vishakhapattinam	65 K / 11 / SE
14	Nellore	66 B / 1 / SW	59	Vishakhapattinam	65 K / 15 / SW
15	Nellore & Prakasam	66 B / 1 / NW	60	Vishakhapattinam	65 K / 15 / NW
16	Prakasam	66 A / 4 / SW	61	Vishakhapattinam	65 K / 15 / NE
17	Prakasam	66 A / 4 / NW	62	Vishakhapattinam	65 O / 3 / NW
18	Prakasam	66 A / 3 / SW	63	Vishakhapattinam	65 O / 2 / SW
19	Prakasam	66 A / 3 / SE	64	Vishakhapattinam	65 O / 2 / SE
20	Prakasam	66 A / 3 / NE	65	Vishakhapattinam	65 O / 2 / NE
21	Prakasam	66 A / 2 / SE	66	Vishakhapattinam	65 O / 6 / NW
22	Prakasam	66 A / 2 / NE	67	Vishakhapattinam	65 O / 5 / SW
23	Prakasam	66 A / 6 / NW	68	Vishakhapattinam & Vizhiyanagaram	65 O / 5 / SE
24	Prakasam & Guntur	66 A / 5 / SW	69	Vizhiyanagaram	65 O / 5 / NE
25	Guntur	66 A / 5 / SE	70	Vizhiyanagaram	65 O / 9 / NW
26	Guntur	66 A / 9 / SW	71	Vizhiyanagaram	65 N / 12 / SW
27	Guntur	66 A / 9 / SE	72	Vizhiyanagaram & Srikakulam	65 N / 12 / SE
28	Guntur	66 A / 9 / NE	73	Srikakulam	65 N / 12 / NE
29	Guntur & Krishna	66 A / 13 / SW	74	Srikakulam	65 N / 16 / NW
30	Krishna	66 A / 14 / NW	75	Srikakulam	65 N / 16 / NE
31	Krishna	66 A / 14 / NE	76	Srikakulam	74 B / 4 / NW
32	Krishna	66 A / 13 / SE	77	Srikakulam	74 B / 3 / SW
33	Krishna	66 E / 1 / SW	78	Srikakulam	74 B / 3 / SE
34	Krishna	66 E / 1 / NW	79	Srikakulam	74 B / 3 / NE
35	Krishna	66 E / 1 / NE	80	Srikakulam	74 B / 7 / NW
36	Krishna	65 H / 4 / SE	81	Srikakulam	74 B / 6 / SW
37	Krishna	65 H / 4 / NE	82	Srikakulam	74 B / 6 / SE
38	Krishna	65 H / 3 / SE	83	Srikakulam	74 B / 6 / NE
39	Krishna	65 H / 7 / SW	84	Srikakulam	74 B / 10 / NW
40	Krishna	65 H / 7 / SE	85	Srikakulam	74 B / 9 / SW
41	Krishna & West Godavari	65 H / 11 / SW	86	Srikakulam	74 B / 9 / NW
42	West Godavari & East Godavari	65 H / 11 / SE	87	Srikakulam	74 B / 9 / NE
43	East Godavari	65 H / 15 / SW	88	Srikakulam & Ganjam	74 A / 12 / SE
44	East Godavari	65 H / 15 / NW	89	Ganjam & Srikakulam	74 A / 16 / SW
45	East Godavari	65 H / 15 / NE			



**ODISHA**

SL NO	DISTRICTS	GRIDS	SL NO	DISTRICTS	GRIDS
1	Balasore	73 K / 15 / NE	24	Jagatsinghpur	74 I / 5 / NE
2	Balasore	73 K / 15 / SE	25	Jagatsinghpur&Kendrapara	73 L / 11 / SE
3	Balasore	73 K / 15 / SW	26	Jagatsinghpur&Kendrapara	73 L / 15 / SW
4	Balasore	73 O / 2 / SE	27	Kendrapara	73 L / 11 / NE
5	Balasore	73 O / 2 / SW	28	Kendrapara	73 L / 14 / NE
6	Balasore	73 O / 3 / NW	29	Kendrapara	73 L / 14 / SE
7	Balasore	73 O / 6 / SW	30	Kendrapara	73 L / 14 / SW
8	Bhadrak	73 K / 16 / SE	31	Kendrapara	73 L / 15 / NW
9	Bhadrak	73 K / 16 / SW	32	Kendrapara	73 P / 2 / NW
10	Bhadrak	73 L / 13 / NE	33	Kendrapara&Bhadrak	73 L / 13 / SE
11	Bhadrak	73 P / 1 / SW	34	Puri	74 E / 10 / NE
12	Bhadrak&Balasore	73 K / 16 / NW	35	Puri	74 E / 10 / NW
13	Ganjam	74 A / 15 / SE	36	Puri	74 E / 13 / SE
14	Ganjam	74 A / 16 / NE	37	Puri	74 E / 13 / SW
15	Ganjam	74 A / 16 / NW	38	Puri	74 E / 6 / NE
16	Ganjam	74 E / 3 / NE	39	Puri	74 E / 6 / SE
17	Ganjam	74 E / 3 / NW	40	Puri	74 E / 6 / SW
18	Ganjam	74 E / 3 / SW	41	Puri	74 E / 9 / SE
19	Ganjam&Puri	74 E / 2 / SE	42	Puri	74 I / 1 / NE
20	Jagatsinghpur	73 L / 12 / NE	43	Puri	74 I / 1 / SE
21	Jagatsinghpur	73 L / 12 / NW	44	Puri	74 I / 1 / SW
22	Jagatsinghpur	73 L / 8 / NE	45	Puri&Jagatsinghpur	74 I / 5 / NW
23	Jagatsinghpur	73 L / 8 / SE	46	Balasore&East midnapore	73 O / 6 / SE

**WEST BENGAL**

SL NO	DISTRICTS	GRIDS	SL NO	DISTRICTS	GRIDS
1	East midnapore	73 O / 10 /SW	16	South 24 parganas	79 C / 6 /NE
2	South 24 parganas	79 C / 2 /SE	17	South 24 parganas	79 C / 10 /NW
3	South 24 parganas	79 C / 6 /SW	18	North 24 parganas	79 C / 10 /NE
4	South 24 parganas	79 C / 6 /SE	19	North 24 parganas	79 C / 14 /NW
5	South 24 parganas	79 C / 10 /SW	20	North 24 parganas	79 C / 14 /NE
6	North 24 parganas	79 C / 10 /SE	21	North 24 parganas	79 G / 2 /NW
7	North 24 parganas	79 C / 14 /SW	22	East midnapore	73 O / 13 /SW
8	North 24 parganas	79 C / 14 /SE	23	East midnapore	73 O / 13 /SE
9	North 24 parganas	79 G / 2 /SW	24	South 24 parganas	79 C / 1 /SW
10	East midnapore	73 O / 10 /NW	25	South 24 parganas	79 C / 1 /SE
11	East midnapore	73 O / 10 /NE	26	South 24 parganas	79 C / 5 /SW
12	East midnapore	73 O / 14 /NW	27	South 24 parganas	79 C / 5 /SE
13	South 24 parganas	79 C / 2 /NW	28	South 24 parganas	79 C / 1 /NE
14	South 24 parganas	79 C / 2 /NE	29	South 24 parganas	73 C / 2 /SW
15	South 24 parganas	79 C / 6 /NW			



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