

SHORE LINE CHANGE ATLAS OF THE INDIAN COAST

(Volume-III)

Karnataka and Kerala



SPACE APPLICATIONS CENTRE, ISRO
Ahmedabad

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Abstract	This Atlas comprises of shoreline change maps prepared using satellite data of 2004-06 and 2014-16 time-frames on 1:25,000 scale for the entire country (Volume – III shows maps of Karnataka and Kerala). The maps show eroding, stable and accreting coast. Data used, methodology, results, area under erosion and accretion and status of coastal protection measures are briefly described. Around 40 km of the Karnataka coast is under erosion and 48 km is under accretion, while 231 km of the coast is stable in nature. Total area that have eroded in Karnataka is about 72 ha and around 111 ha of area have accreted. In Kerala, around 137 km of the coast is estimated to be under erosion and 121 km is observed to have accreted, while 327 km of the coast is observed to be in stable condition. The total area accreted along the Kerala coast is 303 ha whereas 285 ha area is estimated to have eroded.
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MESSAGE

The Coastal Zone represents a complex environmental entity, which is in constant interaction with the marine and terrestrial processes. The coastal zone has been receiving increased attention due to the immense anthropogenic pressure and inevitable development activities related to trade and transport. The coast is bestowed with rich bio-diversity and fragile ecosystems like mangroves and coral reefs that are highly sensitive to any climatic and environmental changes.

The coastal region, due to the influence of natural and anthropogenic forces and the sporadic events like cyclones undergo severe erosions leading to loss of human livelihood and crucial biodiversity besides critically damaging the coastal constructions and aesthetic quality that attracts huge economic benefits. Quantifying coastal change is essential for calculating trends in erosion, evaluating processes that shape coastal landscapes and predicting the response of coast to future storms and sea-level rise. The dynamic natures of the coast prompt for frequent monitoring and comprehending the coastal erosion activities. Space technology has been effectively deployed in identification and measurement of such activities.

Space Applications Centre (SAC) in collaboration with a large number of scientific organization & universities of the country has carried out various scientific investigation/inventory of the entire coastal zone of India using satellite data like impact of sea level rise on the Indian coastal environment, development of Coastal Zone Information System (CZIS), mapping and monitoring of coral reefs and mangroves, inventory of the coastal land use etc. One such significant work was preparation of Shoreline Change Atlas of India for the time frame 1989-91 and 2004-06.

The present Shoreline Change Atlas is an outcome of the shoreline change mapped for the entire Indian coast between the time frames of 2004-06 and 2014-16 carried out by Space Applications Centre, ISRO, Ahmedabad based on recommendation of Coastal Protection and Development Advisory Committee (CPDAC) at the request of Central Water Commission, Department of Water Resources, River Development & Ganga Rejuvenation, Ministry of Jal Shakti, Government of India.

I congratulate the team of scientists for carrying out such an important study for the entire Indian coast. This study assumes greater significance in the context of planning shoreline protection measures to be constructed by various maritime States and UTs. I am sure this atlas will be highly useful not only to the coastal zone managers and to the authorities involved but also to the scientific community working in the coastal environment and climate change studies.

(S.K. Haldar)
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FOREWORD

Coastal zone is one of the most fragile ecosystems having rich biodiversity and is characterised by constant interactions between various natural processes and human activities. Human interventions along the global coastal zones are profoundly increasing and may lead to disastrous consequences, if developmental activities are carried out with improper understanding of the coastal processes. In addition, the coastal ecosystems are also vulnerable to natural phenomena such as waves, tides, storm surges, erosion etc.

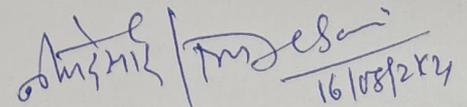
India has more than 7500 km. long coastline with diverse coastal ecosystem and hence, Coastal Zone in India, assumes its importance, more so because of high population pressure, development of various industries, spurt in recreational activities, exploitation of renewable and non-renewable natural resources, discharge of waste effluents and municipal sewage etc. The Indian shoreline is also dotted with vital coastal habitats like mangrove and coral reefs, ecological sensitive and biologically diverse regions and archaeologically and culturally important places. The natural and anthropogenic activities change the equilibrium of sediment transport along the coast and induce coastal erosion, thereby threatening the valuable resources. In view of its dynamic nature, frequent monitoring of the coast is also required and that can be achieved only through satellite based methods.

In India, the use of satellite data for coastal zone studies have been initiated by Space Applications Centre (SAC), ISRO, Ahmedabad in collaboration with various scientific organisations and universities across the country. For the past 30 years, SAC has been engaged in conducting various national level programmes aimed at detailed scientific investigations and preparing inventory of the entire coastal zone of India. I am happy to know that geo-sciences team at SAC/ISRO has completed Indian coastal shoreline change analysis (for 2004-06 and 2014-16 time frames) using Resourcesat-1&2 LISS-IV data and publishing these maps in the form of an atlas in six (6) volumes.

I am sure, this 6-volume atlas will be useful to the scientific community and decision makers in investigating the coastal challenges as well as for taking appropriate actions to protect the Indian coast, which will go a long way in conserving the coastal environment of the country. I would like to place on record my deep appreciation for all those scientists and support staff, who have made contributions for the successful execution of this project.

Place: Ahmedabad

Date: 16 August 2021


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PREFACE

Coastal regions of the world undergo a continuous process of erosion & accretion due to natural reasons and anthropogenic as well. The climatic change and consequently the rise in sea level is likely to be one of the major factors causing coastal erosion and accretion in the near future. The risks and hazards arising due to coastal erosion have raised a serious concern for the Indian coastal regions too, as a large population survives on the economy of its resources. Coastal erosion and accretion are reflected as the shift in the shoreline. Hence, a systematic and repetitive inventory and monitoring of shoreline change are the pre-requisite for a proper coastal management and forms the baseline data to carry out coastal protection measures by the maritime States and Union Territories besides its use by the scientific community.

Space Applications Centre (ISRO) had brought out Atlas of maps showing shoreline changes for the entire Indian coast between time frame 1989–1991 and 2004–2006 at 1:25,000 scale. The project was funded by Coastal Management Directorate, Central Water Commission, Ministry of Water Resources, New Delhi. Coastal Protection and Development Advisory Committee (apex body concerned with planning of coastal protection measures at the national level in India) requested Space Applications Centre to update the existing shoreline change maps using recent satellite data (2014-16 time frame) for assessing status of coastal erosion. The mapping has been completed at 1:25,000 scale using IRS LISS IV data and changes in shoreline have been brought out between 2004-06 and 2014-16 time frame.

The atlas also shows location and type of coastal protection measures taken up by maritime states and UTs based on the data provided. The atlas has been brought out in six volumes covering the entire Indian coastline. Six volumes contain 618 maps prepared covering 7549 km of the Indian coastline. The maps suggest that about 1144 km is under erosion, 1084 km is under accretion and 5321 km of the coastline has been observed showing no change.

I congratulate the entire team specially Mr. Ratheesh Ramakrishnan, Scientist SF and Mrs. Preeti Rajput, Scientist SD of Space Applications Centre, ISRO Ahmedabad.

(I M Bahuguna)

SUMMARY

Shoreline is a dynamic geomorphological entity that coincides with the physical interface of land and ocean. The shoreline responds to the coastal processes exerted by waves, tides, nearshore currents and the resultant sediment transport and the pressure exerted by anthropogenic influences. The equilibrium in the sediment supply gets disturbed due to either natural phenomena or human intervention causing shoreline changes. The shoreline changes are attributed as erosion (accretion), where the shoreline shift landwards (seawards). The change in shoreline positions are of essential importance to the coastal scientists, engineers and managements, where the shoreline change information is required in the design of any sustainable management plans.

Coastal erosion ails threat to the life and livelihood along the shoreline, destroying settlements and infrastructures like road and pose major hazard to the ecologically sensitive habitats like mangroves and turtle nesting grounds. Coastal erosion, as in other maritime countries, is a serious problem along the Indian coast. India forms a peninsula and has a long coast on its east and west regions with varied coastal processes dominating the coastal dynamics. The Indian coast is relentlessly modified by the mounting development activities along the coastal region, which under improper management at times leads to severe coastal erosion.

Inventory related to coastal erosion are a pre-requisite in understanding the coastal dynamics of the region. Planning measures for sustainable development along the coastal region require a systematic inventory of shoreline changes. In this view, Space Applications Centre in collaboration with Central Water Commission, mapped the shoreline changes for the time frame 1989-91 and 2004-06 on 1:25, 000 scale for the entire Indian coast based on multirate remote sensing data in GIS environment. The database were then used to generate A3 size Shoreline Change Atlas of all the maritime states of India. Central Water Commission requested to update the existing shoreline change maps (1989-91 & 2004-06 time-frame) using the satellite data of 2014-16 time-frame. The major objective was to prepare digital shoreline change atlas on 1:25, 000 scale in GIS environment using the shoreline delineated for the time-frame 2004-06 and 2014-16, depict and quantify shoreline changes as eroding/accreting/stable, show status of shoreline protection measures taken by respective states.

Assessment of shoreline change using satellite images have gained its applicability owing to the synoptic observations covering a large spatial scale and its availability in temporal domain. LISS-4 images of 2014-16 (on board Resourcesat-2) and 2004-06 (on board IRS P6) time-frames

have been used to delineate the shoreline for entire Indian coast. The high tide line (HTL) is considered as the shoreline and on-screen digitization of the HTL has been carried out based on the geomorphic indicators.

The shoreline change status along 7549 km of the Indian coast is assessed that excludes river/creek mouths. About 1144 km of the Indian coast is under erosion, while 1084 km of the coast is accreting and the coastline is observed to be stable along 5321 km. The Indian coastal region have in total lost around 3680 ha of land due to erosion whereas around 4042 ha of area have been gained due to accretion. West Bengal coast is having around 35 percentage of its coast under erosion, which is the largest among the Indian coastal state and percentage of shoreline under accretion is the largest for Andhra Pradesh state (26%). Percentage of stable coast is largest along the Gujarat coast (87%) followed by the Lakshadweep Islands (82%), while more than 57 percentage of the West Bengal coast is under either erosion or accretion. A long coastal stretch to the northern Andhra Pradesh coast is eroding whereas a long coastal stretch along the Saurashtra coast of Gujarat is stable in nature.

The major natural processes involved in the coastal erosion are the wave induced erosion and littoral drift. Alongshore shift of inlets are observed due to growth of spits and erosion at the other side and is dominant at Chilika inlet, Odisha and Mulki-Pavanje Estuary, Karnataka. The processes of longshore sediment transport occurring naturally along the coasts are highly altered by the constructions of breakwaters and have triggered coastal erosion due to obstruction of the littoral drift. Sand mining and land reclamation are the other anthropogenic activities altering the sediment dynamics and triggering coastal erosion. Andaman and Nicobar Island is observed to have critical shoreline changes, where the coast is regaining the equilibrium after the subsidence, uplift and erosion due to tsunami associated with the 2004 mega earthquake. The inventory along with current status of coastal protection measures taken up by concerned state departments has been used to prepare a Shoreline Change Atlas of the Indian Coast.

The baseline data are aimed towards initiating appropriate action by concerned Maritime states and UTs besides use by the scientific community as well decision makers of the country. The Atlas shall function as a reference material to obtain information on the status of shoreline changes during 2004-06 and 2014-16 time-frames along entire Indian coastline. Areas under coastal erosion and status of coastal protection measures taken up by respective maritime State and Union Territory are depicted and can be used for planning coastal protection measures.

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1. INTRODUCTION

The coastal zone is in constant interaction between various natural processes and human activities that leads to a modification of its geomorphology. Coastal zone in India assumes its importance due the presence of fragile ecosystems and its interaction with anthropogenic activities. The coast is also subjected to exploitation of natural resources and is used as a medium for discharge of waste effluent and municipal sewages. The coastal regions are also overburdened with mounting developmental activities, increasing load on harbours, spurt in recreational activities and above all petroleum exploration activities.

Shoreline is a dynamic geomorphological entity, which responds to the external forces exerted by waves, tides, nearshore currents and the resultant sediment transport. When the resultant sediment transport entering a particular area is greater than the sediment going out from the area, accretion or beach development takes place. On the other hand, when there is a deficit of the incoming sediment supply into a particular area with reference to the sediment going out of the same area, beach erosion takes place. The equilibrium in the sediment supply is fairly maintained by the coastal geomorphic environment. However, sometimes this equilibrium gets disturbed due to either natural phenomena or human intervention. Natural phenomenon like intense wave activities during monsoon, cyclones and changes in river mouth during flood conditions contributes towards disrupting the equilibrium, while construction of coastal structures like breakwaters, dam construction in the rivers are the human interventions

India has a long shoreline of about 7500 km including its island territories. The destruction and loss of land due to erosion is a severe problem, particularly for a country like India facing an increased population growth. Erosion of the coastal region poses a major threat not only to the human population, but also to the vital coastal ecosystem. The dynamic interaction between nearshore features and the hydrodynamics of the region, termed as coastal processes, determines the stability of the adjacent shoreline. Moreover, various developments along the coast enhance the changes in the shoreline. Indian coast forms a peninsula and has a long coast on its east and west regions with varied coastal processes dominating the coastal dynamics. These include tide-

dominated regions along the northern parts of the west coast, open coast with high wave energy along the southern parts of the west coast, strong longshore sediment transport along the southern parts of the east coast and the coast strongly influenced with river discharges along the northern parts of the east coast. The coastal geomorphology and the land-use pattern along the Indian coast also show a varied range, which includes coral reefs, mangrove belts, tidal mudflats, rocky coasts, wide sandy beaches and deltaic and bay environments.

The Indian coast is relentlessly modified by the mounting development activities along the coastal region, which under improper management at times leads to severe coastal erosion. Management plans with proper understanding of the coastal processes and coastal dynamics are needed to achieve sustainable development along the coastal region, where planning measures have to be taken up at the national level. Inventory related to coastal erosion are a pre-requisite in understanding the coastal dynamics of the region. Planning measures for sustainable development along the coastal region require a systematic inventory of shoreline changes occurring along the entire Indian coast on 1 : 25,000 scale. Space Applications Centre, along with Coastal Protection and Development Advisory Committee (CPDAC) (apex body concerned with planning of coastal protection measures at the national level in India) have brought out shoreline change atlas (SAC, 2014 and Rajawat et al, 2015). The atlas depicts the shoreline changes for the time-frame 1989-1991 (using SPOT-1/2 HRV1-MLA) and 2004–2006 (using IRS-P6 LISSIV), that was mapped on 1 : 25,000 scale for the entire Indian coast.

Coastal Management Directorate, Central Water Commission, Ministry of Water Resources, New Delhi have requested to update the existing shoreline change maps (1989-91 & 2004-06 time-frame) using recent satellite data (2014-16 time-frame) for assessing coastal erosion. CPDAC recommended the need for preparation of Shoreline Change Atlas of the Indian coast showing information related to coastal erosion derived from satellite data and protection measures undertaken by all maritime states of India. It is in this context, Space Applications Centre in collaboration with Central Water Commission, have mapped the shoreline for the time-frame 2014-16 on 1:25, 000 scale for the entire Indian coast based on LISS-IV images of 2014-16 in GIS environment. The information is

catalogued as per Survey of India topographical map indexing which is 1:25000 Scale.

The major objective is to prepare digital shoreline change atlas on 1:25, 000 scale in GIS environment using the shoreline delineated for the time-frame 2004-06 and 2014-16. The atlas shall depict and quantify shoreline changes as eroding/accreting/stable, show status of shoreline protection measures taken by respective states and generate A3 size state wise Coastal Atlas of all the maritime states of India.

The detailed objectives are:

- i) To prepare shoreline database of 2014-16 time-frame for all the maritime states and UT.
- ii) To quantify and classify the shoreline as shoreline under erosion, stable and accretion for entire Indian coast by integrating shoreline using database of 2004-06 and 2014-16 period.
- iii) To integrate the information on coastal erosion and shoreline protection measures of all the maritime states and UT of India in GIS environment.
- iv) To generate Six Volumes of A-3 size coloured Coastal Atlas of India (Volume I covering Gujarat, Daman & Diu, Volume II covering Maharashtra & Goa, Volume III covering Karnataka & Kerala, Volume IV covering Tamil Nadu, Pondicherry & Andhra Pradesh, Volume V covering Odisha & West Bengal and Volume VI covering Lakshadweep & Andaman & Nicobar).

2. DATA USED

High tidal line is demarcated using IRS-P6 LISSIV data of 2004-06 period and Resourcesat-2 LISS-IV data of 2014-16 time-frame procured from NRSC. The LISS-IV is a multispectral (three-VNIR-band) push-broom camera having a spatial resolution of 5.8m with a swath of 23.9km for IRS-P6 and 70km for Resourcesat-2. Both the satellites orbits in a sun-synchronous orbit at an altitude of 817km with a 5-day revisit cycle.

Detailed list of the satellite data used is given in the Annexure-III. In few cases where suitable data were not available, the data of nearest time-frame was used. Shoreline changes are computed with respect to the spatial changes in the Highest High Tide Line. The status of coastal protection measures taken up by maritime states and UTs was provided through Central Water Commission (CWC), New Delhi. These were prepared in spatial format and were put in the GIS database.

DATABASE Standards

Satellite images of Resourcesat LISS-IV, having a spatial resolution of 5 m is used for both 2004-06 and 2014-16 time frame. Geometric projection for the images are set to UTM (Standard LANDSAT projection for Indian region). Image to image rectifications are carried out with an overlap error less than 1 pixel.

The vector layers are projected in polyconic projection system, with a planimetric accuracy of 6.25 m and weed tolerance of 3.125 m. Onscreen digitization are carried out in 1:12,500 scale. "State" and "year" attributes are created for the high tide line digitised using the satellite images.

3. METHODOLOGY

We have undertaken following steps to prepare shoreline change atlas:

- i. LISS-IV images of 2014-16 (on board Resourcesat-2) and 2004-06 (on board IRS P6) time-frames have been used to delineate the shoreline for entire Indian coast. LANDSAT orthorectified products are used as base map. Image to image co-registration is carried out on LISS-IV images of both time-frames to bring the data set to same geo-reference with an error of +/- 1 pixel.
- ii. High tide line (HTL) is considered as the shoreline. On-screen digitization of the HTL has been carried out based on the geomorphic indicators (NCSCM, 2015). Image interpretation keys based on Nayak et al (1991) is used to identify the geomorphic indicators to delineate the HTL.
- iii. The HTL is prepared for all maritime states and Union territories of India on 1:25,000 scale. The 1°X1° grid consists of 8X8 rectangular grids or cells. Each rectangular grid or cell represents one Survey of India (SOI) topographic area on 1:25,000 scale.
- iv. Limited field checks were carried out and based on field observations, corrections were incorporated while finalizing the map. Field photographs were also taken during the field visits.
- v. Accuracy Assessment: Classification as well as planimetric accuracy of the maps was assessed while carrying out the fieldwork. Overall, the classification accuracy of these maps range from 90-95% at 90% confidence level. The Planimetric Accuracy of these maps is 6.25 m as per SOI standard.
- vi. Spatial layer for habitation (as point feature) and, rail and road (as line features) are taken from CZIS database.
- vii. Spatial analysis techniques are used to compute the spatial shift among the HTL of different time frame.
- viii. Polygons for areas under erosion and accretion were created.

- ix. Areas under erosion and accretion were measured for the main shoreline (excluding creeks, river mouths, estuaries). Shore length under erosion, accretion and stable categories were measured for the main shoreline (excluding creeks, river mouths, estuaries). Areas with no changes were considered as stable.
- x. A table containing the length of eroding, accreting and stable coast along with the area of erosion and accretion for each SOI grid has been generated for the maritime state and U.T.
- xi. Shoreline protection measures have been depicted as per the information provided by the maritime State/UT agencies through Central Water Commission.
- xii. A standard map composition and layout were finalised and have been used for final map composition of each map.
- xiii. Final maps depicting shoreline changes were utilized for preparing shoreline change Atlas of the Indian coast (Six Volumes). Volume I covers Gujarat, Daman & Diu, Volume II covers Maharashtra & Goa, Volume III covers Karnataka & Kerala, Volume IV covers Tamil Nadu, Puducherry & Andhra Pradesh, Volume V covers Odisha & West Bengal and Volume VI covers Lakshadweep & Andaman & Nicobar Islands.

4. RESULTS

The shoreline change maps of Karnataka and Kerala coasts at each SOI grid at 1:25000 scale are given in Section-II.

Karnataka

The Karnataka coast extends from 12° 43' N to 14° 51' N and 74° E to 75° E. The northern coast is rocky while the southern coast has long linear beaches. Coastal geomorphic features in Karnataka include beaches, rocky headlands, spits, estuaries, shallow lagoons, mudflats and mangroves at few places. Shallow lagoons are observed near Coondapur and the Kalinadi. Rocky coast is observed near Ankola to Karwar at numerous locations. The shoreline change estimation is carried out along the 319 km stretch of the Karnataka coast (which does not include the mouth of the river/estuary, creeks and their inner parts). The change analysis have avoided the coastal segments at major ports and harbours. Around 40 km of the state is under erosion and 48 km of the coast is under accretion, while 231 km of the coast is stable in nature (Figure 1). Total area that have eroded between 2004-06 to 2014-16 is about 72 ha and around 111 ha of area have accreted. Details of the erosion/accretion status at each SOI grid is given in Table 1. Karnataka coast is divided into 2 sectors, the north and the south, where the northern sector consists of coastal region of the Uttara Kannada District and the southern sector consists of the Udupi and Dakshina Kannada District.

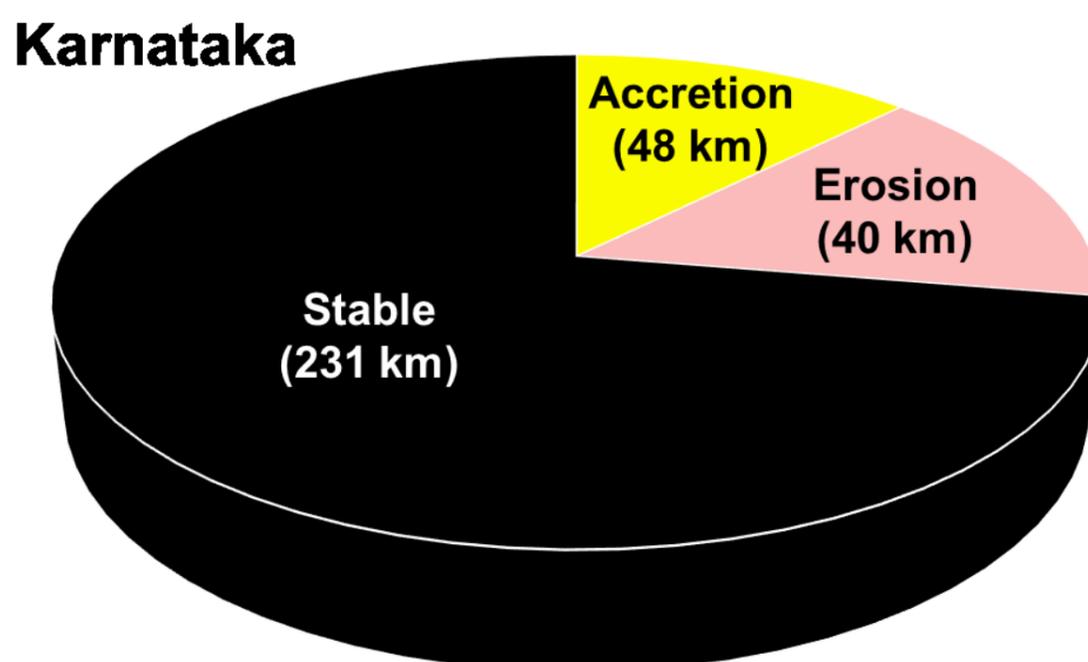


Figure 1: Shoreline change status of Karnataka coast

The northern Karnataka coast largely comprises of rocky coast and around 144 km of the coast is in stable condition. Around 12 km of the coast is under erosion, while 26 km of the coast is accreting.

Major changes in the shoreline at the northern sector are along the river/creek mouths. Plate (1) and (2) shows the changes at Kali River (48J01SW) and the stream to the north of Belekere (46J06NW). Considerable stretch of coast is under erosion along the Sharavati River mouth (48J07SE), while erosion in other places are in discrete patches.

The southern sector of the Karnataka coast is more dynamic compared to the north. Erosion is observed along 28 km, while accreting coast is along 22 km. About 87 km of the coast in the southern sector is stable in nature. Severe erosions are along the stretch of southern coast from Ullal (48L13SW) to Someshwar (48L13SW) and is shown in Plate (3). The region also show severe dynamics along the river mouth, where the shift in the river mouth is observed at Mulki River (48K16SW) (Plate 4). Eroding coast are to south of Shiruru (48K09NW), along a straight stretch of beach at Kudarkodu (48K09SE), at Padubidri (48K16NW), Hejemadikodi (48K16SW) and to the south of Mangalore Port (48L13NW).

Table 1: Mapsheet-wise results of shoreline changes for 2004-06 and 2014-16 time-frame for Karnataka coast

Serial No.	Mapsheet No.	Erosion Area (in ha)	Erosion Length (in km)	Accretion Area (in ha)	Accretion Length (in km)	Stable Length (in km)	Total Length (in km)
1	48J01NW	0.00	0.00	1.06	0.91	2.28	3.19
2	48J01SW	4.03	1.57	5.81	2.36	13.34	17.27
3	48J01SE	2.25	0.72	10.09	1.77	8.16	10.65
4	48J02NE	0.68	0.33	1.44	0.71	16.34	17.38
5	48J06NW	1.91	0.70	13.81	5.36	16.14	22.20
6	48J06SW	2.11	0.48	13.47	5.41	20.07	25.96
7	48J07NW	0.10	0.16	0.00	0.00	4.40	4.56
8	48J07NE	0.38	0.33	3.41	2.51	10.25	13.09
9	48J07SE	9.98	4.78	2.57	1.64	9.49	15.90
10	48J08NE	0.00	0.00	2.01	1.68	16.37	18.05
11	48J08SE	1.97	1.35	0.89	0.48	9.08	10.92
12	48J12SW	0.00	0.00	3.78	2.17	3.92	6.09
13	48K09NW	2.62	3.20	1.56	0.89	17.77	21.86
14	48K09SW	0.63	0.48	1.83	0.93	7.94	9.35
15	48K09SE	2.60	3.02	0.95	0.56	1.93	5.51
16	48K10NE	3.58	3.14	8.34	4.61	7.52	15.27
17	48K10SE	0.63	0.48	0.62	0.81	13.07	14.36
18	48K11NE	2.90	1.03	9.24	4.53	9.06	14.62
19	48K11SE	1.67	1.33	0.12	0.13	14.10	15.55
20	48K12NE	0.24	0.31	0.00	0.00	7.79	8.10
21	48K16NW	5.10	4.36	0.61	0.39	1.77	6.51
22	48K16SW	7.96	3.11	17.20	2.63	8.23	13.97
23	48L13NW	8.66	4.01	6.07	3.86	6.49	14.37
24	48L13SW	12.05	5.30	6.51	3.40	5.35	14.05
	Total	72.1	40.2	111.4	47.7	230.9	318.8

Kerala

The Kerala coast extends from 8° 8' N to 12° 46' N and 74° 40' E to 76° 56' E along the southwestern coast of India. The Kerala coast is bestowed with rivers, lakes and is famous for its beautiful beaches and backwaters. Estimation of shoreline change is carried out along the 585 km of the Kerala coastal stretch (which does not include the mouth of the river/estuary, creeks and their inner parts). The change analysis have avoided the coastal segments at major ports and harbours. Around 137 km of the coast is estimated to be under erosion and 121 km is observed to have accreted while 327 km of the coast is observed to be in stable condition (Figure 2). The total area accreted along the Kerala coast is 303 ha whereas 285 ha area of Kerala coast is estimated to have eroded. Details of erosion/accretion status at each SOI grid is given in Table 2.

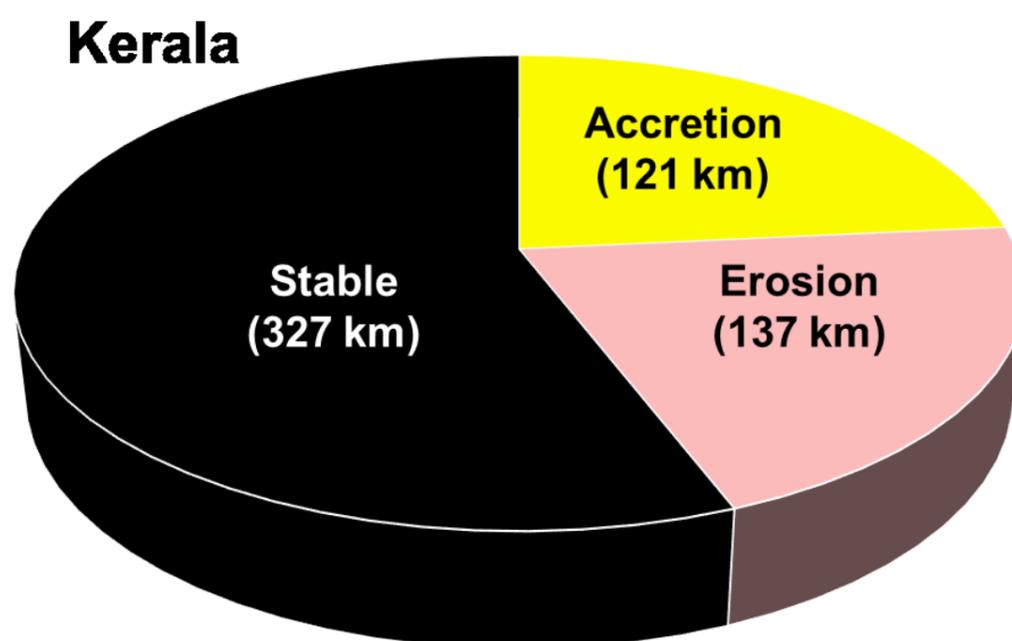


Figure 2. Shoreline change status of Kerala coast

Analysis of the shoreline change is carried out by dividing Kerala coast into three sectors based on the district boundaries. The northern sector comprises of the coastal area of Kasaragod, Kannur and Kozhikode districts; the coastal region of Malappuram, Thrissur and Ernakulam district is under the central sector and the coastal stretch of Alappuzha, Kollam and Thiruvananthapuram is defined under the southern sector.

Along the northern sector, the coastal length under erosion and accretion is estimated to be around 40 km and 42 km respectively and 142 km stretch of the coast is stable in nature. Major changes are observed at the river mouths. Chittari (48P03SW) and Valapattanam (49M05NW) rivers show erosion at the northern and southern spit, while Shiriya, Kumbla, Mogral (48L14SE) and Thejaswini (48P04NW) rivers show accretion at both the sides of the river mouth. The southern spit of Chandragiri (48L15NE) and

Muthalipuzha (49M10SW) (plate 5) is eroding, and the northern spit have accreted. Coastal erosion in the northern sector are mainly to the north of Mogral River (48L14SE), at Kottikulam (48P03NW), Kappad (48M11NE and 49M11SE), Pudiyangadi (49M15SW), at north of Beypore and at Kadallundi (49M16NW).

At the central sector, coastal length of about 51 km is estimated to be under erosion, accretion is along 45 km and 65 km of the coast is stable in nature. A long coastal stretch between Bharathapuzha (49N13SE) and Periyar (58B04NE) shows a sequence of eroding and accreting coast adjacent to each other. Along this coastal stretch, server erosion is observed at Ponnani (49N13SE), Putiyirutti (49N14NE), the mouth of Chettava Lake (58B02SW) and at Vadanapalli (58B03NW), which is sequenced in between accreting beach at Aglad (49N14NE), Edakkazhiyur (49N14SE) and Triprayar (58B04NE). Plate (6) shows the adjacent eroding accreting beaches at Edakkara (49N14NE). Other beaches under erosion are at Parappanagadi (49M16SW), Tanur (49N13NW), Azhikod (58B04NE), Edvanakad (58B04SE) and at Mannasserri (58C05NW).

The erosion at the southern sector is estimated to be along 46 km of coastal length, while 34 km of the coast is accreting and 120 km of the coast is stable in nature. A large stretch of the coast is eroding at Panmana (58C12SW) (Plate 7). The coastal stretch between Nirkunnam (58C07NW) and Purakkad (58C07SW) (Plate 8) and the northern spit of the Kayamkulam Kayal (58C08NE) (Plate 9) are also observed to be under severe erosion. Due to the construction of coastal breakwater near Kottamkulangara (58C06SW) the southern coast have accreted while eroding the northern coast (plate 10). Arattungal (58C06NW), Kottukada (58C06SW), Ambalappuzha (58C07NW), Valiyathura (58D15NE) are the other coastal stretches under erosion in the southern sector.

Table 2: Mapsheet-wise results of shoreline changes for 2004-06 and 2014-16 time-frame for Kerala coast

Serial No.	Mapsheet No.	Erosion Area (in ha)	Erosion Length (in km)	Accretion Area (in ha)	Accretion Length (in km)	Stable Length (in km)	Total Length (in km)
1	48L14NE	0.46	0.44	8.71	5.97	6.15	12.56
2	48L15NE	6.87	1.2	14.3	3.4	2.65	7.25
3	48P04NE	0	0	0	0	7.74	7.74
4	49M05NW	6.29	4.56	11.4	6.09	7.31	17.96
5	49M05SW	0.04	0.1	0	0	4.9	5
6	49M10NW	3.22	2.68	1.73	1.44	9	13.12
7	49M11NE	2.92	1.81	4.25	2.93	12.98	17.72
8	49M11SE	6.09	4.54	0	0	3	7.54
9	49M15SW	5.69	3.98	0	0	2.34	6.32
10	49M16NW	5.15	5.61	0.79	0.65	9.29	15.55

11	49N13NW	4.02	1.66	0	0.02	3.42	5.1
12	49N13SE	6.47	3.38	10.1	3.25	8.44	15.07
13	58B02SW	11.2	5.36	5.48	3.25	2.36	10.97
14	58B04NE	5.66	5.34	0	0	9.43	14.77
15	58C05NW	4.3	3.46	0	0	1.95	5.41
16	58C05SW	0.91	1.5	0.45	0.26	12.28	14.04
17	58C07SE	4.6	2.74	12.8	2.23	4.67	9.64
18	58C08NE	16.7	7.3	2.73	1.39	6.25	14.94
19	58D09NW	0	0	2.11	0.85	15.16	16.01
20	58D14NW	2.54	2.5	3.22	1.03	3.9	7.43
21	58D15NE	7.37	5.63	1.72	0.77	14.24	20.64
22	48L13SW	0	0	1.04	0.84	0	0.84
23	48L14NW	0	0	4.47	1.92	0	1.92
24	48L14SE	5.25	3.45	6.87	3.23	7.27	13.95
25	48P03NW	4.43	3.48	2.44	1.94	4.57	9.99
26	48P03SW	3.07	1.58	5.6	3.04	10.65	15.27
27	48P04NW	0.94	0.62	9.55	1.76	5.51	7.89
28	48P04SE	2.81	2.58	2.76	1.54	17.43	21.55
29	48P08SW	0	0	0	0	1.03	1.03
30	49M05SE	0.74	0.5	4.27	3.35	15.74	19.59
31	49M06NE	0.61	1.01	0.34	0.3	1.58	2.89
32	49M10SW	6.46	1.91	2.8	1.85	10.7	14.46
33	49M11NW	0	0	2.07	1.28	2.42	3.7
34	49M16SW	4.2	3.58	2.23	2.22	8.52	14.32
35	49N13NE	0	0	8.24	5.55	2.97	8.52
36	49N14NE	16.7	7.57	15.8	6.25	2.23	16.05
37	49N14SE	0	0	25.4	5.06	0	5.06
38	58B03NW	18.9	9.16	8.67	4.59	1.82	15.57
39	58B03SE	5.1	2.68	0	0	3.95	6.63
40	58B03SW	1.19	1.51	11.4	4.75	2.28	8.54
41	58B04SE	3.84	3.66	11.7	5.87	5.11	14.64
42	58C01NE	9.68	2.9	18.3	3.82	4.2	10.92
43	58C06NW	17.3	4.05	10.4	3.4	6.87	14.32
44	58C06SW	15.3	7.34	13.6	2.6	4.24	14.18
45	58C07NW	6.51	3.87	30.6	9.42	2.08	15.37
46	58C07SW	27.5	4.46	0	0	1.12	5.58
47	58C12SW	30.5	5.31	0	0	3.3	8.61
48	58C08SE	0.22	0.22	0.5	0.48	7.76	8.46
49	58D09SE	0	0	3.54	2.58	10.6	13.18
50	58D09SW	3.26	2.04	0.07	0.16	3.06	5.26
51	58D10NE	0	0	4.41	3.73	6.54	10.27
52	58D14SE	0	0	1.35	1.04	2.19	3.23
53	58D14SW	0	0	12.1	3.68	10.88	14.56
54	58D15SE	0	0	0	0	0.47	0.47
55	58H03SW	0.08	0.06	3.02	1.35	12.62	14.03
	Total	285	137.33	303	121.13	327.17	585.63

5. END USE

Coastal management plans require a proper understanding of the coastal processes and coastal dynamics to achieve a sustainable development along the coastal region. The inventory of shoreline change is the pre-requisite in understanding the dynamics of the coastal region. As the Indian coastal regions are modified by mounting development activities, an improper management at times shall lead to severe coastal erosion. Planning measures for sustainable development along the coastal region require a systematic inventory of shoreline changes occurring along the entire Indian coast on 1: 25,000 scale.

The Atlas can be used as a reference material for obtaining information on status of shoreline changes during 2004-06 and 2014-16 time-frames along entire Indian coastline. Areas under coastal erosion and status of coastal protection measures taken up by respective maritime State and Union Territory are depicted and can be used for planning coastal protection measures.

The Atlas is extremely useful to Coastal Management Directorate, Central Water Commission for providing guidance towards coastal protection works in maritime states of India.

All the State Public Works Departments, Ports and Harbour Authorities, Coastal Regulation Zone Authorities shall be able to have better management of the shorelines in respective states.

ACKNOWLEDGEMENTS

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We are highly grateful to the quality check team Shri T.V.R Murthy, Shri J.G Patel, Shri R.J Bhanderi, Shri B.P Rathore and Shri Manish Parmar for meticulously checking the shoreline change database and giving invaluable suggestion towards improving the same. We express our sincere gratitude to Ms. Savita Kumari and Ms. Anupama Sahoo for helping us in the map composition and database management.

Project team
Shoreline Change Atlas

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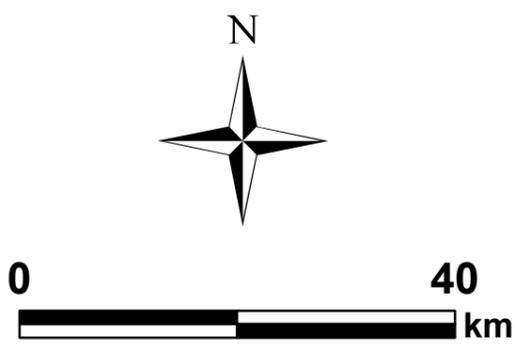
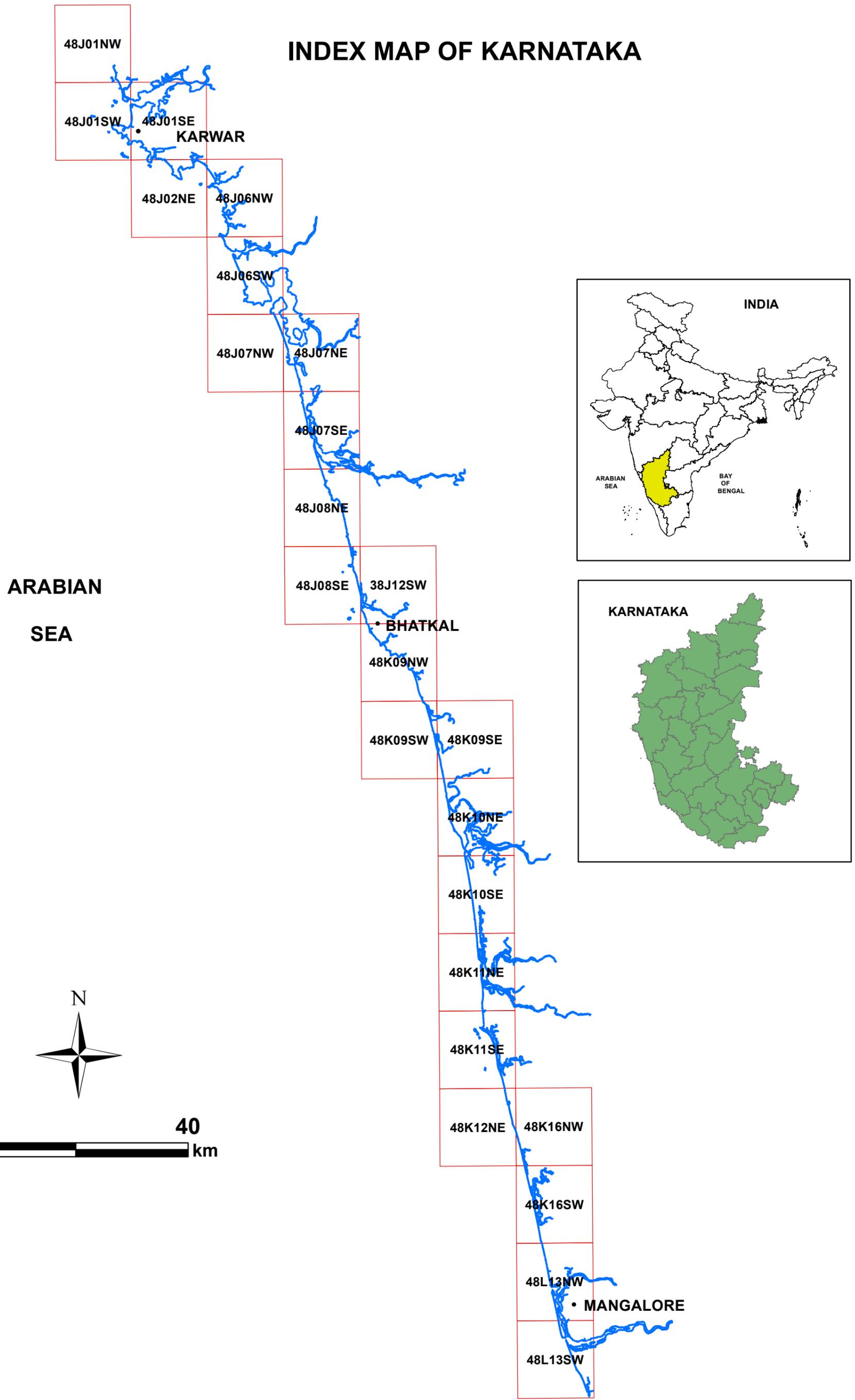
SHORELINE CHANGE MAPS

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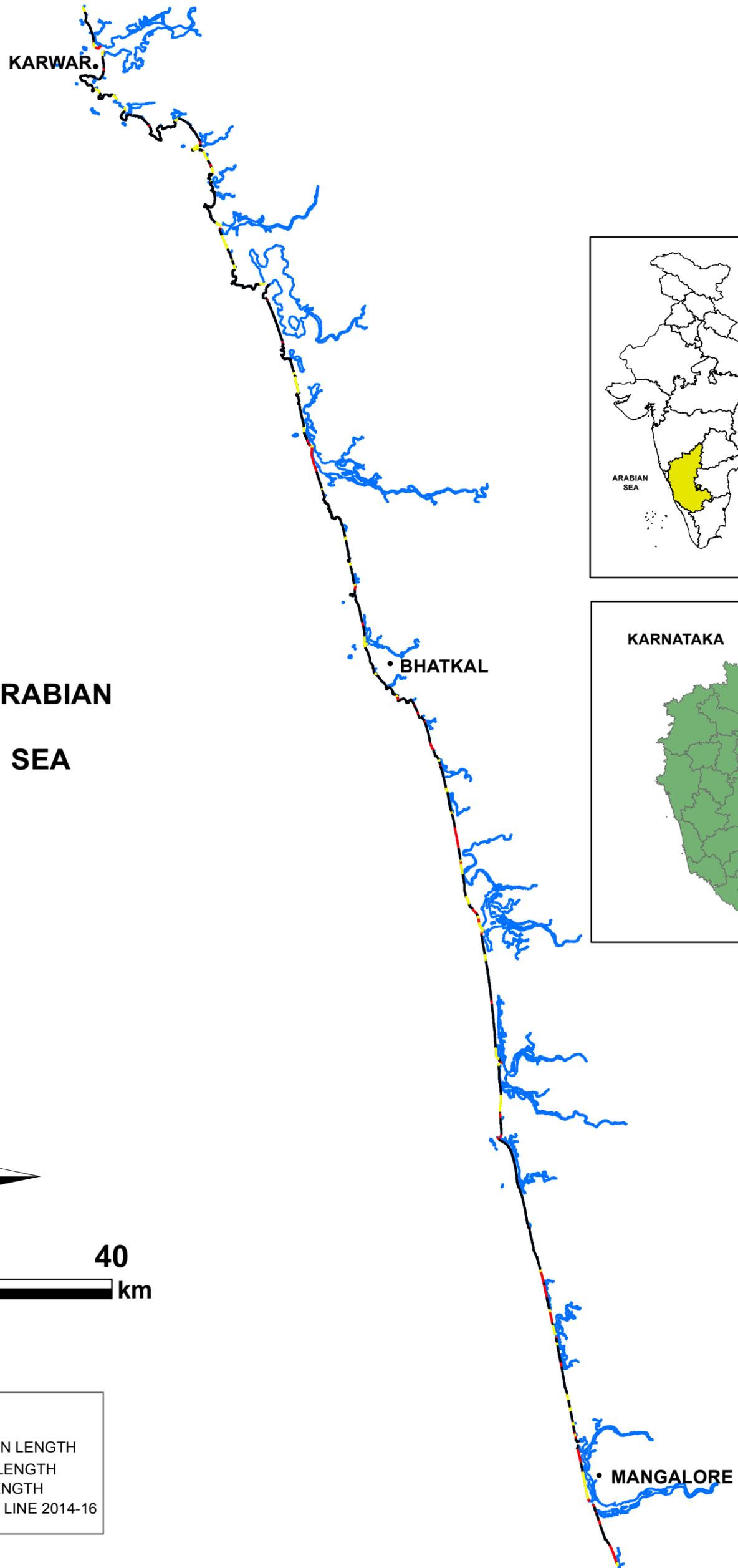
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	ACCRETION
	HIGH-TIDE LINE 2014-16
	HIGH-TIDE LINE 2004-06
	STABLE
	ROAD
	RAILWAY
	SEA WALL
	GROYNES
	BREAKWATER
	JETTY
	STATE BOUNDARY
	PORT/HARBOUR
	HABITATION

SHORELINE CHANGE MAPS
KARNATAKA

INDEX MAP OF KARNATAKA



SHORELINE CHANGES OF KARNATAKA



ARABIAN
SEA



LEGEND	
	ACCRETION LENGTH
	EROSION LENGTH
	STABLE LENGTH
	HIGH-TIDE LINE 2014-16

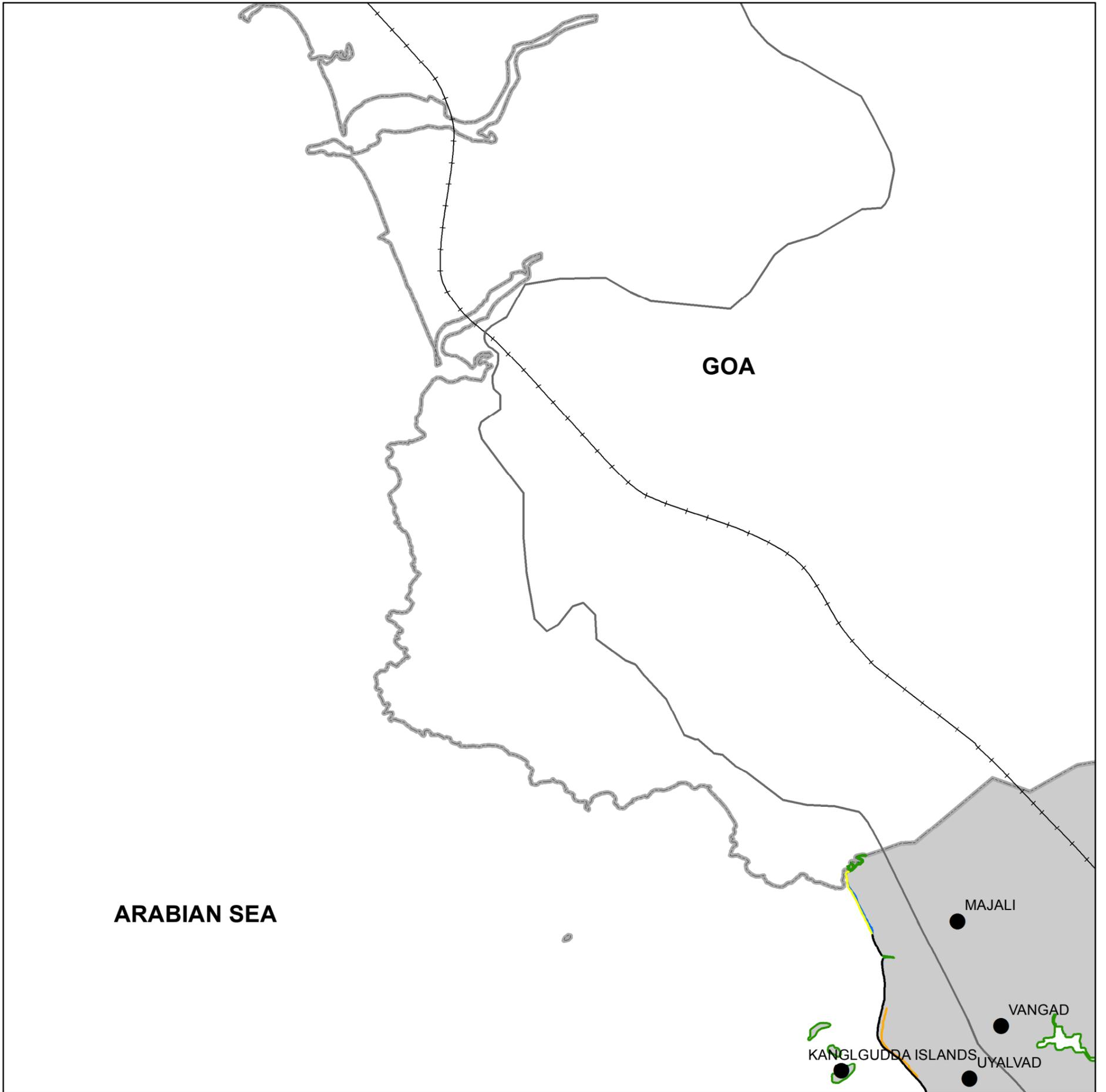
SHORELINE CHANGE MAP

FOR OFFICIAL USE ONLY

UTTARA KANNADA DISTRICT

KARNATAKA

SHEET NO. 48J01NW



Legend

- ACCRETION
- HIGH-TIDE LINE 2014-16
- HIGH-TIDE LINE 2004-06
- STABLE
- ROAD
- RAILWAY
- SEA WALL
- STATE BOUNDARY
- HABITATION

INDEX TO SHEETS

48E16SE	48I04SW	48I04SE
SEA	48J01NW	48J01NE
SEA	48J01SW	48J01SE



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
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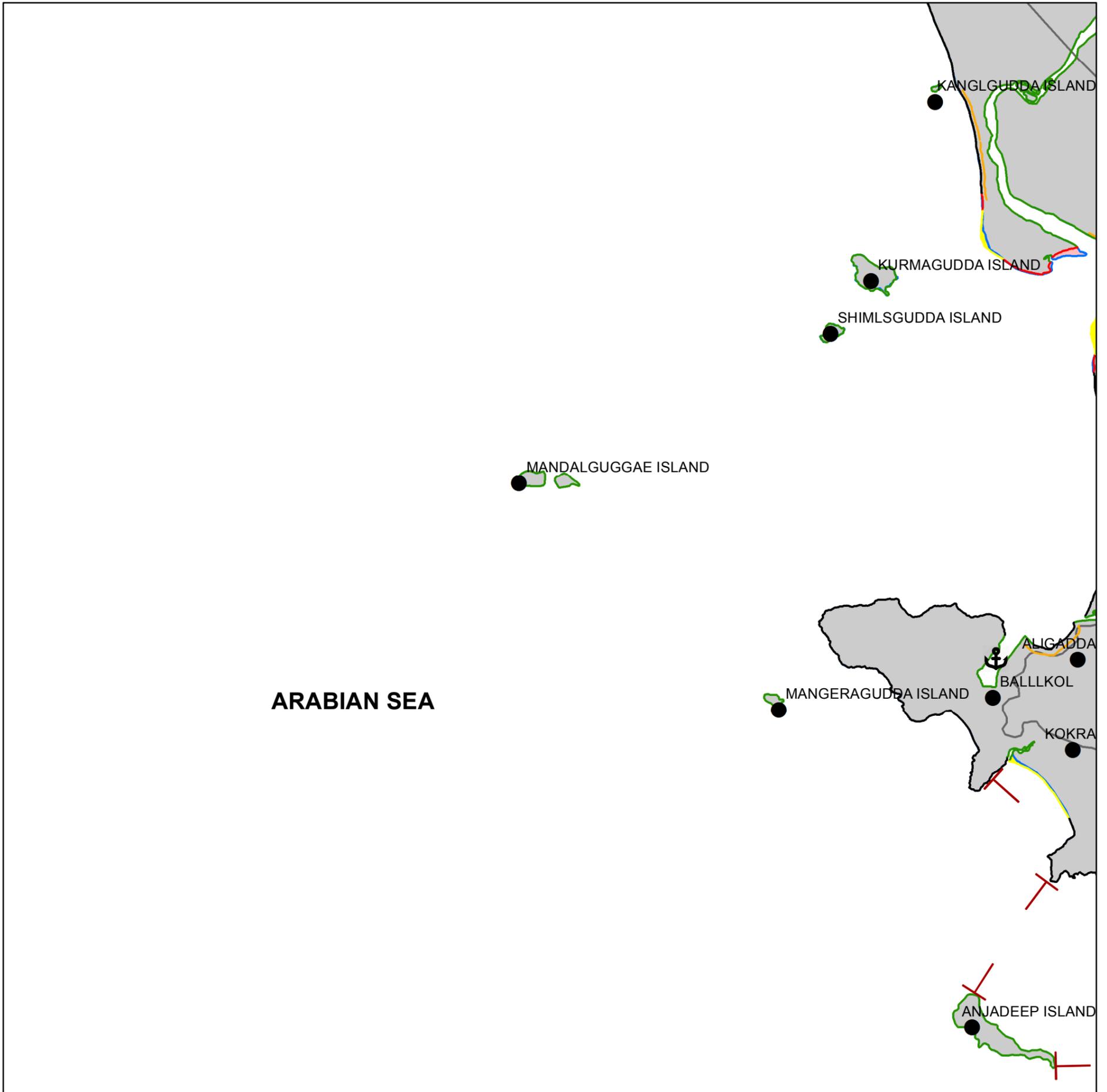
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UTTARA KANNADA DISTRICT

KARNATAKA

SHEET NO. 48J01SW



ARABIAN SEA

Legend

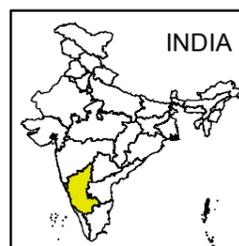
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- ACCRETION
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- HIGH-TIDE LINE 2004-06
- STABLE
- ROAD
- SEA WALL
- BREAKWATER
- ⚓ PORT/HARBOUR
- HABITATION

INDEX TO SHEETS

SEA	48J01NW	48J01NE
SEA	48J01SW	48J01SE
SEA	SEA	48J02NE



0 2 km



DATA SOURCE:
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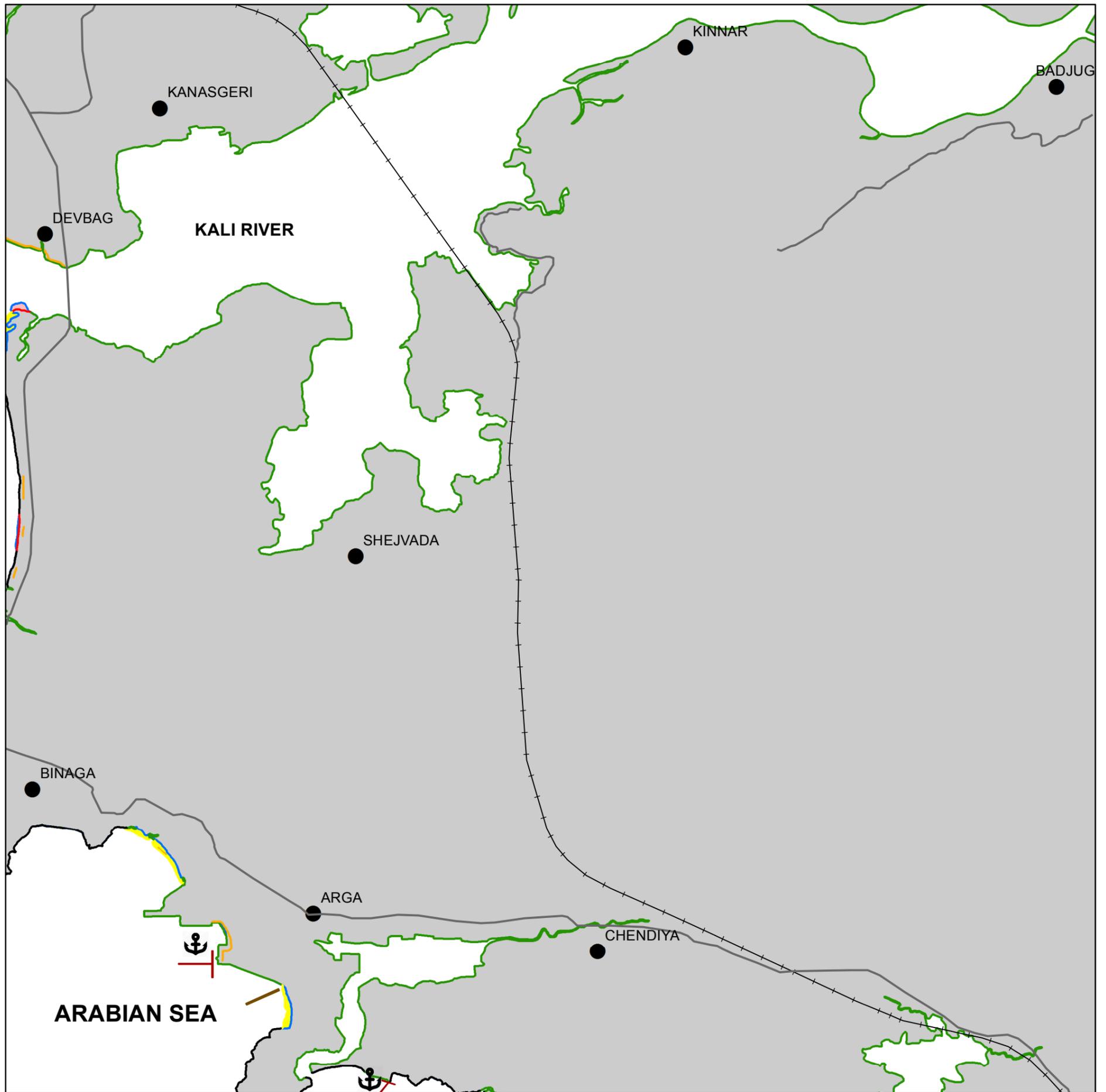
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UTTARA KANNADA DISTRICT

KARNATAKA

SHEET NO. 48J01SE



Legend

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- HIGH-TIDE LINE 2014-16
- HIGH-TIDE LINE 2004-06
- STABLE
- ROAD
- RAILWAY
- SEA WALL
- BREAKWATER
- JETTY
- ⚓ PORT/HARBOUR
- HABITATION

INDEX TO SHEETS

48J01NW	48J01NE	48J05NW
48J01SW	48J01SE	48J05SW
SEA	48J02NE	48J06NW



0 2 km



DATA SOURCE:
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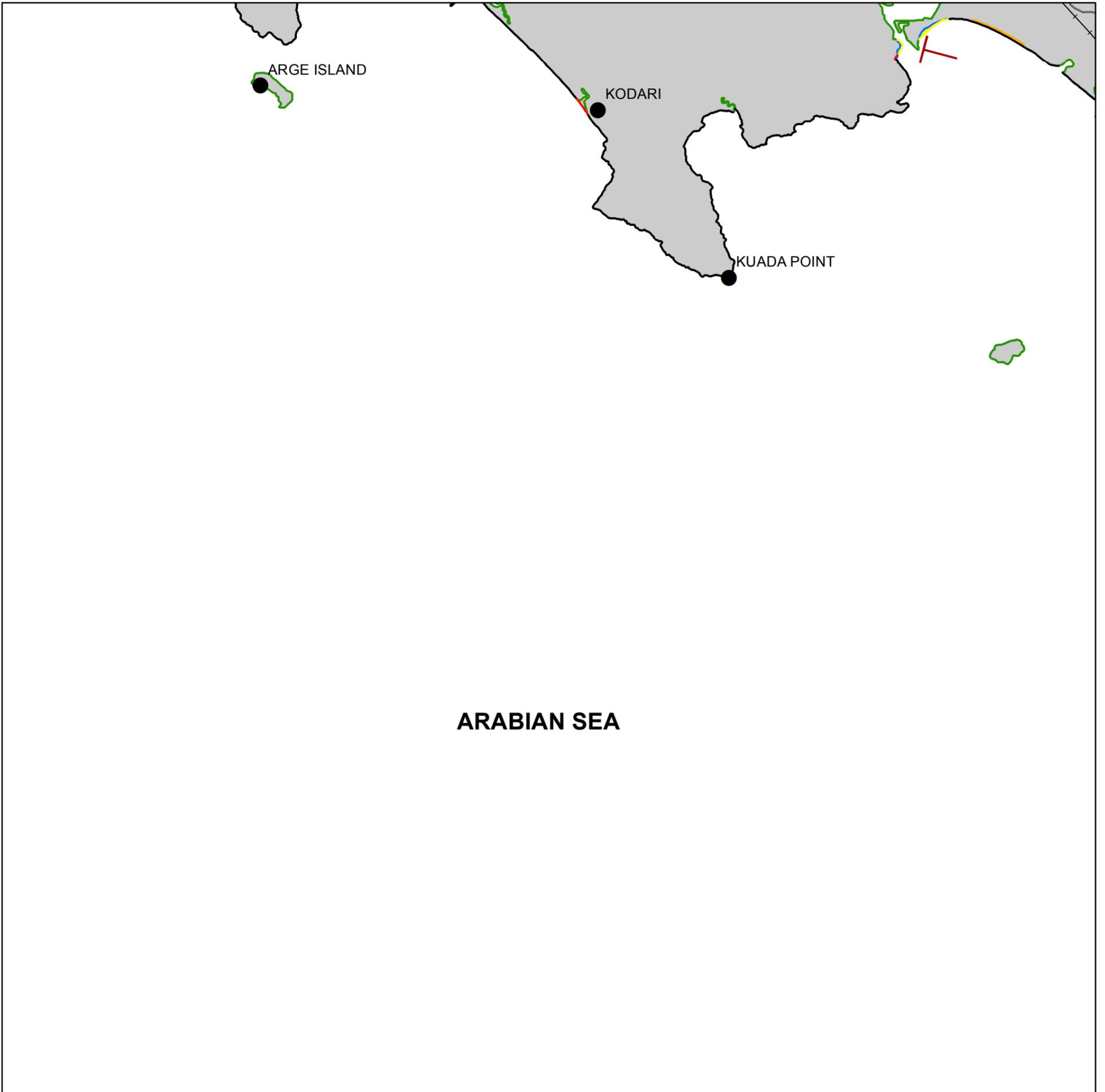


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SHEET NO. 48J02NE

UTTARA KANNADA DISTRICT

KARNATAKA

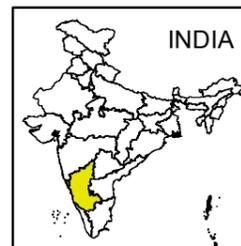


Legend

- EROSION
- ACCRETION
- HIGH-TIDE LINE 2014-16
- HIGH-TIDE LINE 2004-06
- STABLE
- ROAD
- ++ RAILWAY
- SEA WALL
- ++ BREAKWATER
- HABITATION

INDEX TO SHEETS

48J01SW	48J01SE	48J05NW
SEA	48J02NE	48J06NW
SEA	SEA	48J06SW



DATA SOURCE:
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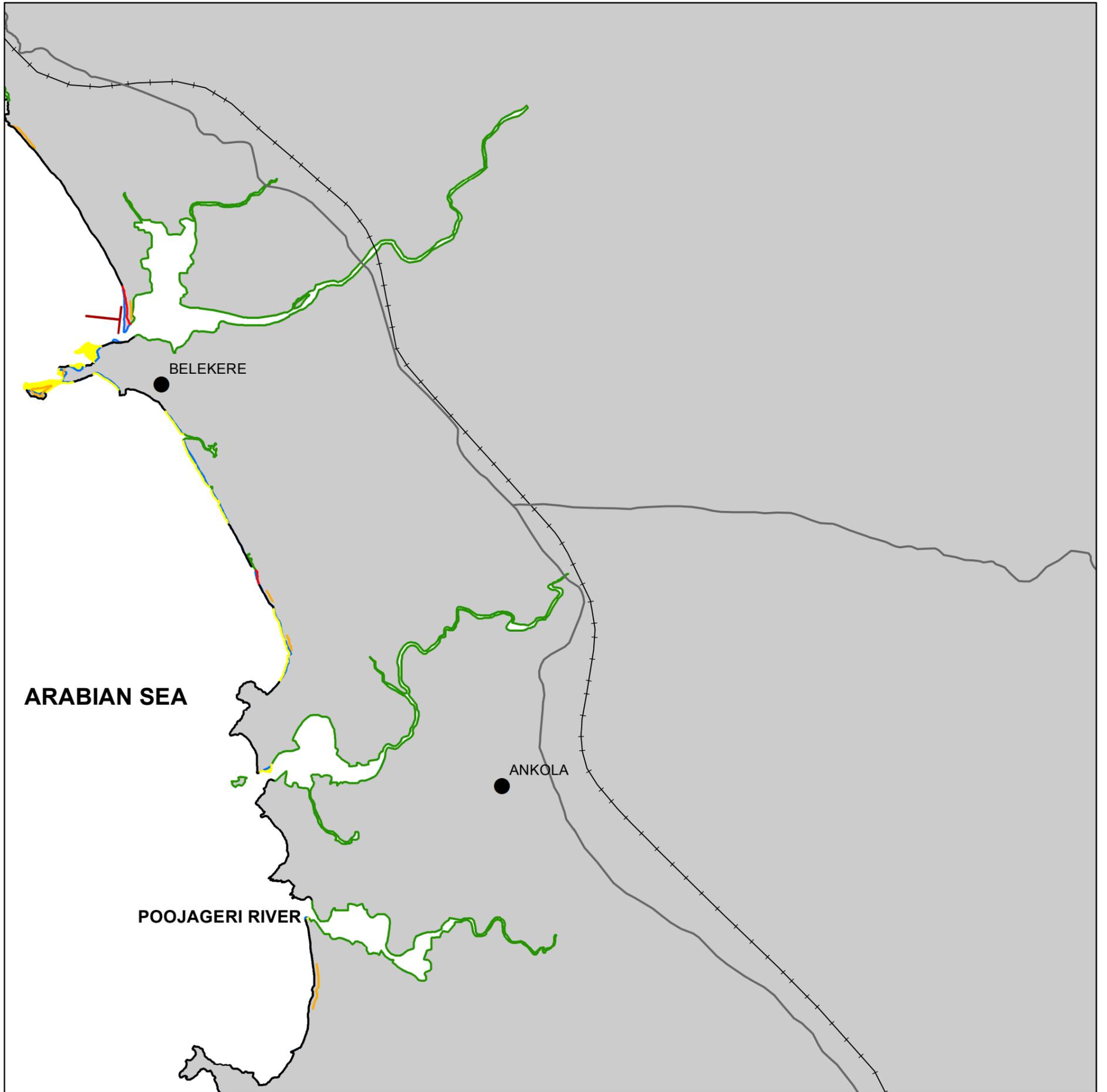
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UTTARA KANNADA DISTRICT

KARNATAKA

SHEET NO. 48J06NW



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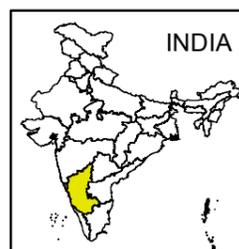
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- STABLE
- ROAD
- RAILWAY
- SEA WALL
- BREAKWATER
- HABITATION

INDEX TO SHEETS

48J01SE	48J05SW	48J05SE
48J02NE	48J06NW	48J06NE
SEA	48J06SW	48J06SE



0 2 km



DATA SOURCE:
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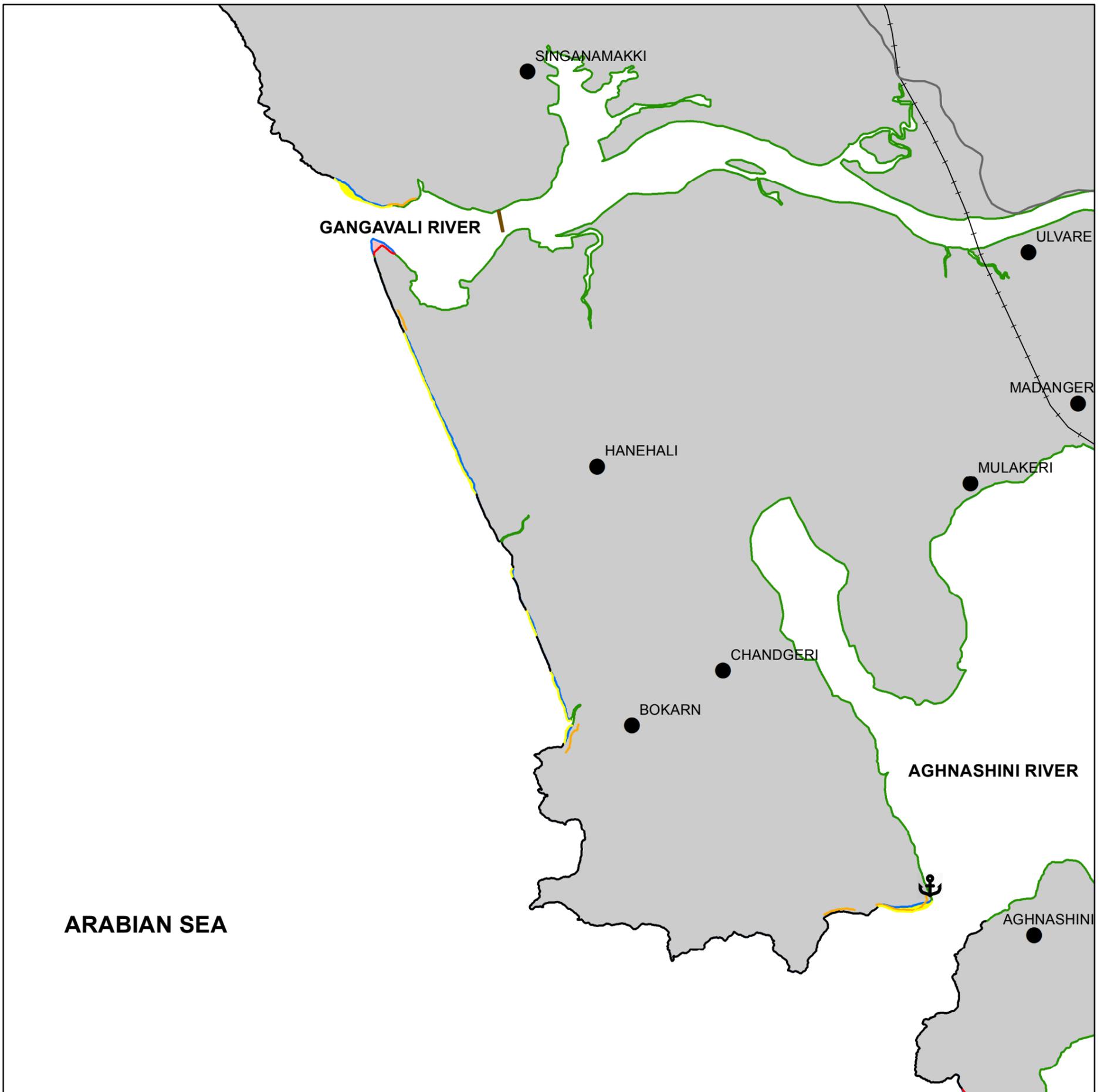
SHORELINE CHANGE MAP

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UTTARA KANNADA DISTRICT

KARNATAKA

SHEET NO. 48J06SW



Legend

- EROSION
- ACCRETION
- HIGH-TIDE LINE 2014-16
- HIGH-TIDE LINE 2004-06
- STABLE
- ROAD
- RAILWAY
- SEA WALL
- JETTY
- HABITATION
- PORT/HARBOUR

INDEX TO SHEETS

48J02NE	48J06NW	48J06NE
SEA	48J06SW	48J06SE
SEA	48J07NW	48J07NE



0 2 km



DATA SOURCE:
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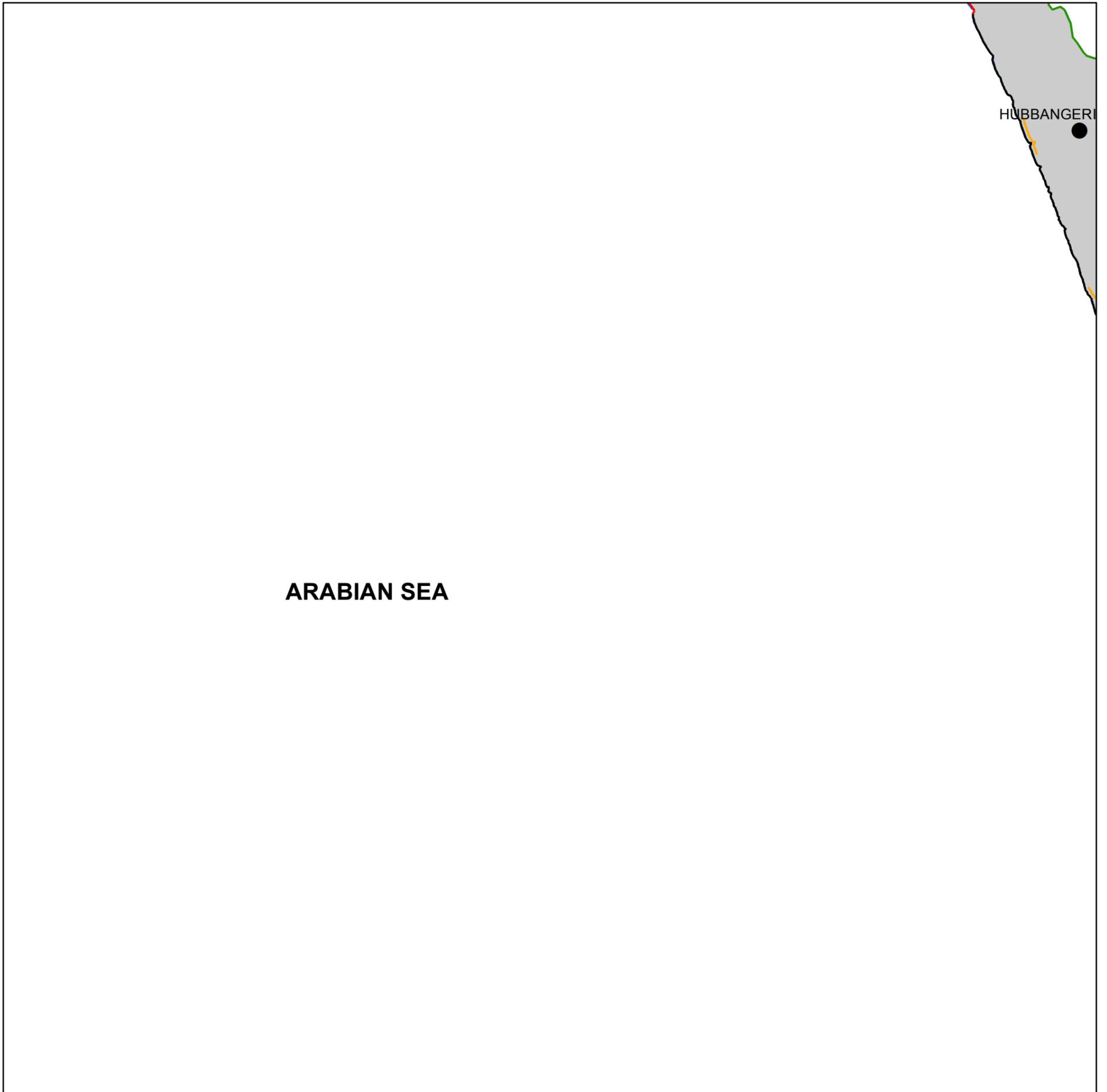
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UTTARA KANNADA DISTRICT

KARNATAKA

SHEET NO. 48J07NW



ARABIAN SEA

HUBBANGERI

Legend

-  EROSION
-  HIGH-TIDE LINE 2014-16
-  HIGH-TIDE LINE 2004-06
-  STABLE
-  SEA WALL
-  HABITATION



0 2 km



INDEX TO SHEETS

SEA	48J06SW	48J06SE
SEA	48J07NW	48J07NE
SEA	SEA	48J07SE



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

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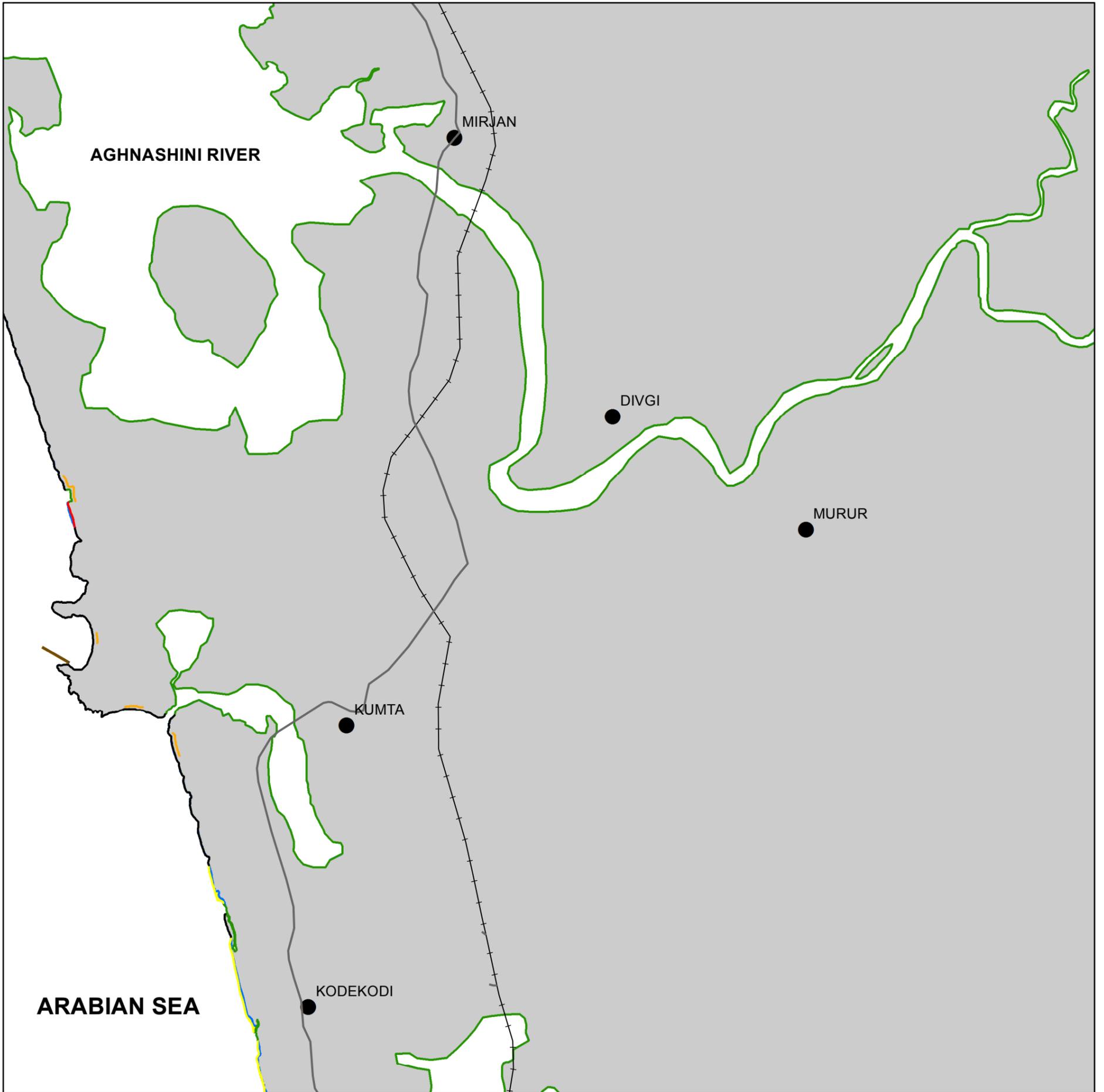
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UTTARA KANNADA DISTRICT

KARNATAKA

SHEET NO. 48J07NE

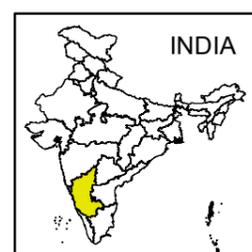


Legend

- EROSION
- ACCRETION
- HIGH-TIDE LINE 2014-16
- HIGH-TIDE LINE 2004-06
- STABLE
- ROAD
- RAILWAY
- SEA WALL
- JETTY
- HABITATION

INDEX TO SHEETS

48J06SW	48J06SE	48J10SW
48J07NW	48J07NE	48J11NW
SEA	48J07SE	48J11SW



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI



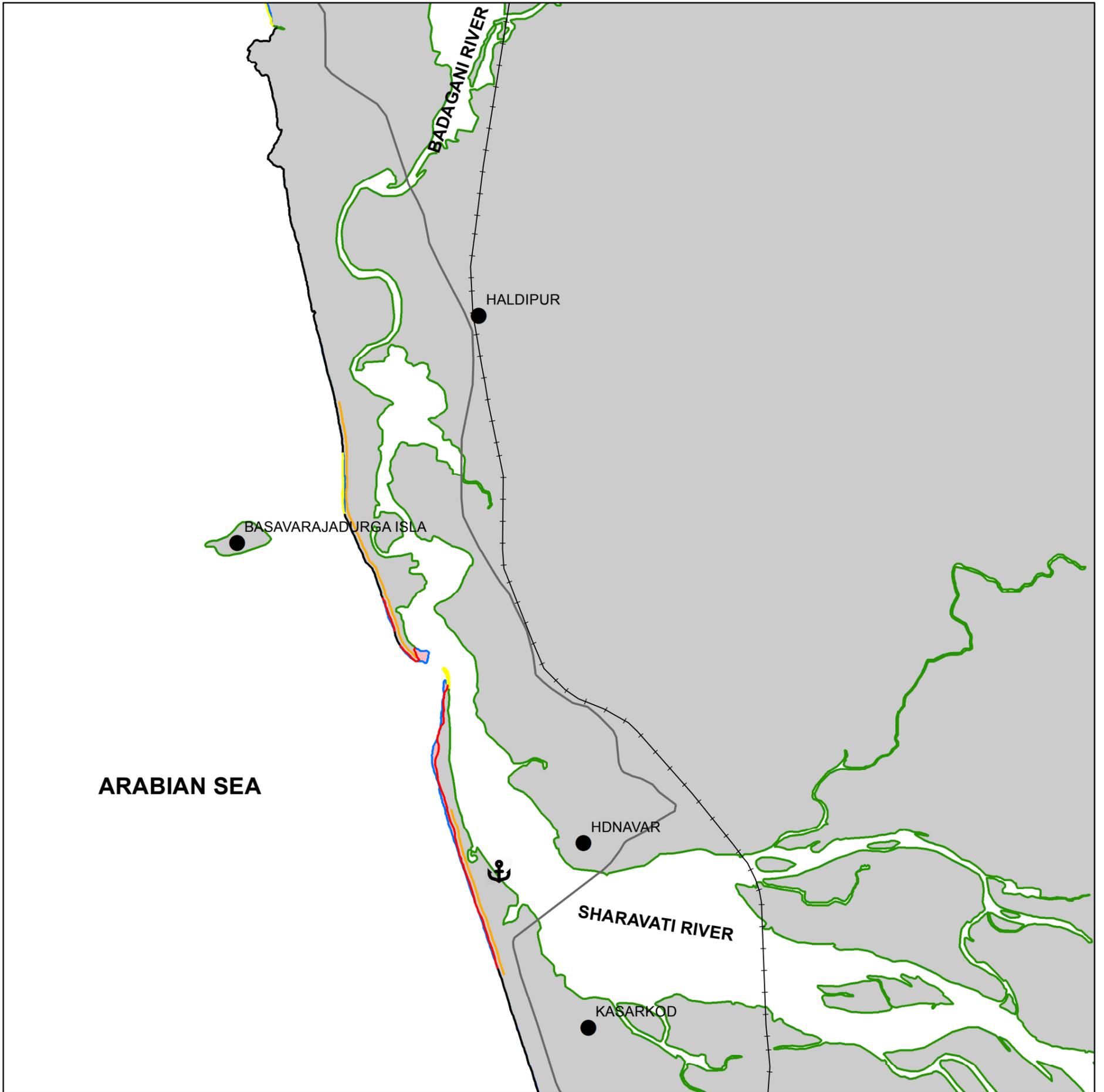
SHORELINE CHANGE MAP

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UTTARA KANNADA DISTRICT

KARNATAKA

SHEET NO. 48J07SE



Legend

- EROSION
- ACCRETION
- HIGH-TIDE LINE 2014-16
- HIGH-TIDE LINE 2004-06
- STABLE
- ROAD
- RAILWAY
- SEA WALL
- ⚓ PORT/HARBOUR
- HABITATION



0 2 km



INDEX TO SHEETS

48J07NW	48J07NE	48J11NW
SEA	48J07SE	48J11SW
SEA	48J08NE	48J12NW



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI



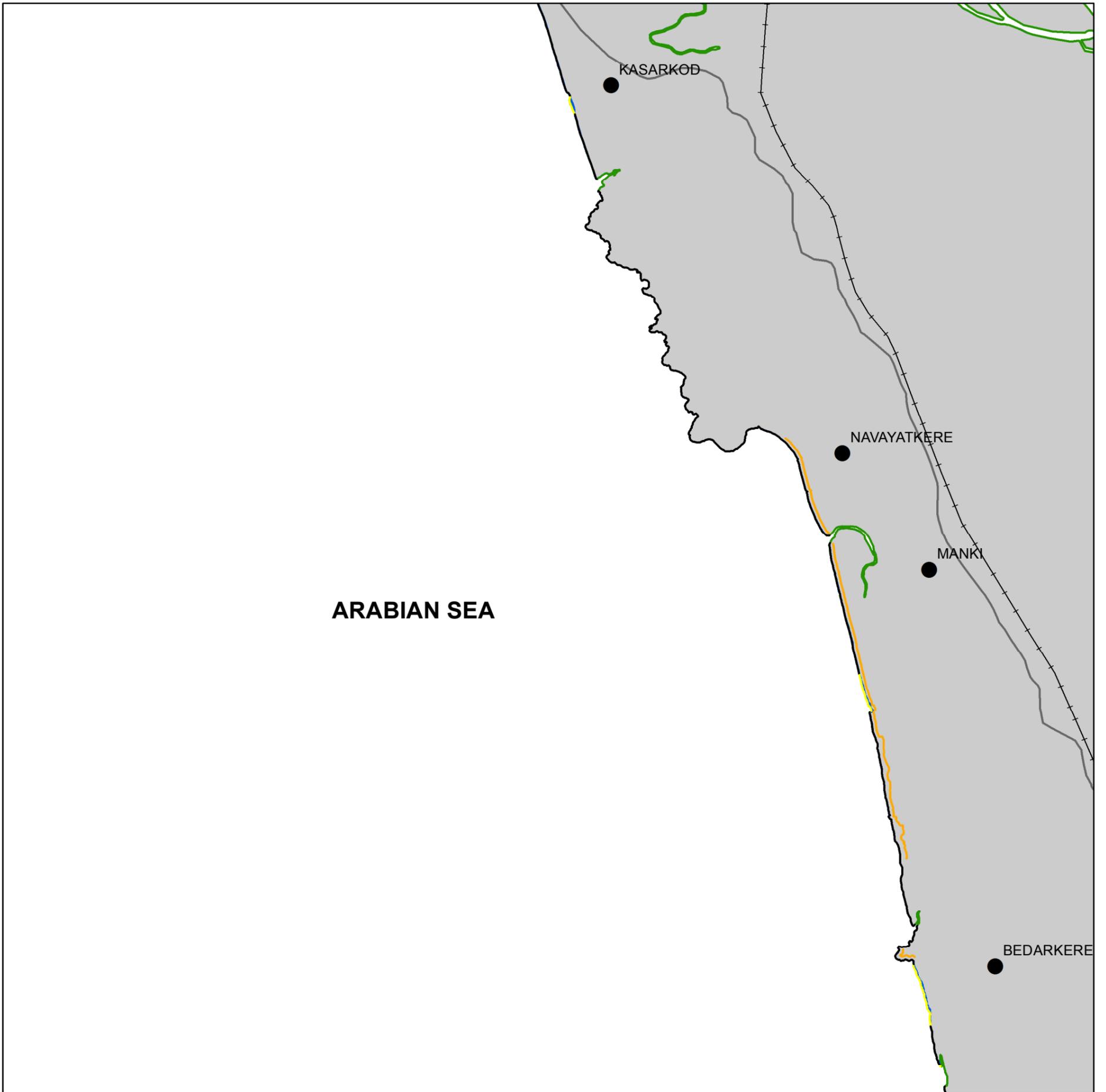
SHORELINE CHANGE MAP

FOR OFFICIAL USE ONLY

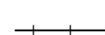
UTTARA KANNADA DISTRICT

KARNATAKA

SHEET NO. 48J08NE



Legend

-  ACCRETION
-  HIGH-TIDE LINE 2014-16
-  HIGH-TIDE LINE 2004-06
-  STABLE
-  ROAD
-  RAILWAY
-  SEA WALL
-  HABITATION

INDEX TO SHEETS

SEA	48J07SE	48J11SW
SEA	48J08NE	48J12NW
SEA	48J08SE	48J12SW



0 2 km



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI



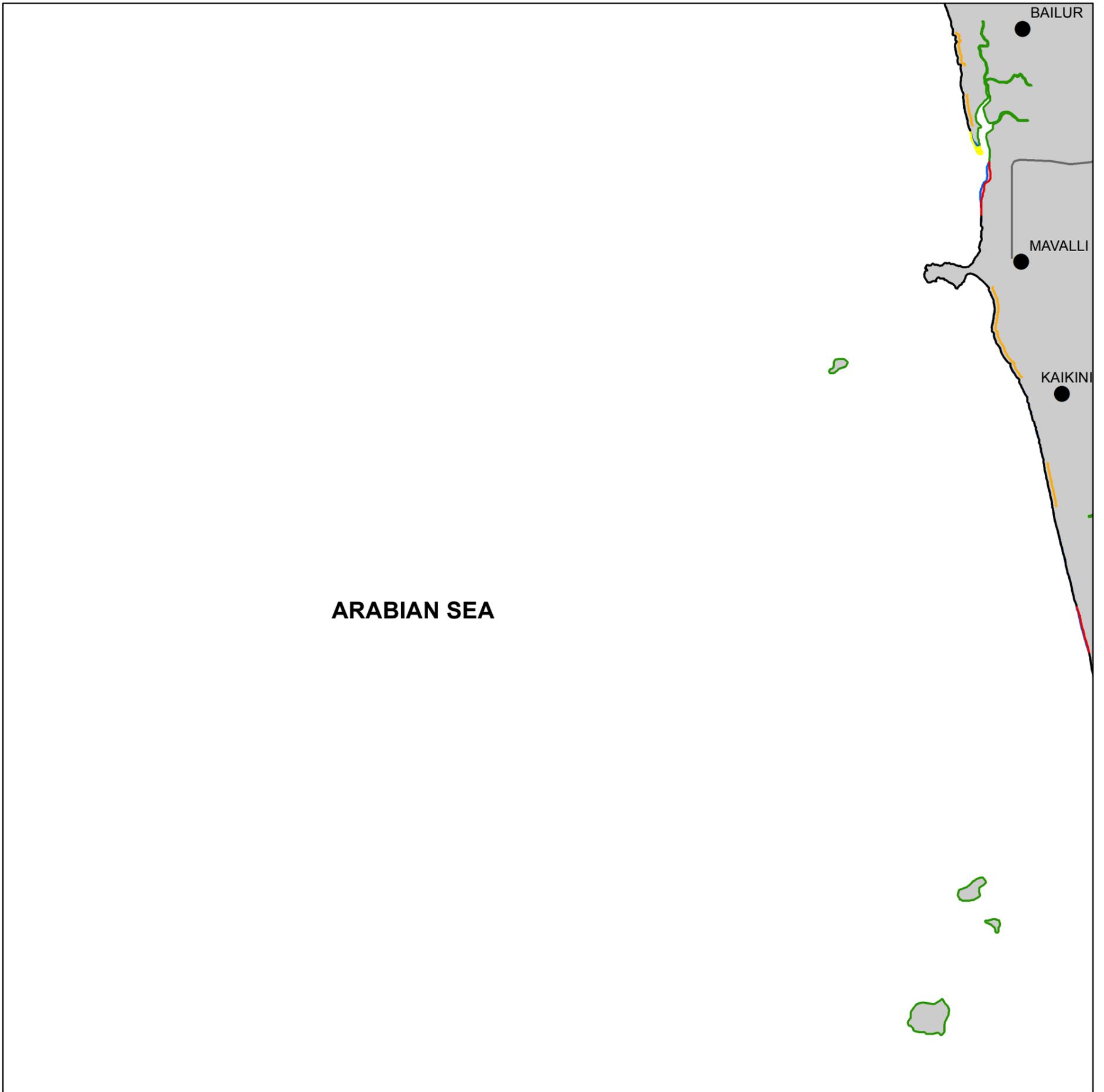
SHORELINE CHANGE MAP

FOR OFFICIAL USE ONLY

UTTARA KANNADA DISTRICT

KARNATAKA

SHEET NO. 48J08SE



Legend

- EROSION
- ACCRETION
- HIGH-TIDE LINE 2014-16
- HIGH-TIDE LINE 2004-06
- STABLE
- ROAD
- SEA WALL
- HABITATION

INDEX TO SHEETS

SEA	48J08NE	48J12NW
SEA	48J08SE	48J12SW
SEA	SEA	47K09NW



0 2 km



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI



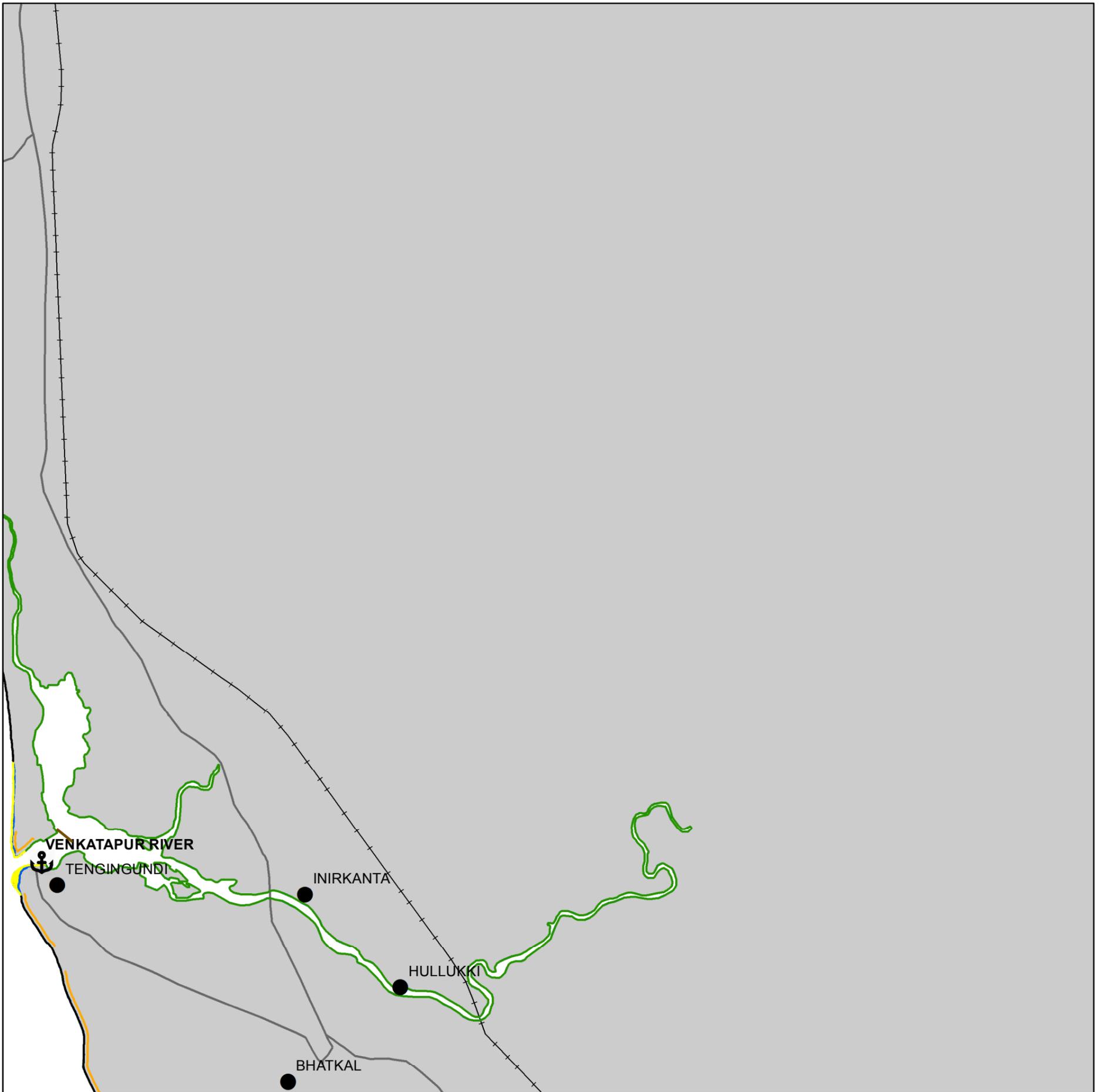
SHORELINE CHANGE MAP

FOR OFFICIAL USE ONLY

UTTARA KANNADA DISTRICT

KARNATAKA

SHEET NO. 48J12SW



Legend

- ACCRETION
- HIGH-TIDE LINE 2014-16
- HIGH-TIDE LINE 2004-06
- STABLE
- ROAD
- RAILWAY
- SEA WALL
- JETTY
- PORT/HARBOUR
- HABITATION

INDEX TO SHEETS

48J08NE	48J12NW	48J12NE
48J08SE	48J12SW	48J12SE
SEA	47K09NW	48K09NE



0 2 km



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI

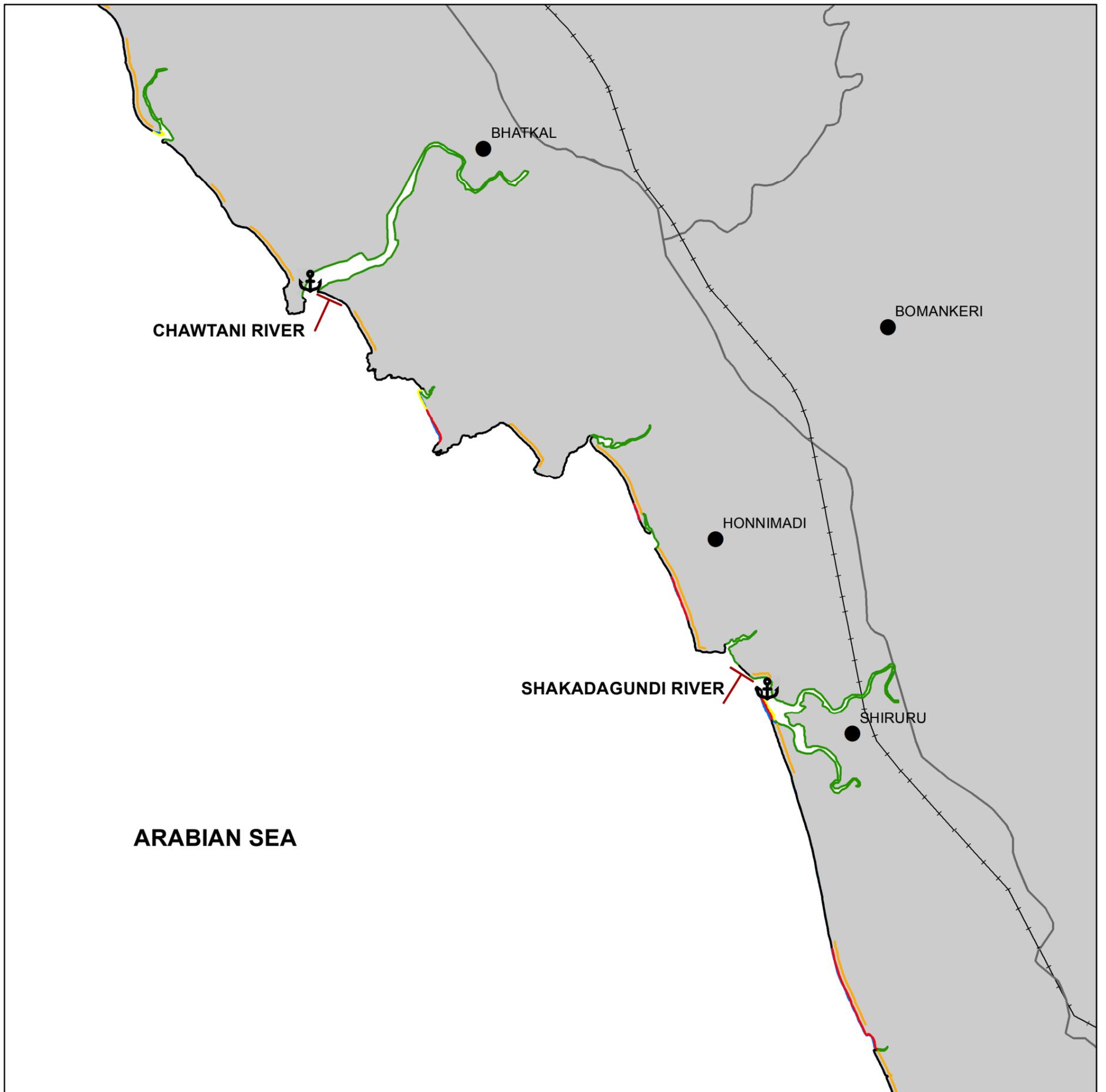


SHORELINE CHANGE MAP

FOR OFFICIAL USE ONLY

UTTARA KANNADA/UDUPI DISTRICT **KARNATAKA**

SHEET NO. 48K09NW



Legend

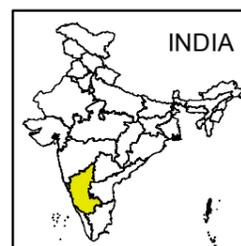
- EROSION
- ACCRETION
- HIGH-TIDE LINE 2014-16
- HIGH-TIDE LINE 2004-06
- STABLE
- ROAD
- RAILWAY
- SEA WALL
- BREAKWATER
- ⚓ PORT/HARBOUR
- HABITATION

INDEX TO SHEETS

48J08SE	48J12SW	48J12SE
SEA	48K09NW	48K09NE
SEA	48K09SW	48K09SE



0 2 km



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI



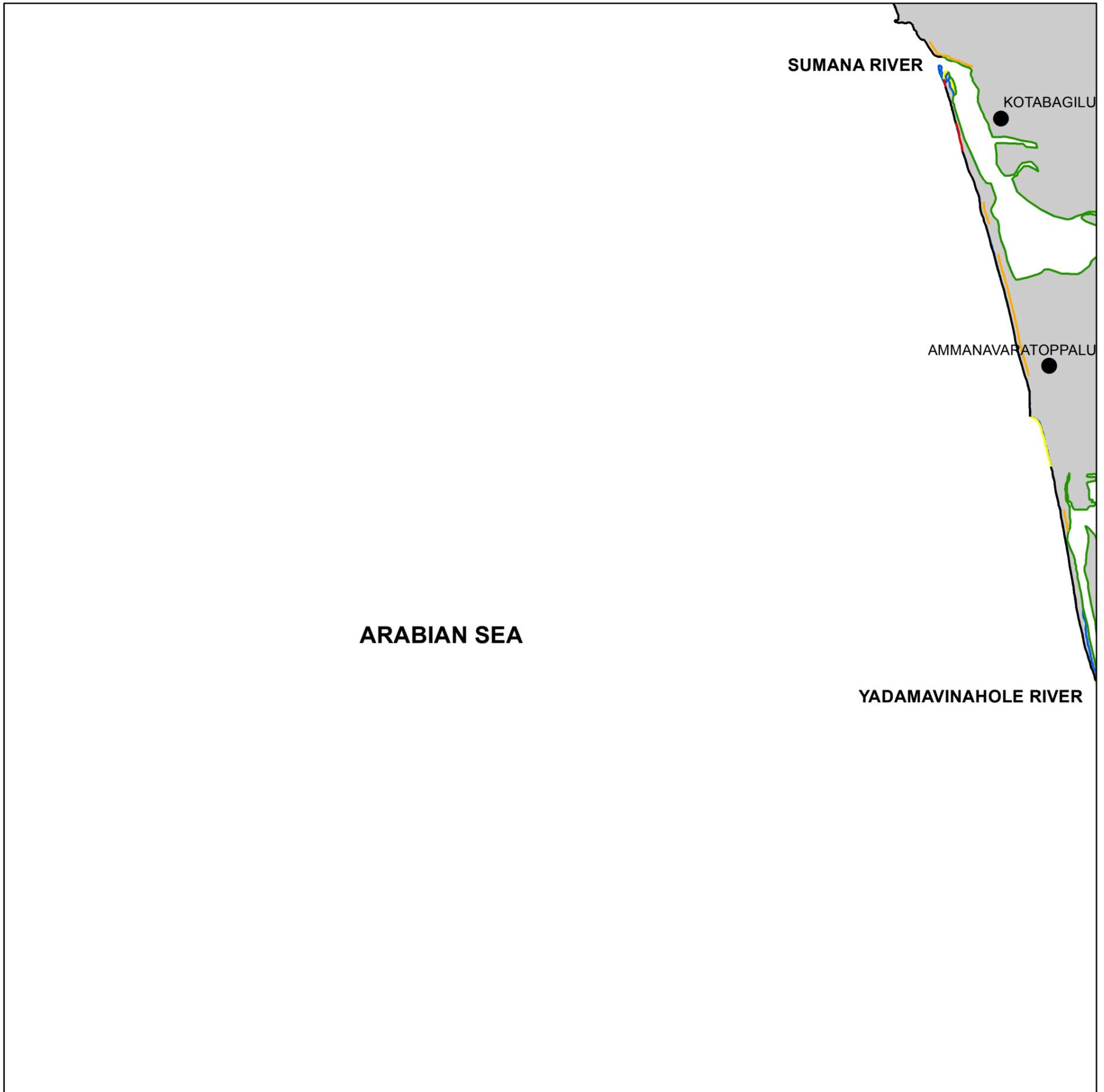
SHORELINE CHANGE MAP

FOR OFFICIAL USE ONLY

UDUPI DISTRICT

KARNATAKA

SHEET NO. 48K09SW



Legend

- EROSION
- ACCRETION
- HIGH-TIDE LINE 2014-16
- HIGH-TIDE LINE 2004-06
- STABLE
- SEA WALL
- HABITATION

INDEX TO SHEETS

SEA	47K09NW	48K09NE	
SEA	48K09SW	48K09SE	
SEA	SEA	48K10NE	

INDIA

KARNATAKA

DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
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AND CENTRAL WATER COMMISSION, NEW DELHI

SHORELINE CHANGE MAP

FOR OFFICIAL USE ONLY
SHEET NO. 48K09SE

UDUPI DISTRICT

KARNATAKA

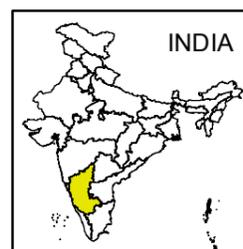


Legend

- EROSION
- ACCRETION
- HIGH-TIDE LINE 2014-16
- HIGH-TIDE LINE 2004-06
- STABLE
- ROAD
- RAILWAY
- SEA WALL
- BREAKWATER
- HABITATION

INDEX TO SHEETS

47K09NW	48K09NE	49K13NW
48K09SW	48K09SE	48K13SW
SEA	48K10NE	48K14NW



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16



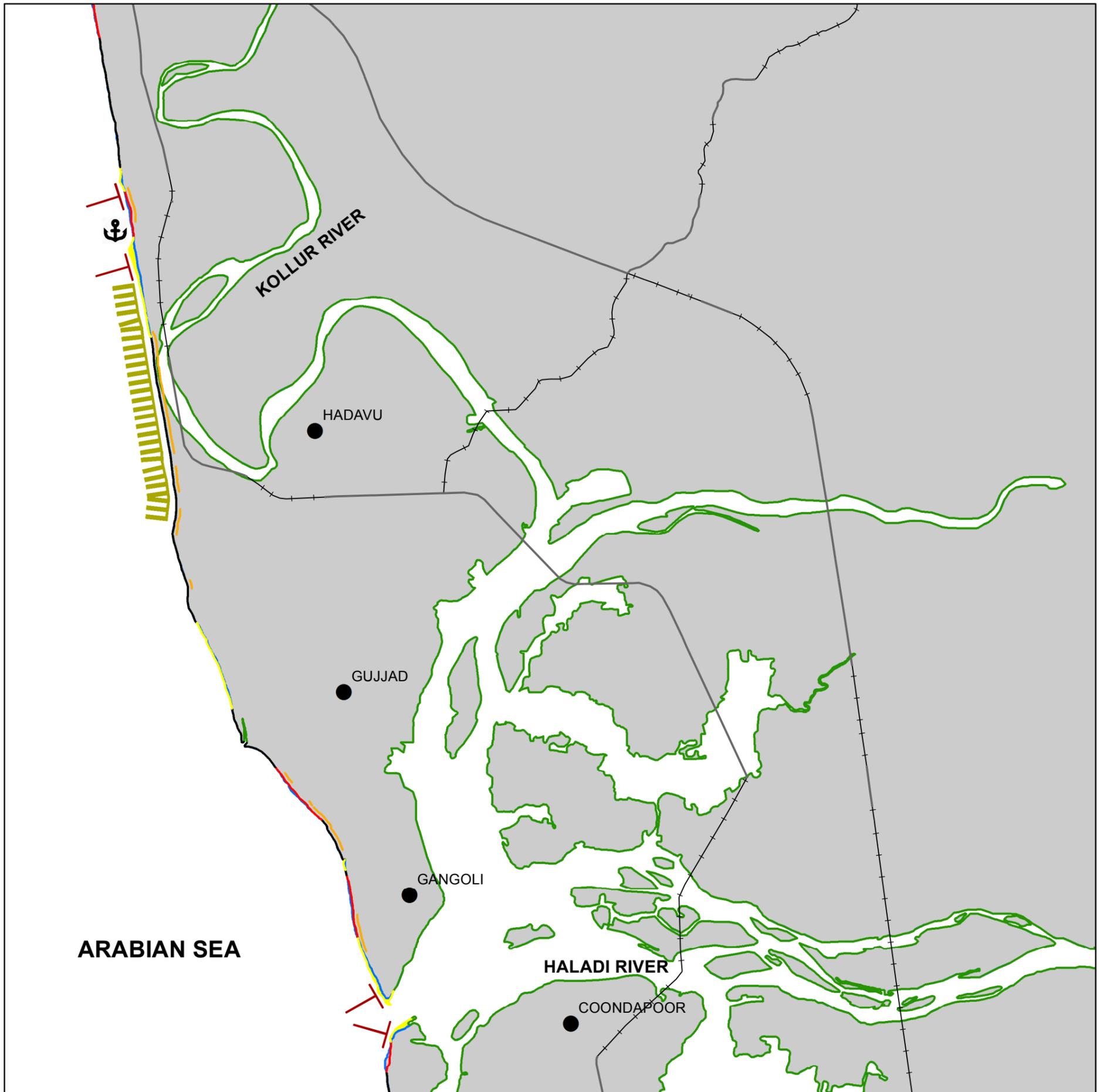
SHORELINE CHANGE MAP

FOR OFFICIAL USE ONLY

UDUPI DISTRICT

KARNATAKA

SHEET NO. 48K10NE



Legend

- EROSION
- ACCRETION
- HIGH-TIDE LINE 2014-16
- HIGH-TIDE LINE 2004-06
- STABLE
- ROAD
- RAILWAY
- SEA WALL
- GROYNES
- BREAKWATER
- ⚓ PORT/HARBOUR
- HABITATION

INDEX TO SHEETS

48K09SW	48K09SE	48K13SW
SEA	48K10NE	48K14NW
SEA	48K10SE	48K14SW

0 2 km

INDIA

KARNATAKA

DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI

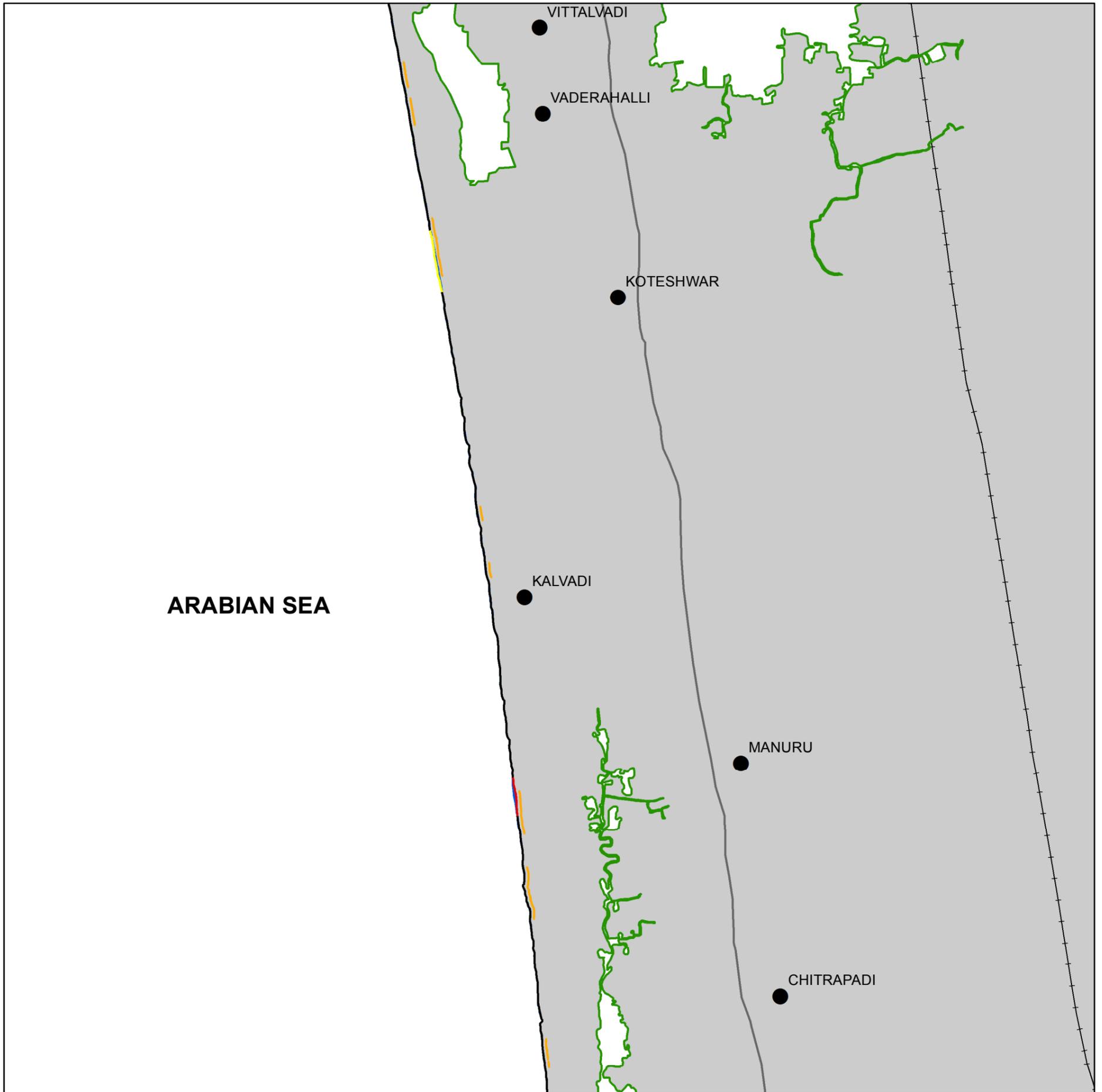
SHORELINE CHANGE MAP

FOR OFFICIAL USE ONLY

UDUPI DISTRICT

KARNATAKA

SHEET NO. 48K10SE



Legend

- EROSION
- ACCRETION
- HIGH-TIDE LINE 2014-16
- HIGH-TIDE LINE 2004-06
- STABLE
- ROAD
- RAILWAY
- SEA WALL
- HABITATION

INDEX TO SHEETS

SEA	48K10NE	48K14NW
SEA	48K10SE	48K14SW
SEA	48K11NE	48K15NW



0 2 km



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI



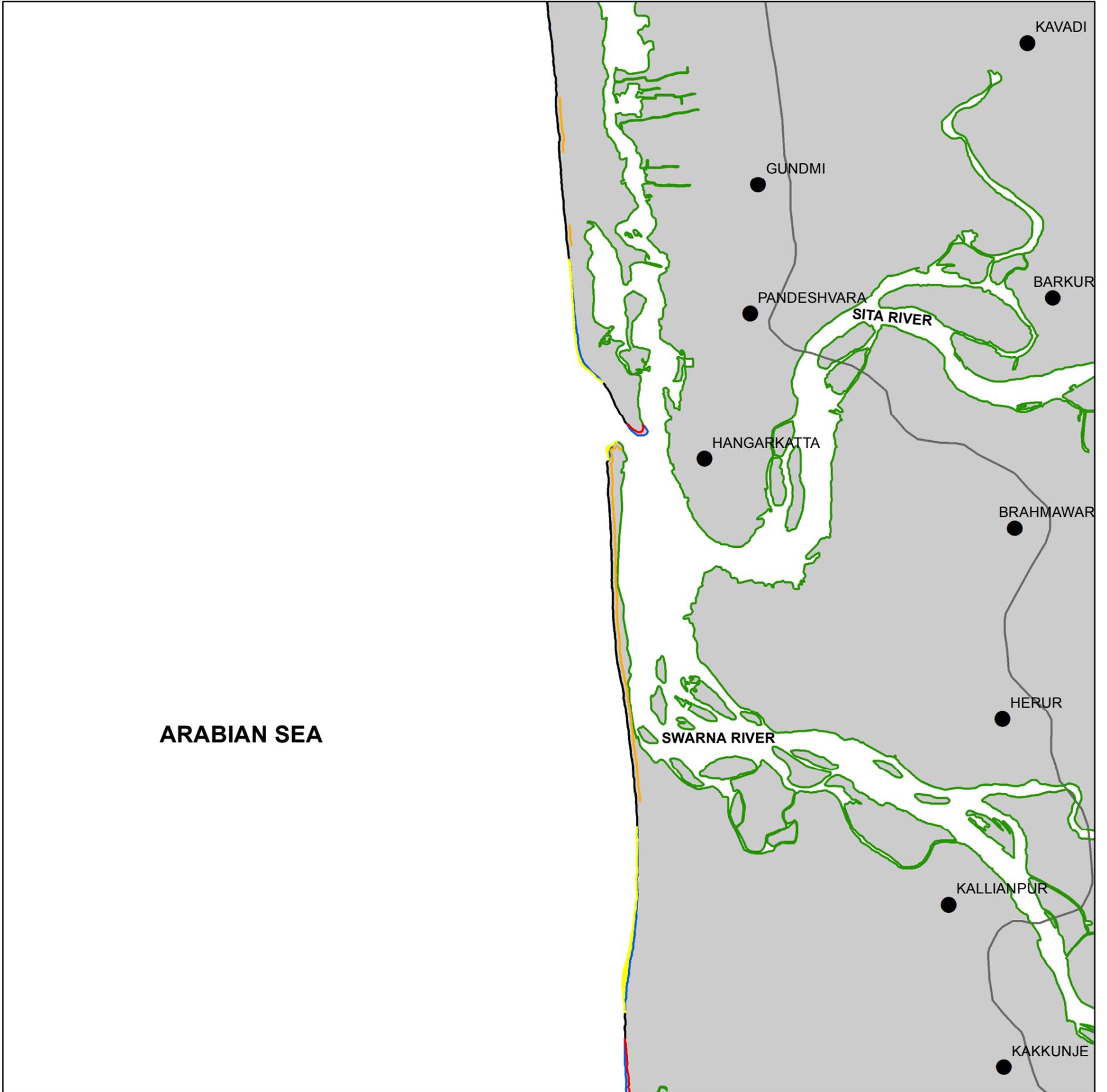
SHORELINE CHANGE MAP

FOR OFFICIAL USE ONLY

UDUPI DISTRICT

KARNATAKA

SHEET NO. 48K11NE

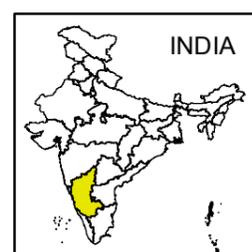


Legend

- EROSION
- ACCRETION
- HIGH-TIDE LINE 2014-16
- HIGH-TIDE LINE 2004-06
- STABLE
- ROAD
- SEA WALL
- JETTY
- HABITATION

INDEX TO SHEETS

SEA	48K10SE	48K14SW
SEA	48K11NE	48K15NW
SEA	48K11SE	48K15SW



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI



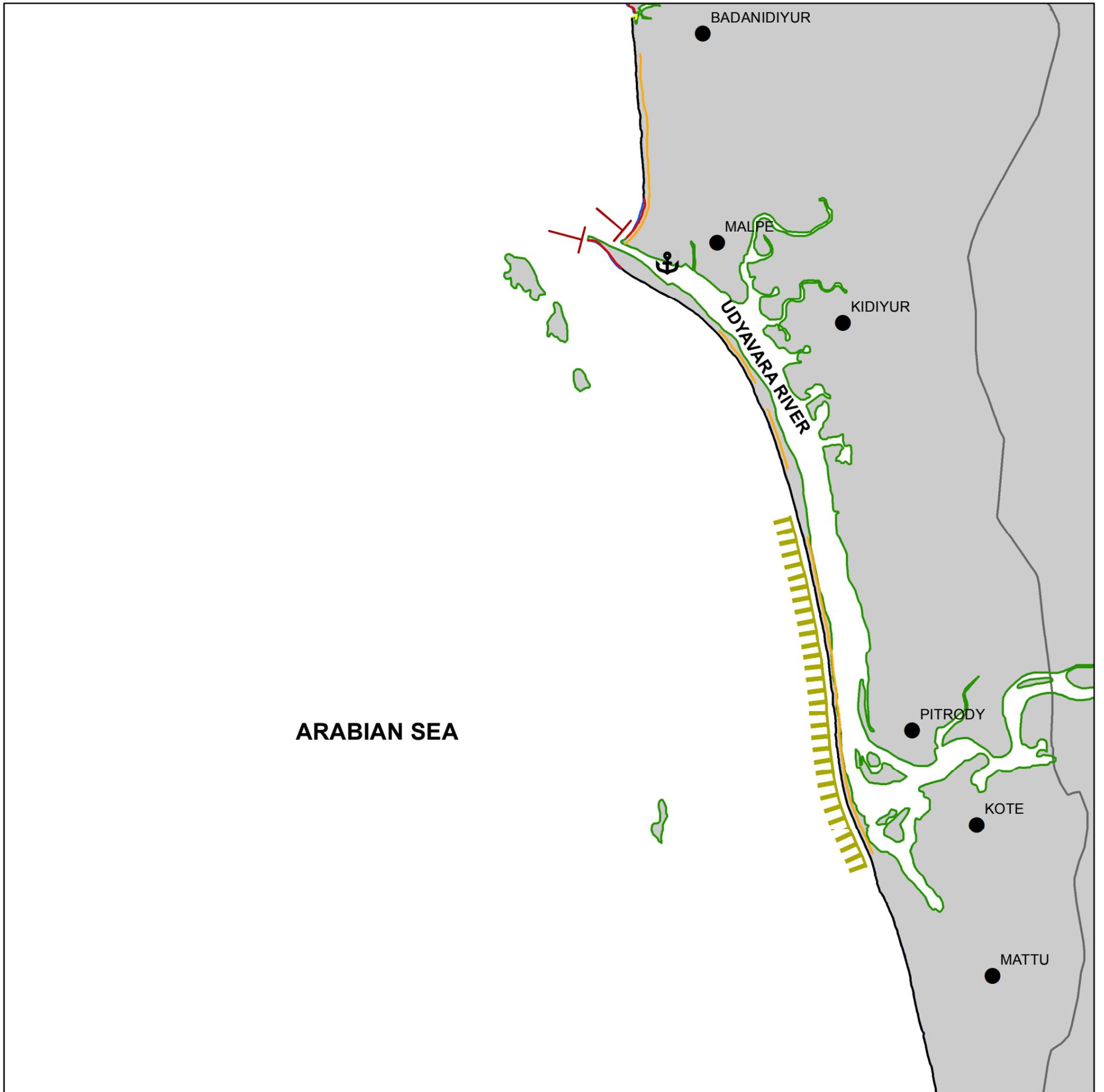
SHORELINE CHANGE MAP

FOR OFFICIAL USE ONLY

UDUPI DISTRICT

KARNATAKA

SHEET NO. 48K11SE



ARABIAN SEA

Legend

- EROSION
- ACCRETION
- HIGH-TIDE LINE 2014-16
- HIGH-TIDE LINE 2004-06
- STABLE
- ROAD
- SEA WALL
- GROYNES
- BREAKWATER
- ⚓ PORT/HARBOUR
- HABITATION

INDEX TO SHEETS

SEA	48K11NE	48K15NW
SEA	48K11SE	48K15SW
SEA	48K12NE	48K16NW



0 2 km



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI



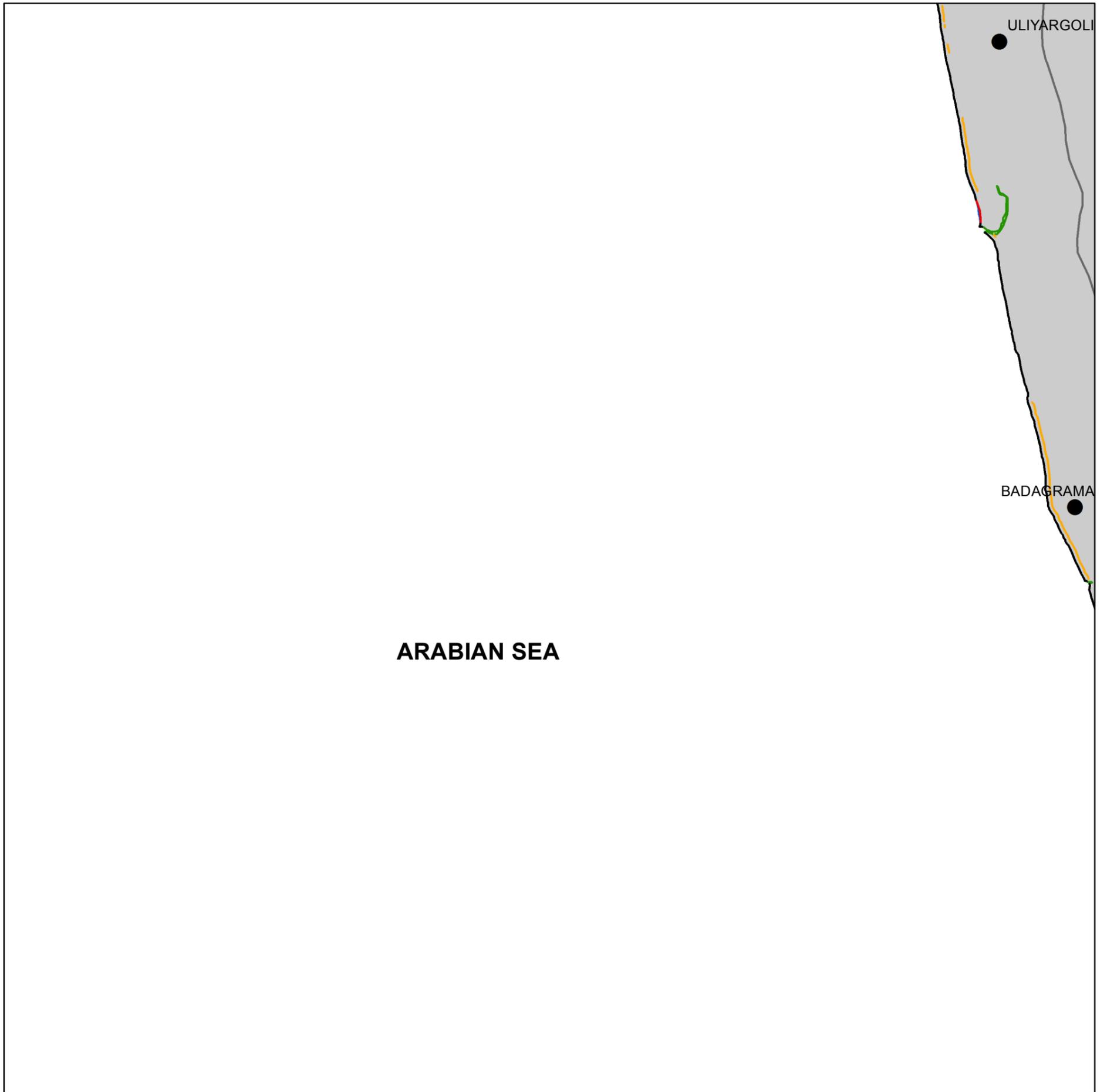
SHORELINE CHANGE MAP

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UDUPI DISTRICT

KARNATAKA

SHEET NO. 48K12NE



Legend

- EROSION
- HIGH-TIDE LINE 2014-16
- HIGH-TIDE LINE 2004-06
- STABLE
- ROAD
- SEA WALL
- HABITATION

INDEX TO SHEETS

SEA	48K11SE	48K15SW
SEA	48K12NE	48K16NW
SEA	48K12SE	48K16SW



0 2 km



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI



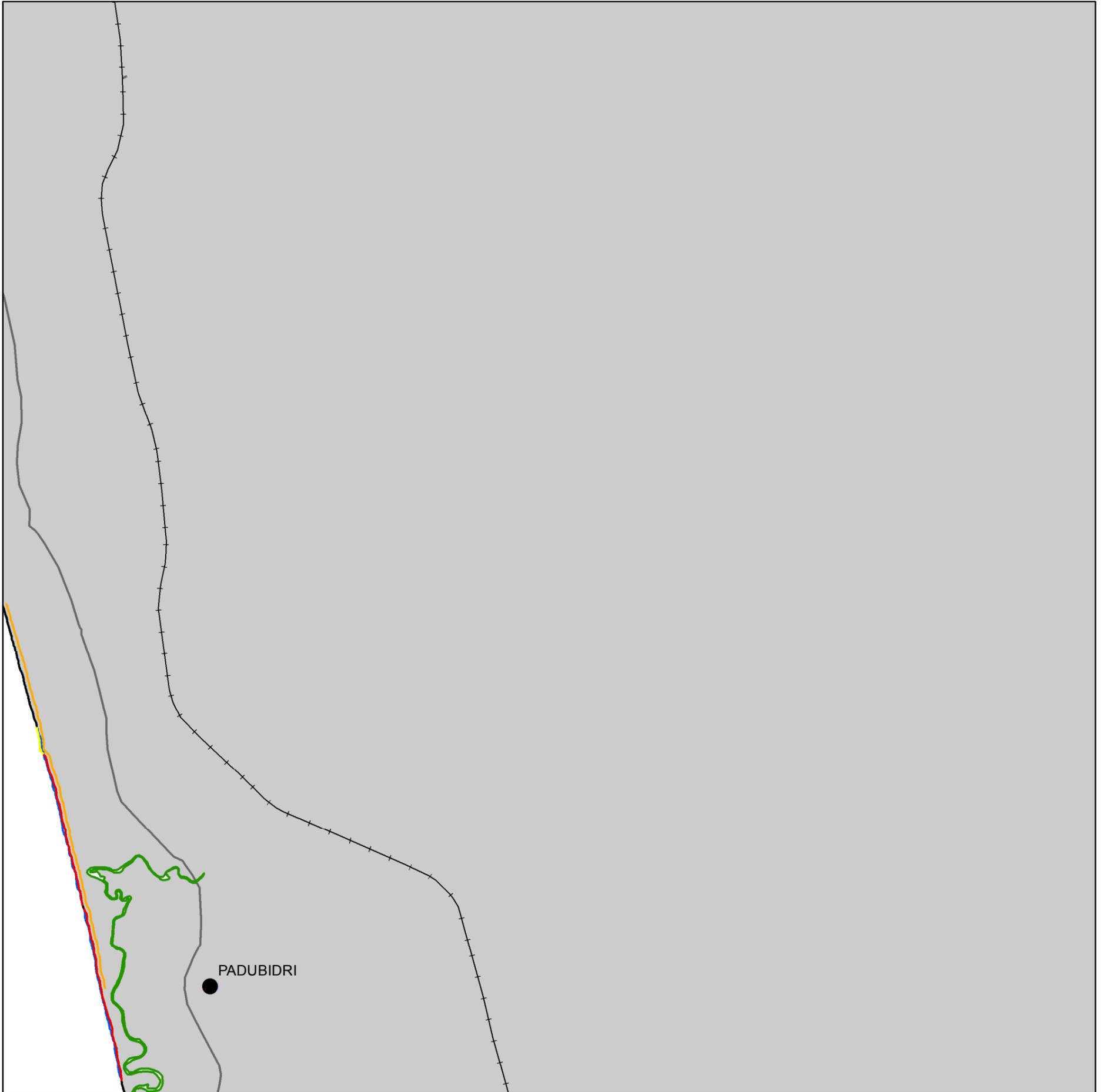
SHORELINE CHANGE MAP

FOR OFFICIAL USE ONLY

UDUPI DISTRICT

KARNATAKA

SHEET NO. 48K16NW



Legend

- EROSION
- ACCRETION
- HIGH-TIDE LINE 2014-16
- HIGH-TIDE LINE 2004-06
- STABLE
- ROAD
- RAILWAY
- SEA WALL
- HABITATION

INDEX TO SHEETS

48K11SE	48K15SW	48K15SE
48K12NE	48K16NW	48K16NE
SEA	48K16SW	48K16SE



0 2 km



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

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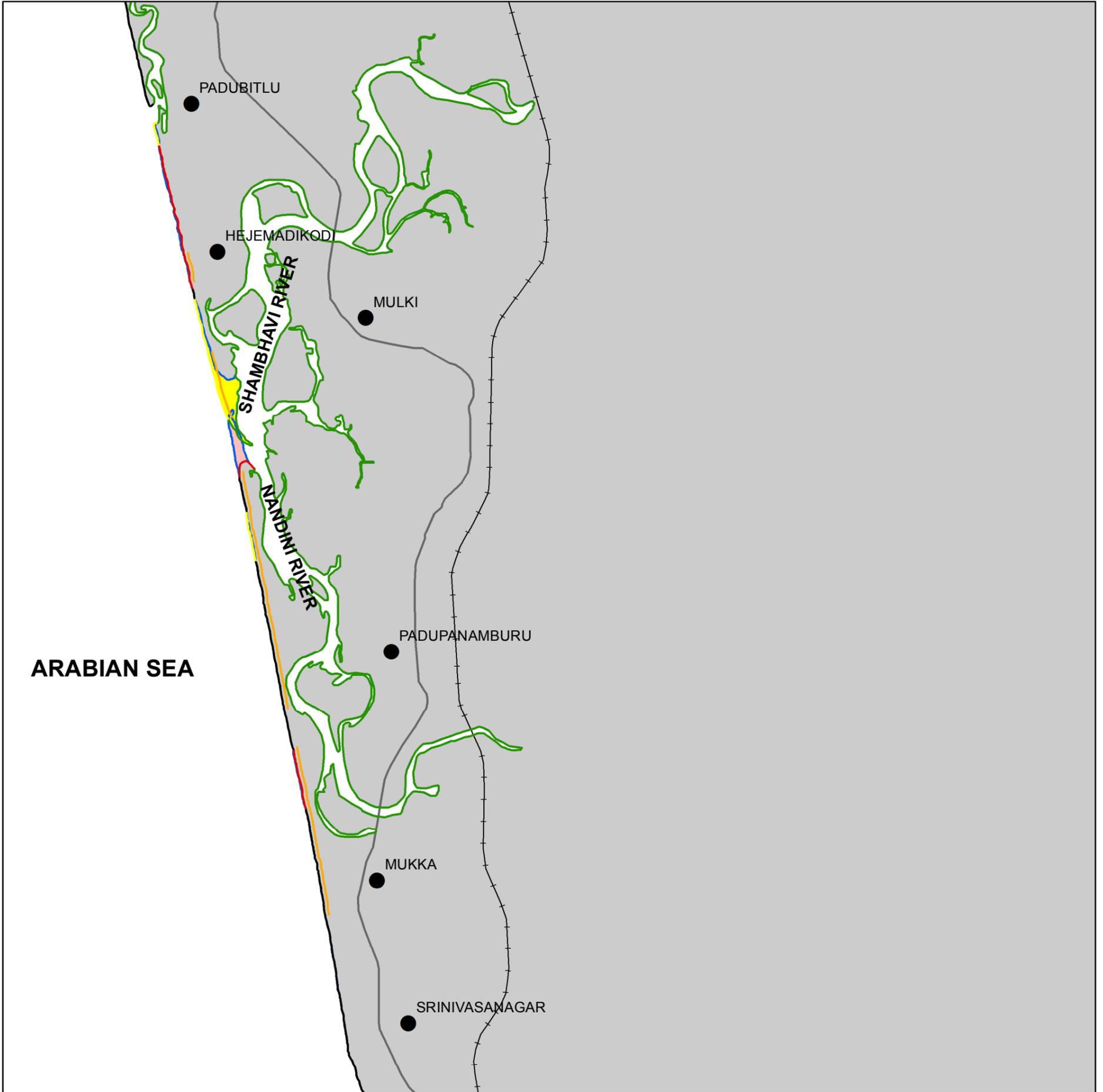


SHORELINE CHANGE MAP

UDUPI/DAKSHINA KANNADA
DISTRICT

KARNATAKA

FOR OFFICIAL USE ONLY
SHEET NO. 48K16SW



Legend

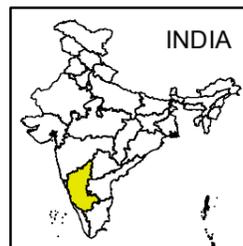
- EROSION
- ACCRETION
- HIGH-TIDE LINE 2014-16
- HIGH-TIDE LINE 2004-06
- STABLE
- ROAD
- RAILWAY
- SEA WALL
- HABITATION

INDEX TO SHEETS

48K12NE	48K16NW	48K16NE
SEA	48K16SW	48K16SE
SEA	48L13NW	48L13NE



0 2 km



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI



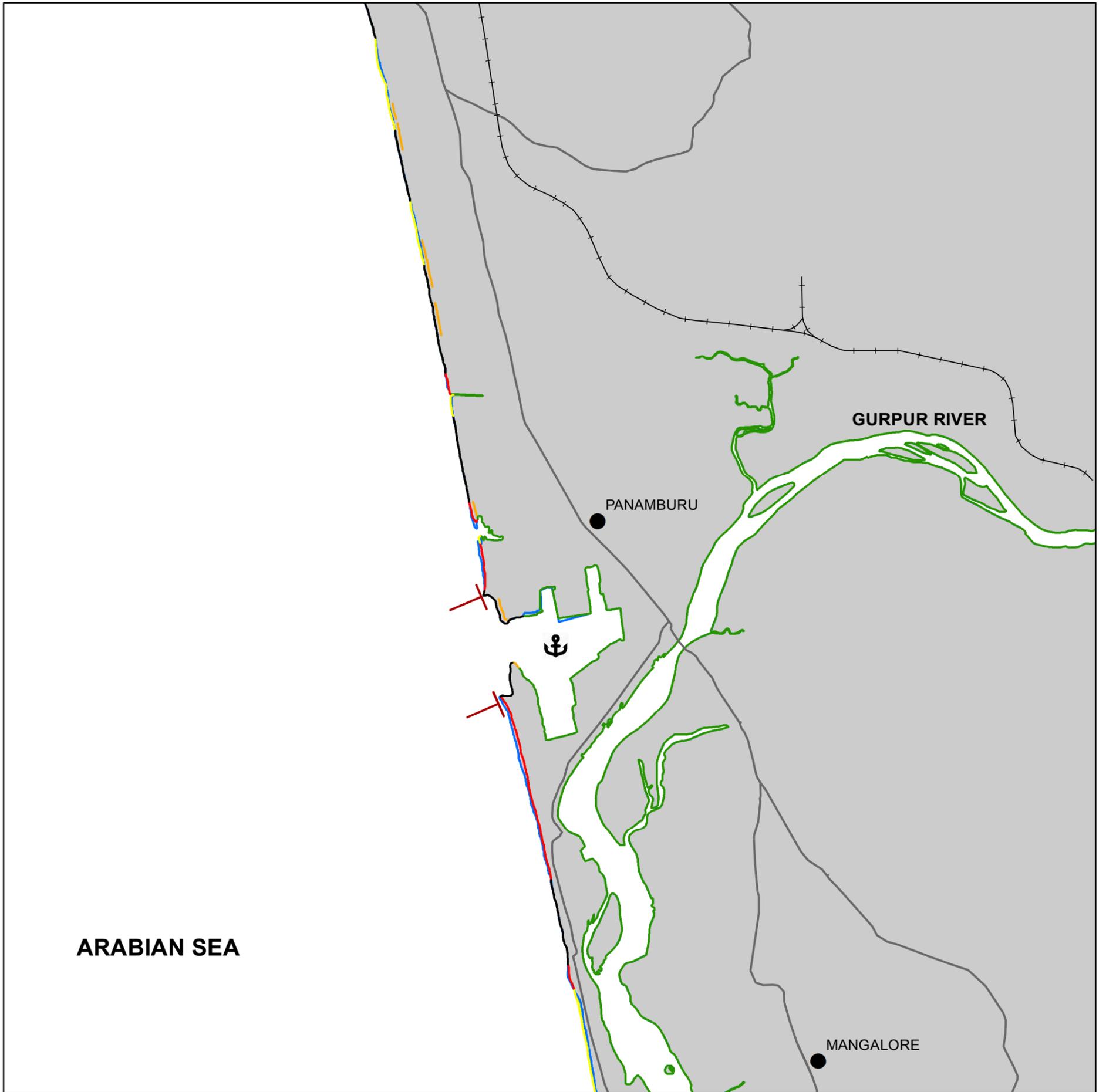
SHORELINE CHANGE MAP

FOR OFFICIAL USE ONLY

DAKSHINA KANNADA DISTRICT

KARNATAKA

SHEET NO. 48L13NW



Legend

- EROSION
- ACCRETION
- HIGH-TIDE LINE 2014-16
- HIGH-TIDE LINE 2004-06
- STABLE
- ROAD
- RAILWAY
- SEA WALL
- BREAKWATER
- ⚓ PORT/HARBOUR
- HABITATION

INDEX TO SHEETS

SEA	48K16SW	48K16SE	
SEA	48L13NW	48L13NE	
SEA		48L13SE	

0 2 km

INDIA

KARNATAKA

DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI

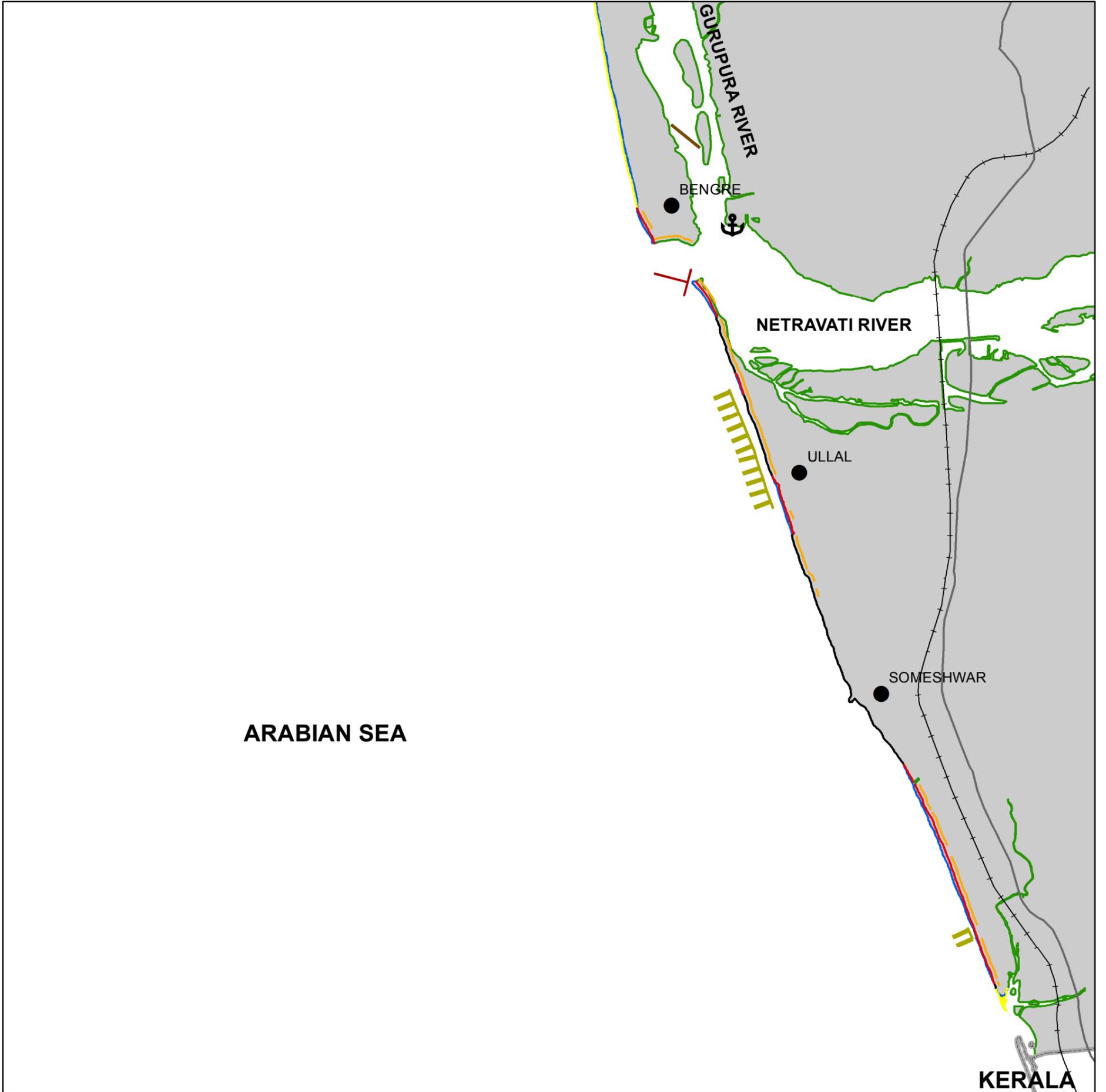
SHORELINE CHANGE MAP

FOR OFFICIAL USE ONLY

DAKSHINA KANNADA DISTRICT

KARNATAKA

SHEET NO. 48L13SW



ARABIAN SEA

KERALA

Legend

- EROSION
- ACCRETION
- HIGH-TIDE LINE 2014-16
- HIGH-TIDE LINE 2004-06
- STABLE
- ROAD
- RAILWAY
- SEA WALL
- GROYNES
- BREAKWATER
- JETTY
- STATE BOUNDARY
- ⚓ PORT/HARBOUR
- HABITATION

INDEX TO SHEETS

SEA	48L13NW	48L13NE
SEA	48L13SW	48L13SE
SEA	48L14NW	48L14NE



0 2 km



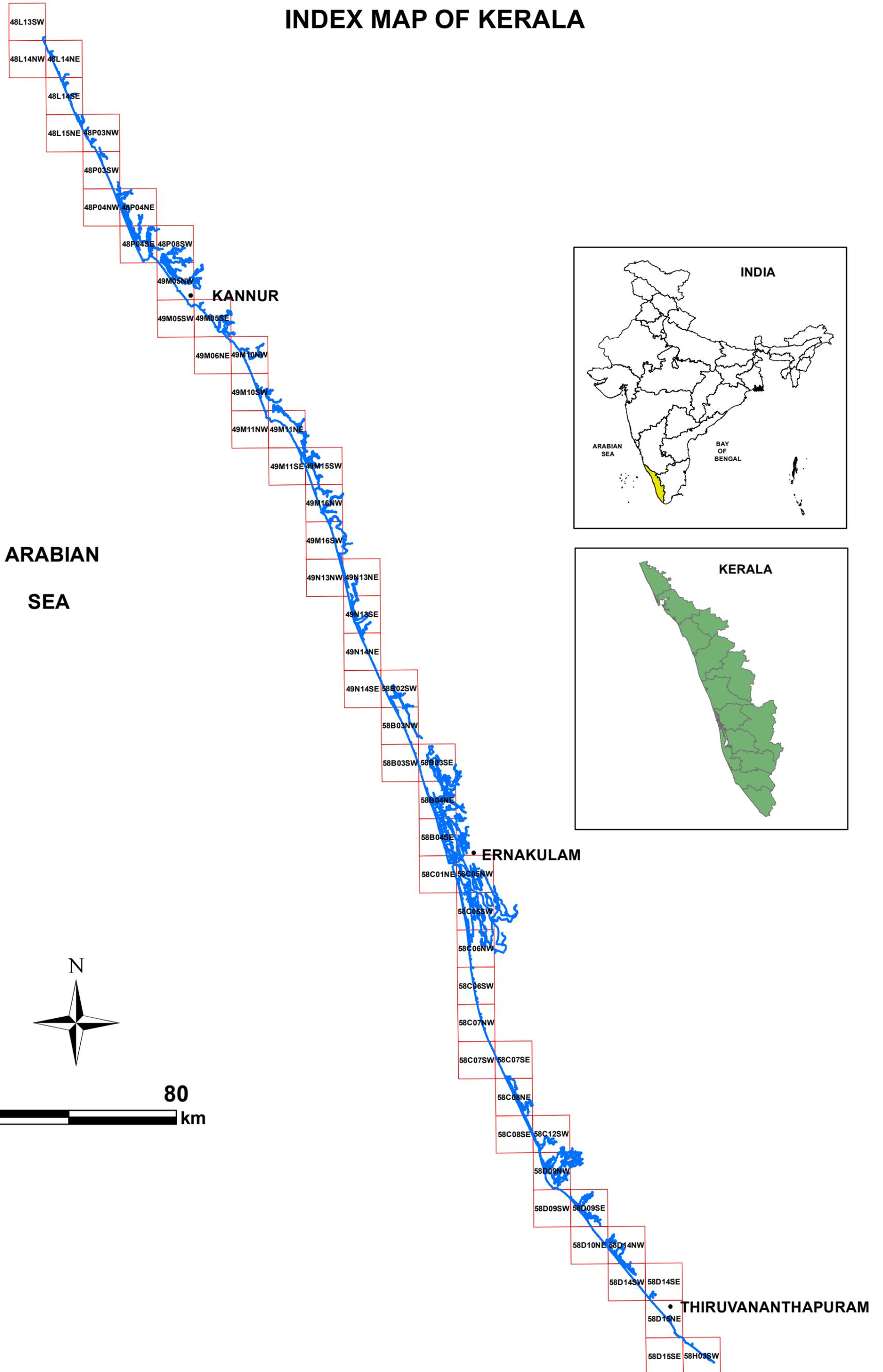
DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI

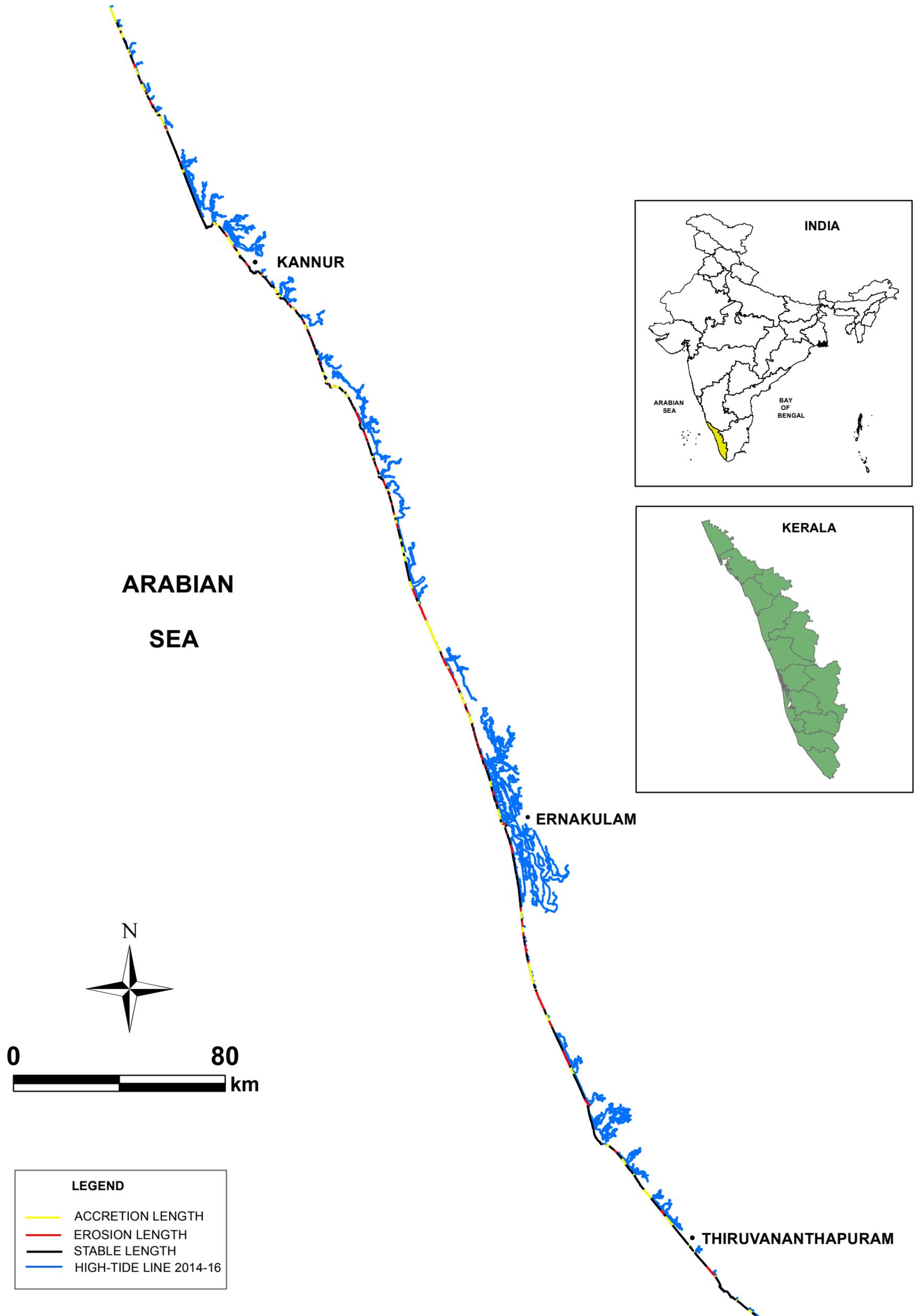


SHORELINE CHANGE MAPS
KERALA

INDEX MAP OF KERALA



SHORELINE CHANGES OF KERALA



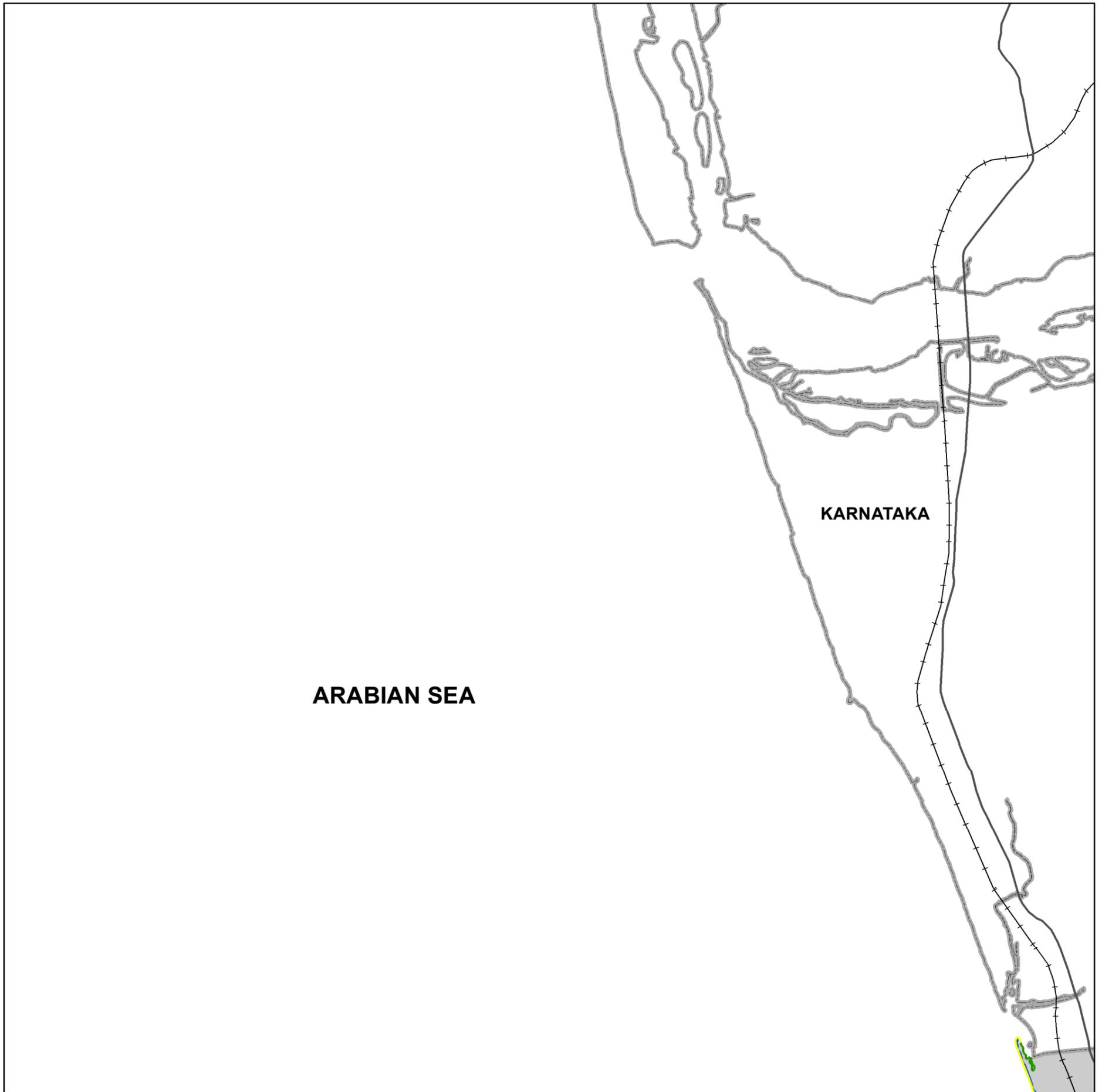
SHORELINE CHANGE MAP

FOR OFFICIAL USE ONLY

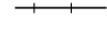
KASARAGOD DISTRICT

KERALA

SHEET NO. 48L13SW



Legend

-  ACCRETION
-  HIGH-TIDE LINE 2014-16
-  HIGH-TIDE LINE 2004-06
-  ROAD
-  RAILWAY
-  STATE BOUNDARY

INDEX TO SHEETS

SEA	48L13NW	48L13NE
SEA	48L13SW	48L13SE
SEA	48L14NW	48L14NE



0 2 km



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI



SHORELINE CHANGE MAP

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KASARAGOD DISTRICT

KERALA

SHEET NO. 48L14NW



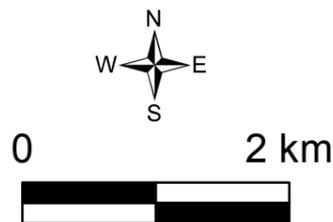
ARABIAN SEA

Legend

-  ACCRETION
-  HIGH-TIDE LINE 2014-16
-  HIGH-TIDE LINE 2004-06
-  ROAD
-  RAILWAY

INDEX TO SHEETS

SEA	48L13SW	48L13SE
SEA	48L14NW	48L14NE
SEA	SEA	48L14SE



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI



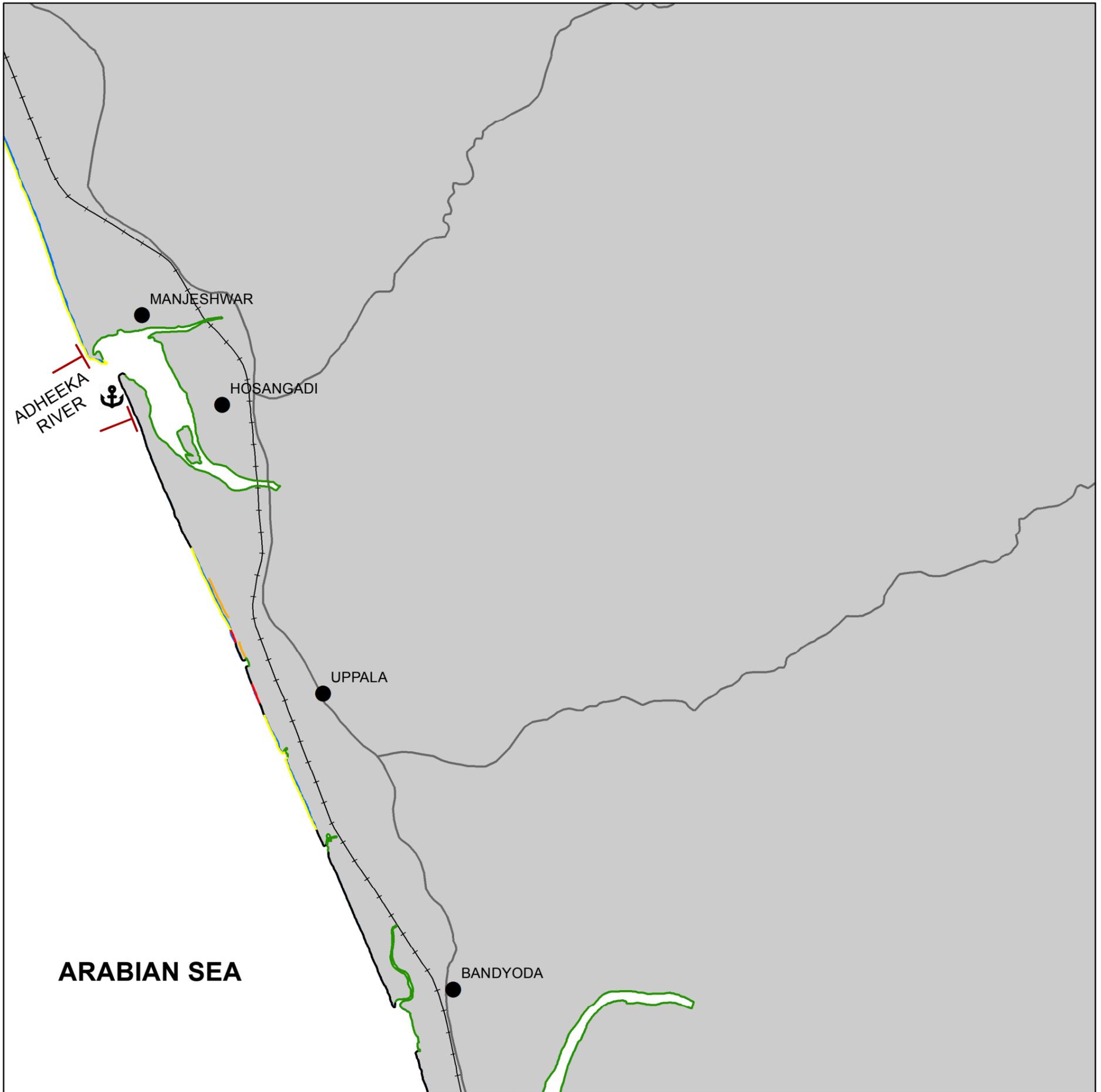
SHORELINE CHANGE MAP

FOR OFFICIAL USE ONLY

KASARAGOD DISTRICT

KERALA

SHEET NO. 48L14NE



Legend

- EROSION
- ACCRETION
- HIGH-TIDE LINE 2014-16
- HIGH-TIDE LINE 2004-06
- STABLE
- ROAD
- RAILWAY
- SEA WALL
- BREAKWATER
- ⚓ PORT/HARBOUR
- HABITATION

INDEX TO SHEETS

48L13SW	48L13SE	48P01SW
48L14NW	48L14NE	48P02NW
SEA	48L14SE	48P02SW



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI



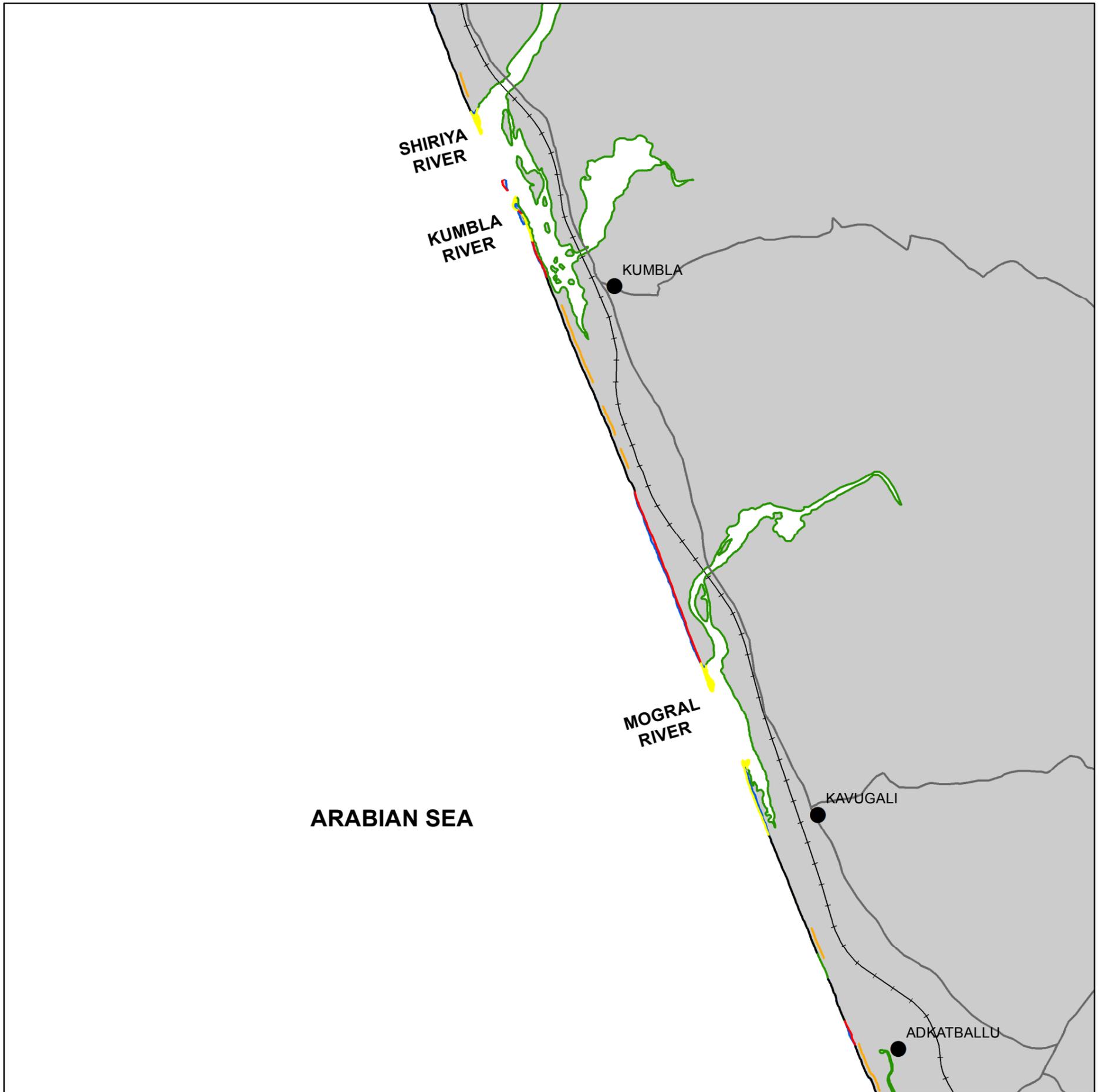
SHORELINE CHANGE MAP

FOR OFFICIAL USE ONLY

KASARAGOD DISTRICT

KERALA

SHEET NO. 48L14SE



Legend

- EROSION
- ACCRETION
- HIGH-TIDE LINE 2014-16
- HIGH-TIDE LINE 2004-06
- STABLE
- ROAD
- RAILWAY
- SEA WALL
- HABITATION

INDEX TO SHEETS

48L14NW	48L14NE	48P02NW
SEA	48L14SE	48P02SW
SEA	48L15NE	48P03NW



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI



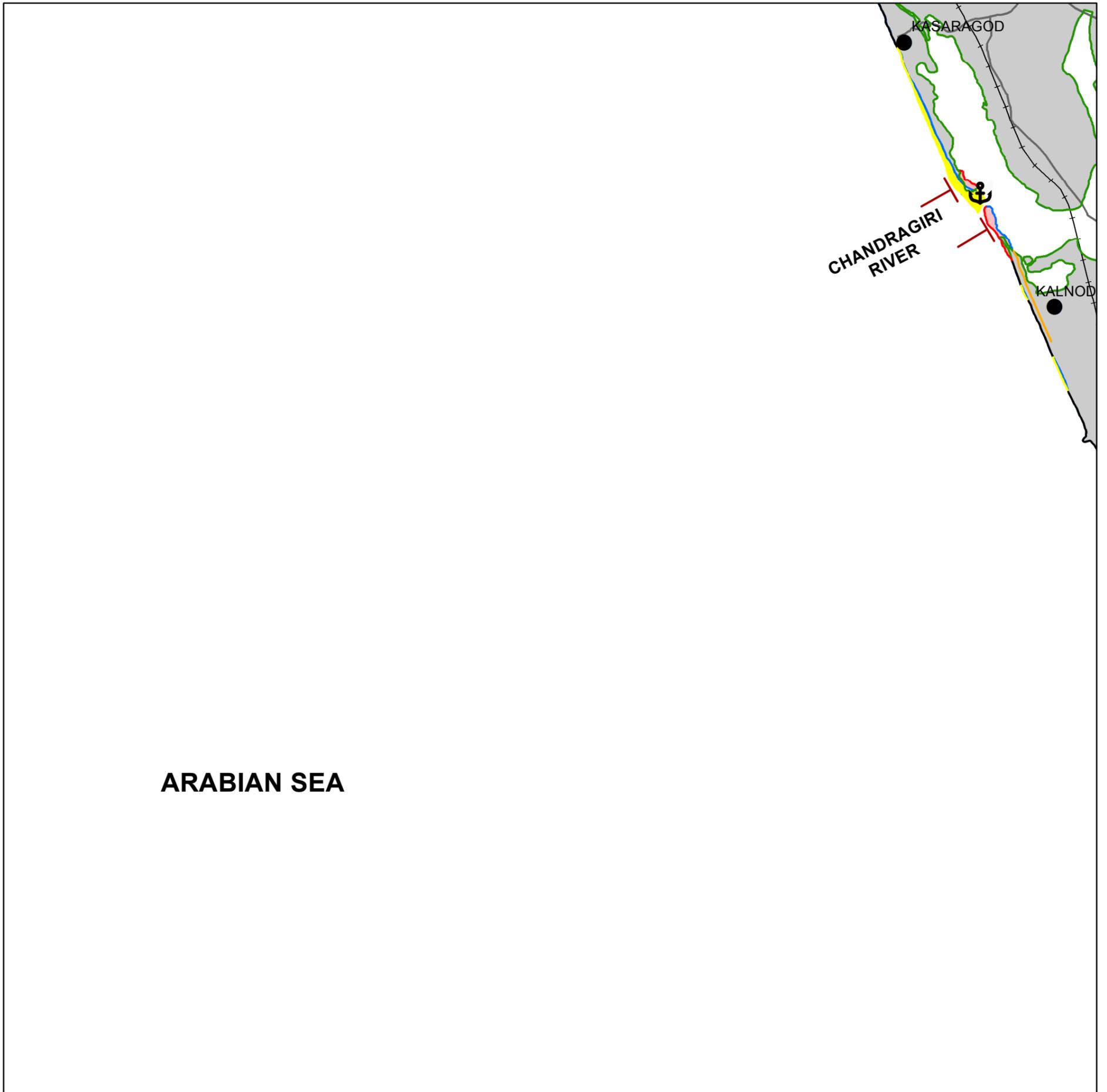
SHORELINE CHANGE MAP

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KASARAGOD DISTRICT

KERALA

SHEET NO. 48L15NE



ARABIAN SEA

Legend

- EROSION
- ACCRETION
- HIGH-TIDE LINE 2014-16
- HIGH-TIDE LINE 2004-06
- STABLE
- ROAD
- ++ RAILWAY
- SEA WALL
- ++ BREAKWATER
- PORT/HARBOUR
- HABITATION

INDEX TO SHEETS

SEA	48L14SE	48P02SW
SEA	48L15NE	48P03NW
SEA	SEA	48P03SW



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI



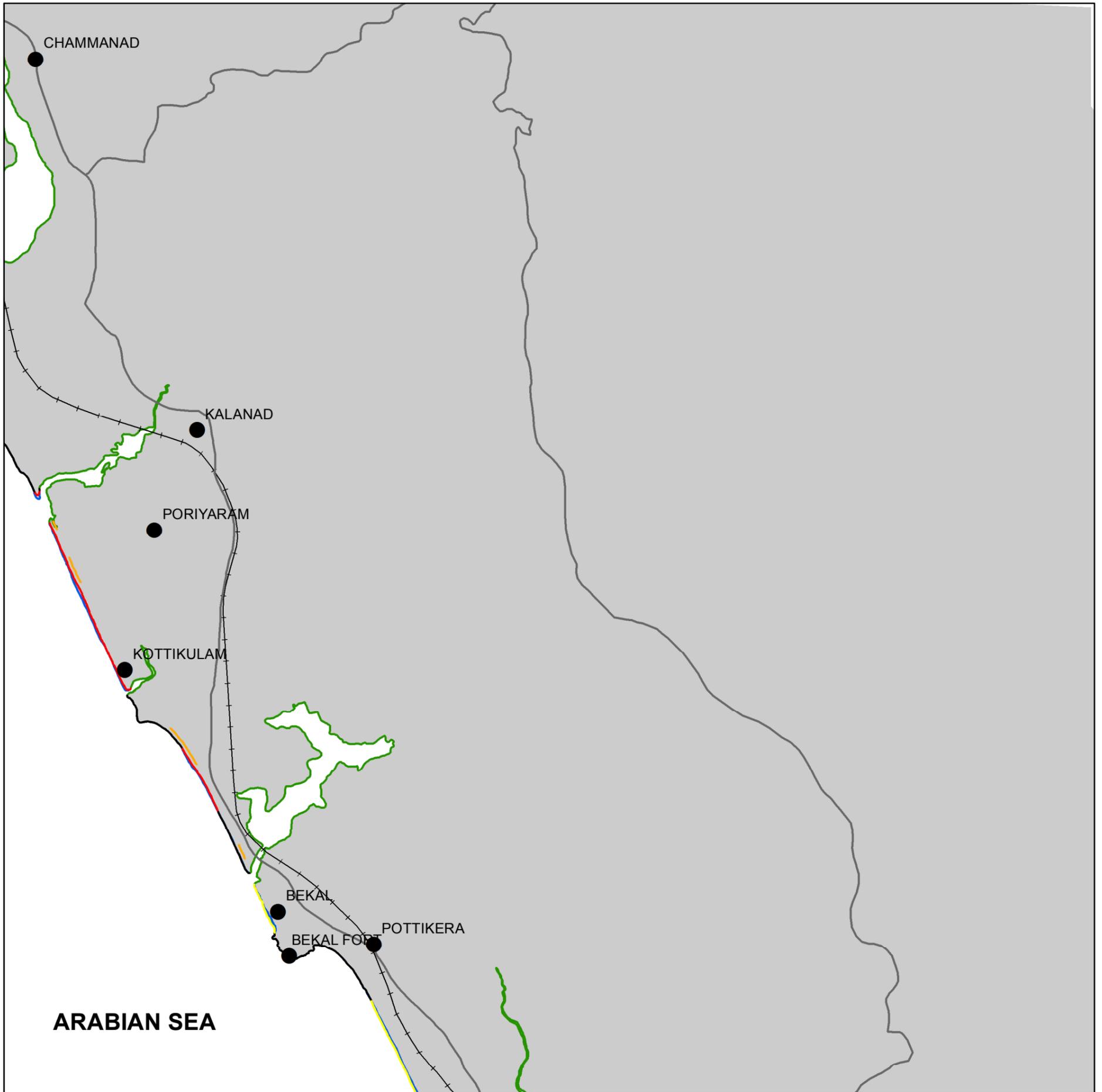
SHORELINE CHANGE MAP

FOR OFFICIAL USE ONLY

KASARAGOD DISTRICT

KERALA

SHEET NO. 48P03NW



Legend

- EROSION
- ACCRETION
- HIGH-TIDE LINE 2014-16
- HIGH-TIDE LINE 2004-06
- STABLE
- ROAD
- RAILWAY
- SEA WALL
- HABITATION

INDEX TO SHEETS

48L14SE	48P02SW	48P02SE
48L15NE	48P03NW	48P03NE
SEA	48P03SW	48P03SE



0 2 km



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI



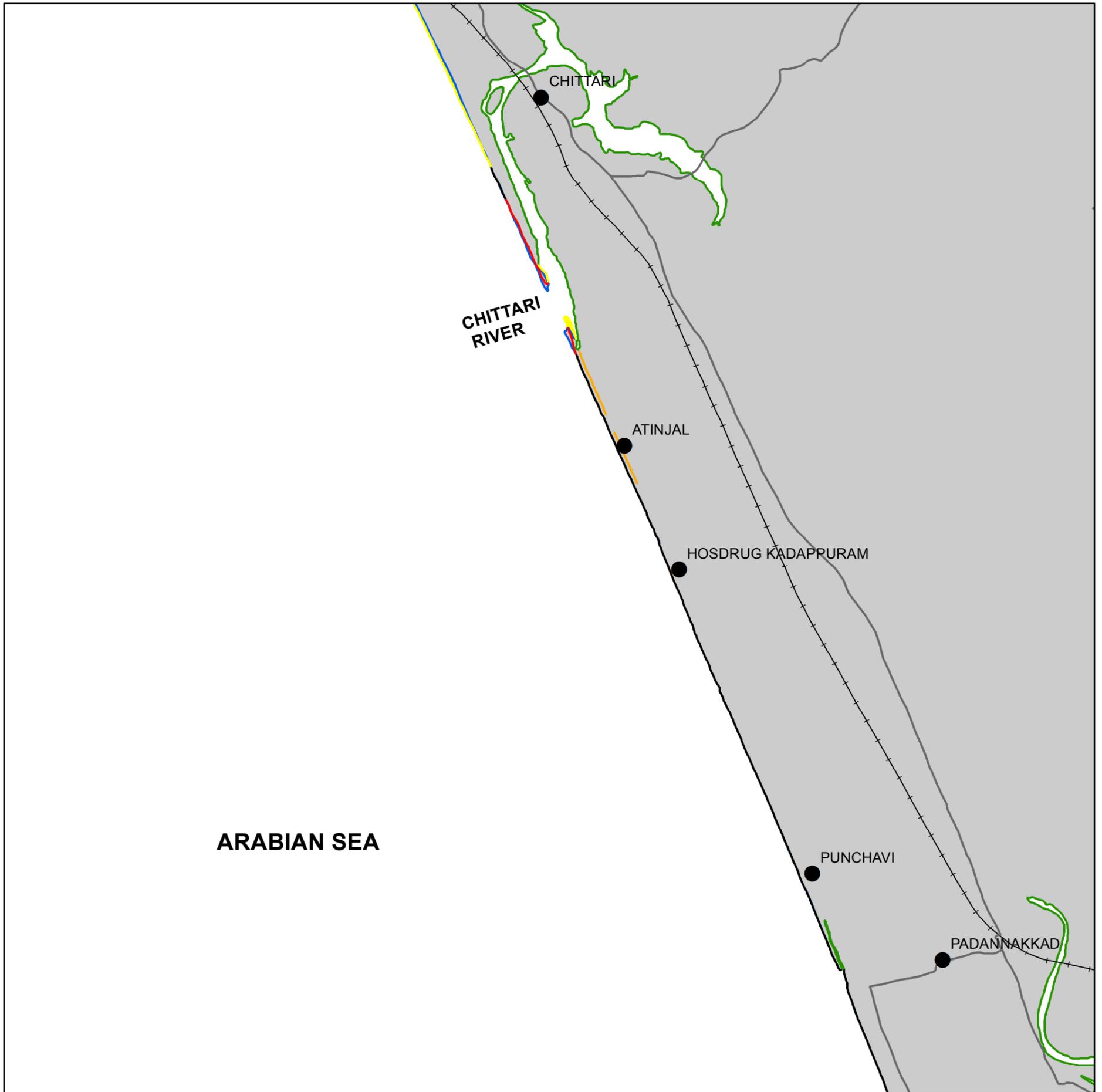
SHORELINE CHANGE MAP

FOR OFFICIAL USE ONLY

KASARAGOD DISTRICT

KERALA

SHEET NO. 48P03SW



ARABIAN SEA

Legend

- EROSION
- ACCRETION
- HIGH-TIDE LINE 2014-16
- HIGH-TIDE LINE 2004-06
- STABLE
- ROAD
- RAILWAY
- SEA WALL
- HABITATION

INDEX TO SHEETS

48L15NE	48P03NW	48P03NE
SEA	48P03SW	48P03SE
SEA	48P04NW	48P04NE



0 2 km



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI



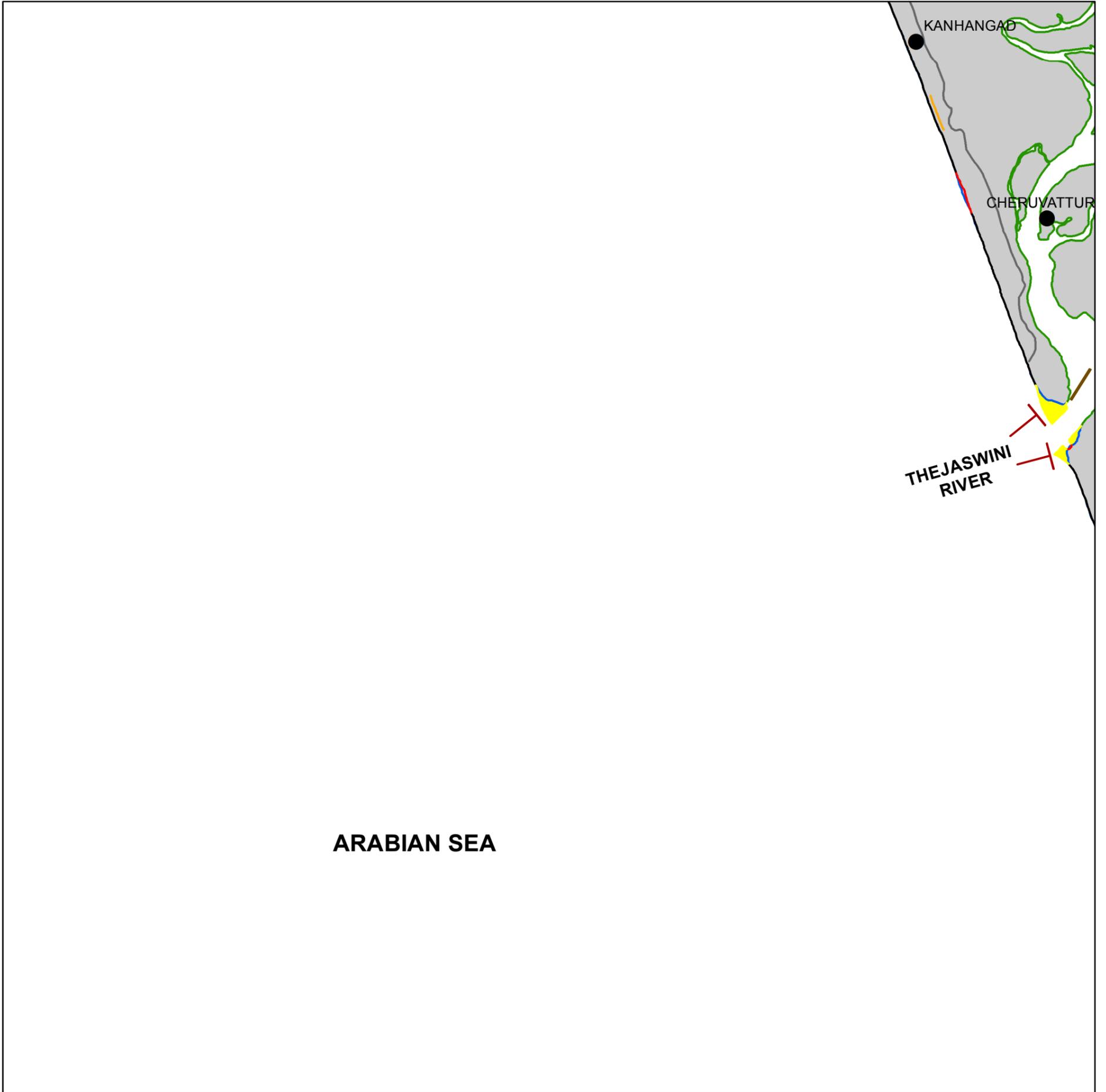
SHORELINE CHANGE MAP

FOR OFFICIAL USE ONLY

KASARAGOD DISTRICT

KERALA

SHEET NO. 48P04NW



ARABIAN SEA

Legend

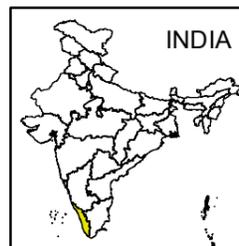
- EROSION
- ACCRETION
- HIGH-TIDE LINE 2014-16
- HIGH-TIDE LINE 2004-06
- STABLE
- ROAD
- SEA WALL
- BREAKWATER
- JETTY
- HABITATION

INDEX TO SHEETS

SEA	48P03SW	48P03SE
SEA	48P04NW	48P04NE
SEA	SEA	48P04SE



0 2 km



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI



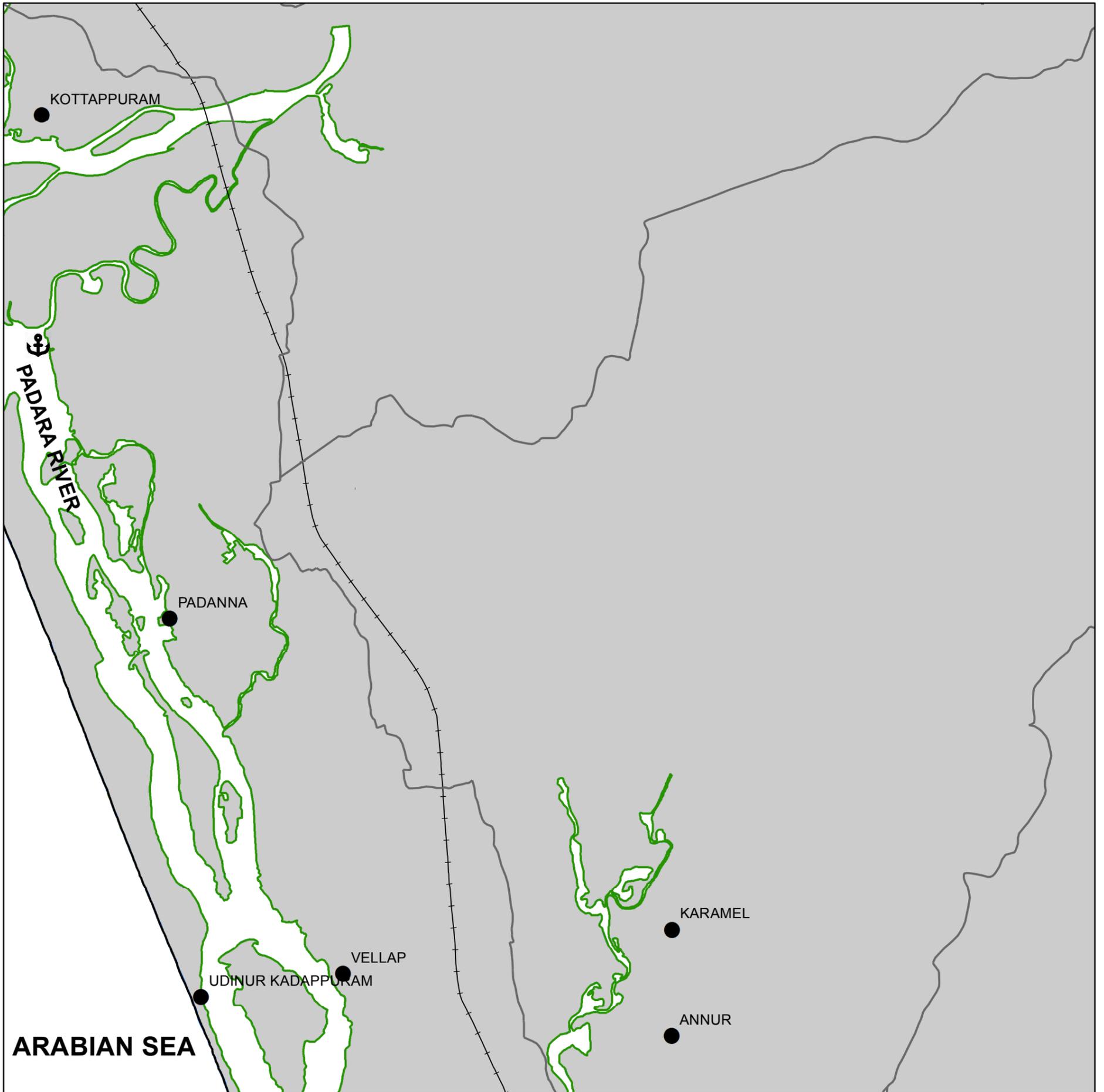
SHORELINE CHANGE MAP

FOR OFFICIAL USE ONLY

KASARAGOD/KANNUR DISTRICT

KERALA

SHEET NO. 48P04NE



Legend

- HIGH-TIDE LINE 2014-16
- HIGH-TIDE LINE 2004-06
- STABLE
- ROAD
- +— RAILWAY
- PORT/HARBOUR
- HABITATION

INDEX TO SHEETS

48P03SW	48P03SE	48P07SW
48P04NW	48P04NE	48P08NW
SEA	48P04SE	48P08SW



0 2 km



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI

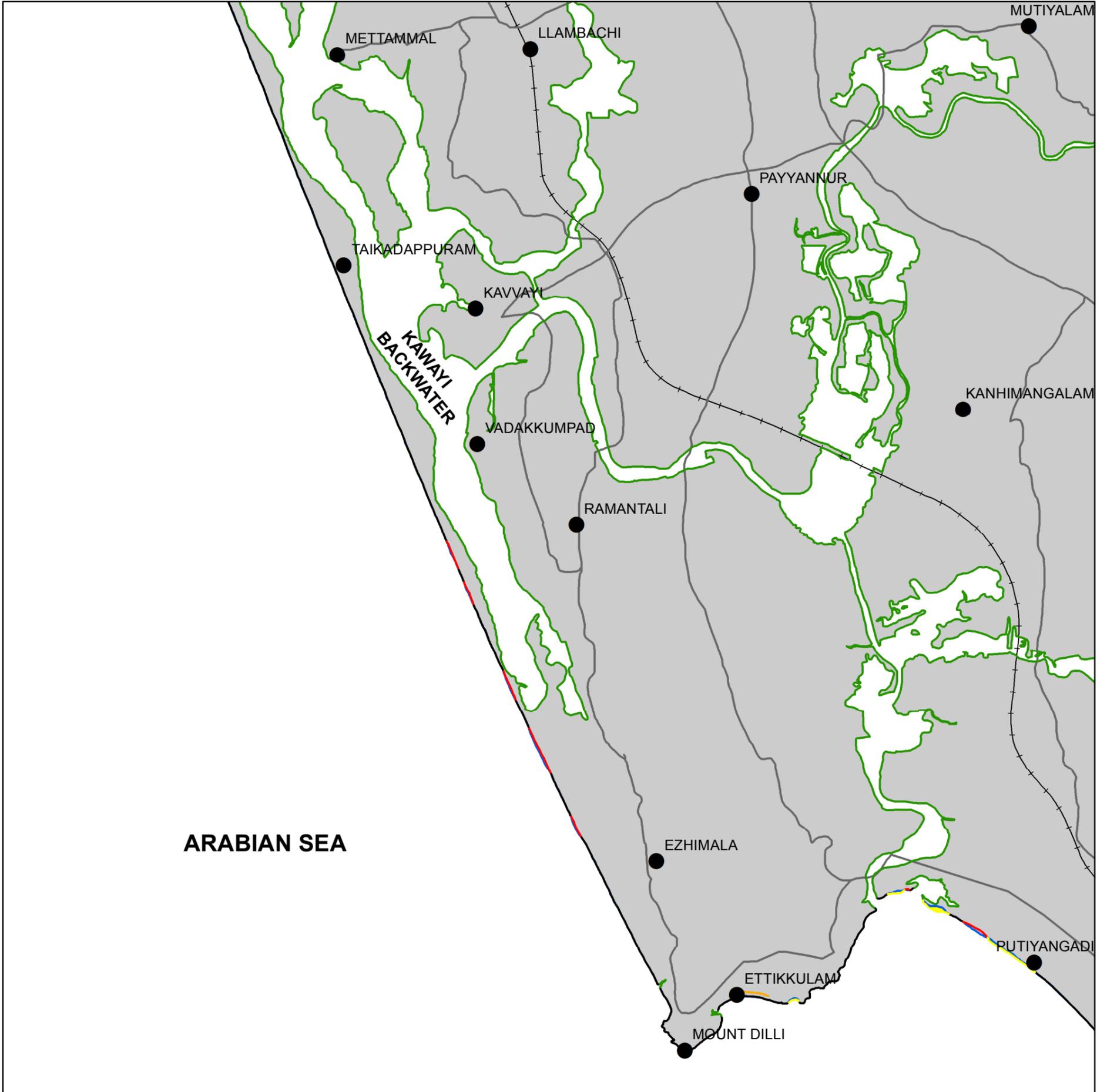


SHORELINE CHANGE MAP

FOR OFFICIAL USE ONLY

KASARAGOD/KANNUR DISTRICT **KERALA**

SHEET NO. 48P04SE



ARABIAN SEA

Legend

- EROSION
- ACCRETION
- HIGH-TIDE LINE 2014-16
- HIGH-TIDE LINE 2004-06
- STABLE
- ROAD
- RAILWAY
- SEA WALL
- HABITATION

INDEX TO SHEETS

48P04NW	48P04NE	48P08NW
SEA	48P04SE	48P08SW
SEA	SEA	49M05NW



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI



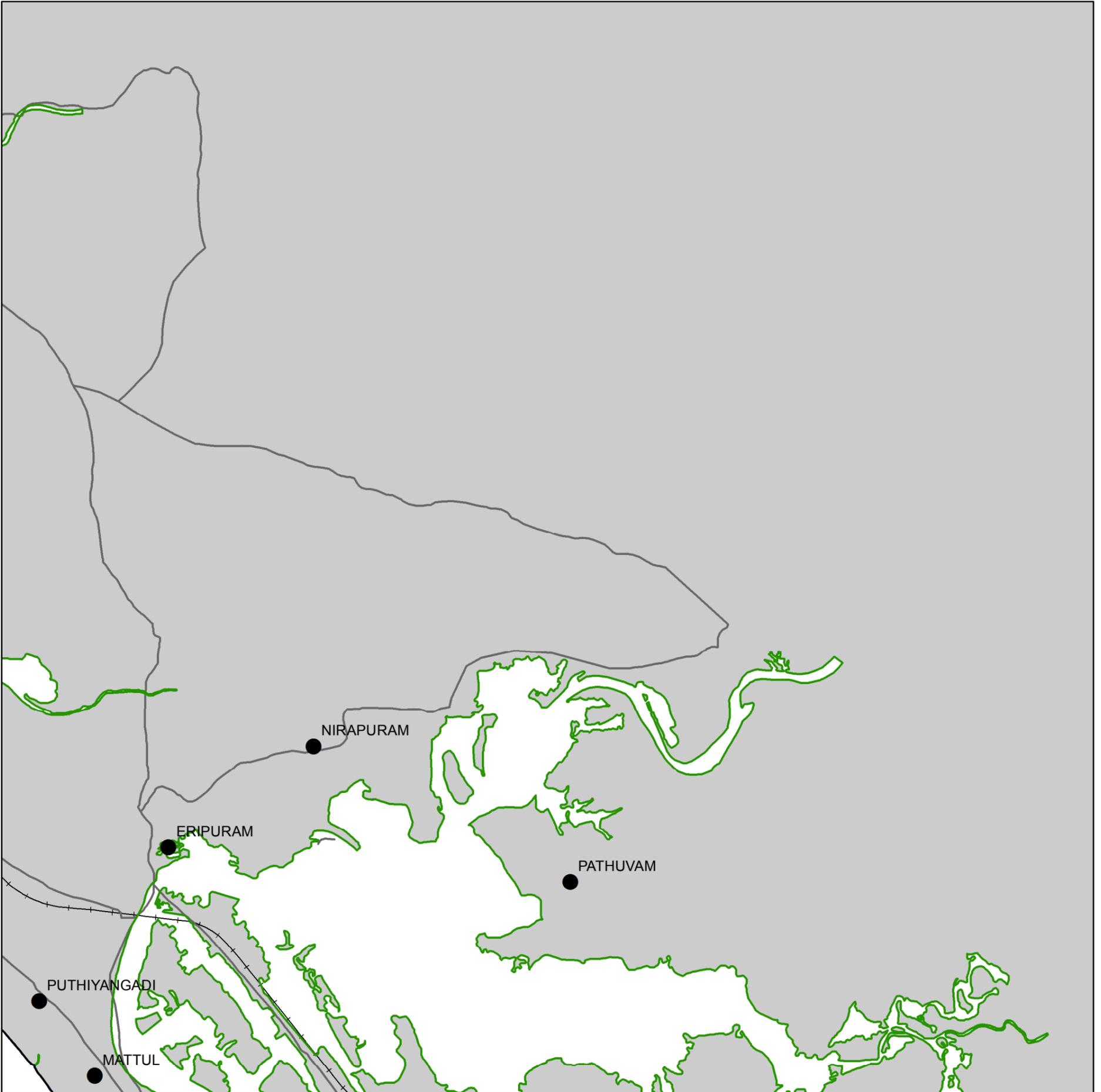
SHORELINE CHANGE MAP

FOR OFFICIAL USE ONLY

KANNUR DISTRICT

KERALA

SHEET NO. 48P08SW

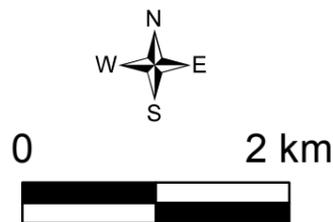


Legend

- HIGH-TIDE LINE 2014-16
- HIGH-TIDE LINE 2004-06
- STABLE
- ROAD
- +—+ RAILWAY
- HABITATION

INDEX TO SHEETS

48P04NE	48P08NW	48P08NE
48P04SE	48P08SW	48P08SE
SEA	49M05NW	49M05NE



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI



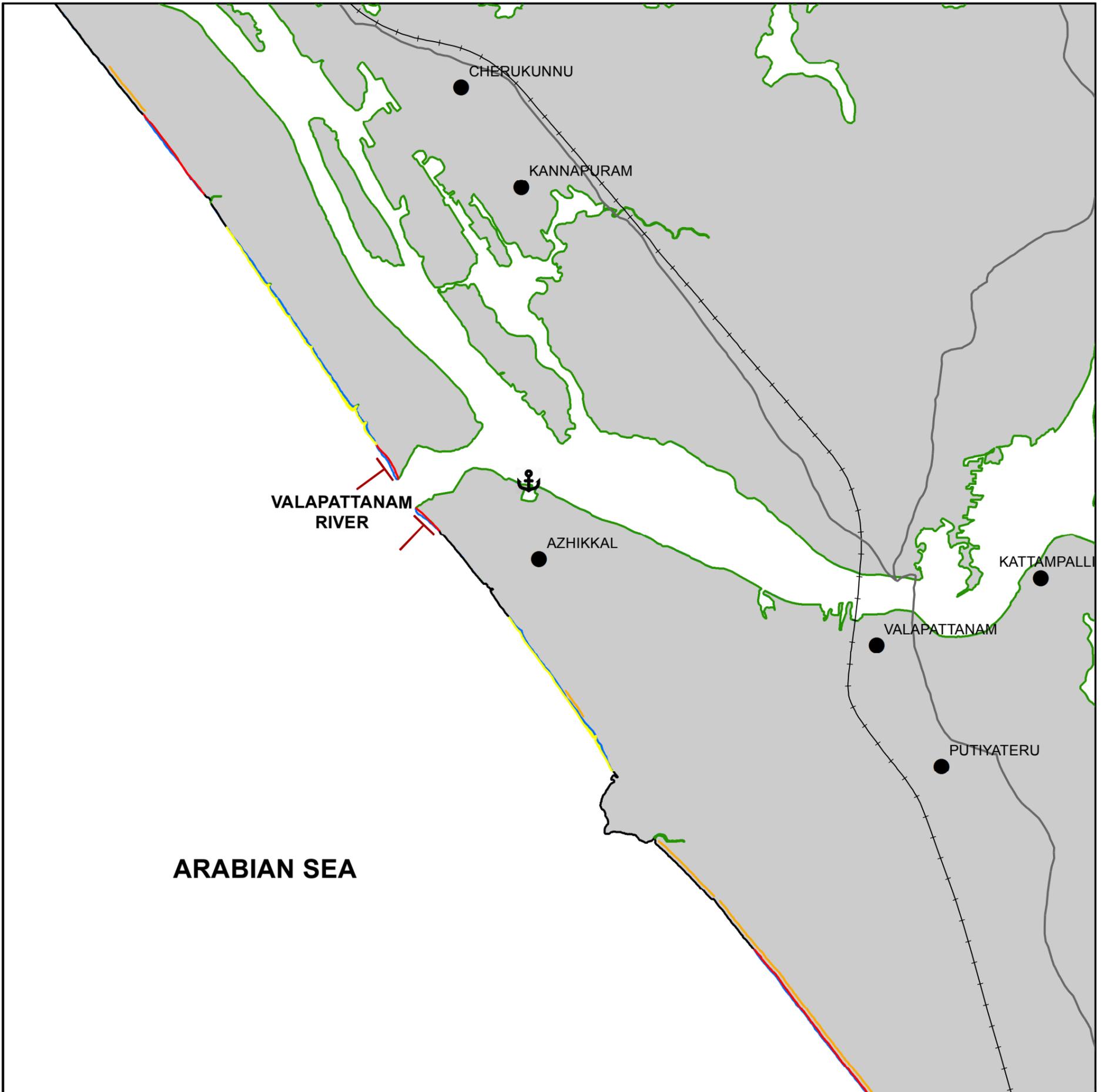
SHORELINE CHANGE MAP

FOR OFFICIAL USE ONLY

KANNUR DISTRICT

KERALA

SHEET NO. 49M05NW



Legend

- EROSION
- ACCRETION
- HIGH-TIDE LINE 2014-16
- HIGH-TIDE LINE 2004-06
- STABLE
- ROAD
- RAILWAY
- SEA WALL
- BREAKWATER
- ⚓ PORT/HARBOUR
- HABITATION

INDEX TO SHEETS

48P04SE	48P08SW	48P08SE
SEA	49M05NW	49M05NE
SEA	49M05SW	49M05SE



0 2 km



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI



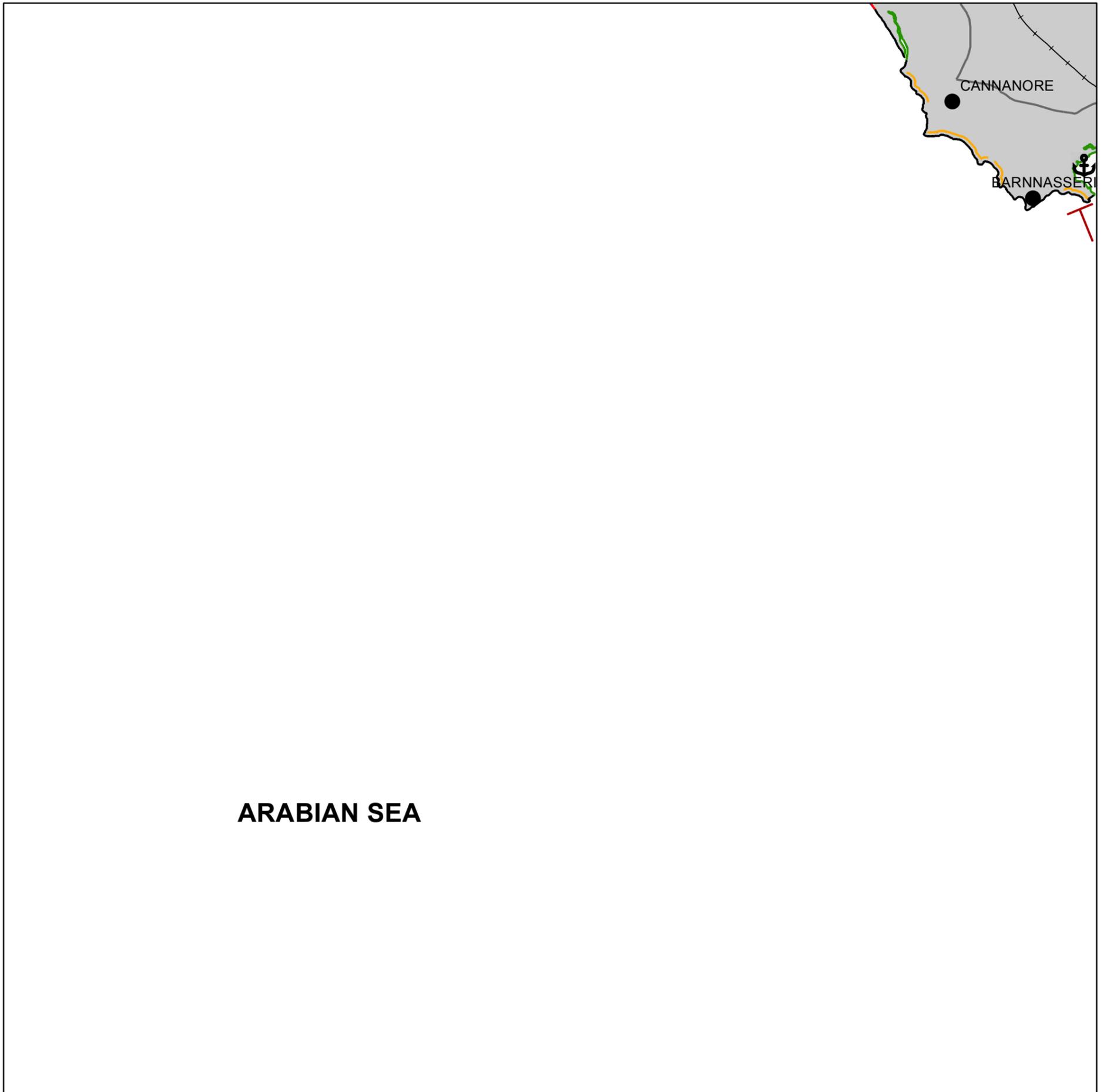
SHORELINE CHANGE MAP

FOR OFFICIAL USE ONLY

KANNUR DISTRICT

KERALA

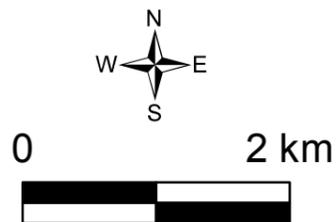
SHEET NO. 49M05SW



ARABIAN SEA

Legend

-  EROSION
-  HIGH-TIDE LINE 2014-16
-  HIGH-TIDE LINE 2004-06
-  STABLE
-  ROAD
-  RAILWAY
-  SEA WALL
-  BREAKWATER
-  PORT/HARBOUR
-  HABITATION



INDEX TO SHEETS

SEA	49M05NW	49M05NE
SEA	49M05SW	49M05SE
SEA	SEA	49M06NE



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI

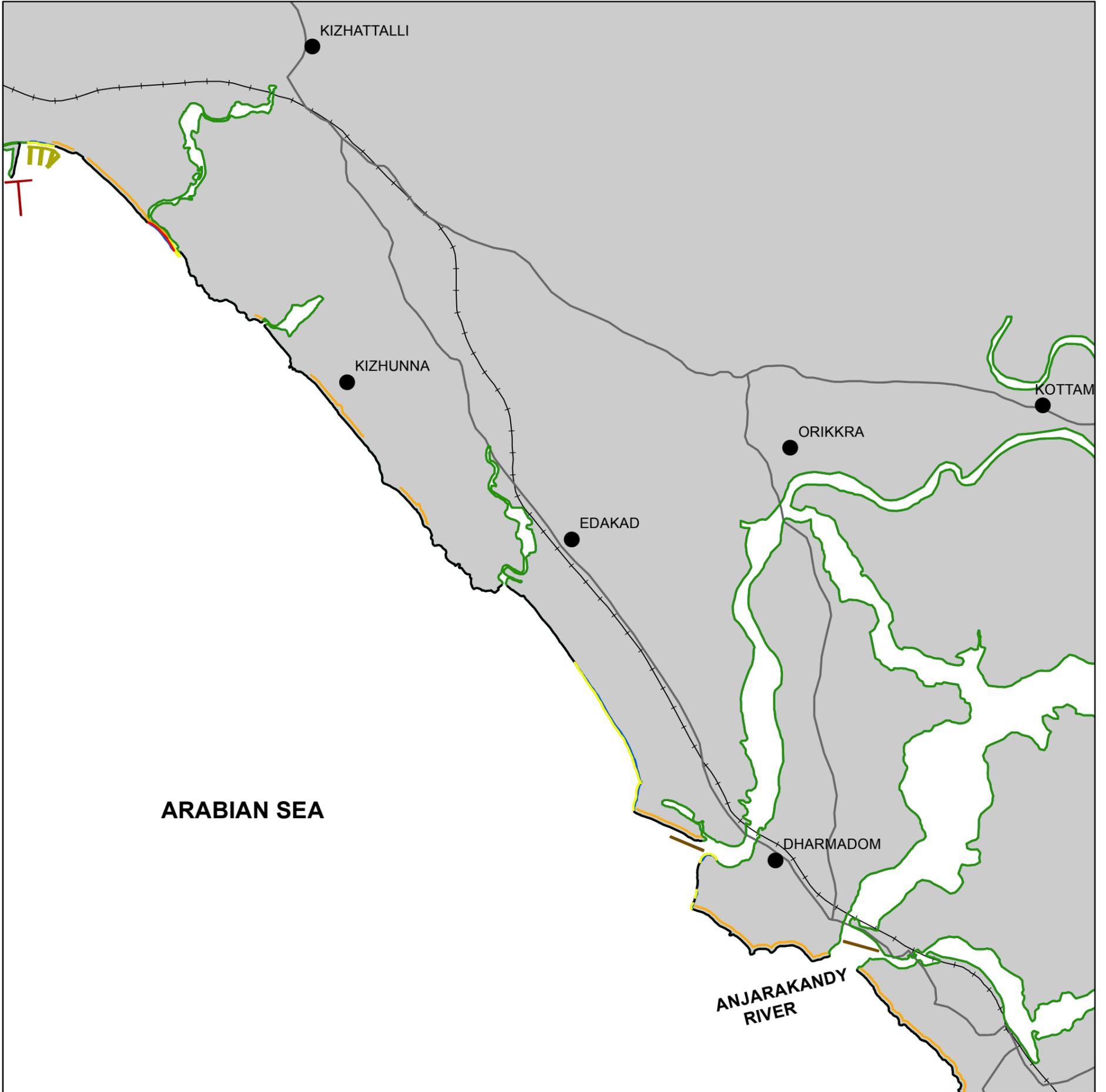


SHORELINE CHANGE MAP

FOR OFFICIAL USE ONLY
SHEET NO. 49M05SE

KANNUR DISTRICT

KERALA



Legend

- EROSION
- ACCRETION
- HIGH-TIDE LINE 2014-16
- HIGH-TIDE LINE 2004-06
- STABLE
- ROAD
- RAILWAY
- SEA WALL
- GROYNES
- BREAKWATER
- JETTY
- HABITATION

INDEX TO SHEETS

49M05NW	49M05NE	49M05NW
49M05SW	49M05SE	49M05SW
SEA	49M06NE	49M10NW



0 2 km



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI

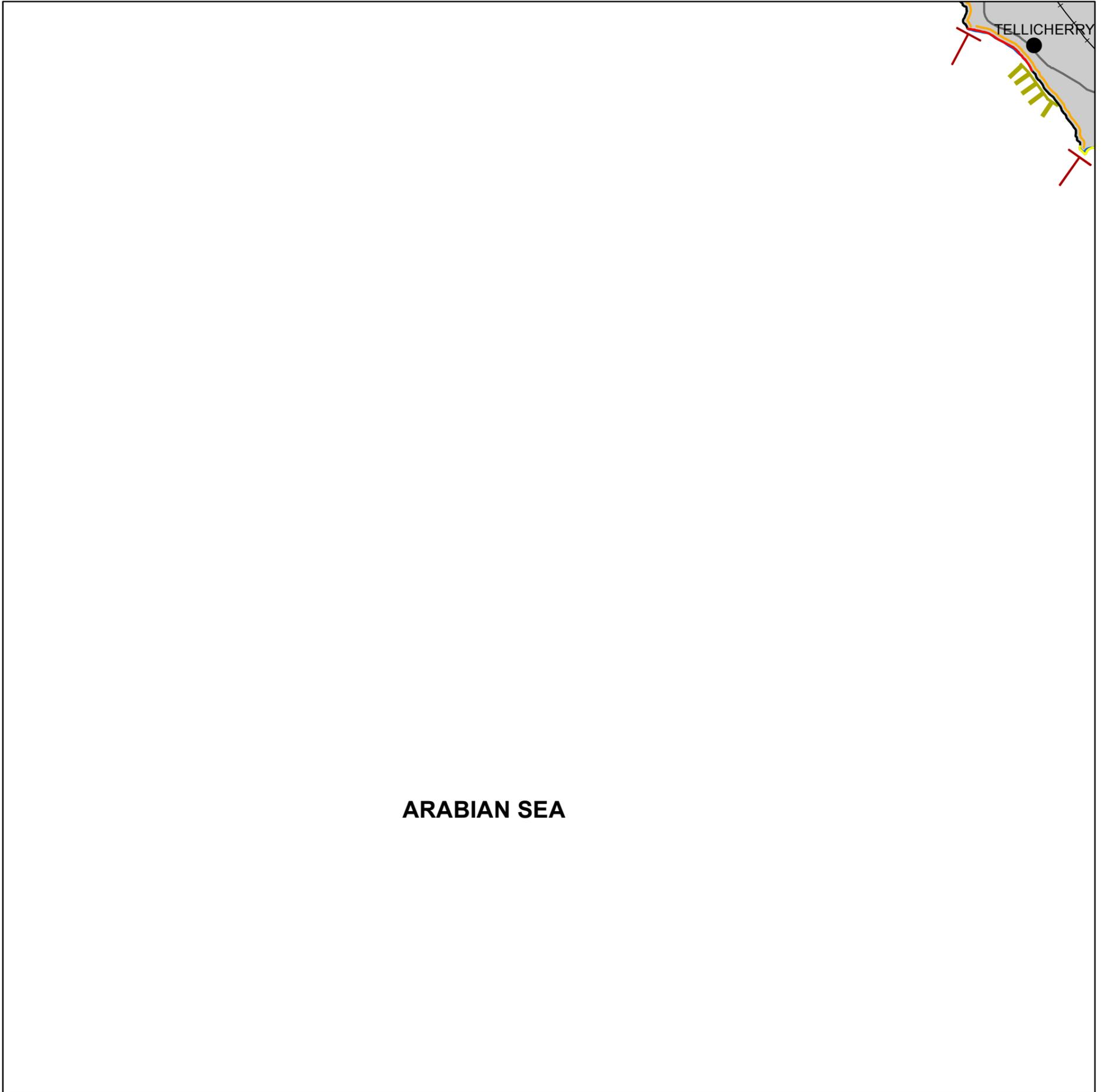


SHORELINE CHANGE MAP

FOR OFFICIAL USE ONLY
SHEET NO. 49M06NE

KANNUR DISTRICT

KERALA



ARABIAN SEA

Legend

- EROSION
- ACCRETION
- HIGH-TIDE LINE 2014-16
- HIGH-TIDE LINE 2004-06
- STABLE
- ROAD
- RAILWAY
- SEA WALL
- GROYNES
- BREAKWATER
- HABITATION

INDEX TO SHEETS

49M05SW	49M05SE	49M05SW
SEA	49M06NE	49M10NW
SEA	SEA	49M10SW



0 2 km



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI

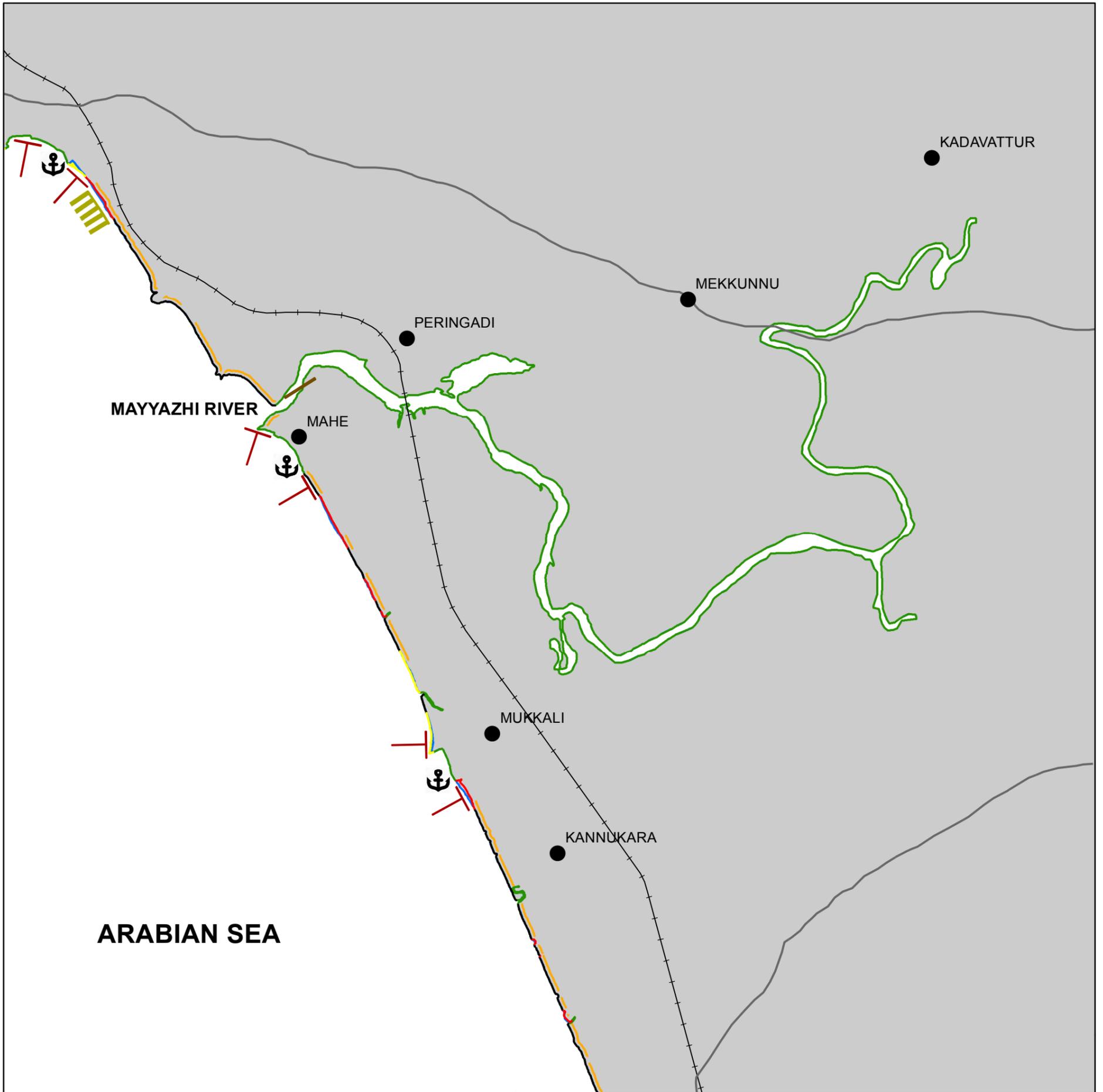


SHORELINE CHANGE MAP

KANNUR/KOZHIKODE
MAHE (PUDUCHERRY) DISTRICT

KERALA

FOR OFFICIAL USE ONLY
SHEET NO. 49M10NW



Legend

- EROSION
- ACCRETION
- HIGH-TIDE LINE 2014-16
- HIGH-TIDE LINE 2004-06
- STABLE
- ROAD
- RAILWAY
- SEA WALL
- GROYNES
- BREAKWATER
- JETTY
- ⚓ PORT/HARBOUR
- HABITATION

INDEX TO SHEETS

49M05SE	49M09SW	49M09SE
49M06NE	49M10NW	49M10NE
SEA	49M10SW	49M10SE



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI



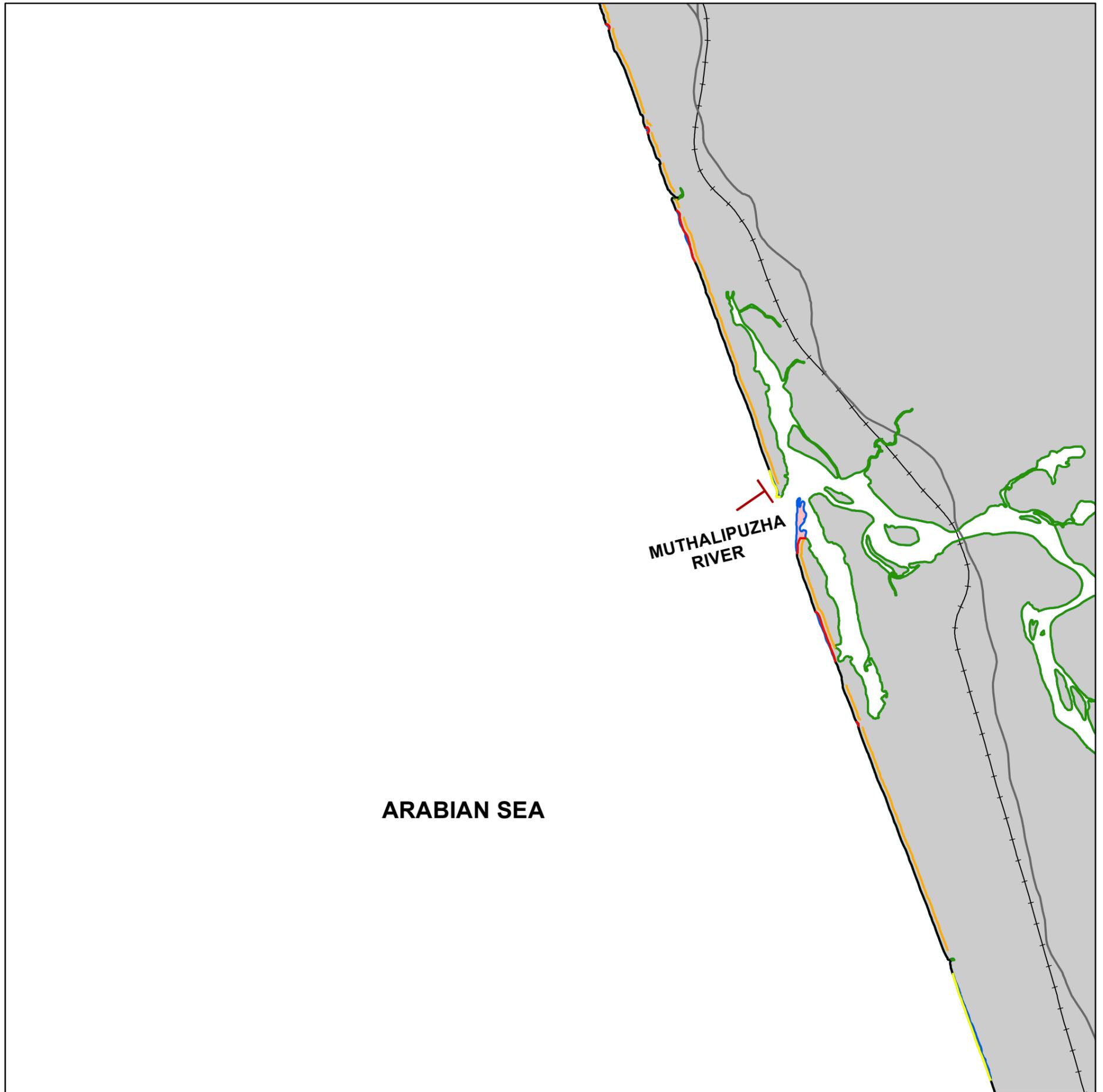
SHORELINE CHANGE MAP

FOR OFFICIAL USE ONLY

KOZHIKODE DISTRICT

KERALA

SHEET NO. 49M10SW



Legend

- EROSION
- ACCRETION
- HIGH-TIDE LINE 2014-16
- HIGH-TIDE LINE 2004-06
- STABLE
- ROAD
- RAILWAY
- SEA WALL
- BREAKWATER
- HABITATION

INDEX TO SHEETS

49M06NE	49M10NW	49M10NE
SEA	49M10SW	49M10SE
SEA	49M11NW	49M11NE



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI



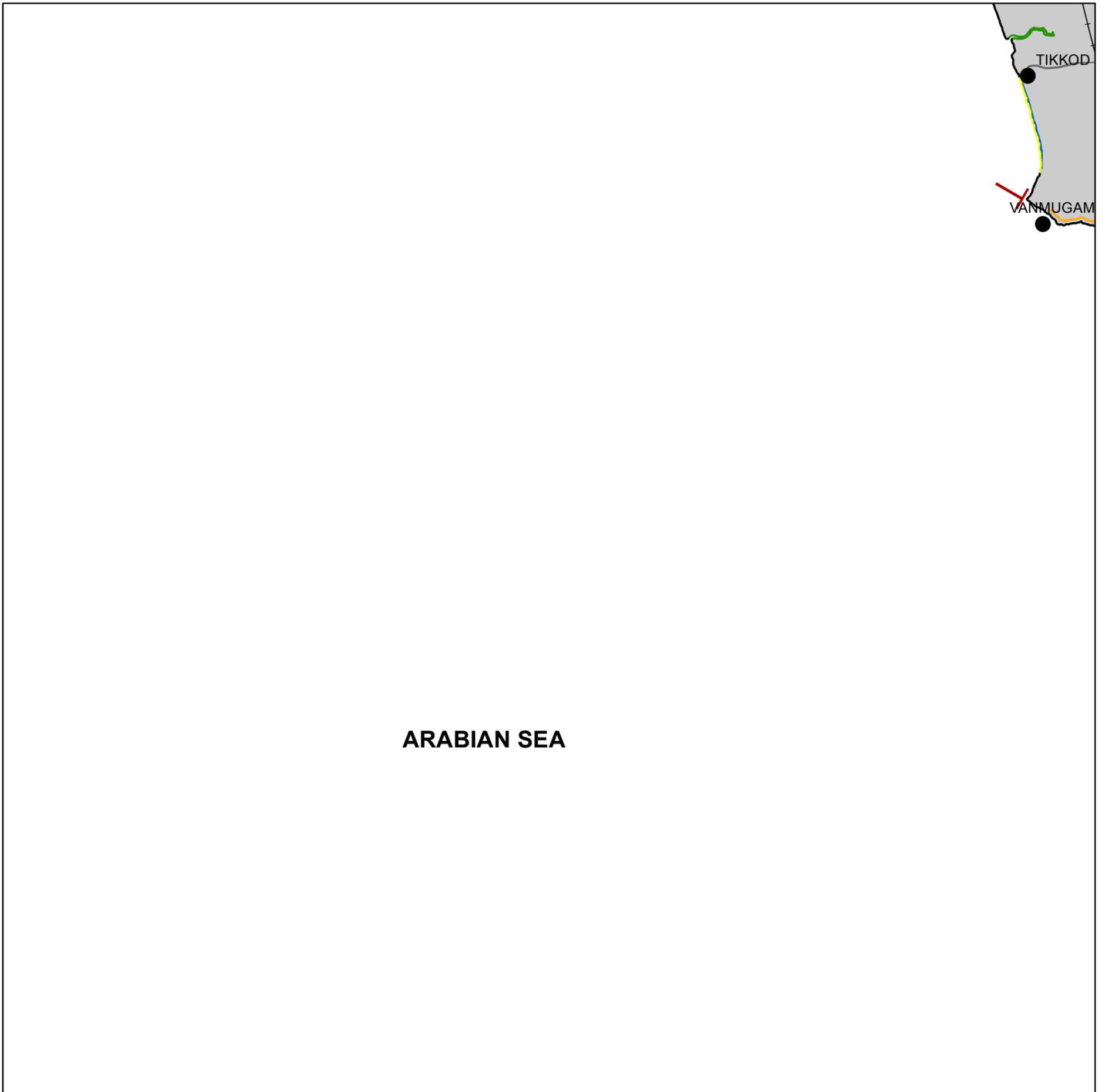
SHORELINE CHANGE MAP

FOR OFFICIAL USE ONLY

KOZHIKODE DISTRICT

KERALA

SHEET NO. 49M11NW



Legend

-  ACCRETION
-  HIGH-TIDE LINE 2014-16
-  HIGH-TIDE LINE 2004-06
-  STABLE
-  ROAD
-  RAILWAY
-  SEA WALL
-  BREAKWATER
-  HABITATION

INDEX TO SHEETS

SEA	49M10SW	49M10SE
SEA	49M11NW	49M11NE
SEA	SEA	49M11SE



0 2 km



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI



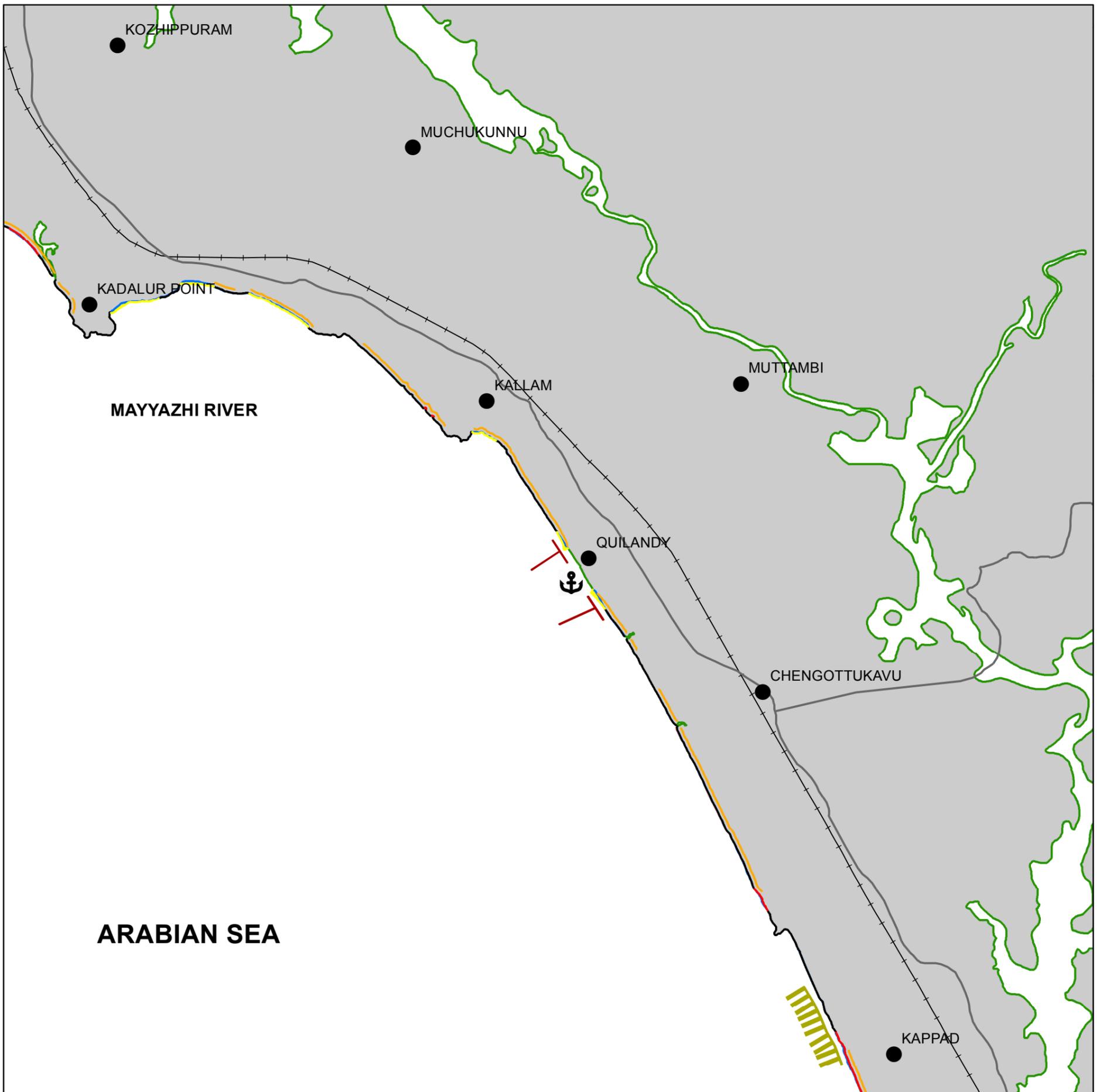
SHORELINE CHANGE MAP

FOR OFFICIAL USE ONLY

KOZHIKODE DISTRICT

KERALA

SHEET NO. 49M11NE



Legend

- EROSION
- ACCRETION
- HIGH-TIDE LINE 2014-16
- HIGH-TIDE LINE 2004-06
- STABLE
- ROAD
- RAILWAY
- SEA WALL
- GROYNES
- BREAKWATER
- ⚓ PORT/HARBOUR
- HABITATION

INDEX TO SHEETS

49M10SW	49M10SE	49M14SW
49M11NW	49M11NE	49M15NW
SEA	49M11SE	49M15SW



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI



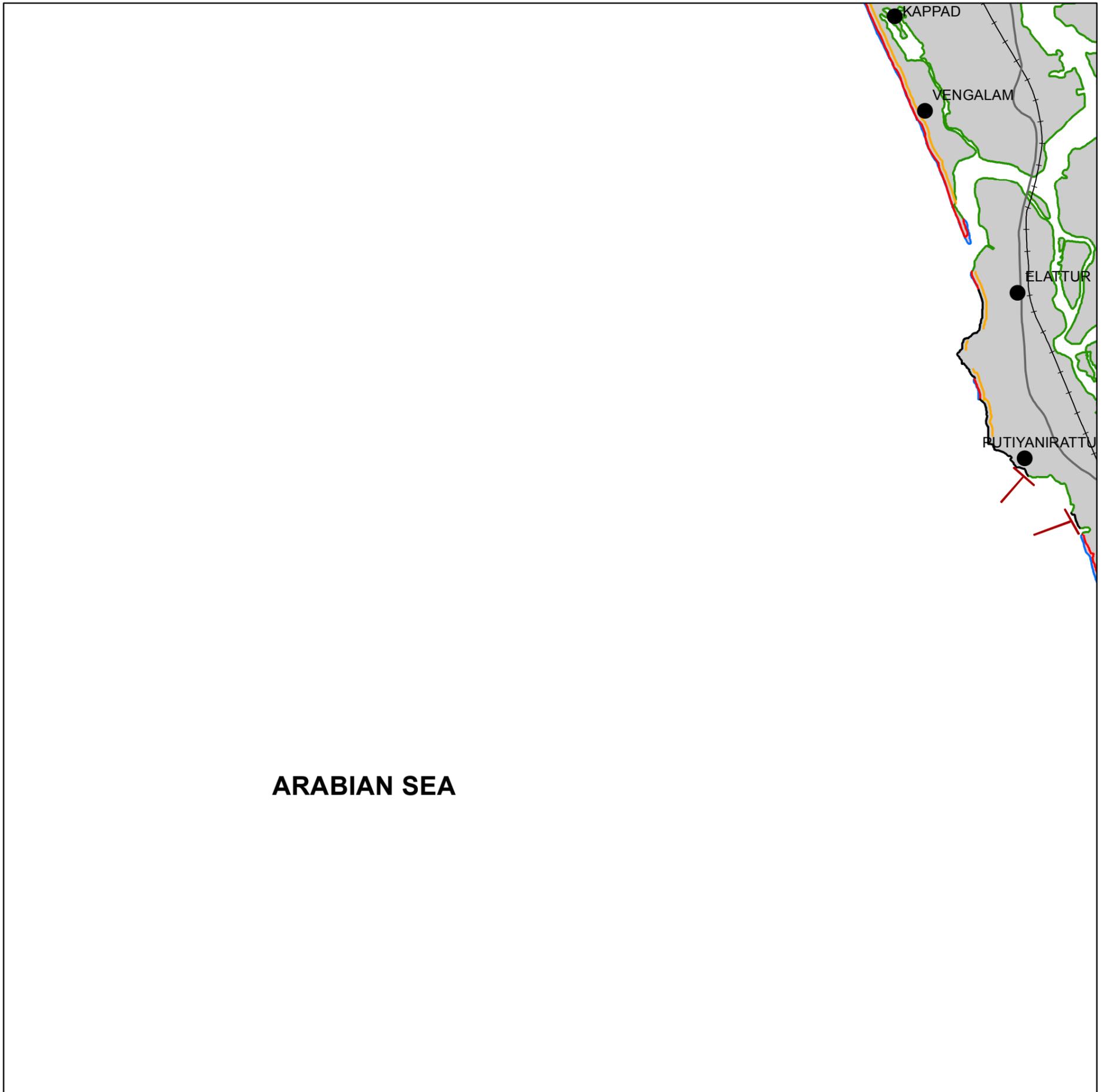
SHORELINE CHANGE MAP

FOR OFFICIAL USE ONLY

KOZHIKODE DISTRICT

KERALA

SHEET NO. 49M11SE



ARABIAN SEA

Legend

-  EROSION
-  HIGH-TIDE LINE 2014-16
-  HIGH-TIDE LINE 2004-06
-  STABLE
-  ROAD
-  RAILWAY
-  SEA WALL
-  BREAKWATER
-  HABITATION

INDEX TO SHEETS

49M11NW	49M11NE	49M15NW
SEA	49M11SE	49M15SW
SEA	SEA	49M16NW



0 2 km



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI



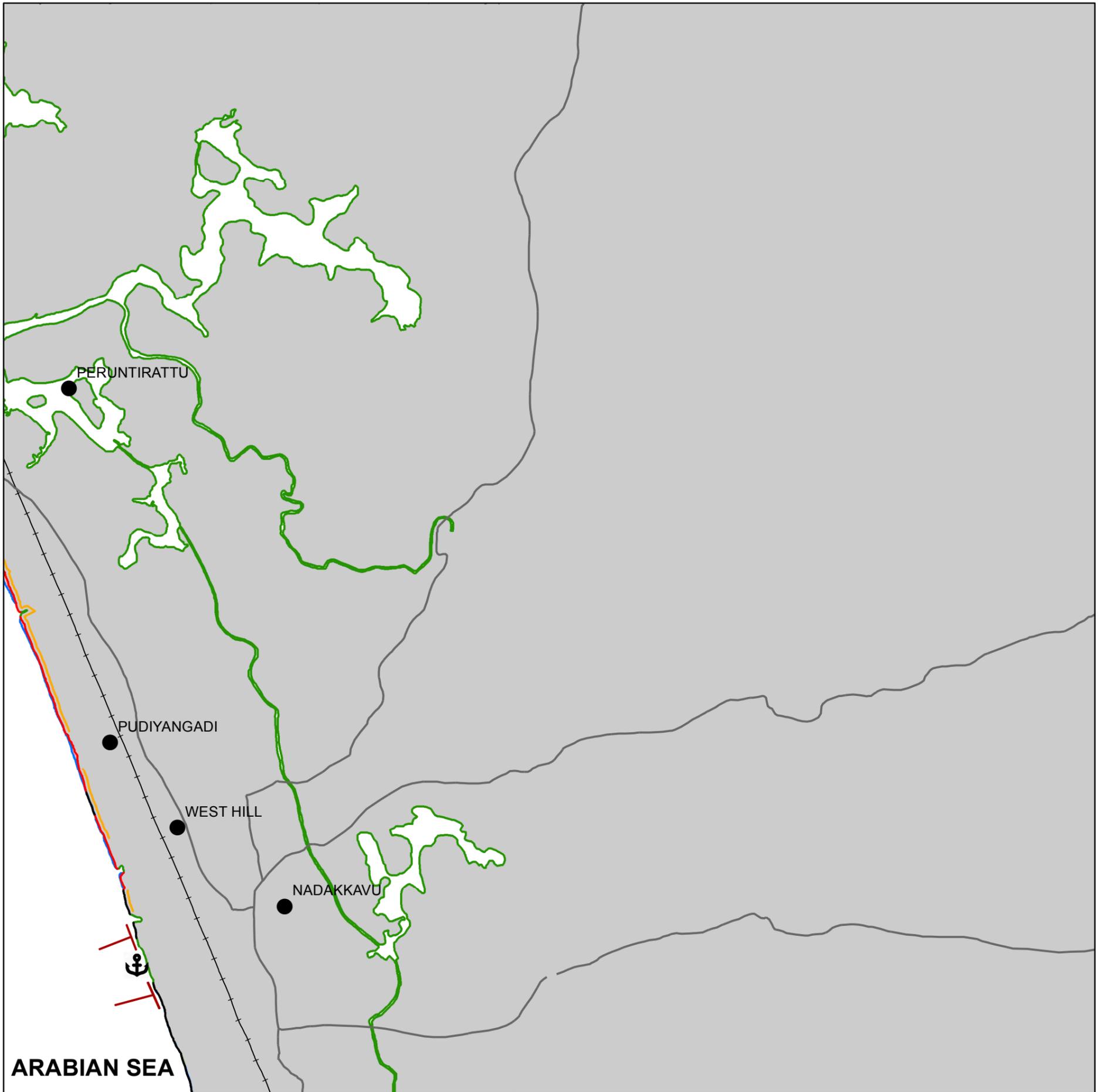
SHORELINE CHANGE MAP

FOR OFFICIAL USE ONLY

KOZHIKODE DISTRICT

KERALA

SHEET NO. 49M15SW



Legend

- EROSION
- HIGH-TIDE LINE 2014-16
- HIGH-TIDE LINE 2004-06
- STABLE
- ROAD
- RAILWAY
- SEA WALL
- BREAKWATER
- ⚓ PORT/HARBOUR
- HABITATION

INDEX TO SHEETS

49M11NE	49M15NW	49M15NE
49M11SE	49M15SW	49M15SE
SEA	49M16NW	49M16NE



0 2 km



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI



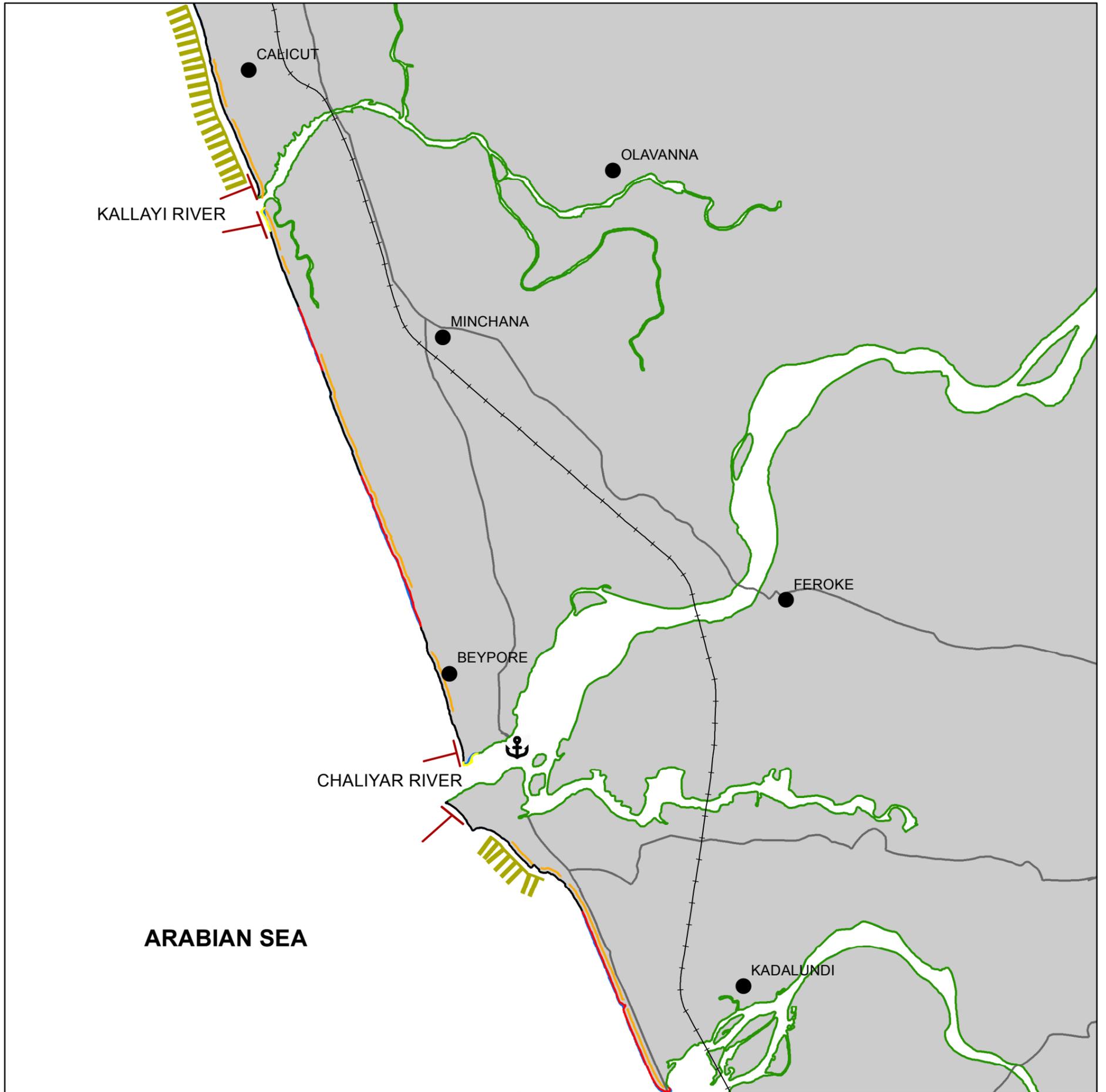
SHORELINE CHANGE MAP

FOR OFFICIAL USE ONLY

KOZHIKODE/MALAPPURAM DISTRICT

KERALA

SHEET NO. 49M16NW



Legend

- EROSION
- ACCRETION
- HIGH-TIDE LINE 2014-16
- HIGH-TIDE LINE 2004-06
- STABLE
- ROAD
- RAILWAY
- SEA WALL
- GROYNES
- BREAKWATER
- ⚓ PORT/HARBOUR
- HABITATION

INDEX TO SHEETS

49M11SE	49M15SW	49M15SE
SEA	49M16NW	49M16NE
SEA	49M16SW	49M16SE



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI



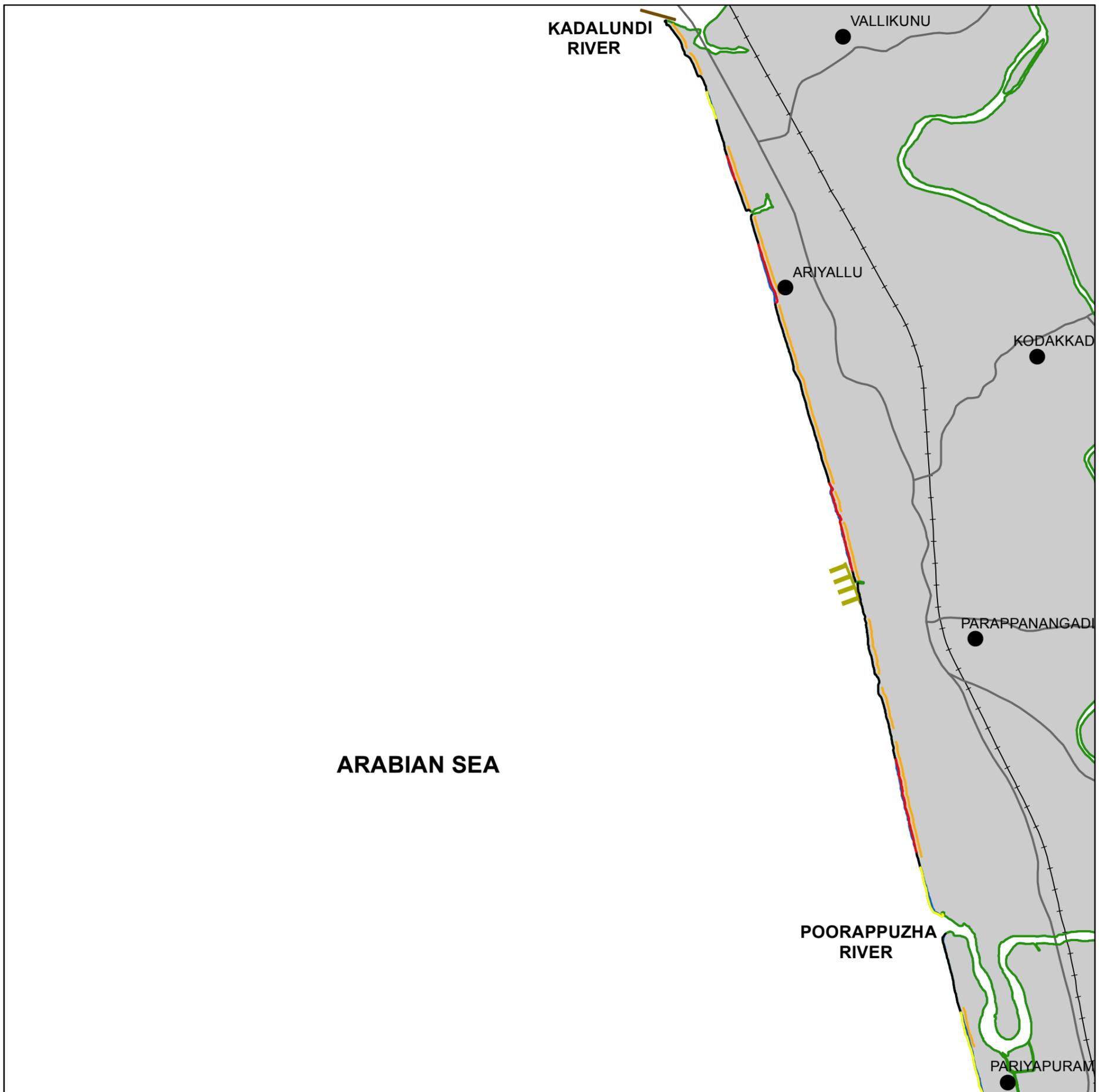
SHORELINE CHANGE MAP

FOR OFFICIAL USE ONLY

MALAPPURAM DISTRICT

KERALA

SHEET NO. 49M16SW



Legend

- EROSION
- ACCRETION
- HIGH-TIDE LINE 2014-16
- HIGH-TIDE LINE 2004-06
- STABLE
- ROAD
- RAILWAY
- SEA WALL
- GROYNES
- JETTY
- HABITATION

INDEX TO SHEETS

SEA	49M16NW	49M16NE
SEA	49M16SW	49M16SE
SEA	49N13NW	49N13NE



0 2 km



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI



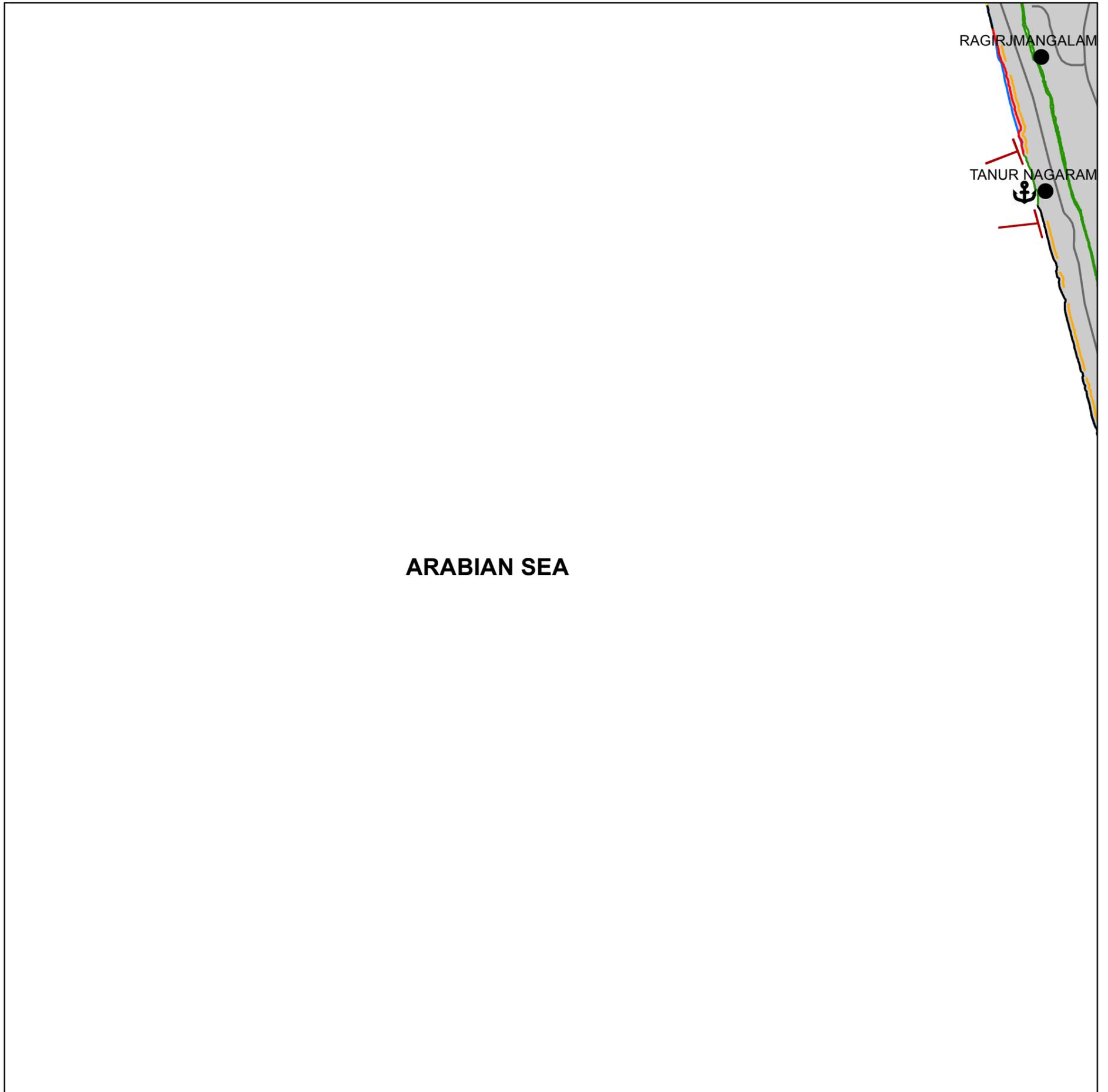
SHORELINE CHANGE MAP

FOR OFFICIAL USE ONLY

MALAPPURAM DISTRICT

KERALA

SHEET NO. 49N13NW



Legend

- EROSION
- ROAD
- HIGH-TIDE LINE 2014-16
- HIGH-TIDE LINE 2004-06
- STABLE
- SEA WALL
- BREAKWATER
- ⚓ PORT/HARBOUR
- HABITATION



INDEX TO SHEETS

SEA	49M16SW	49M16SE
SEA	49N13NW	49N13NE
SEA	SEA	49N13SE



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI



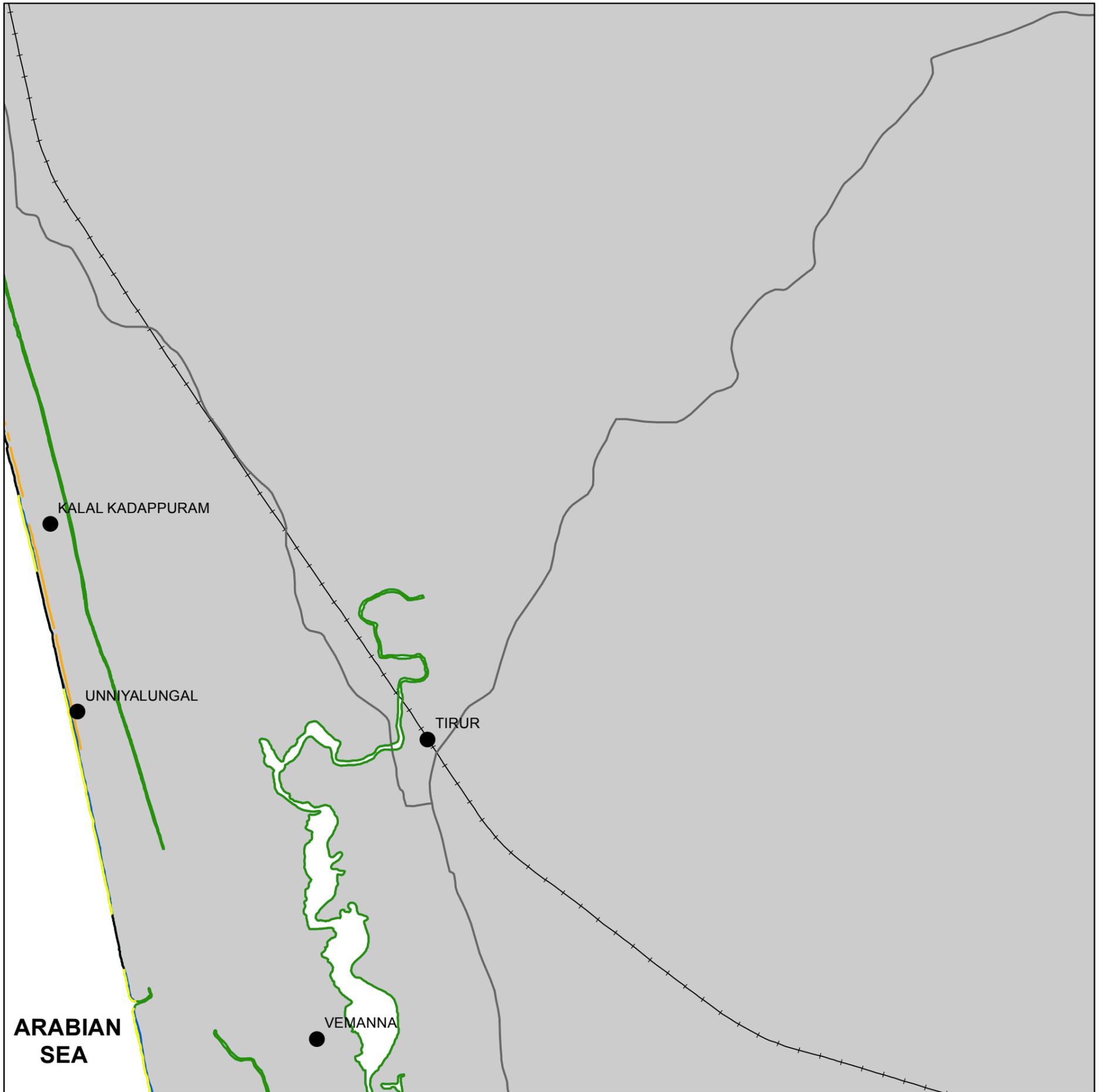
SHORELINE CHANGE MAP

FOR OFFICIAL USE ONLY

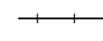
MALAPPURAM DISTRICT

KERALA

SHEET NO. 49N13NE



Legend

-  ACCRETION
-  HIGH-TIDE LINE 2014-16
-  HIGH-TIDE LINE 2004-06
-  STABLE
-  ROAD
-  RAILWAY
-  SEA WALL
-  HABITATION

INDEX TO SHEETS

49M16SW	49M16SE	58A04SW
49N13NW	49N13NE	58B01NW
SEA	49N13SE	58B01SW



0 2 km



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI



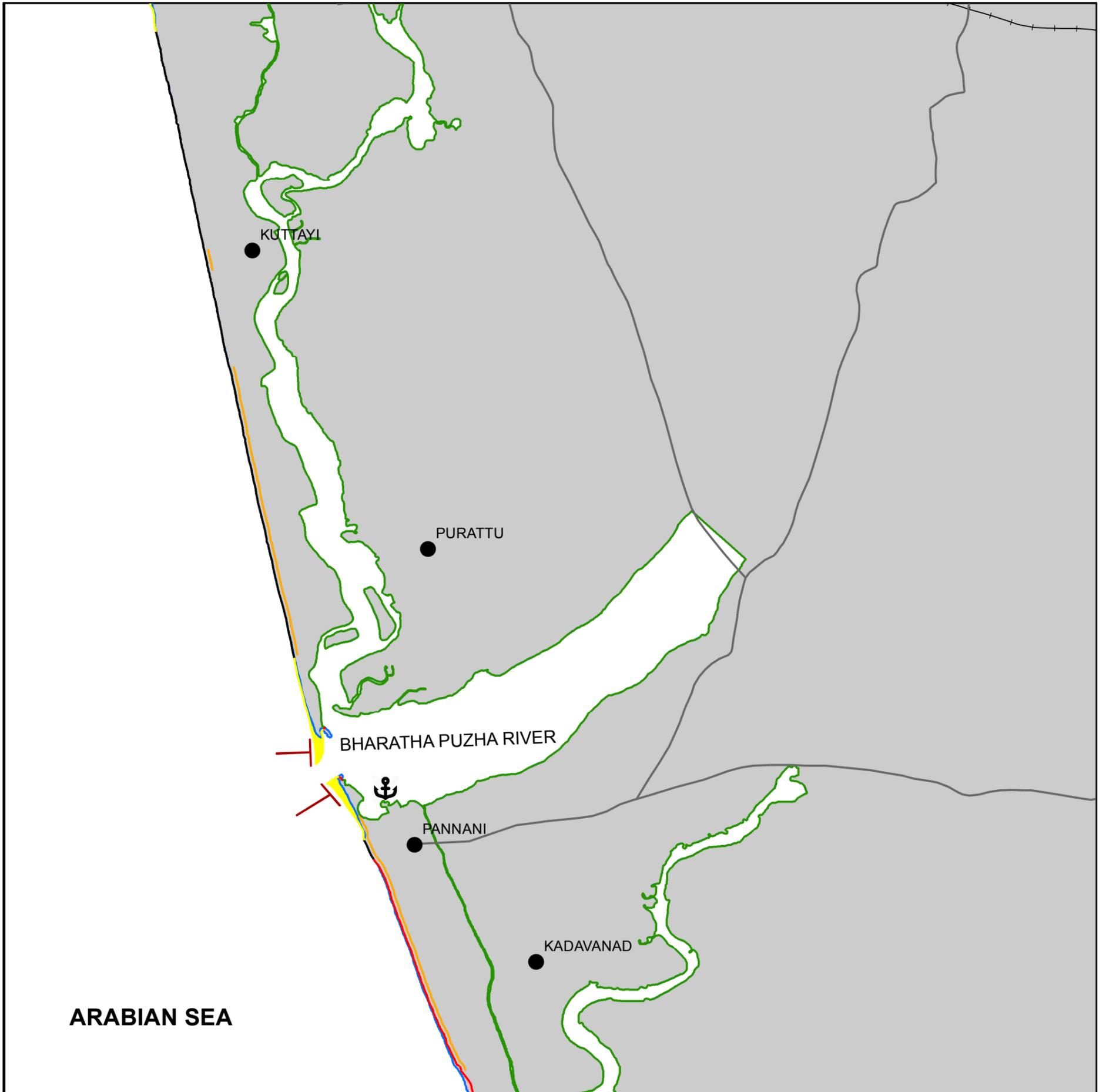
SHORELINE CHANGE MAP

FOR OFFICIAL USE ONLY

MALAPPURAM DISTRICT

KERALA

SHEET NO. 49N13SE



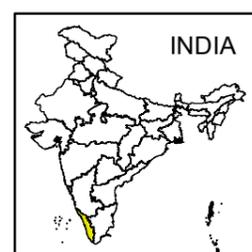
ARABIAN SEA

Legend

- EROSION
- ACCRETION
- HIGH-TIDE LINE 2014-16
- HIGH-TIDE LINE 2004-06
- STABLE
- ROAD
- RAILWAY
- SEA WALL
- BREAKWATER
- ⚓ PORT/HARBOUR HABITATION

INDEX TO SHEETS

49N13NW	49N13NE	58B01NW
SEA	49N13SE	58B01SW
SEA	49N14NE	58B02NW



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI

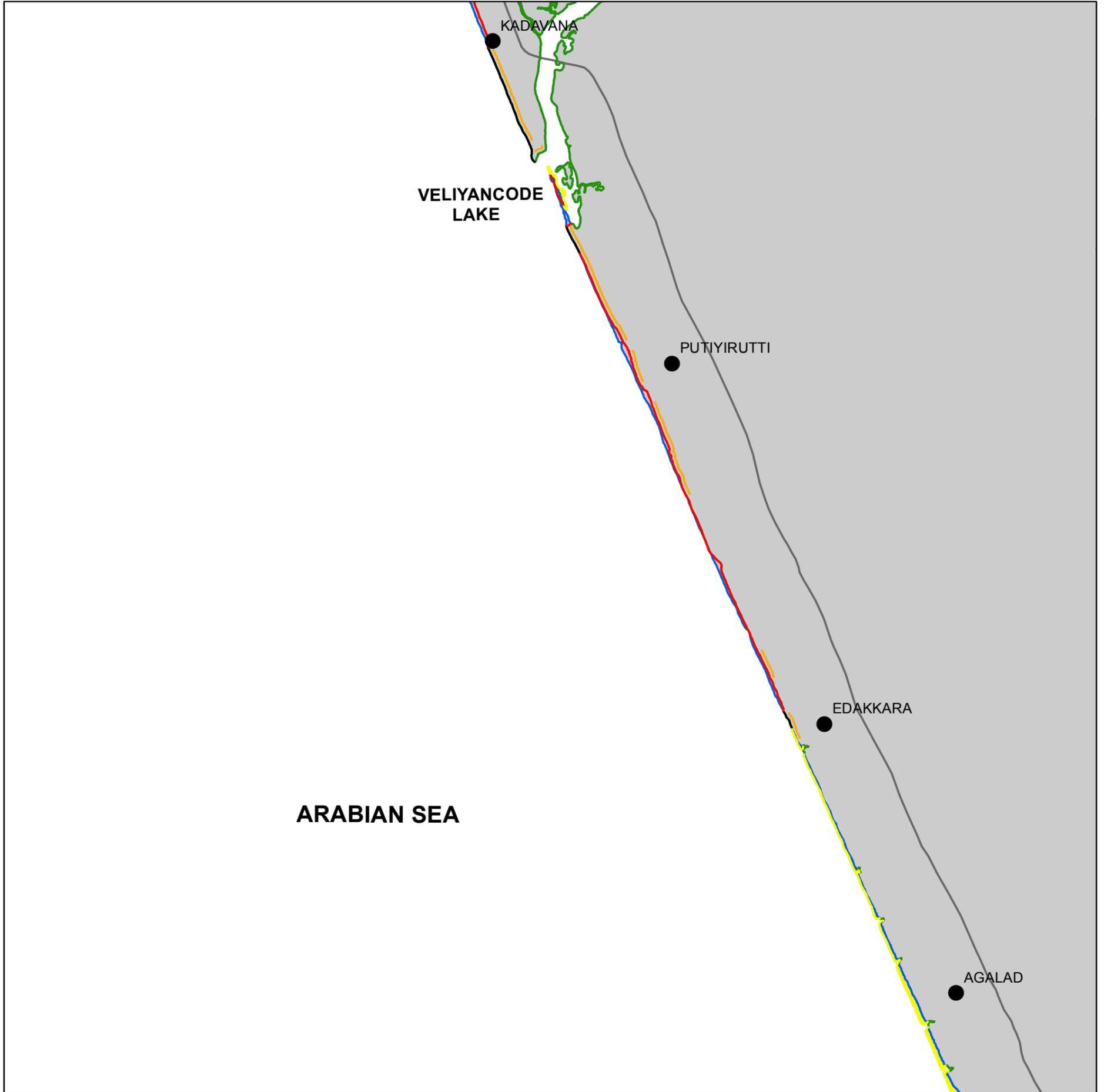


SHORELINE CHANGE MAP

MALAPPURAM/THRISSUR
DISTRICT

FOR OFFICIAL USE ONLY
SHEET NO. 49N14NE

KERALA



Legend

- EROSION
- ACCRETION
- HIGH-TIDE LINE 2014-16
- HIGH-TIDE LINE 2004-06
- STABLE
- ROAD
- SEA WALL
- HABITATION

INDEX TO SHEETS

SEA	49N13SE	58B01SW
SEA	49N14NE	58B02NW
SEA	49N14SE	58B02SW



0 2 km



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI



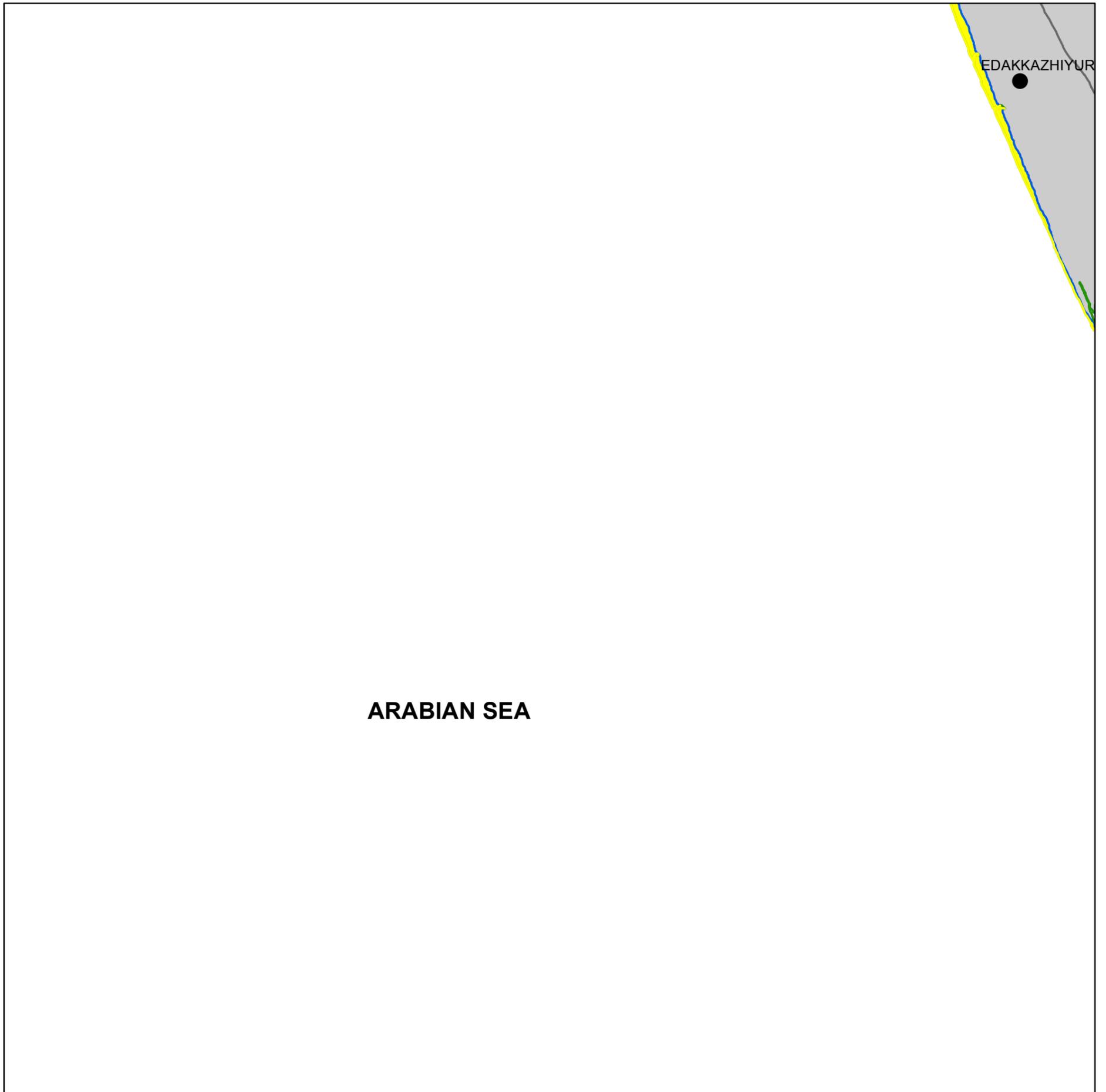
SHORELINE CHANGE MAP

FOR OFFICIAL USE ONLY

THRISSUR DISTRICT

KERALA

SHEET NO. 49N14SE



Legend

-  ACCRETION
-  HIGH-TIDE LINE 2014-16
-  HIGH-TIDE LINE 2004-06
-  ROAD
-  HABITATION

INDEX TO SHEETS

SEA	49N14NE	58B02NW
SEA	49N14SE	58B02SW
SEA	SEA	58B03NW



0 2 km



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI



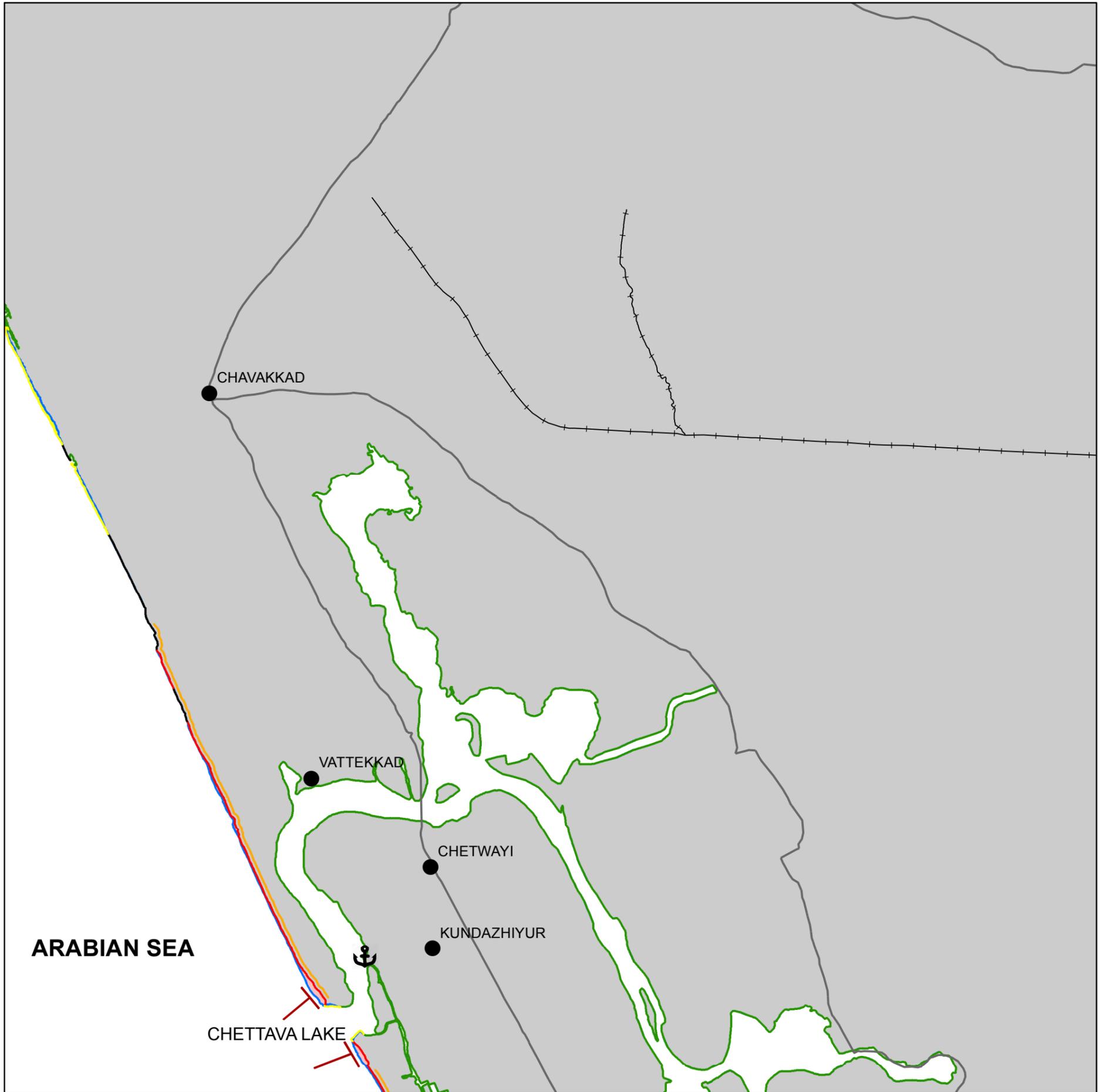
SHORELINE CHANGE MAP

FOR OFFICIAL USE ONLY

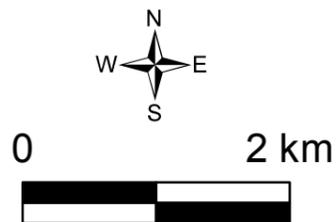
THRISSUR DISTRICT

KERALA

SHEET NO. 58B02SW



- Legend**
- EROSION
 - ACCRETION
 - HIGH-TIDE LINE 2014-16
 - HIGH-TIDE LINE 2004-06
 - STABLE
 - ROAD
 - RAILWAY
 - SEA WALL
 - BREAKWATER
 - ⚓ PORT/HARBOUR
 - HABITATION



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI



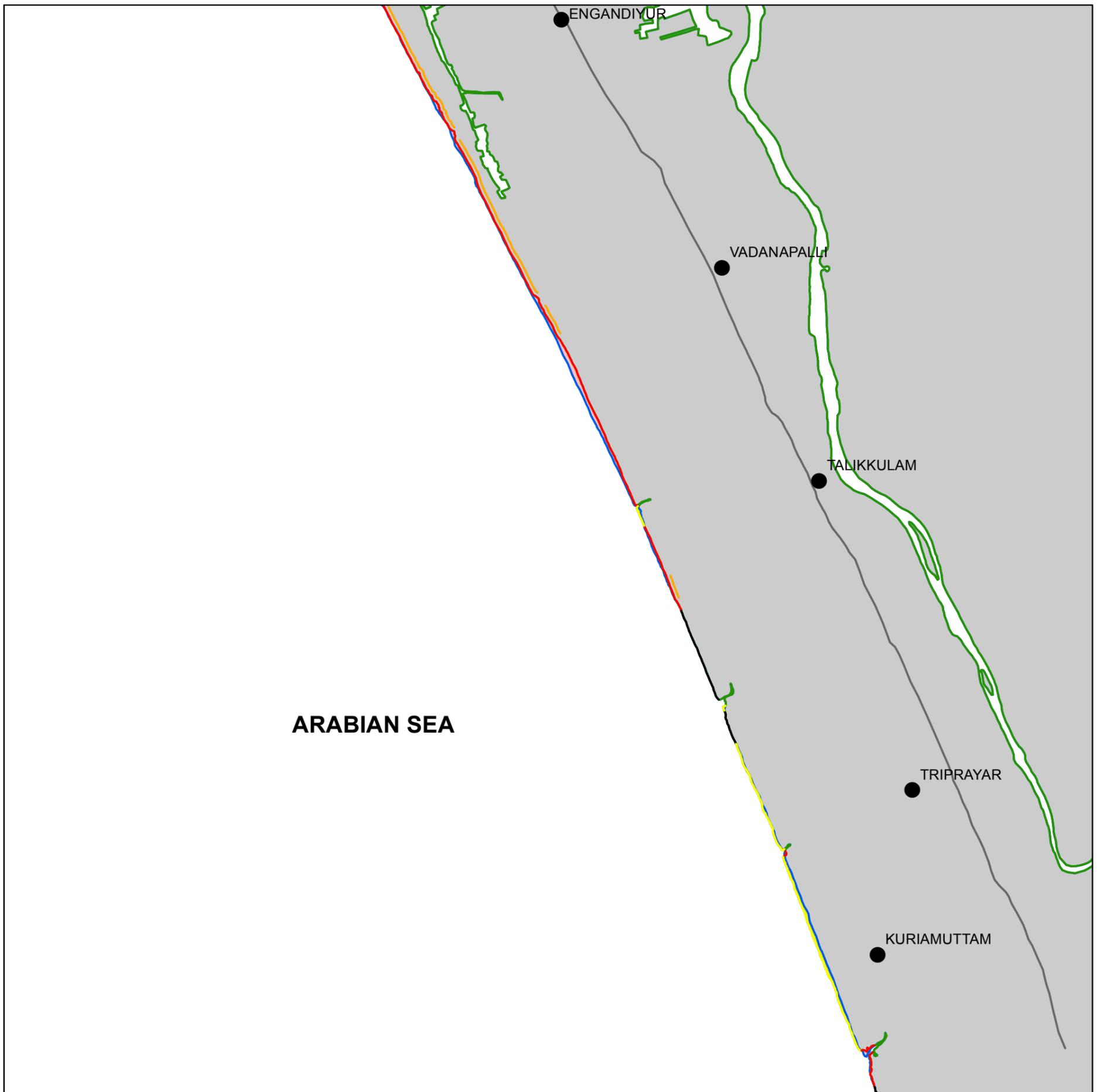
SHORELINE CHANGE MAP

FOR OFFICIAL USE ONLY

THRISSUR DISTRICT

KERALA

SHEET NO. 58B03NW



Legend

- EROSION
- ACCRETION
- HIGH-TIDE LINE 2014-16
- HIGH-TIDE LINE 2004-06
- STABLE
- ROAD
- SEA WALL
- HABITATION

INDEX TO SHEETS

49N14SE	58B02SW	58B02SE
SEA	58B03NW	58B03NE
SEA	58B03SW	58B03SE



0 2 km



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI



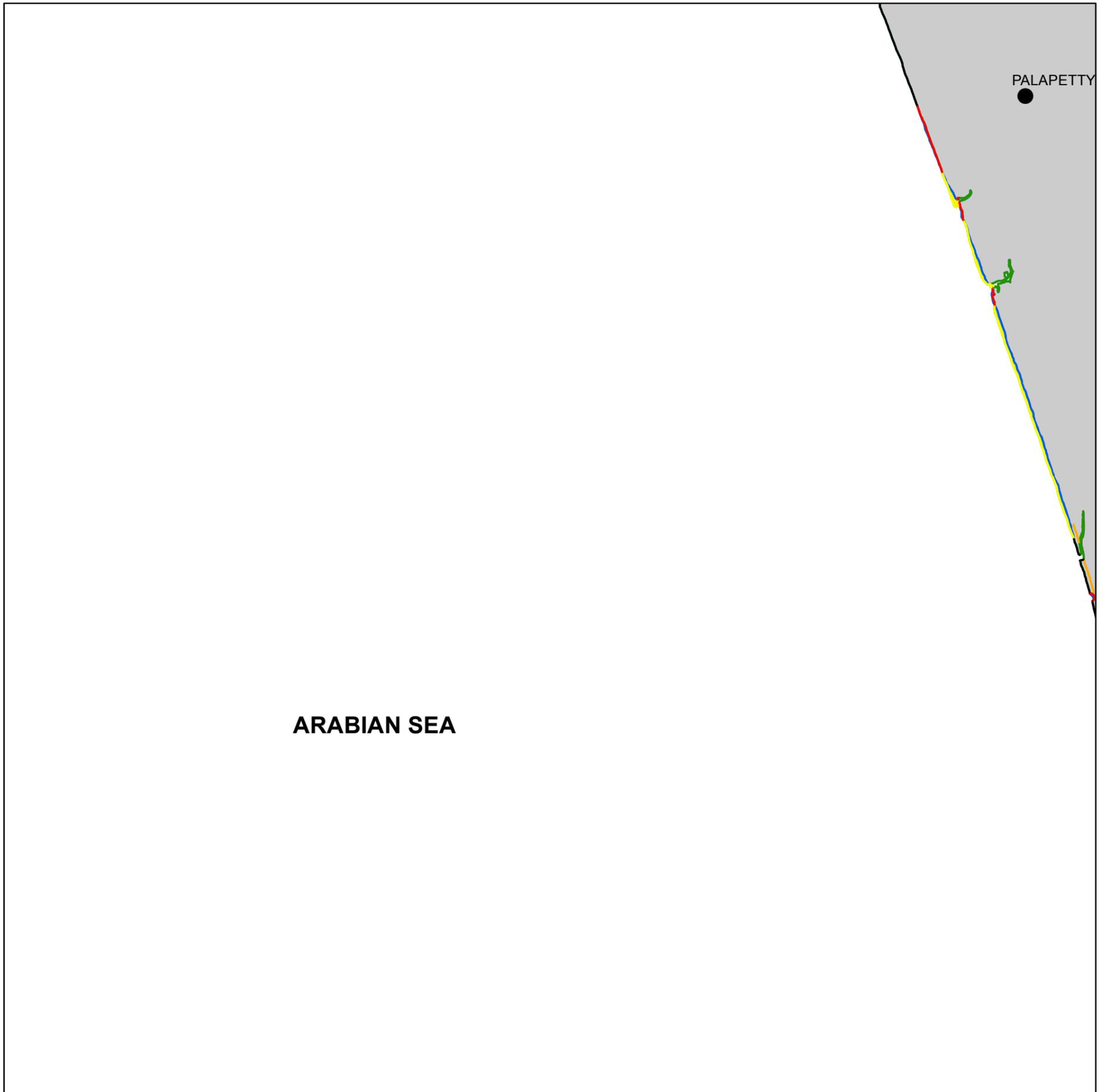
SHORELINE CHANGE MAP

FOR OFFICIAL USE ONLY

THRISSUR DISTRICT

KERALA

SHEET NO. 58B03SW



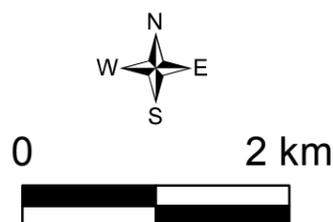
ARABIAN SEA

Legend

- EROSION
- ACCRETION
- HIGH-TIDE LINE 2014-16
- HIGH-TIDE LINE 2004-06
- STABLE
- SEA WALL
- HABITATION

INDEX TO SHEETS

SEA	58B03NW	58B03NE
SEA	58B03SW	58B03SE
SEA	SEA	58B04NE



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI



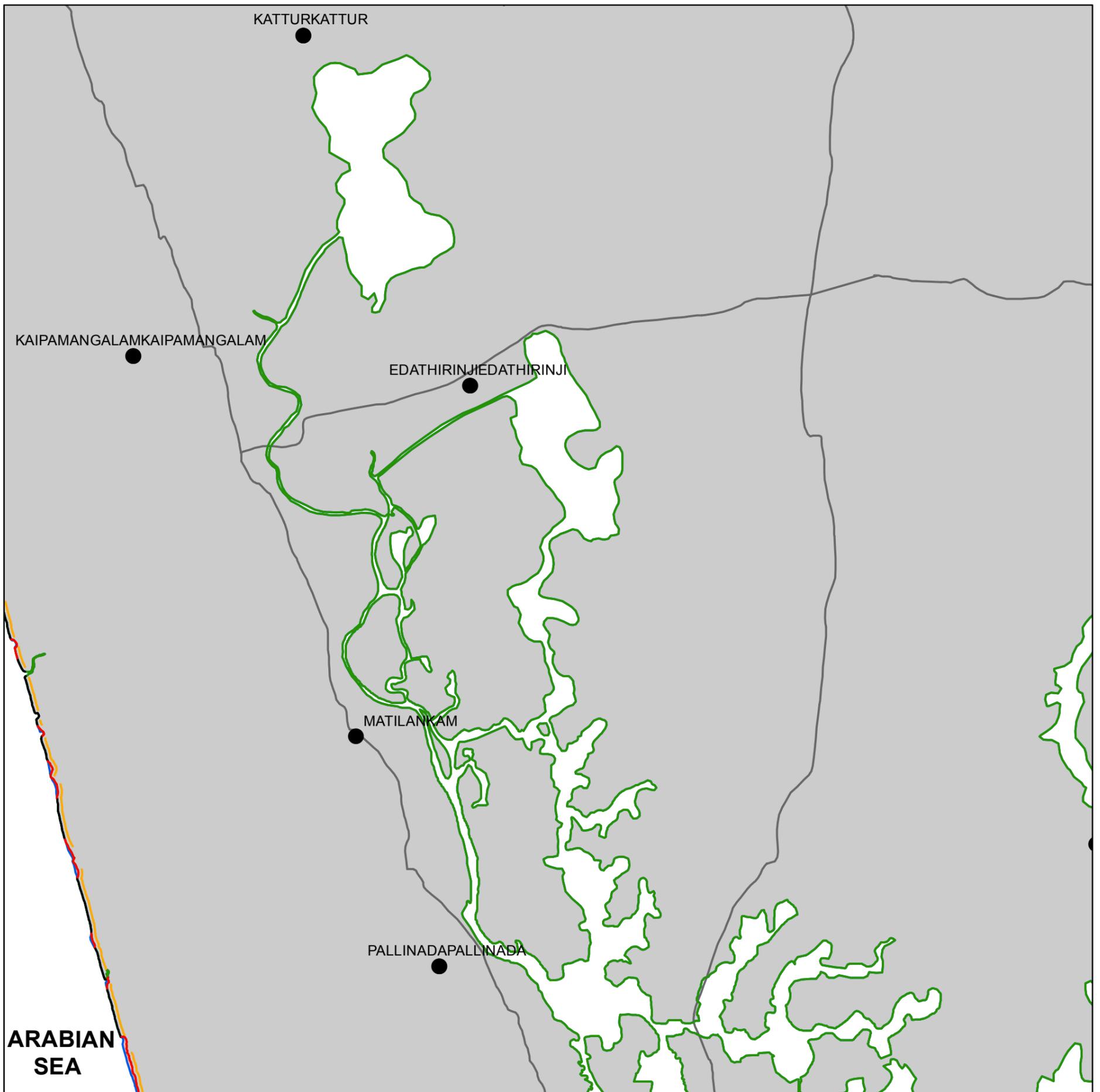
SHORELINE CHANGE MAP

FOR OFFICIAL USE ONLY

THRISSUR DISTRICT

KERALA

SHEET NO. 58B03SE



Legend

- EROSION
- HIGH-TIDE LINE 2014-16
- HIGH-TIDE LINE 2004-06
- STABLE
- ROAD
- SEA WALL
- HABITATION

INDEX TO SHEETS

58B03NW	58B03NE	58B07NW
58B03SW	58B03SE	58B07SW
SEA	58B04NE	58B08NW



0 2 km



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI

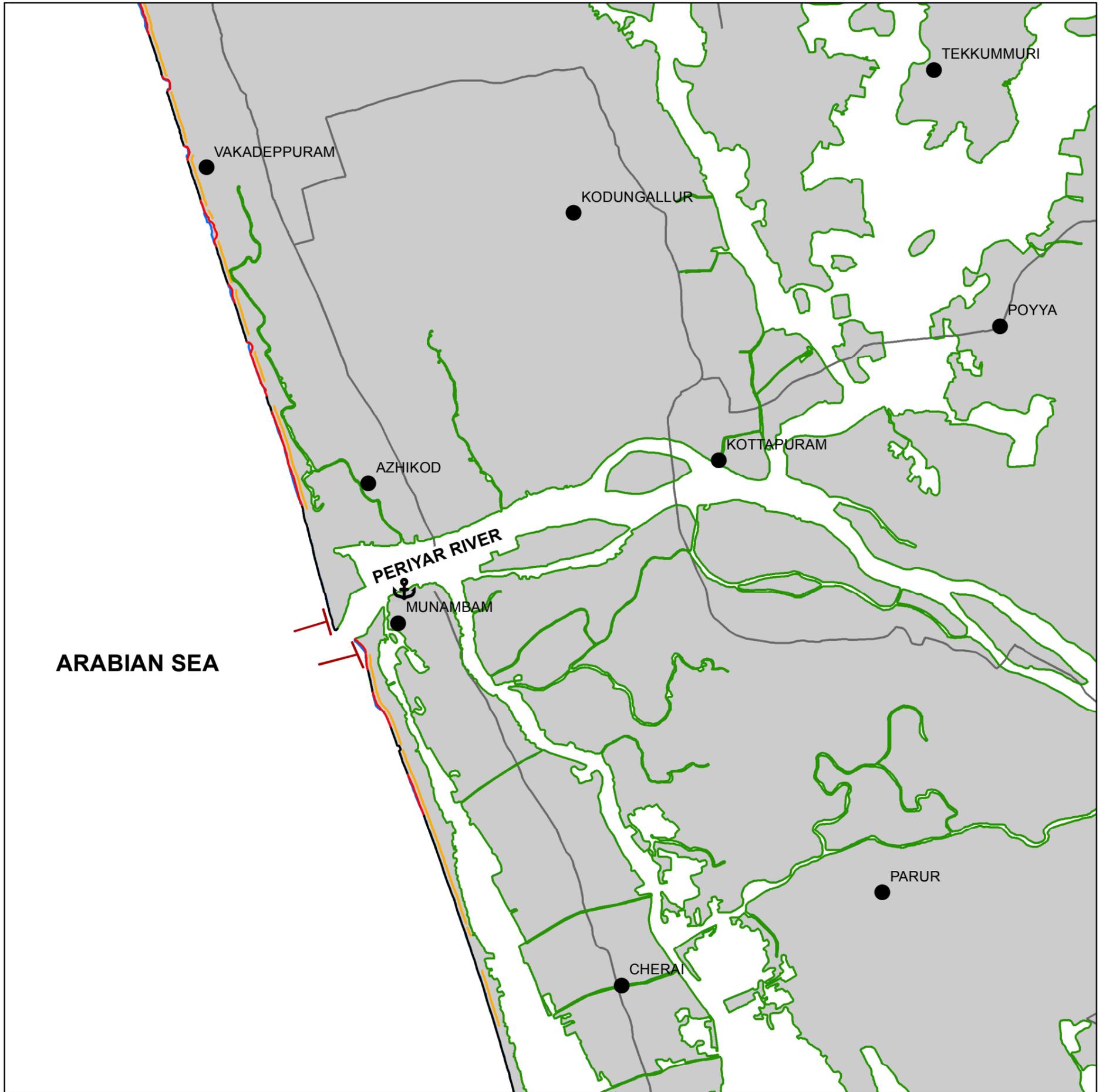


SHORELINE CHANGE MAP

THRISSUR/ERNAKULAM
DISTRICT

KERALA

FOR OFFICIAL USE ONLY
SHEET NO. 58B04NE



Legend

-  EROSION
-  HIGH-TIDE LINE 2014-16
-  HIGH-TIDE LINE 2004-06
-  STABLE
-  ROAD
-  SEA WALL
-  BREAKWATER
-  PORT/HARBOUR
-  HABITATION

INDEX TO SHEETS

58B03SW	58B03SE	58B07SW
SEA	58B04NE	58B08NW
SEA	58B04SE	58B08SW



0 2 km



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI



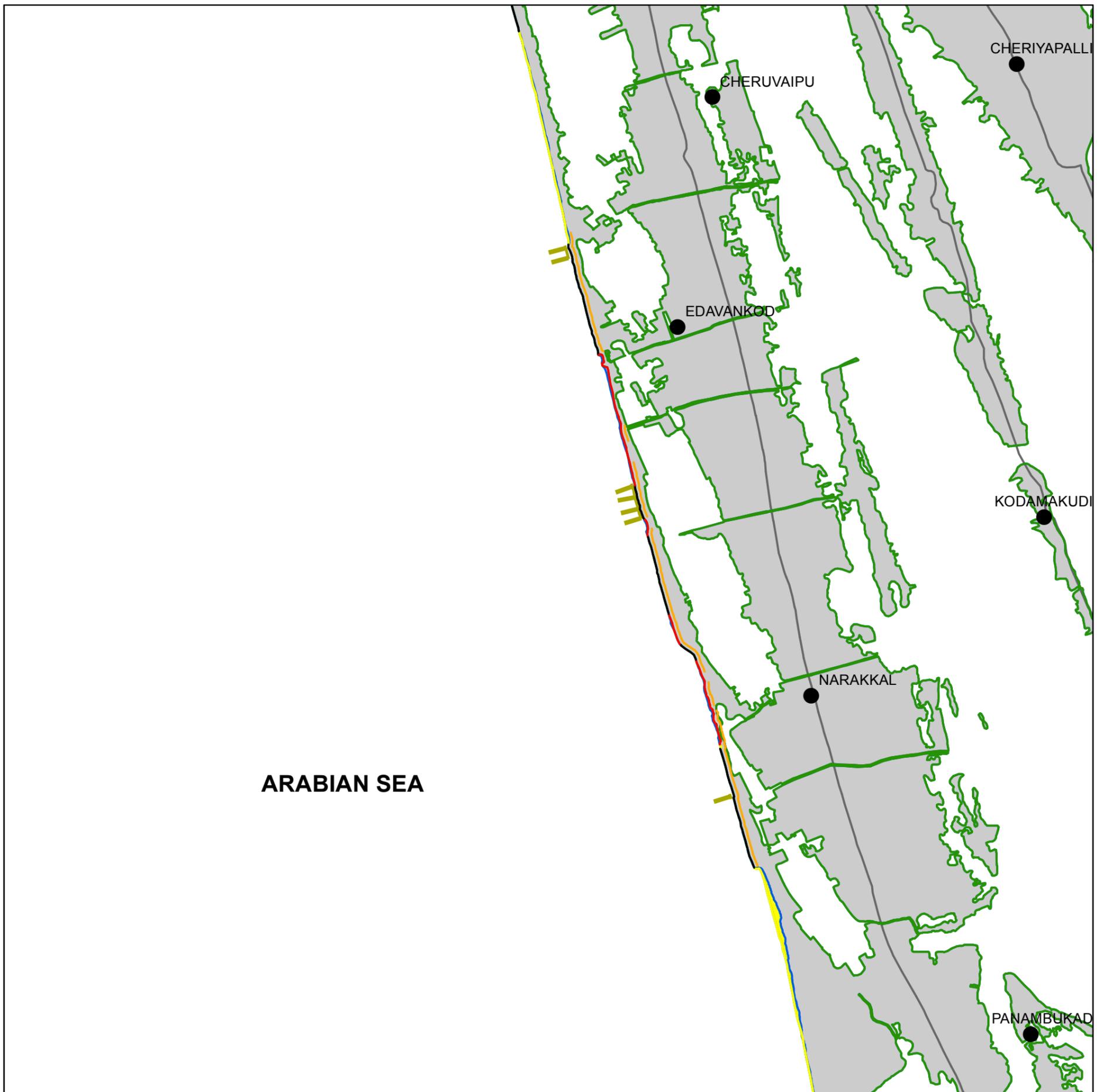
SHORELINE CHANGE MAP

FOR OFFICIAL USE ONLY

ERNAKULAM DISTRICT

KERALA

SHEET NO. 58B04SE



ARABIAN SEA

Legend

- EROSION
- ACCRETION
- HIGH-TIDE LINE 2014-16
- HIGH-TIDE LINE 2004-06
- STABLE
- ROAD
- SEA WALL
- GROYNES
- HABITATION



0 2 km



INDEX TO SHEETS

SEA	58B04NE	58B08NW
SEA	58B04SE	58B08SW
SEA	58C01NE	58C05NW



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI



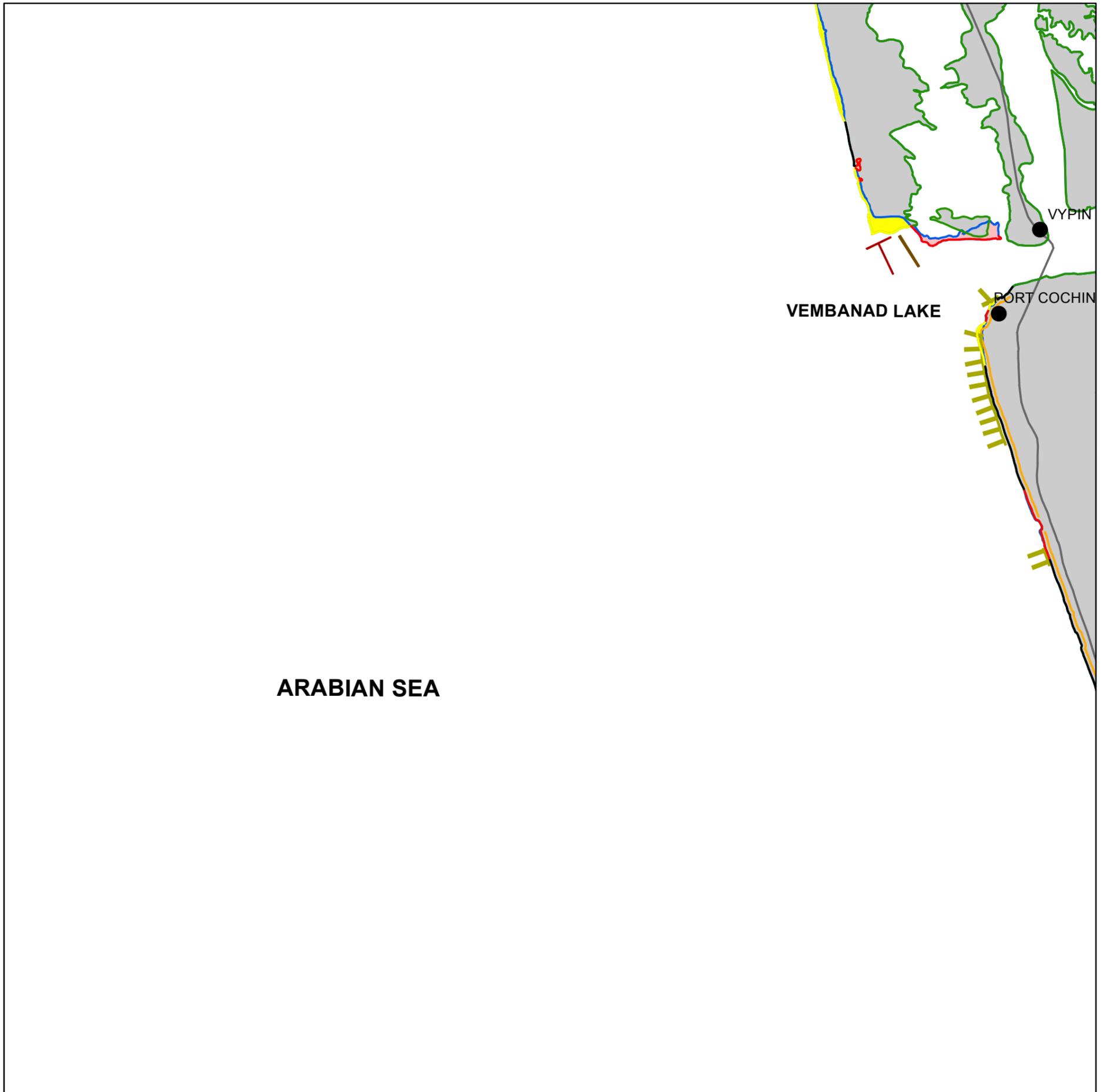
SHORELINE CHANGE MAP

FOR OFFICIAL USE ONLY

ERNAKULAM DISTRICT

KERALA

SHEET NO. 58C01NE



ARABIAN SEA

Legend

- EROSION
- ACCRETION
- HIGH-TIDE LINE 2014-16
- HIGH-TIDE LINE 2004-06
- STABLE
- ROAD
- SEA WALL
- GROYNES
- BREAKWATER
- JETTY
- HABITATION

INDEX TO SHEETS

SEA	58B04SE	58B06SW
SEA	58C01NE	58C05NW
SEA	SEA	58C05SW



0 2 km



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI



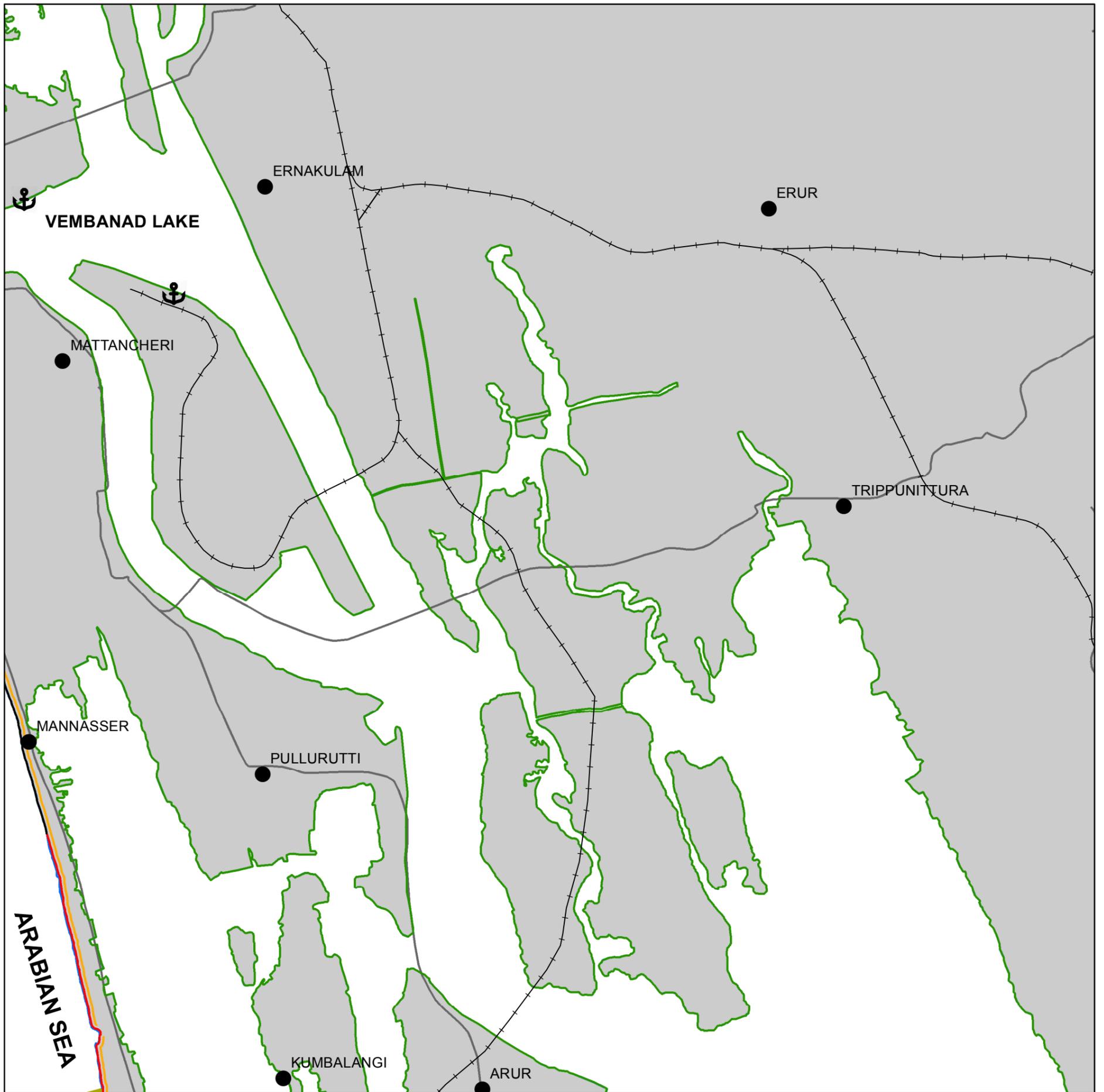
SHORELINE CHANGE MAP

FOR OFFICIAL USE ONLY

ERNAKULAM DISTRICT

KERALA

SHEET NO. 58C05NW



Legend

- EROSION
- HIGH-TIDE LINE 2014-16
- HIGH-TIDE LINE 2004-06
- STABLE
- ROAD
- SEA WALL
- BREAKWATER
- ⚓ PORT/HARBOUR
- HABITATION

INDEX TO SHEETS

58B04SE	58B08SW	58B08SE
58C01NE	58C05NW	58C05NE
SEA	58C05SW	58C05SE



0 2 km



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI

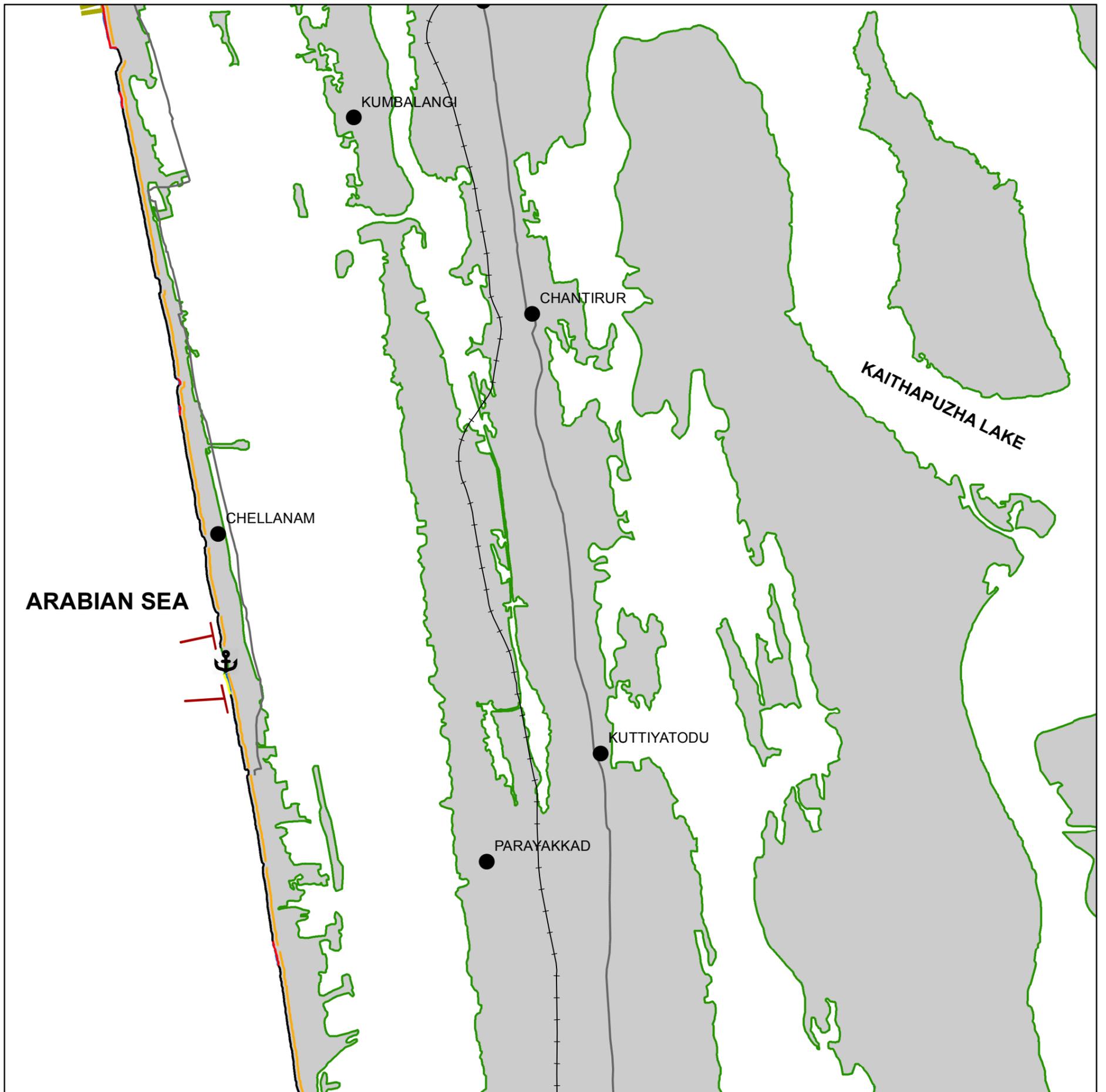


SHORELINE CHANGE MAP

ERNAKULAM/ALAPPUZHA DISTRICT

KERALA

FOR OFFICIAL USE ONLY
SHEET NO. 58C05SW



Legend

- EROSION
- ACCRETION
- HIGH-TIDE LINE 2014-16
- HIGH-TIDE LINE 2004-06
- STABLE
- ROAD
- RAILWAY
- SEA WALL
- GROYNES
- BREAKWATER
- PORT/HARBOUR
- HABITATION

INDEX TO SHEETS

58C01NE	58C05NW	58C05NE
SEA	58C05SW	58C05SE
SEA	58C06NW	58C06NE



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI



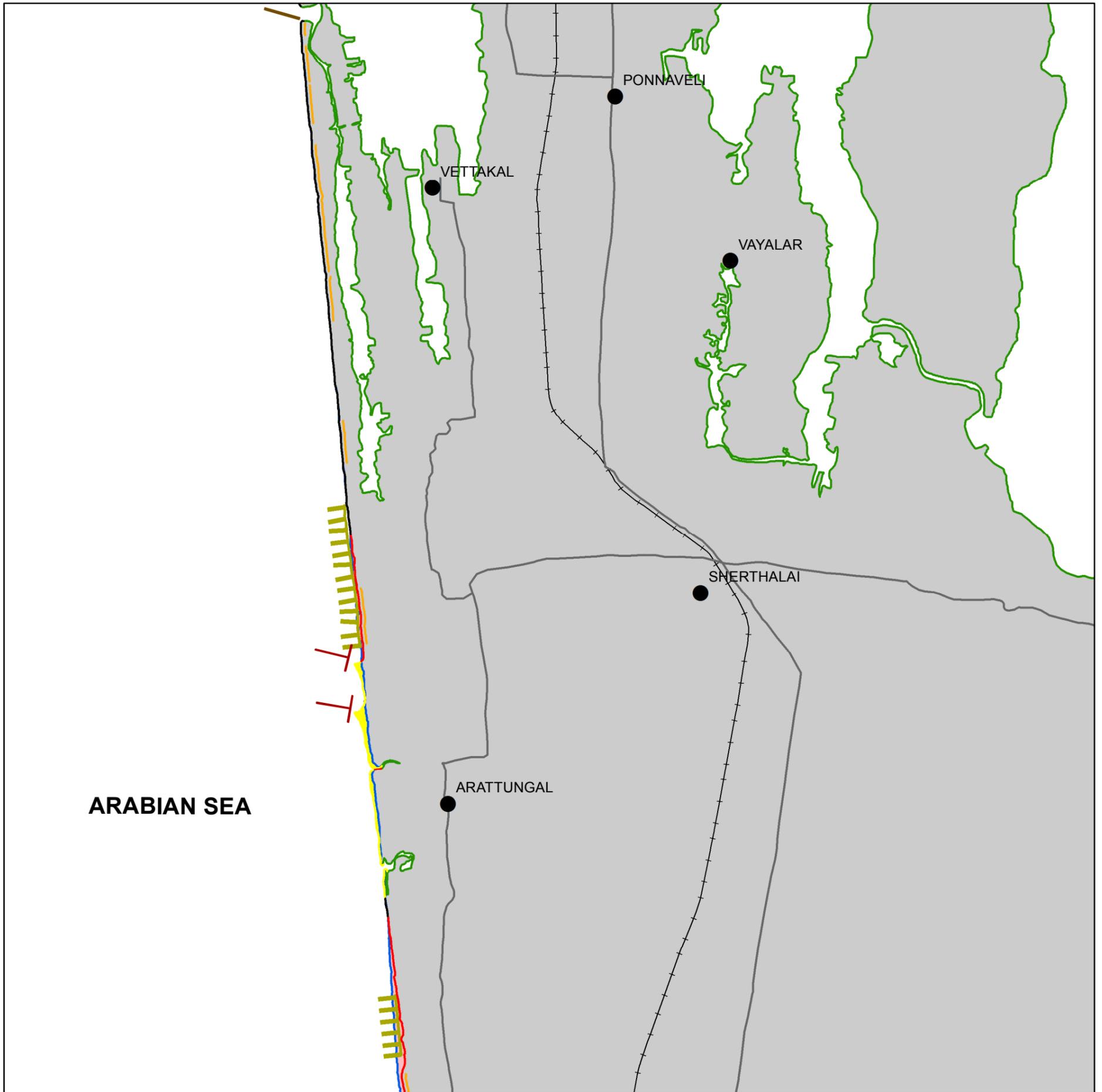
SHORELINE CHANGE MAP

FOR OFFICIAL USE ONLY

ALAPPUZHA DISTRICT

KERALA

SHEET NO. 58C06NW



Legend

- EROSION
- ACCRETION
- HIGH-TIDE LINE 2014-16
- HIGH-TIDE LINE 2004-06
- STABLE
- ROAD
- RAILWAY
- SEA WALL
- GROYNES
- BREAKWATER
- JETTY
- HABITATION

INDEX TO SHEETS

SEA	58C05SW	58C05SE
SEA	58C06NW	58C06NE
SEA	58C06SW	58C06SE



0 2 km



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI



SHORELINE CHANGE MAP

FOR OFFICIAL USE ONLY

ALAPPUZHA DISTRICT

KERALA

SHEET NO. 58C06SW



Legend

- EROSION
- ACCRETION
- HIGH-TIDE LINE 2014-16
- HIGH-TIDE LINE 2004-06
- STABLE
- ROAD
- RAILWAY
- SEA WALL
- GROYNES
- BREAKWATER
- HABITATION

INDEX TO SHEETS

SEA	58C06NW	58C06NE
SEA	58C06SW	58C06SE
SEA	58C07NW	58C07NE



0 2 km



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI



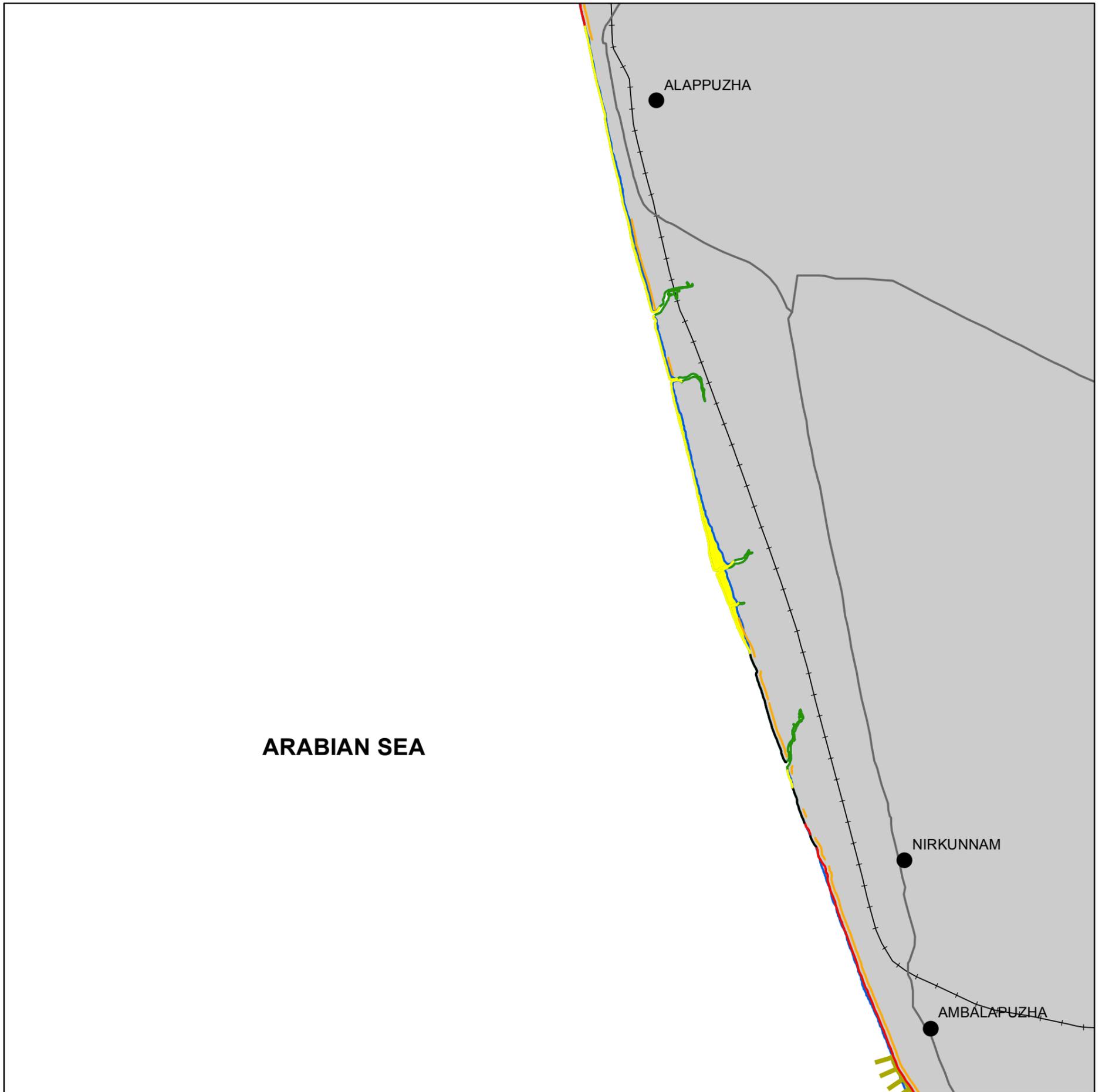
SHORELINE CHANGE MAP

FOR OFFICIAL USE ONLY

ALAPPUZHA DISTRICT

KERALA

SHEET NO. 58C07NW



ARABIAN SEA

Legend

- EROSION
- ACCRETION
- HIGH-TIDE LINE 2014-16
- HIGH-TIDE LINE 2004-06
- STABLE
- ROAD
- RAILWAY
- SEA WALL
- GROYNES
- HABITATION

INDEX TO SHEETS

SEA	58C06SW	58C06SE
SEA	58C07NW	58C07NE
SEA	58C07SW	58C07SE



0 2 km



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI



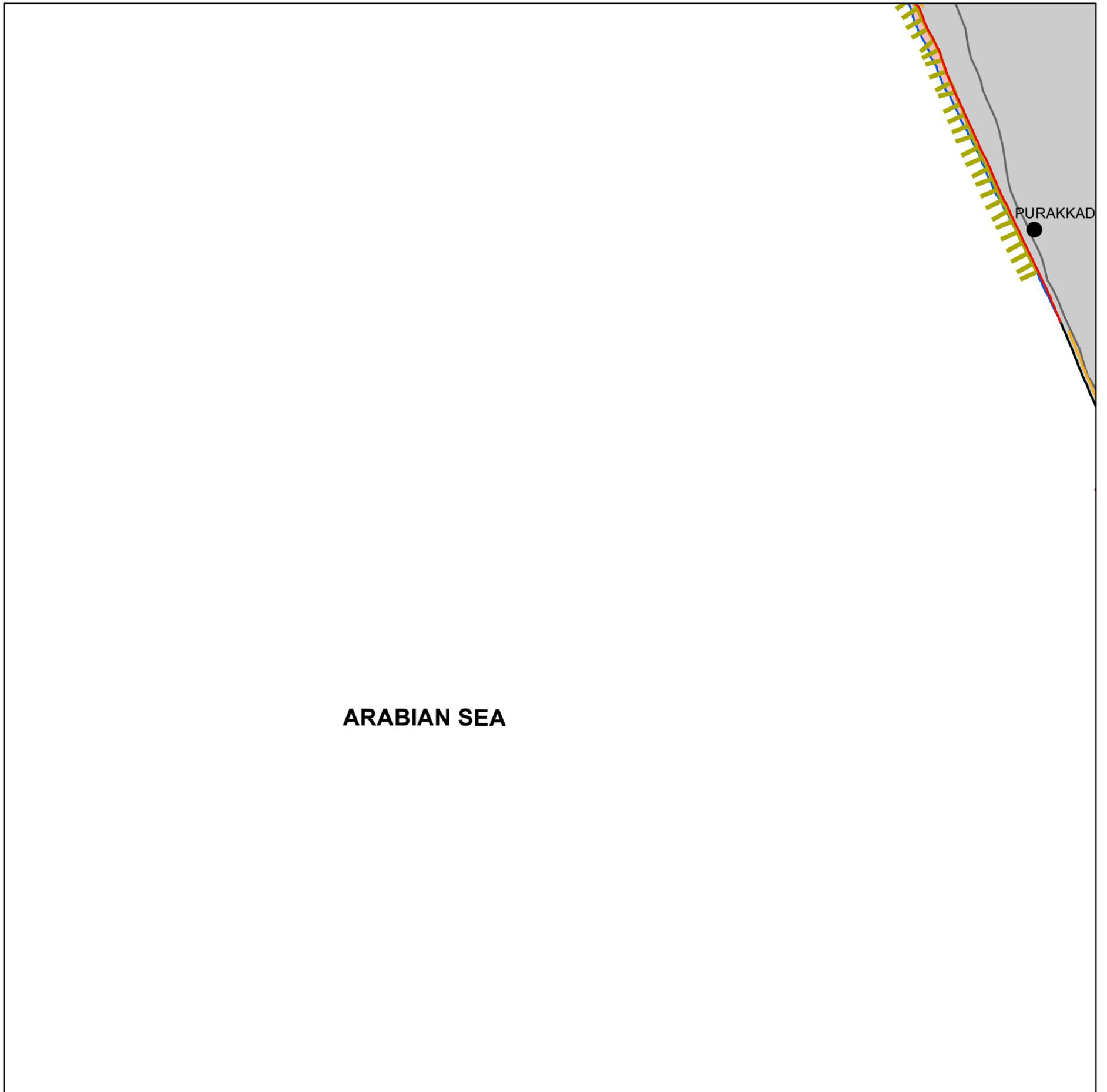
SHORELINE CHANGE MAP

FOR OFFICIAL USE ONLY

ALAPPUZHA DISTRICT

KERALA

SHEET NO. 58C07SW



Legend

-  EROSION
-  HIGH-TIDE LINE 2014-16
-  HIGH-TIDE LINE 2004-06
-  STABLE
-  ROAD
-  SEA WALL
-  GROYNES
-  HABITATION

INDEX TO SHEETS

SEA	58C07NW	58C07NE
SEA	58C07SW	58C07SE
SEA	SEA	58C08NE



0 2 km



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI

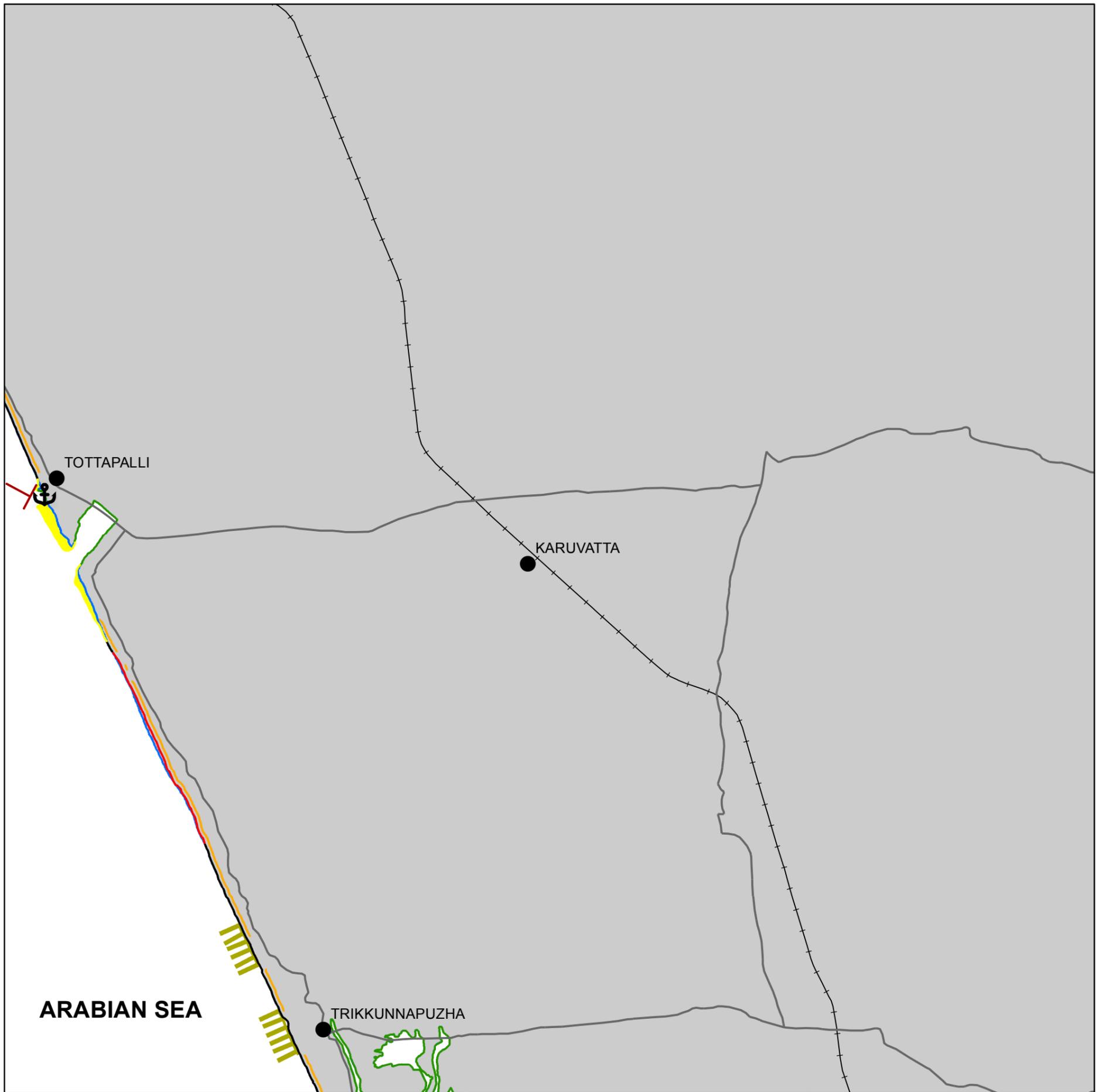


SHORELINE CHANGE MAP

ALAPPUZHA DISTRICT

KERALA

FOR OFFICIAL USE ONLY
SHEET NO. 58C07SE



ARABIAN SEA

Legend

- EROSION
- ACCRETION
- HIGH-TIDE LINE 2014-16
- HIGH-TIDE LINE 2004-06
- STABLE
- ROAD
- RAILWAY
- SEA WALL
- GROYNES
- BREAKWATER
- ⚓ PORT/HARBOUR
- HABITATION

INDEX TO SHEETS

58C07NW	58C07NE	58C11NW
58C07SW	58C07SE	58C11SW
SEA	58C08NE	58C12NW



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI



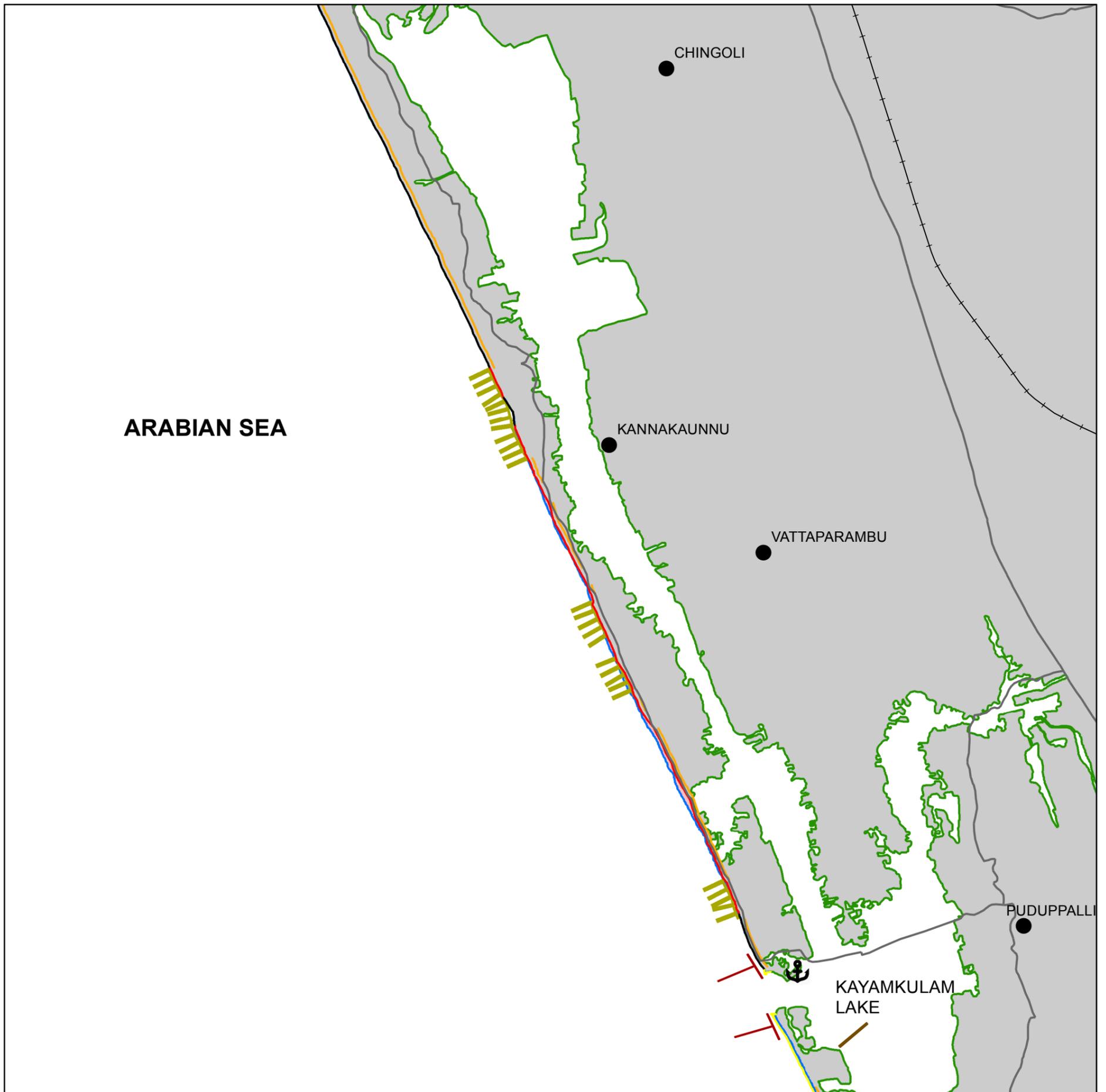
SHORELINE CHANGE MAP

FOR OFFICIAL USE ONLY

ALAPPUZHA DISTRICT

KERALA

SHEET NO. 58C08NE



Legend

- EROSION
- ACCRETION
- HIGH-TIDE LINE 2014-16
- HIGH-TIDE LINE 2004-06
- STABLE
- ROAD
- RAILWAY
- SEA WALL
- GROYNES
- BREAKWATER
- JETTY
- PORT/HARBOUR
- HABITATION

INDEX TO SHEETS

58C07SW	58C07SE	58C11SW
SEA	58C08NE	58C12NW
SEA	58C08SE	58C12SW



0 2 km



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI

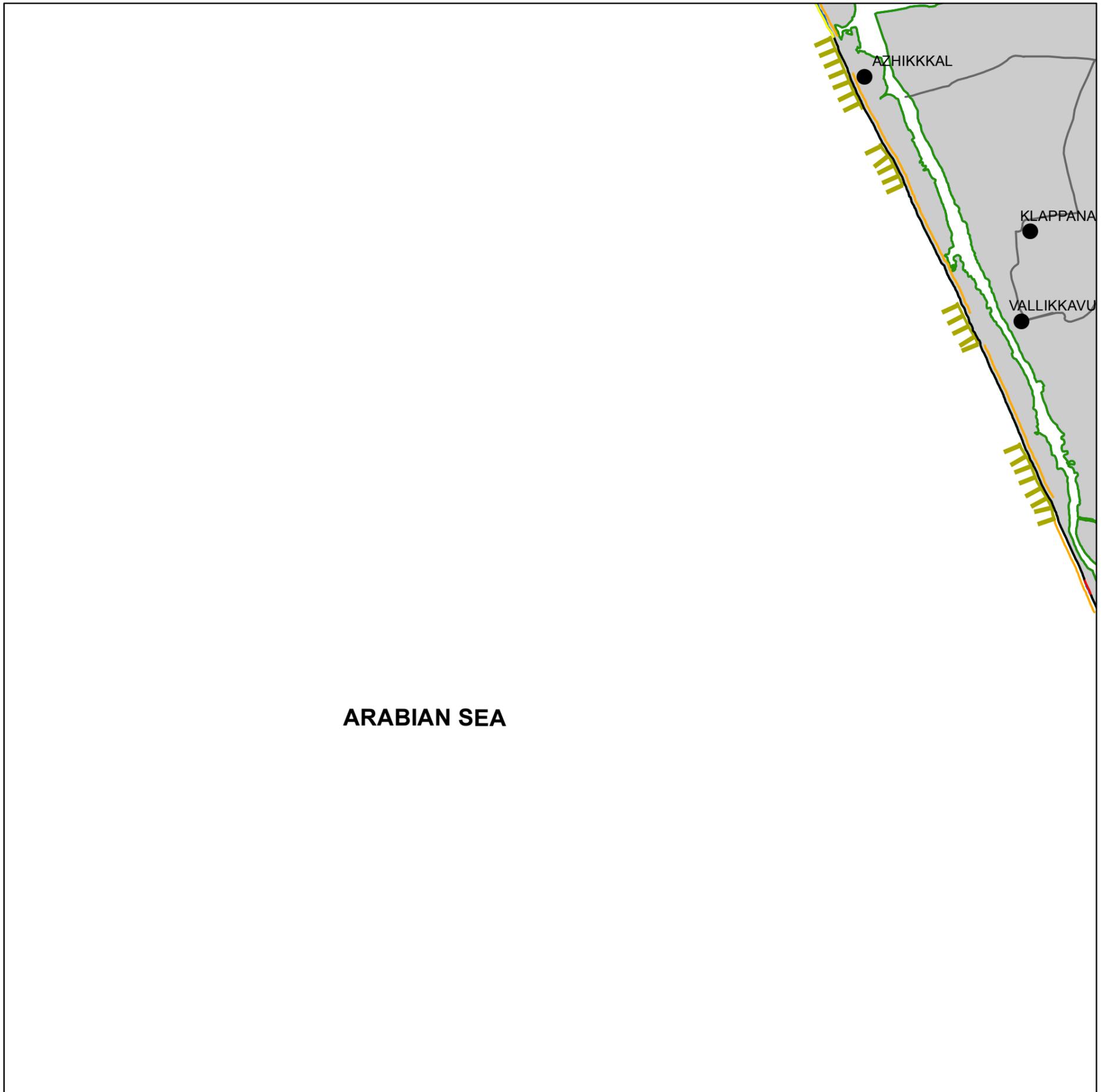


SHORELINE CHANGE MAP

ALAPPUZHA/KOLLAM
DISTRICT

KERALA

FOR OFFICIAL USE ONLY
SHEET NO. 58C08SE



Legend

- EROSION
- ACCRETION
- HIGH-TIDE LINE 2014-16
- HIGH-TIDE LINE 2004-06
- STABLE
- ROAD
- SEA WALL
- GROYNES
- HABITATION

INDEX TO SHEETS

SEA	58C08NE	58C12NW
SEA	58C08SE	58C12SW
SEA	SEA	58D09NW



0 2 km



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI



SHORELINE CHANGE MAP

FOR OFFICIAL USE ONLY

KOLLAM DISTRICT

KERALA

SHEET NO. 58C12SW



Legend

- EROSION
- HIGH-TIDE LINE 2014-16
- HIGH-TIDE LINE 2004-06
- STABLE
- ROAD
- RAILWAY
- SEA WALL
- HABITATION

INDEX TO SHEETS

58C08NE	58C12NW	58C12NE
58C08SE	58C12SW	58C12SE
SEA	58D09NW	58D09NE



0 2 km



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI



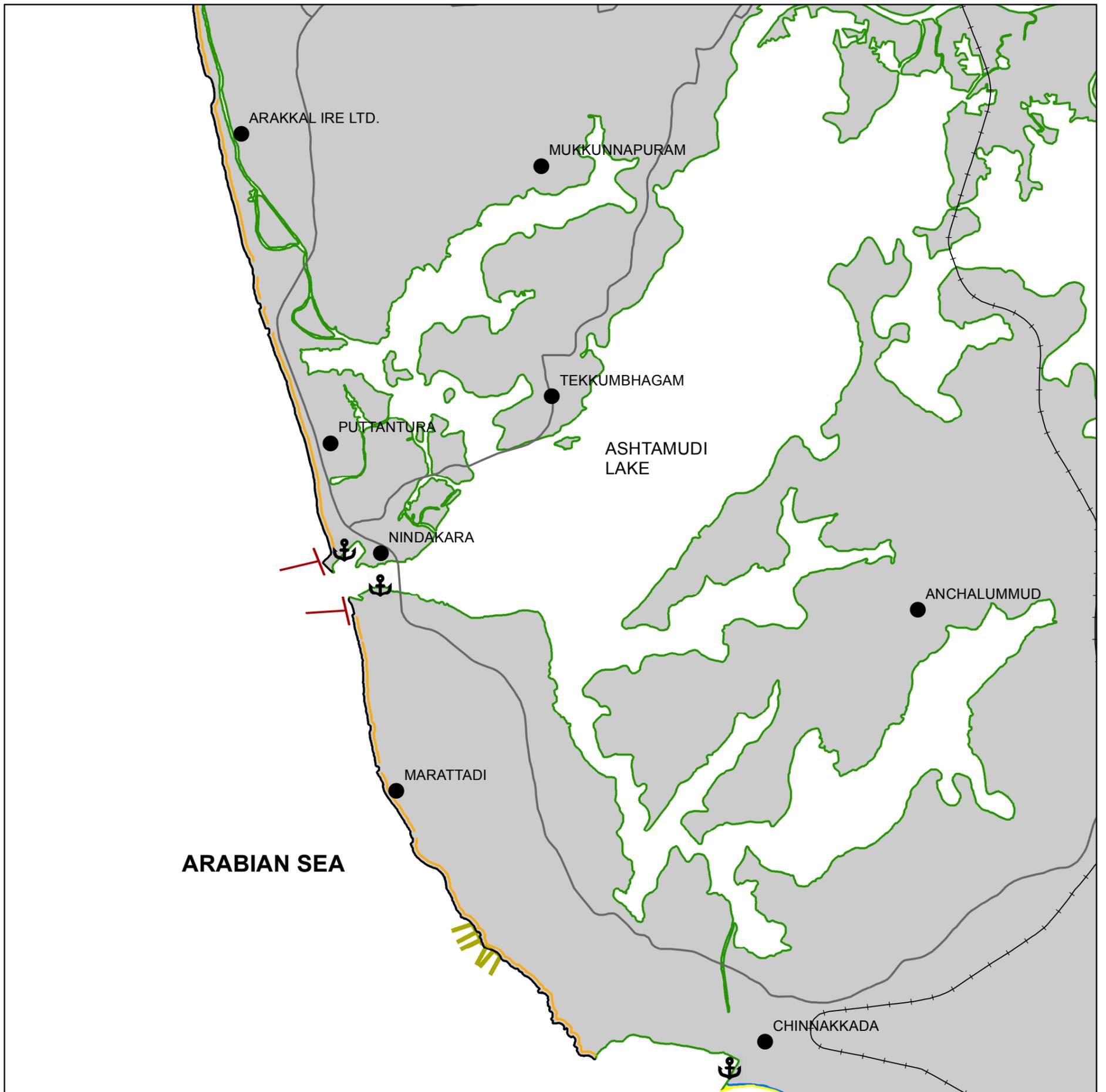
SHORELINE CHANGE MAP

FOR OFFICIAL USE ONLY

KOLLAM DISTRICT

KERALA

SHEET NO. 58D09NW



Legend

-  ACCRETION
-  HIGH-TIDE LINE 2014-16
-  HIGH-TIDE LINE 2004-06
-  STABLE
-  ROAD
-  RAILWAY
-  SEA WALL
-  GROYNES
-  BREAKWATER
-  PORT/HARBOUR
-  HABITATION

INDEX TO SHEETS

58C08SE	58C12SW	58C12SE
SEA	58D09NW	58D09NE
SEA	58D09SW	58D09SE



0 2 km



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI



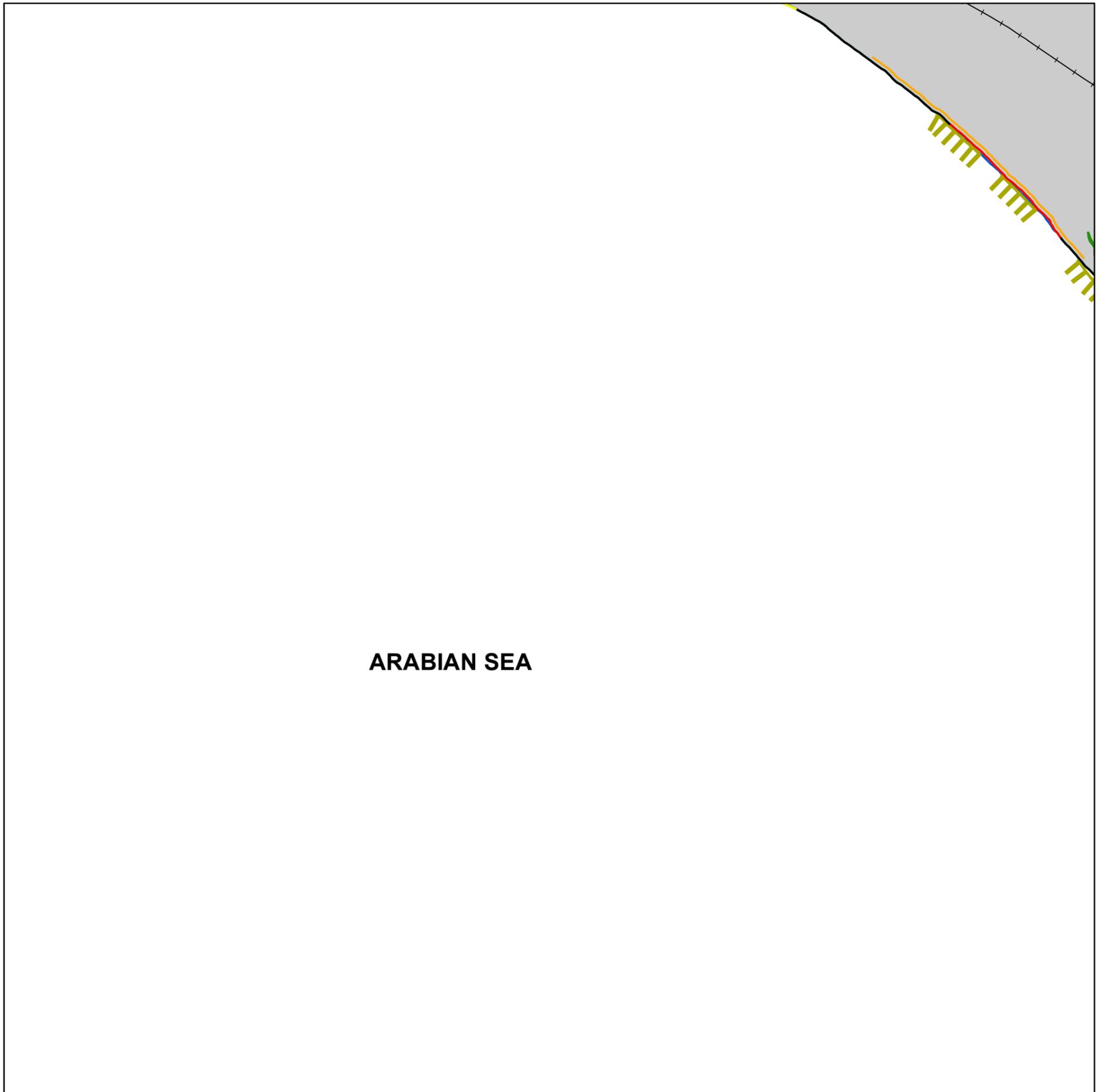
SHORELINE CHANGE MAP

FOR OFFICIAL USE ONLY

KOLLAM DISTRICT

KERALA

SHEET NO. 58D09SW

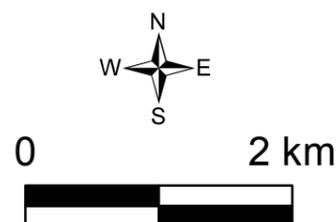


Legend

- EROSION
- ACCRETION
- HIGH-TIDE LINE 2014-16
- HIGH-TIDE LINE 2004-06
- STABLE
- RAILWAY
- SEA WALL
- GROYNES

INDEX TO SHEETS

SEA	58D09NW	58D09NE
SEA	58D09SW	58D09SE
SEA	SEA	58D10NE



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI

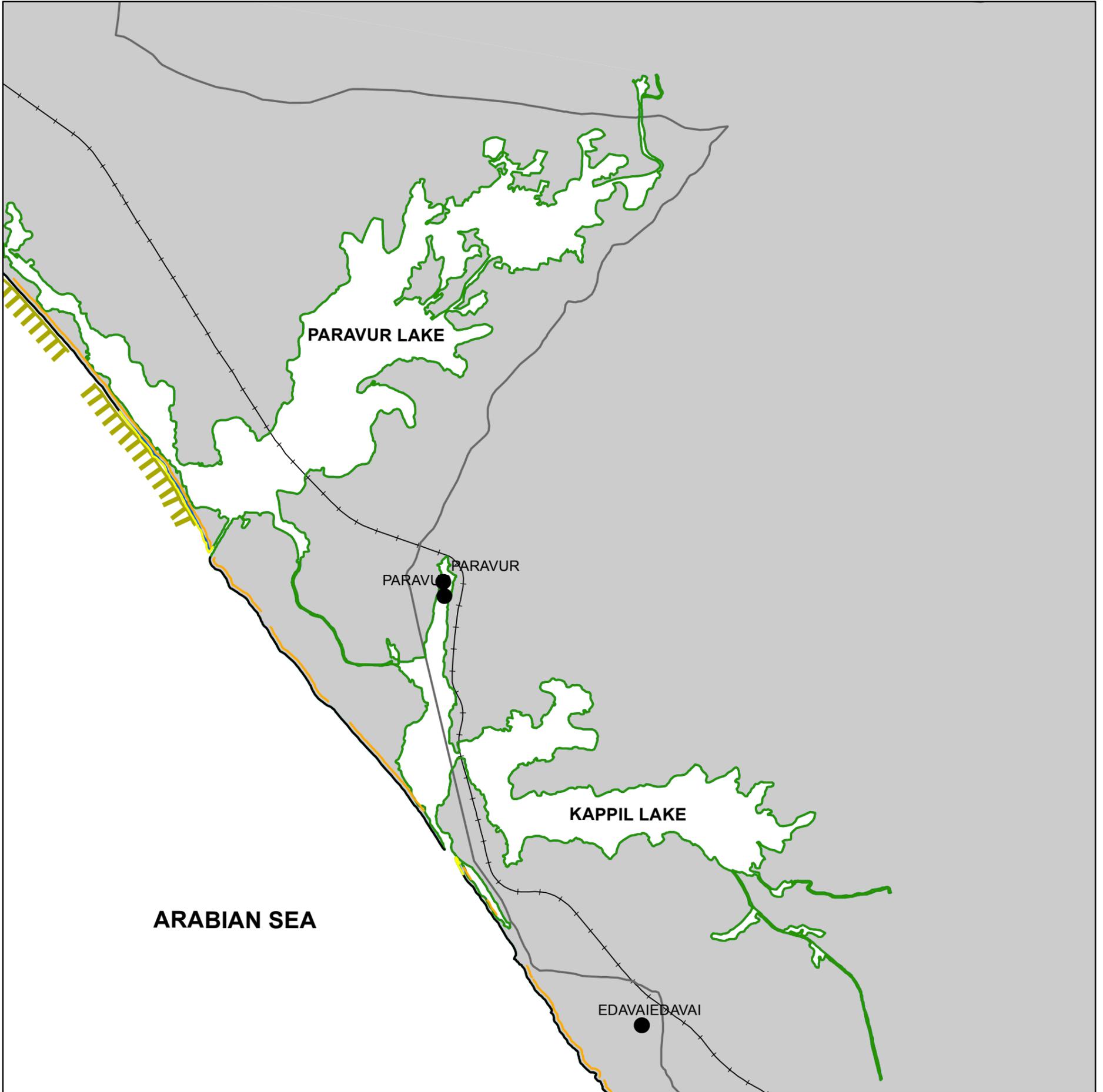


SHORELINE CHANGE MAP

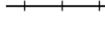
KOLLAM/THIRUVANANTHAPURAM
DISTRICT

KERALA

FOR OFFICIAL USE ONLY
SHEET NO. 58D09SE



Legend

-  ACCRETION
-  HIGH-TIDE LINE 2014-16
-  HIGH-TIDE LINE 2004-06
-  STABLE
-  ROAD
-  RAILWAY
-  SEA WALL
-  GROYNES
-  HABITATION

INDEX TO SHEETS

58D09NW	58D09NE	58D13NW
58D09SW	58D09SE	58D13SW
SEA	58D10NE	58D14NW



0 2 km



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI

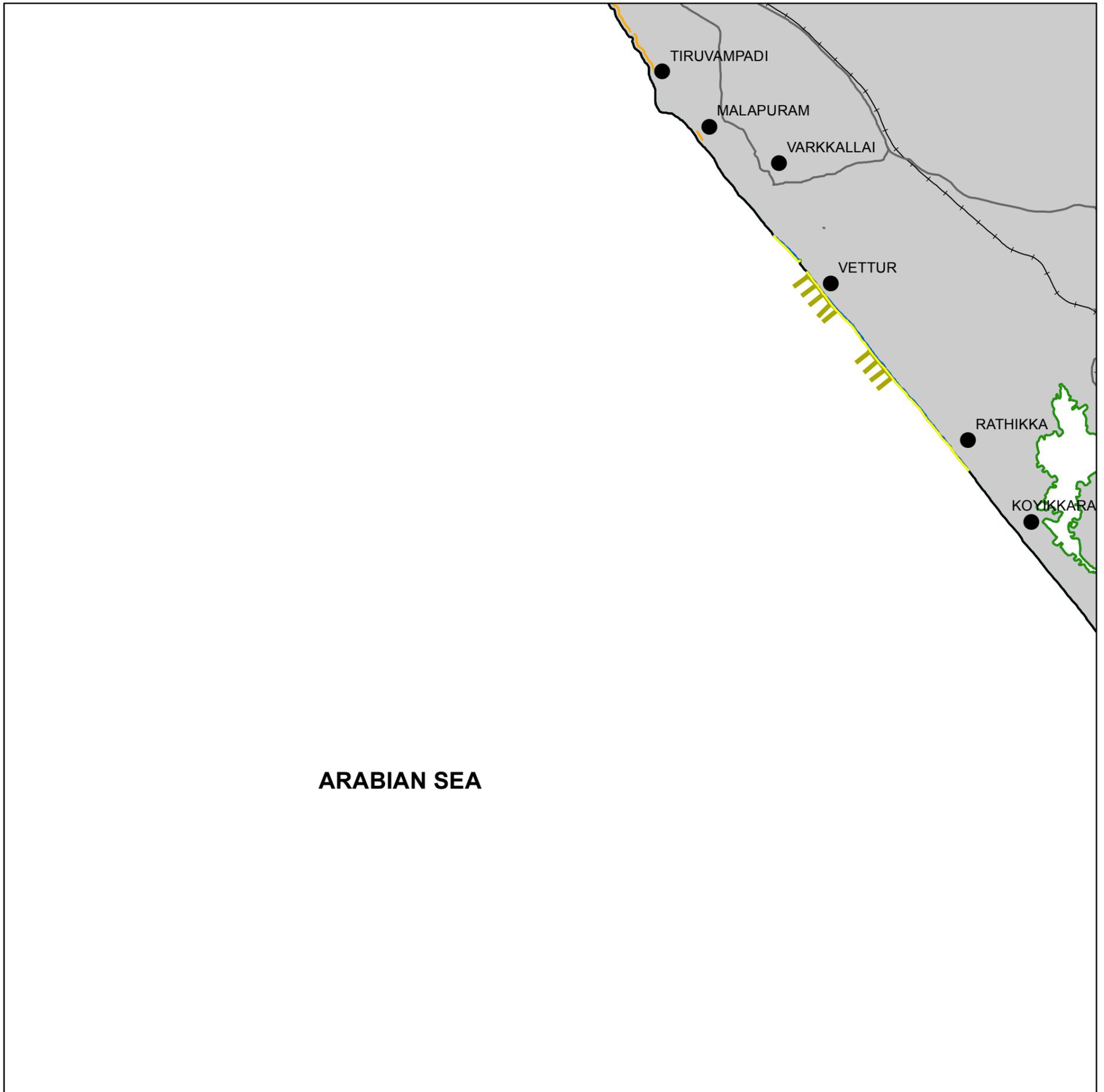


SHORELINE CHANGE MAP

THIRUVANANTHAPURAM
DISTRICT

KERALA

FOR OFFICIAL USE ONLY
SHEET NO. 58D10NE



Legend

- ACCRETION
- HIGH-TIDE LINE 2014-16
- HIGH-TIDE LINE 2004-06
- ROAD
- RAILWAY
- STABLE
- SEA WALL
- GROYNES
- HABITATION

INDEX TO SHEETS

58D09SW	58D09SE	58D13SW
SEA	58D10NE	58D14NW
SEA	SEA	58D14SW



0 2 km



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI



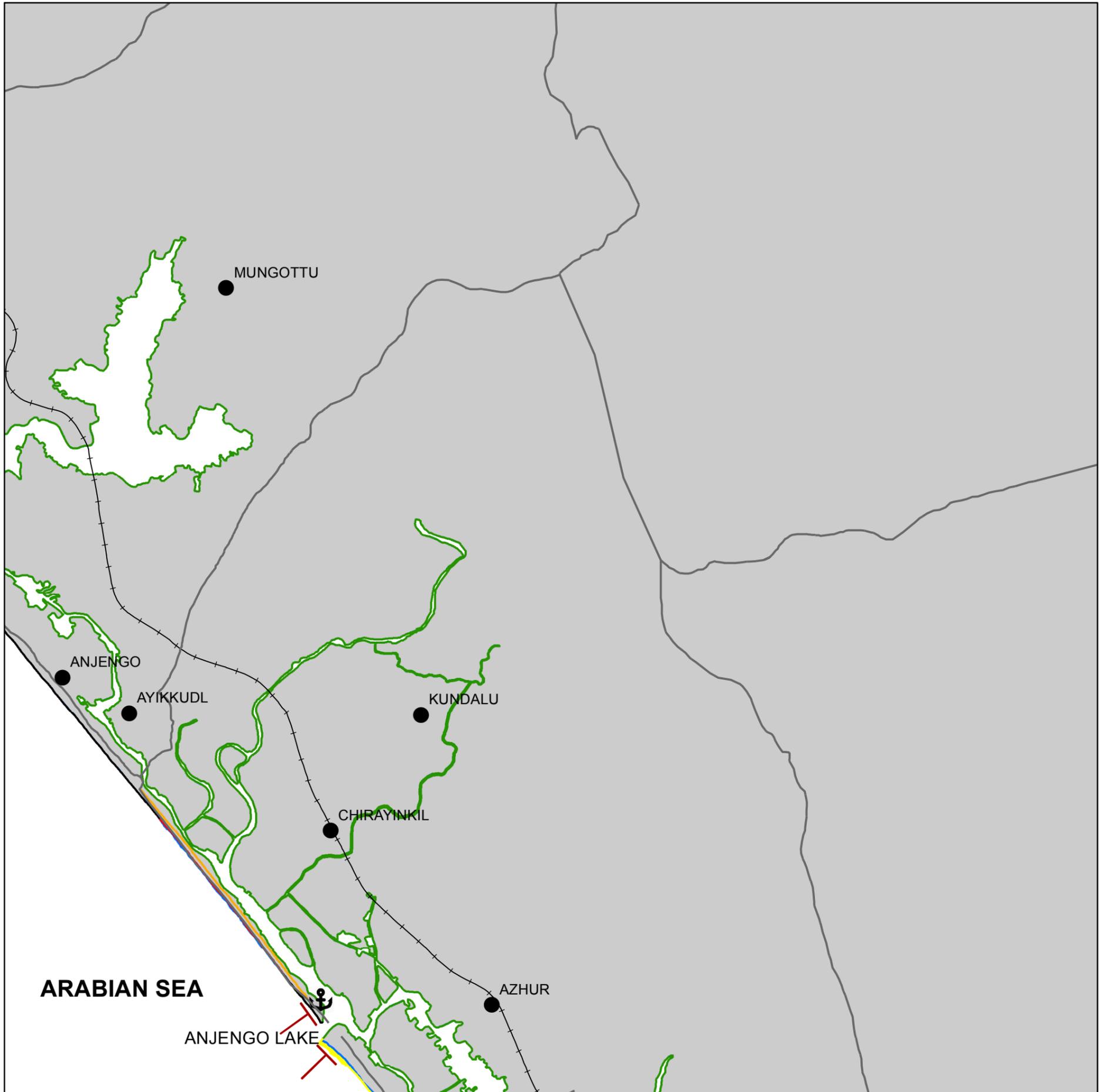
SHORELINE CHANGE MAP

FOR OFFICIAL USE ONLY

THIRUVANANTHAPURAM DISTRICT

KERALA

SHEET NO. 58D14NW



Legend

- EROSION
- ACCRETION
- HIGH-TIDE LINE 2014-16
- HIGH-TIDE LINE 2004-06
- STABLE
- ROAD
- ++ RAILWAY
- SEA WALL
- T BREAKWATER
- ⚓ PORT/HARBOUR
- HABITATION

INDEX TO SHEETS

58D09SE	58D13SW	58D13SE
58D10NE	58D14NW	58D14NE
SEA	58D14SW	58D14SE



0 2 km



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI

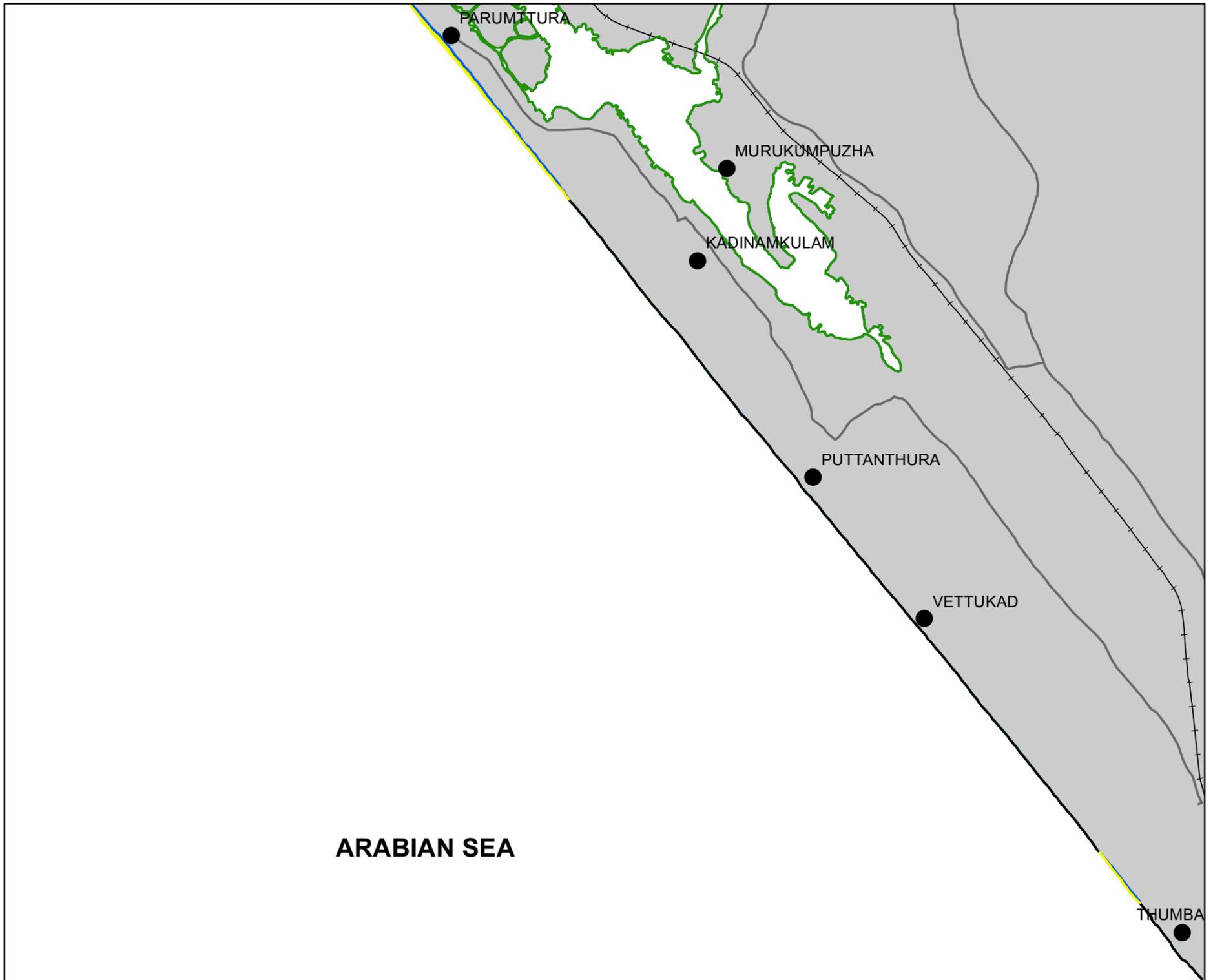


SHORELINE CHANGE MAP

THIRUVANANTHAPURAM
DISTRICT

KERALA

FOR OFFICIAL USE ONLY
SHEET NO. 58D14SW



ARABIAN SEA

Legend

-  ACCRETION
-  HIGH-TIDE LINE 2014-16
-  HIGH-TIDE LINE 2004-06
-  STABLE
-  ROAD
-  RAILWAY
-  HABITATION



INDEX TO SHEETS

58D10NE	58D14NW	58D14NE
SEA	58D14SW	58D14SE
SEA	SEA	58D15NE



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI

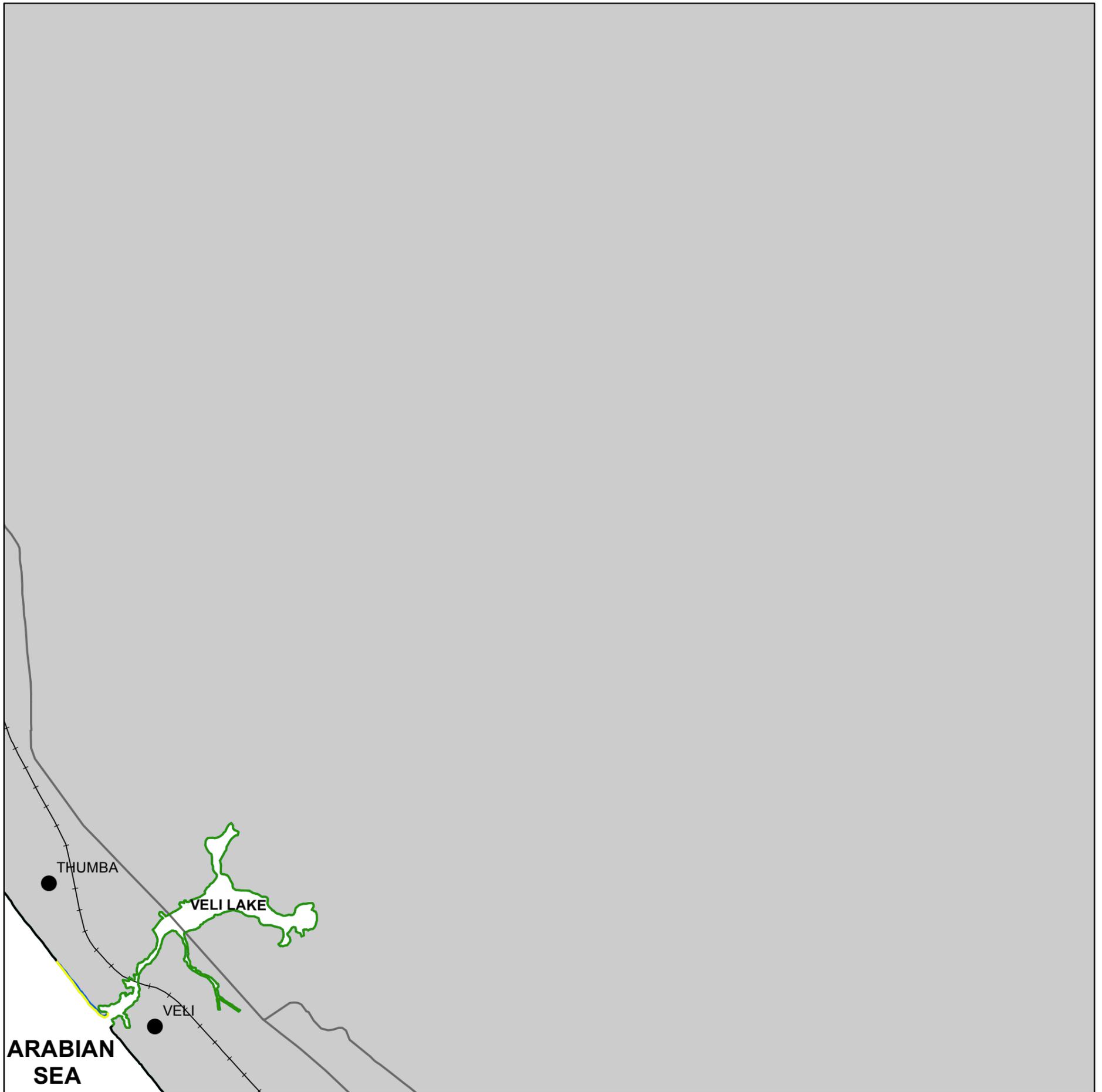


SHORELINE CHANGE MAP

THIRUVANANTHAPURAM
DISTRICT

KERALA

FOR OFFICIAL USE ONLY
SHEET NO. 58D14SE



Legend

-  ACCRETION
-  HIGH-TIDE LINE 2014-16
-  HIGH-TIDE LINE 2004-06
-  STABLE
-  ROAD
-  RAILWAY
-  HABITATION

INDEX TO SHEETS

58D14NW	58D14NE	58H02NW
58D14SW	58D14SE	58H02SW
SEA	58D15NE	58H03NW



0 2 km



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI

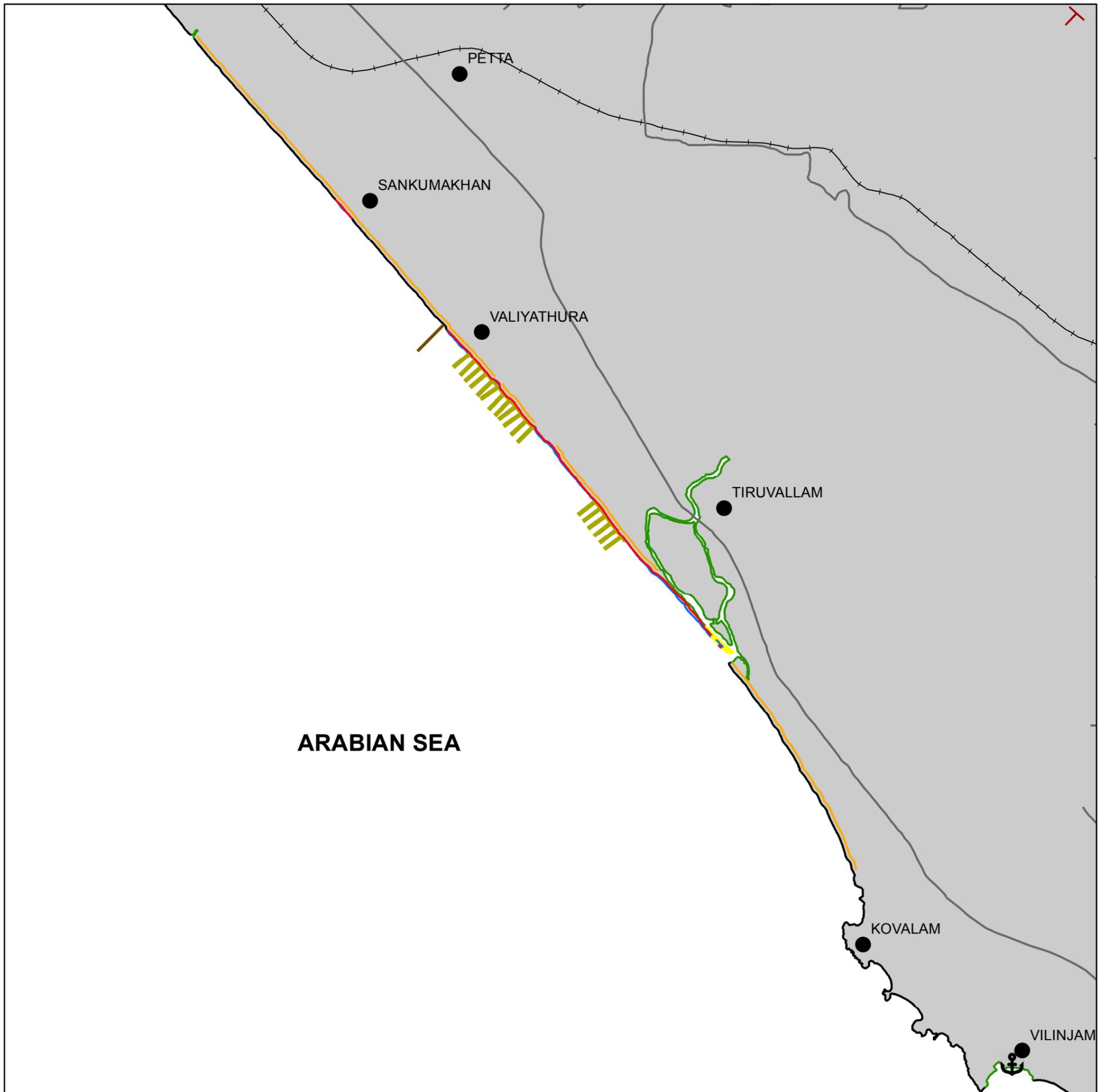


SHORELINE CHANGE MAP

FOR OFFICIAL USE ONLY

THIRUVANANTHAPURAM DISTRICT **KERALA**

SHEET NO. 58D15NE



ARABIAN SEA

Legend

- EROSION
- ACCRETION
- HIGH-TIDE LINE 2014-16
- HIGH-TIDE LINE 2004-06
- STABLE
- ROAD
- RAILWAY
- SEA WALL
- GROYNES
- JETTY
- ⚓ PORT/HARBOUR
- HABITATION

INDEX TO SHEETS

58D14SW	58D14SE	58H02SW
SEA	58D15NE	58H03NW
SEA	58D15SE	58H03SW



0 2 km



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI



SHORELINE CHANGE MAP

FOR OFFICIAL USE ONLY

THIRUVANANTHAPURAM DISTRICT

KERALA

SHEET NO. 58D15SE



ARABIAN SEA

Legend

- HIGH-TIDE LINE 2014-16
- HIGH-TIDE LINE 2004-06
- STABLE
- BREAKWATER
- PORT/HARBOUR

INDEX TO SHEETS

SEA	58D15NE	58H03NW
SEA	58D15SE	58H03SW
SEA	SEA	58H04NW



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI

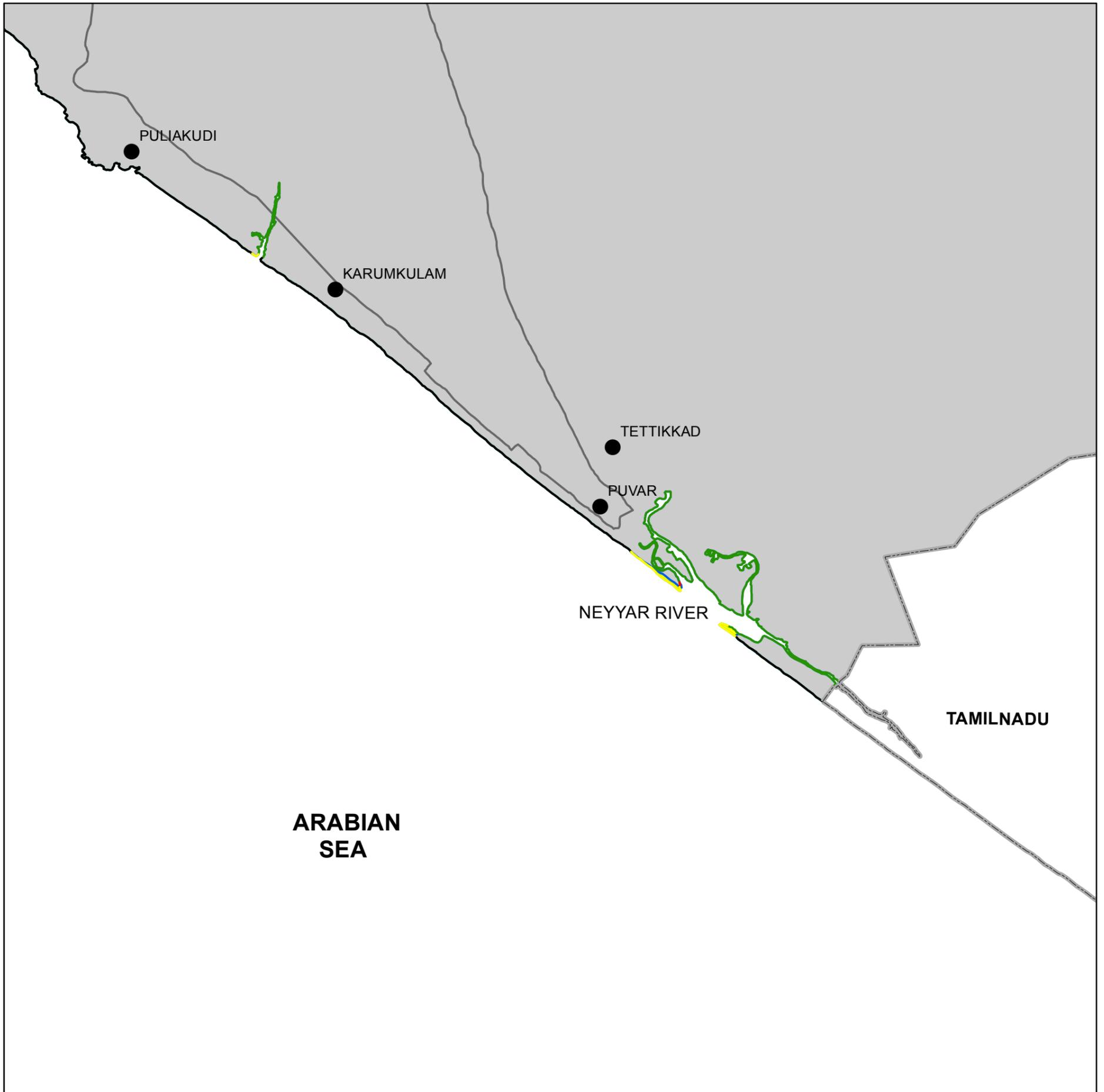


SHORELINE CHANGE MAP

THIRUVANANTHAPURAM
DISTRICT

KERALA

FOR OFFICIAL USE ONLY
SHEET NO. 58H03SW



Legend

- EROSION
- ACCRETION
- HIGH-TIDE LINE 2014-16
- HIGH-TIDE LINE 2004-06
- STABLE
- ROAD
- STATE BOUNDARY
- HABITATION

INDEX TO SHEETS

58D15NE	58H03NW	58H03NH
58D15SE	58H03SW	58H03SH
SEA	58H04NW	58H04NH



0 2 km



DATA SOURCE:
IRS LISS4 IMAGES OF 2004-06 & 2014-16

PREPARED BY:
SPACE APPLICATIONS CENTRE, ISRO, AHMEDABAD
AND CENTRAL WATER COMMISSION, NEW DELHI



HOT SPOTS OF SHORELINE CHANGE

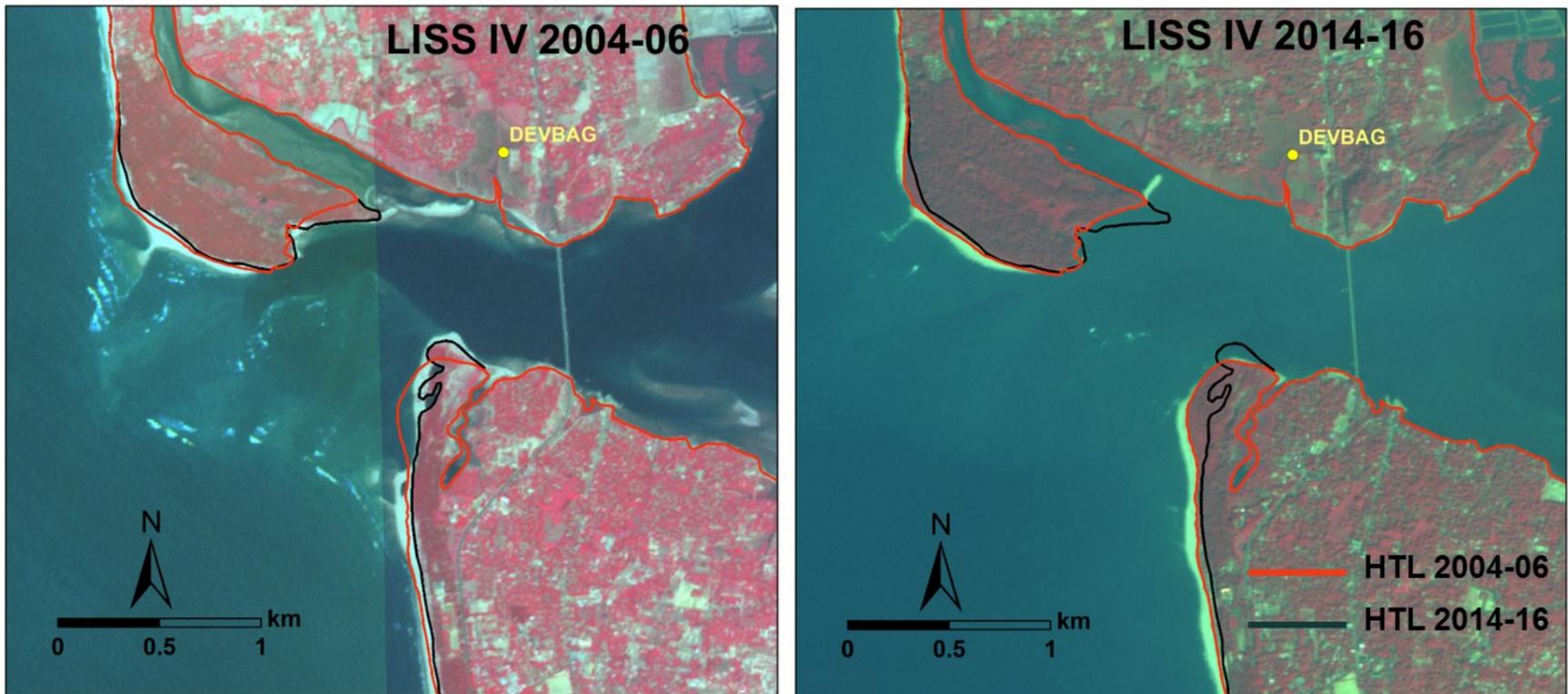


Plate 1: Shoreline changes along the River mouth Kali River (48J01SW) marked on LISS IV images of IRS P6 and Resourcesat-2

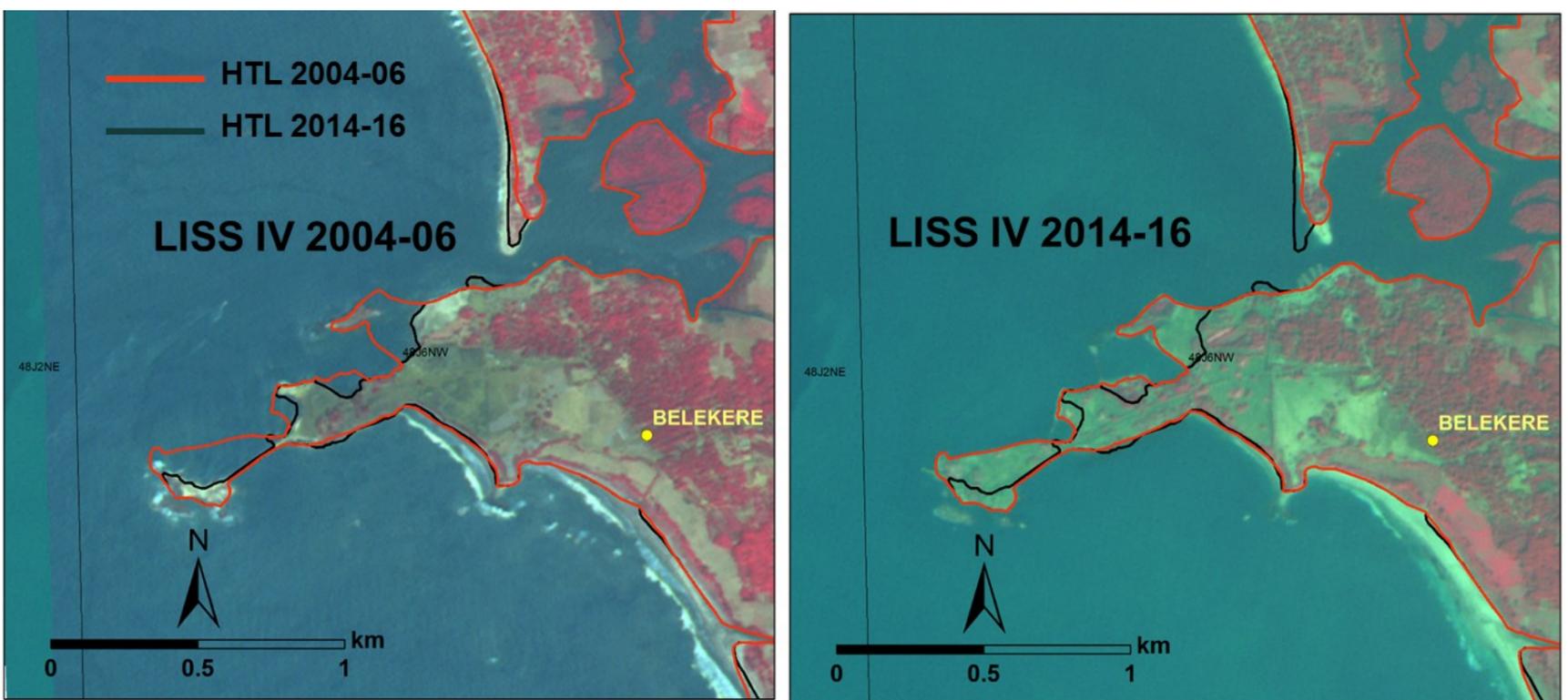


Plate 2: Shoreline changes along the mouth at stream north to Belekere (46J06NW) marked on LISS IV images of IRS P6 and Resourcesat-2

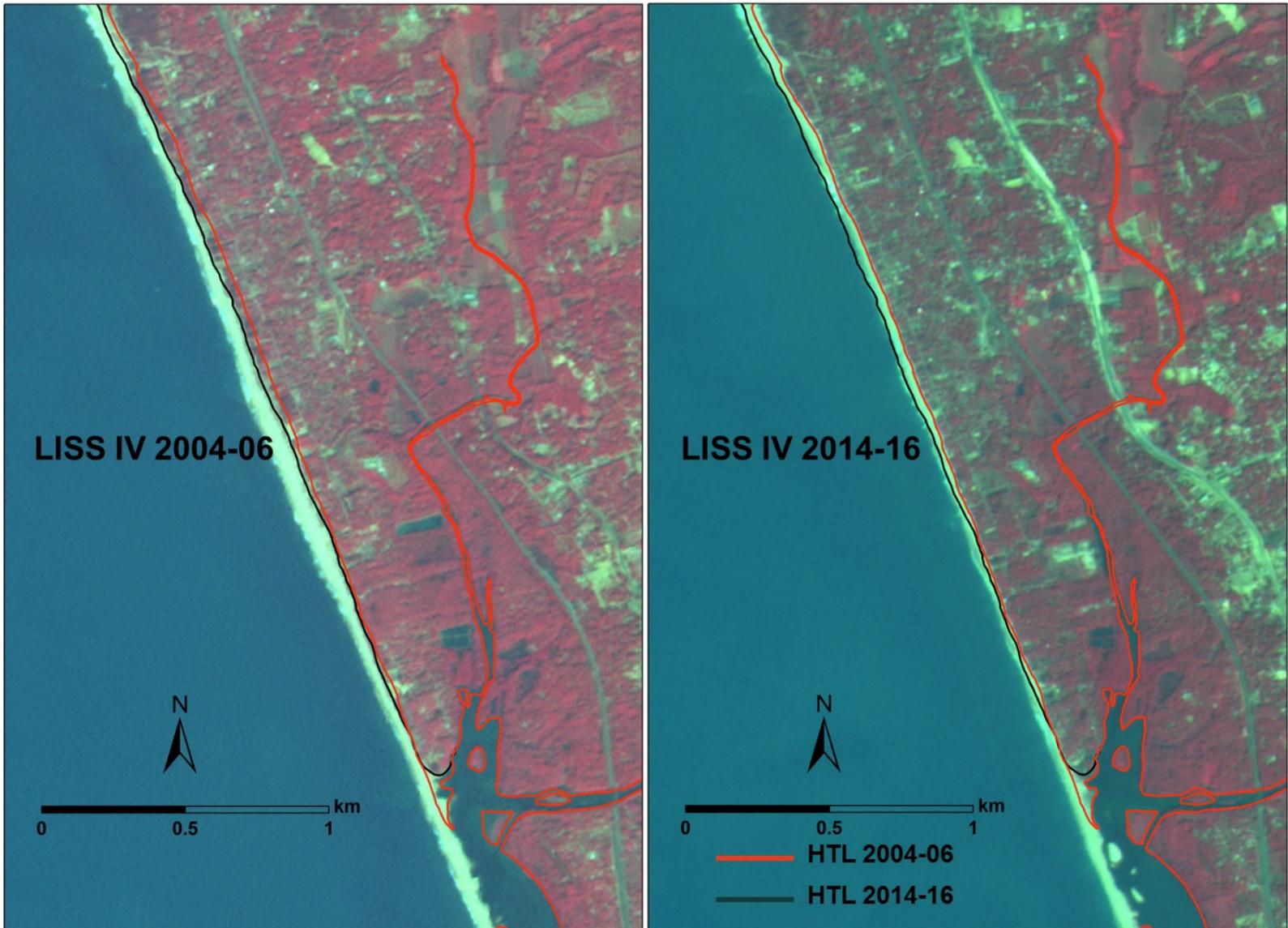


Plate 3: Erosion at Someshwar along the southern coast of Karnataka (48L13SW) marked on LISS IV images of IRS P6 and Resourcesat-2

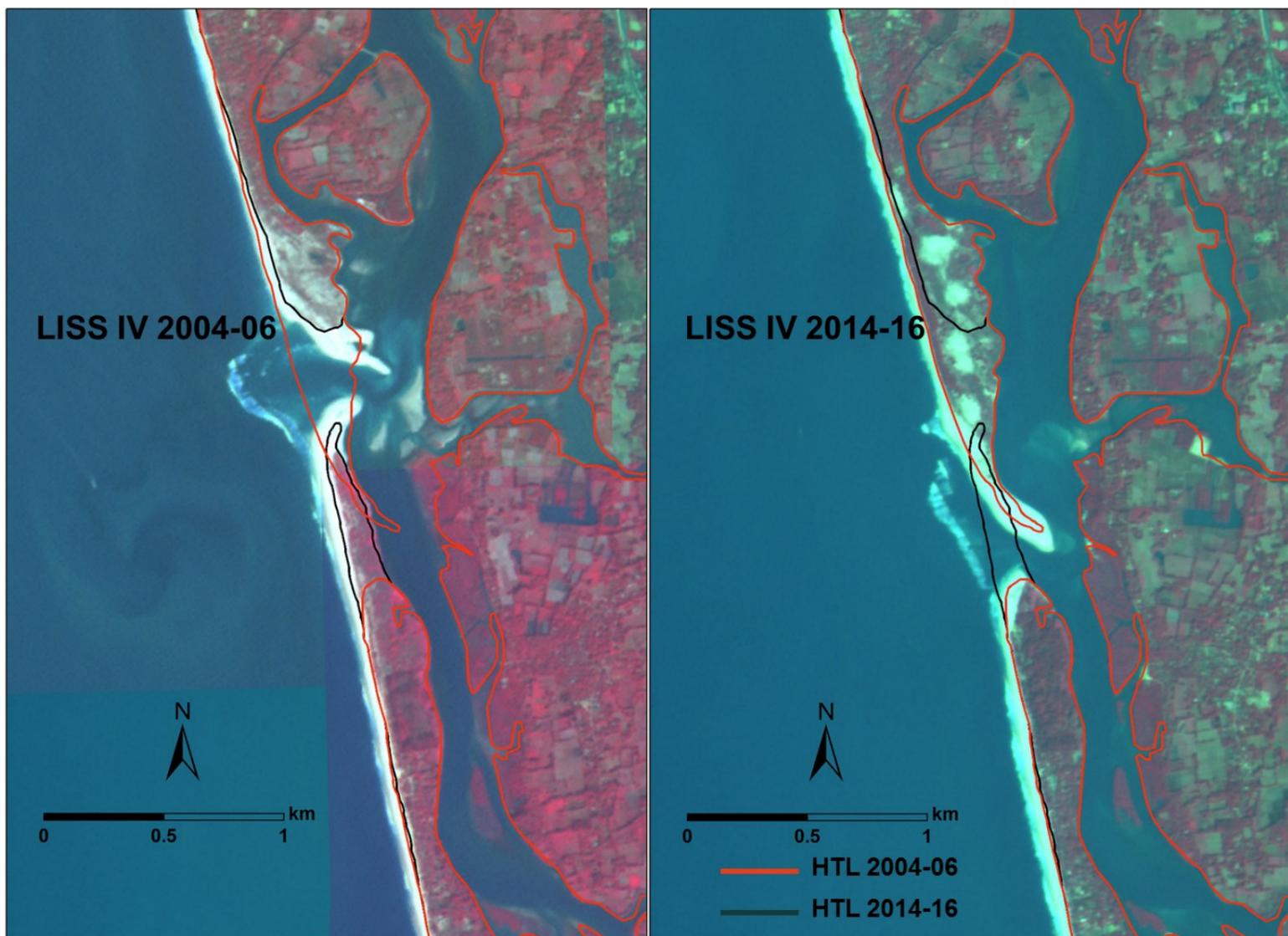


Plate 4: Shoreline changes at the mouth of Mulki River (48K16SW) marked on LISS IV images of IRS P6 and Resourcesat-2

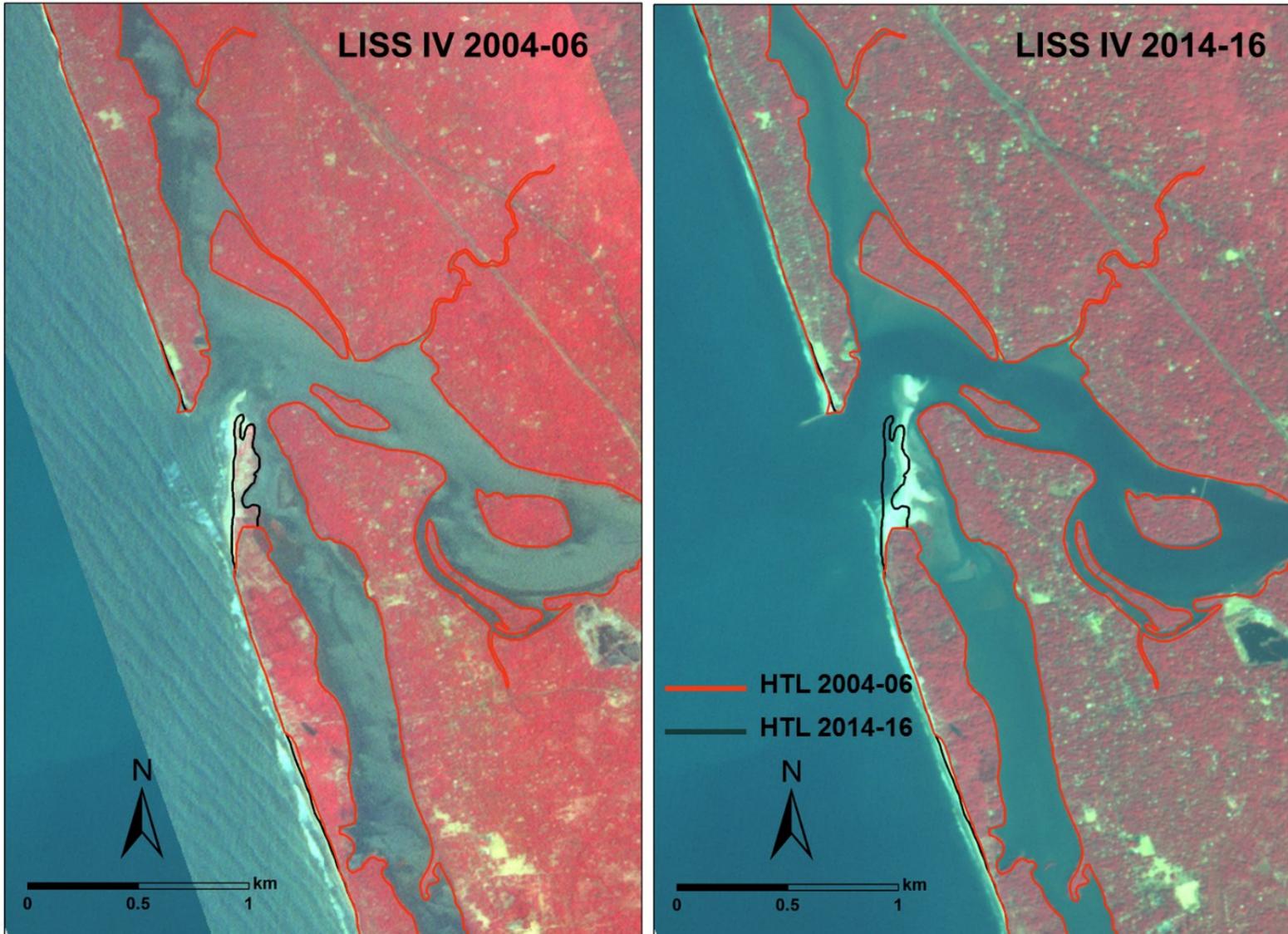


Plate 5: Shoreline changes at the mouth of Muthalipuzha (49M10SW) marked on LISS IV images of IRS P6 and Resourcesat-2

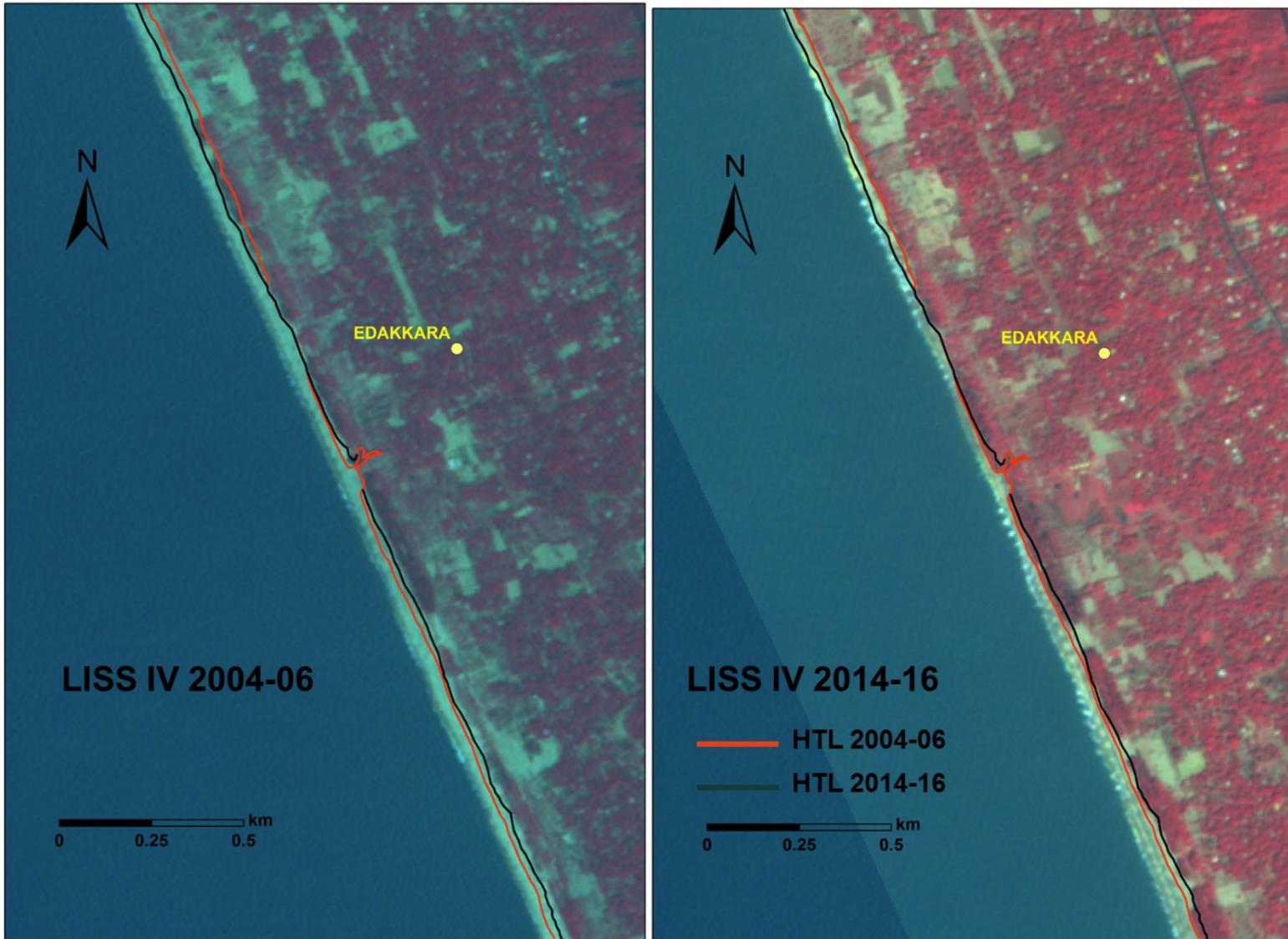


Plate 6: The adjacent coast of erosion and accretion at Edakkara (49N14NE) marked on LISS IV images of IRS P6 and Resourcesat-2

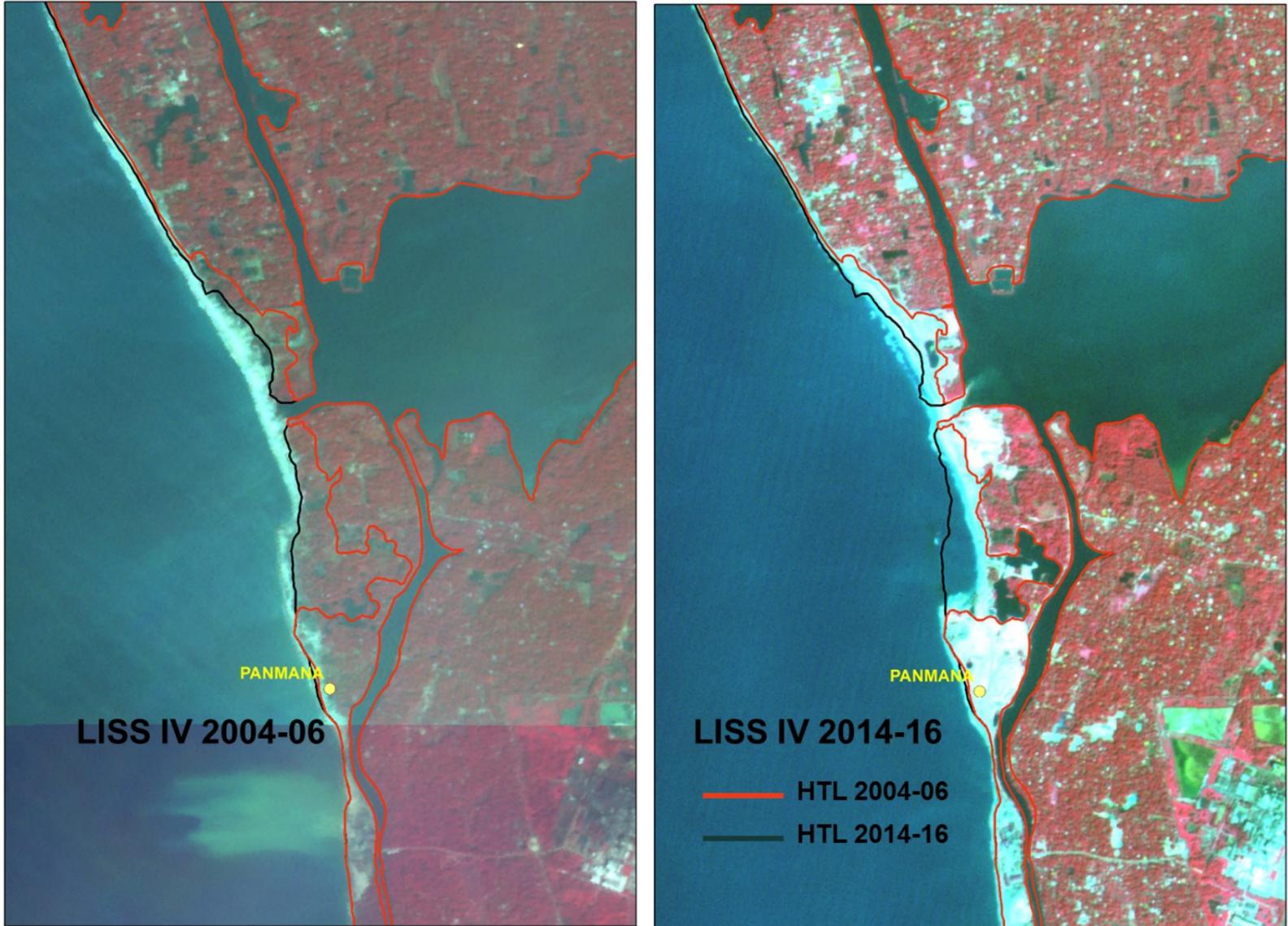


Plate 7: Erosion along coast at Panmana (58C12SW) marked on LISS IV images of IRS P6 and Resourcesat-2

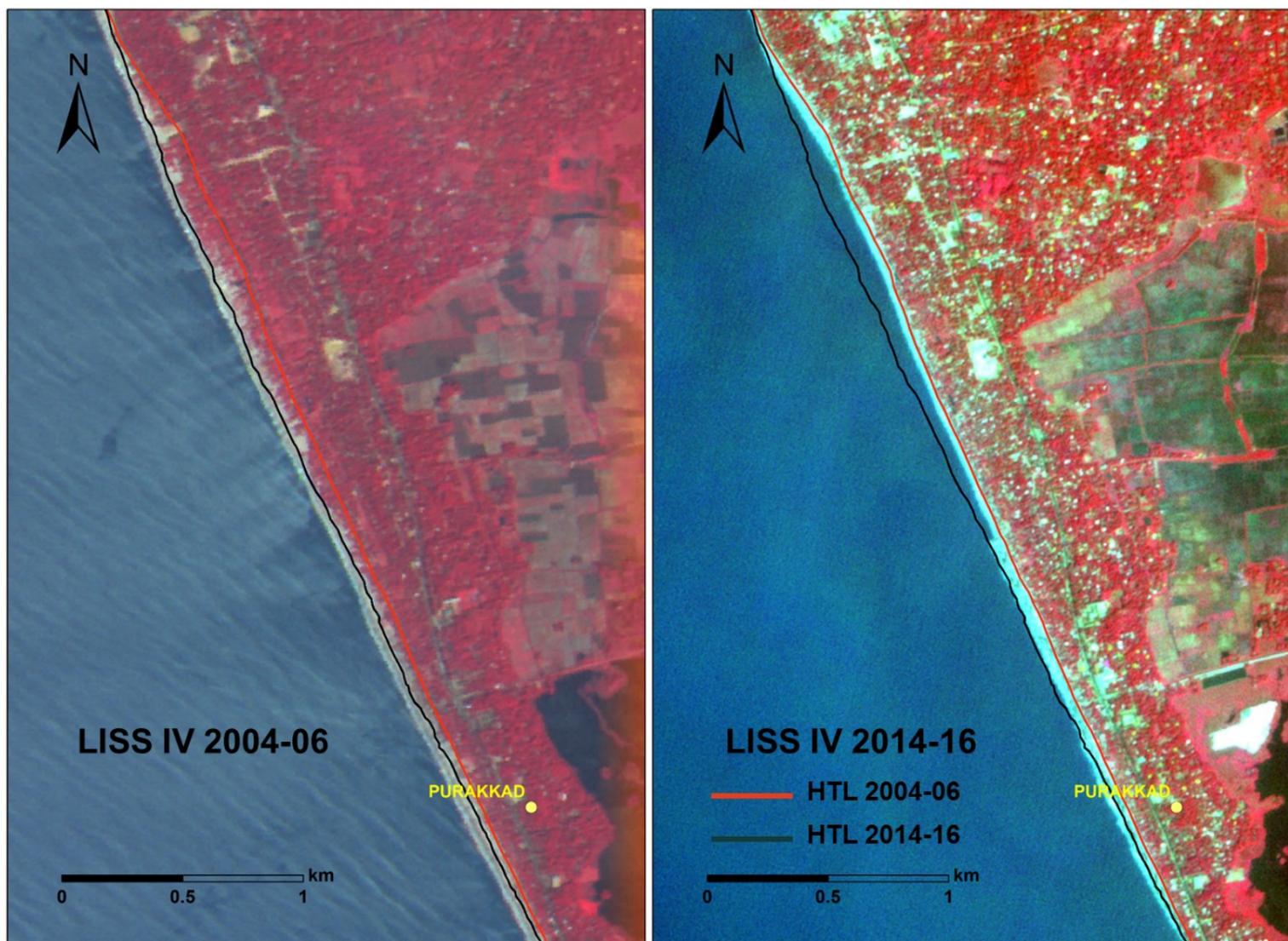


Plate 8: Erosion at Purakkadu Beach (58C07SW) marked on LISS IV images of IRS P6 and Resourcesat-2

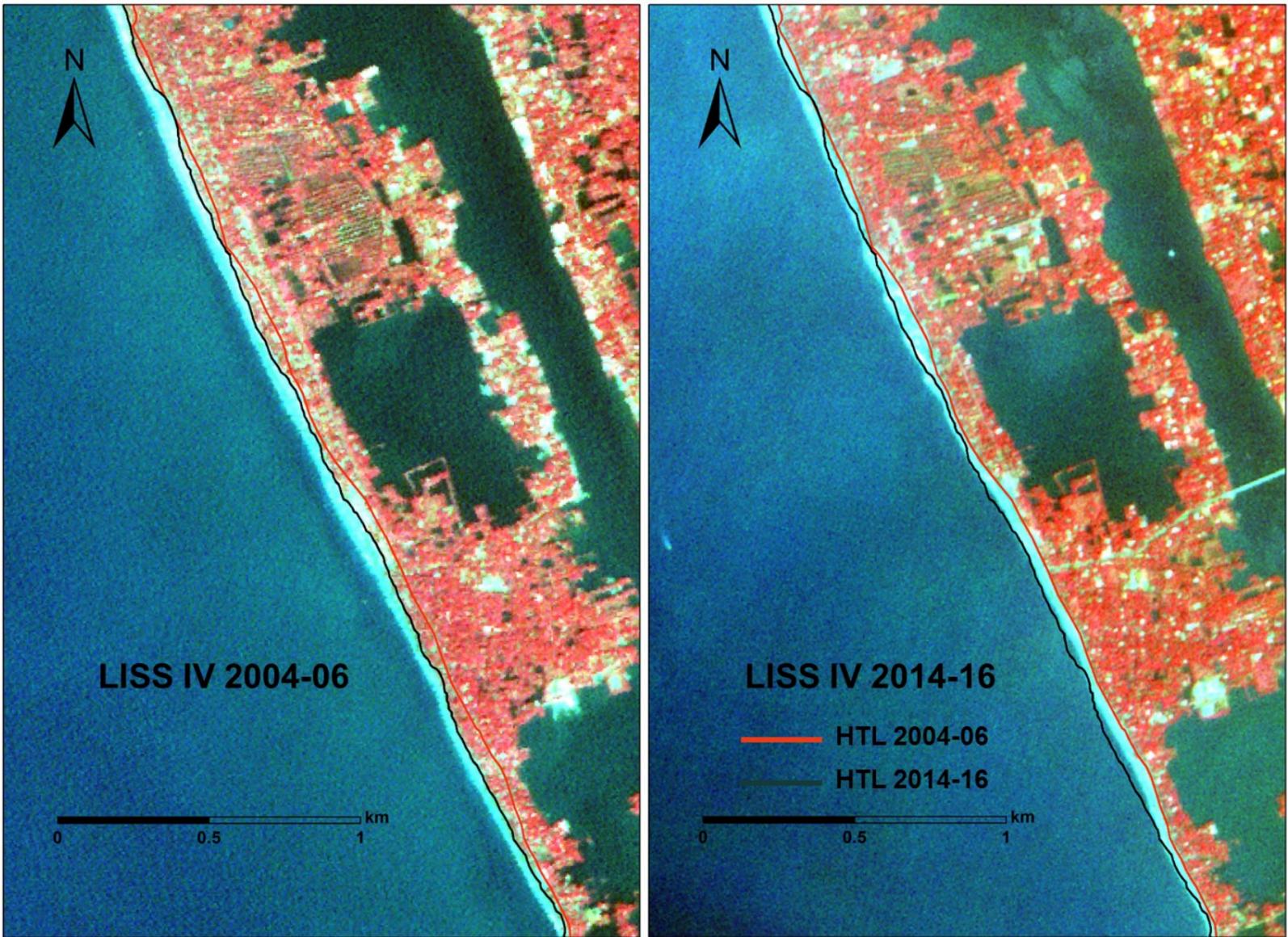


Plate 9: Erosion at the coast to the north of Kayamkulam Kayal (58C08NE) marked on LISS IV images of IRS P6 and Resourcesat-2

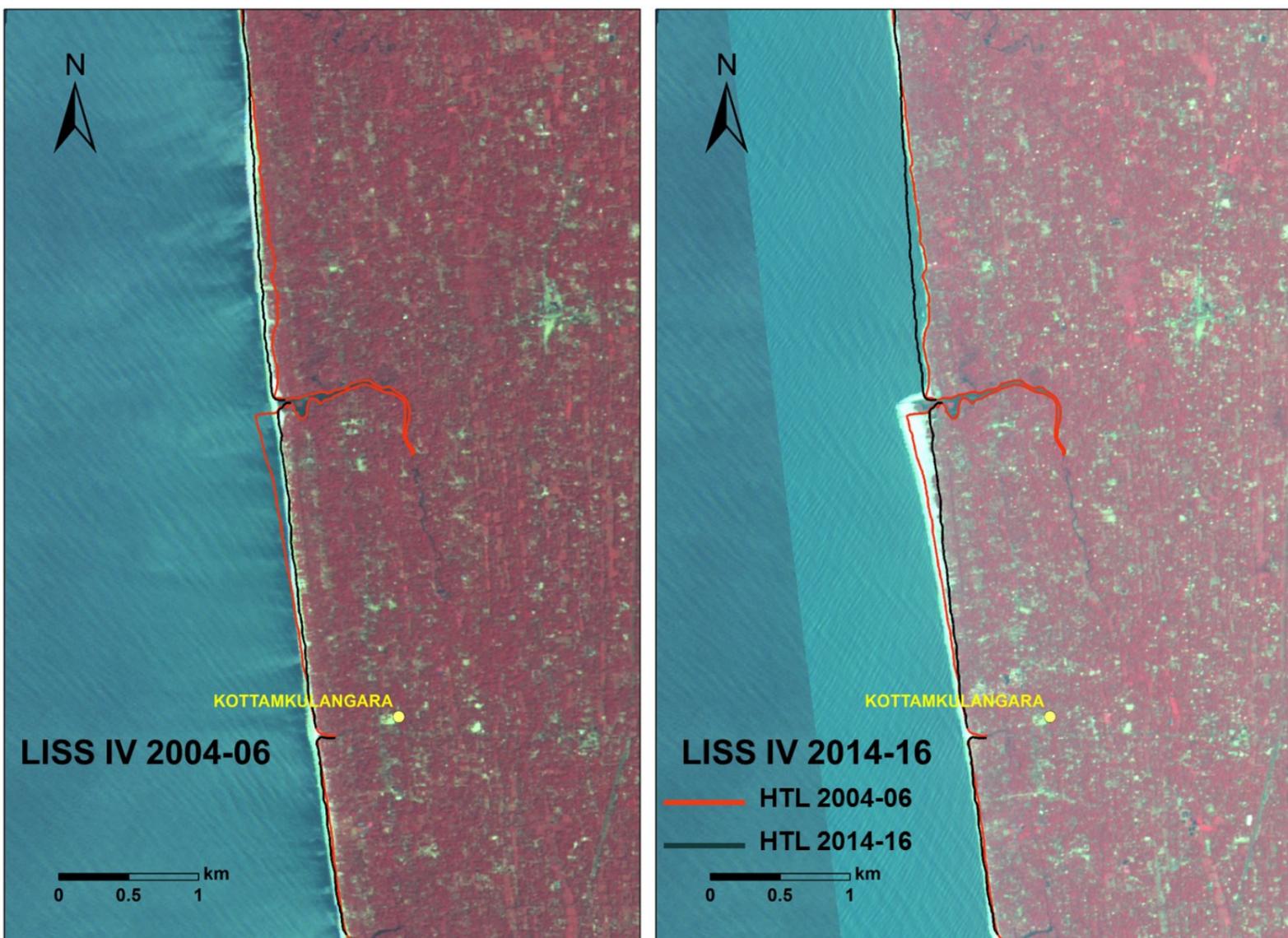


Plate 10: Shoreline changes due to construction at Kottamkulangara (58C06SW) marked on LISS IV images of IRS P6 and Resourcesat-2

LIST OF SATELLITE DATA USED

Table No. 3: Satellite data used for Karnataka Coast (2004-06 time-frame).

S. No.	Map Sheet No.	Satellite	Sensor	Orbit	Scene	Date
1	48J01NW	IRS-P6	LISS IV	8185, 11581	59, 124	15-05-2006, 09-01-2006
2	48J01SE	IRS-P6	LISS IV	8185	59, 60	15-05-2005
3	48J01SW	IRS-P6	LISS IV	8185	59,60	15-05-2005
4	48J02NE	IRS-P6	LISS IV	8185	60	15-05-2005
5	48J06NW	IRS-P6	LISS IV	7290, 8085	111, 60	13-03-2005, 15-05-2005
6	48J07NW	IRS-P6	LISS IV	7290	111, 112	13-03-2005
7	48J08NE	IRS-P6	LISS IV	11311	117	21-12-2005
8	48J08SE	IRS-P6	LISS IV	11311	117	21-12-2005
9	48J12SW	IRS-P6	LISS IV	7489	111	27-03-2005
10	48K09SE	IRS-P6	LISS IV	7489	112	27-03-2005
11	48K09NW	IRS-P6	LISS IV	10288	118	10-10-2005
12	48K09SW	IRS-P6	LISS IV	10288	118	10-10-2005
13	48K10NE	IRS-P6	LISS IV	7489	114	27-03-2005
14	48K10SE	IRS-P6	LISS IV	7489	114	27-03-2005
15	48K11NE	IRS-P6	LISS IV	7489	113	27-03-2005
16	48K11SE	IRS-P6	LISS IV	5727	118	29-11-2004
17	48K12NE	IRS-P6	LISS IV	5727	119	23-11-2004
18	48K16NW	IRS-P6	LISS IV	5727	119	23-09-2004, 20-10-2005
19	48K16SW	IRS-P6	LISS IV	5727	119	23-09-2004, 20-10-2005
20	48L13NW	IRS-P6	LISS IV	11524	120, 121	05-01-2006
21	48L13SW	IRS-P6	LISS IV	11524	120, 121	05-01-2006

Table No. 4: Satellite data used for Karnataka Coast (2014-16 time-frame).

S.No.	Map-Sheet	Satellite	Sensor	Path	Row	Subscene	Date
1	48K11NE	Resourcesat-2	LISS-IV	97	64	b	06-Feb-15
2	48K11SE	Resourcesat-2	LISS-IV	97	64	b	06-Feb-15
3	48K12NE	Resourcesat-2	LISS-IV	97	64	b	06-Feb-15
4	48K16NW	Resourcesat-2	LISS-IV	97	64	b	06-Feb-15
5	48K16SW	Resourcesat-2	LISS-IV	97	64	b	06-Feb-15
6	48K16NW	Resourcesat-2	LISS-IV	97	64	d	06-Feb-15
7	48K16SW	Resourcesat-2	LISS-IV	97	64	d	06-Feb-15
8	48L13NW	Resourcesat-2	LISS-IV	97	64	d	06-Feb-15
9	48L13SW	Resourcesat-2	LISS-IV	97	64	d	06-Feb-15
10	48J1NW	Resourcesat-2	LISS-IV	96	63	b	08-Jan-15
11	48J1NE	Resourcesat-2	LISS-IV	96	63	b	08-Jan-15
12	48J2NE	Resourcesat-2	LISS-IV	96	63	b	08-Jan-15
13	48J6NWE	Resourcesat-2	LISS-IV	96	63	b	08-Jan-15
14	48J6SW	Resourcesat-2	LISS-IV	96	63	b	08-Jan-15
15	48J6SE	Resourcesat-2	LISS-IV	96	63	b	08-Jan-15
16	48J7NW	Resourcesat-2	LISS-IV	96	63	b	08-Jan-15
17	48J7NE	Resourcesat-2	LISS-IV	96	63	b	08-Jan-15
18	48J7NE	Resourcesat-2	LISS-IV	97	63	c	13-Jan-15
19	48J7SE	Resourcesat-2	LISS-IV	97	63	c	13-Jan-15
20	48J8NE	Resourcesat-2	LISS-IV	97	63	c	13-Jan-15

21	48J8SE	Resourcesat-2	LISS-IV	97	63	c	13-Jan-15
22	48J12SW	Resourcesat-2	LISS-IV	97	63	c	13-Jan-15
23	48K9NW	Resourcesat-2	LISS-IV	97	63	c	13-Jan-15
24	48K9SW	Resourcesat-2	LISS-IV	97	64	a	13-Jan-15
25	48K9SE	Resourcesat-2	LISS-IV	97	64	a	13-Jan-15
26	48K10NE	Resourcesat-2	LISS-IV	97	64	a	13-Jan-15
27	48K10SE	Resourcesat-2	LISS-IV	97	64	a	13-Jan-15
28	48K11NE	Resourcesat-2	LISS-IV	97	64	a	13-Jan-15
29	48K11SE	Resourcesat-2	LISS-IV	97	64	a	13-Jan-15

Table No. 5: Satellite data used for Kerala Coast (2004-06 time-frame).

S. No.	Map Sheet No.	Satellite	Sensor	Orbit	Scene	Date
1	48L13SW	IRS P6	LISS IV	11524	120	05-01-2006
2	48L13SE	IRS P6	LISS IV	11524	120	05-01-2006
3	48L14NW	IRS P6	LISS IV	11922	141, 142	02-02-2006
4	48L14SE	IRS P6	LISS IV	11922	141, 142	02-02-2006
5	48P03NW	IRS P6	LISS IV	11922	141, 142	02-02-2006
6	48P03SW	IRS P6	LISS IV	11922	141, 142	02-02-2006
7	48P04NE	IRS P6	LISS IV	11993	53,54	07-02-2006
8	48P04NW	IRS P6	LISS IV	11652	125, 126	14-01-2006
9	48P04SE	IRS P6	LISS IV	11652	125, 126	14-01-2006
10	49P8SW	IRS P6	LISS IV	11652	125, 126	14-01-2006
11	49M05NE	IRS P6	LISS IV	11652	125, 126	14-01-2006
12	49M05NW	IRS P6	LISS IV	11652	125, 126	14-01-2006
13	49M05SW	IRS P6	LISS IV	11652	125, 126	14-01-2006
14	49M05SE	IRS P6	LISS IV	1976	141, 142	04-03-2004
15	49M05SW	IRS P6	LISS IV	1976	141, 142	04-03-2004
16	49M10NW	IRS P6	LISS IV	1976	141, 142	04-03-2004
17	49M06NE	IRS P6	LISS IV	1976	141, 142	04-03-2004
18	49M09SW	IRS P6	LISS IV	1976	141, 142	04-03-2004
19	49M10SW	IRS P6	LISS IV	2658	136	21-04-2004
20	49M11NE	IRS P6	LISS IV	2658	136	21-04-2004
21	49M11NW	IRS P6	LISS IV	2658	136	21-04-2004
22	49M10SE	IRS P6	LISS IV	5926	123	07-12-2004
23	49M11NE	IRS P6	LISS IV	5926	123	07-12-2004
24	49M11SE	IRS P6	LISS IV	5926	123	07-12-2004
25	49M15NW	IRS P6	LISS IV	12078	151, 152, 153	13-02-2006
26	49M15SW	IRS P6	LISS IV	12078	151, 152, 153	13-02-2006
27	49M16NW	IRS P6	LISS IV	12078	151, 152, 153	13-02-2006
28	49M16SW	IRS P6	LISS IV	12078	151, 152, 153	13-02-2006
29	49N13NE	IRS P6	LISS IV	12078	151, 152, 153	13-02-2006
30	49N13SE	IRS P6	LISS IV	12078	151, 152, 153	13-02-2006
31	49N13NW	IRS P6	LISS IV	12078	151, 152, 153	13-02-2006
32	49N13NE	IRS P6	LISS IV	11396	130	27-12-2005
33	49N13NW	IRS P6	LISS IV	11396	130	27-12-2005
34	49N13SE	IRS P6	LISS IV	11396	130	27-12-2005
35	49N13NE	IRS P6	LISS IV	1365	149, 150, 151	21-01-2004
36	49N13SE	IRS P6	LISS IV	1365	149, 150, 151	21-01-2004
37	49N14NE	IRS P6	LISS IV	1365	149, 150, 151	21-01-2004

38	58B02SW	IRS P6	LISS IV	1365	149, 150, 151	21-01-2004
39	58B02SW	IRS P6	LISS IV	1706	149, 150	14-02-2004
40	58B03NW	IRS P6	LISS IV	1706	149, 150	14-02-2004
41	58B03NE	IRS P6	LISS IV	1706	149, 150	14-02-2004
42	58B03SW	IRS P6	LISS IV	1706	149, 150	14-02-2004
43	58B02SW	IRS P6	LISS IV	2047	148	09-03-2004
44	58B03NW	IRS P6	LISS IV	2047	148	09-03-2004
45	58B03NE	IRS P6	LISS IV	2047	148	09-03-2004
46	58B03SW	IRS P6	LISS IV	2047	148	09-03-2004
47	58B03SE	IRS P6	LISS IV	2047	148	09-03-2004
48	58B04NE	IRS P6	LISS IV	2047	148	09-03-2004
49	58B04SE	IRS P6	LISS IV	2047	148	09-03-2004
50	58C01NE	IRS P6	LISS IV	11112	1311,32,133	07-12-2005
51	58C05NW	IRS P6	LISS IV	11112	1311,32,133	07-12-2005
52	58C05SW	IRS P6	LISS IV	11112	1311,32,133	07-12-2005
53	58B04NE	IRS P6	LISS IV	11112	1311,32,133	07-12-2005
54	58B04SE	IRS P6	LISS IV	11112	1311,32,133	07-12-2005
55	58B03NE	IRS P6	LISS IV	11112	1311,32,133	07-12-2005
56	58B03SE	IRS P6	LISS IV	11112	1311,32,133	07-12-2005
57	58B08NW	IRS P6	LISS IV	11112	1311,32,133	07-12-2005
58	58B08SW	IRS P6	LISS IV	11112	1311,32,133	07-12-2005
59	58C05SE	IRS P6	LISS IV	12490	114, 115	14-03-2006
60	58C05SW	IRS P6	LISS IV	12490	114, 115	14-03-2006
61	58C05NW	IRS P6	LISS IV	12490	114, 115	14-03-2006
62	58C06NE	IRS P6	LISS IV	12490	114, 115	14-03-2006
63	58C06NW	IRS P6	LISS IV	12490	114, 115	14-03-2006
64	58C06SW	IRS P6	LISS IV	12490	114, 115	14-03-2006
65	58B08SW	IRS P6	LISS IV	12490	114, 115	14-03-2006
66	58C07SE	IRS P6	LISS IV	12064	26,27,28,29	12-02-2006
67	58C08NE	IRS P6	LISS IV	12064	26,27,28,29	12-02-2006
68	58C06SW	IRS P6	LISS IV	12064	26,27,28,29	12-02-2006
69	58C07NW	IRS P6	LISS IV	12064	26,27,28,29	12-02-2006
70	58C07SW	IRS P6	LISS IV	12064	26,27,28,29	12-02-2006
71	58C08NE	IRS P6	LISS IV	6338	133	05-01-2005
72	58C08SE	IRS P6	LISS IV	6338	133	05-01-2005
73	58C12SW	IRS P6	LISS IV	6338	133	05-01-2005
74	58C12SE	IRS P6	LISS IV	6338	133	05-01-2005
75	58D09NE	IRS P6	LISS IV	6338	133	05-01-2005
76	58D09NW	IRS P6	LISS IV	6338	133	05-01-2005
77	58D09NW	IRS P6	LISS IV	12007	160, 161	08-02-2006
78	58D09SW	IRS P6	LISS IV	12007	160, 161	08-02-2006
79	58D09SE	IRS P6	LISS IV	12007	160, 161	08-02-2006
80	58D09NW	IRS P6	LISS IV	12007	160, 161	08-02-2006
81	58C12SW	IRS P6	LISS IV	12007	160, 161	08-02-2006
82	58C05SW	IRS P6	LISS IV	12007	160, 161	08-02-2006
83	58C05NW	IRS P6	LISS IV	12007	160, 161	08-02-2006
84	58C05SE	IRS P6	LISS IV	12007	160, 161	08-02-2006
85	58C06NE	IRS P6	LISS IV	12007	160, 161	08-02-2006
86	58C06NW	IRS P6	LISS IV	12007	160, 161	08-02-2006
87	58C06SW	IRS P6	LISS IV	12007	160, 161	08-02-2006
88	58C06SE	IRS P6	LISS IV	12007	160, 161	08-02-2006
89	58D09NE	IRS P6	LISS IV	11737	133, 134	20-01-2006

90	58D09SE	IRS P6	LISS IV	11737	133, 134	20-01-2006
91	58D10NE	IRS P6	LISS IV	11737	133, 134	20-01-2006
92	58D14NW	IRS P6	LISS IV	11737	133, 134	20-01-2006
93	58D14SW	IRS P6	LISS IV	11737	133, 134	20-01-2006
94	58D15NE	IRS P6	LISS IV	11936	127, 128	03-02-2006
95	58H03SW	IRS P6	LISS IV	11936	127, 128	03-02-2006
96	58D14SE	IRS P6	LISS IV	11936	127, 128	03-02-2006

Table No. 6: Satellite data used for Kerala Coast (2014-16 time-frame).

S.No.	Map-Sheet No.	Satellite	Sensor	Path	Row	Subscene	Date
1	48L13SW	Resourcesat-2	LISS-IV	97	64	d	06-Feb-15
2	48L14NW	Resourcesat-2	LISS-IV	97	64	d	06-Feb-15
3	48L14NE	Resourcesat-2	LISS-IV	97	64	d	06-Feb-15
4	48L14SE	Resourcesat-2	LISS-IV	97	64	d	06-Feb-15
5	48L15NE	Resourcesat-2	LISS-IV	97	64	d	06-Feb-15
6	48P03NW	Resourcesat-2	LISS-IV	97	64	d	06-Feb-15
7	48P03SW	Resourcesat-2	LISS-IV	98	65	a	18-Jan-15
8	48P04NW	Resourcesat-2	LISS-IV	98	65	a	18-Jan-15
9	48P04NE	Resourcesat-2	LISS-IV	98	65	a	18-Jan-15
10	48P04SE	Resourcesat-2	LISS-IV	98	65	a	18-Jan-15
11	48P08SW	Resourcesat-2	LISS-IV	98	65	a	18-Jan-15
12	48M05NW	Resourcesat-2	LISS-IV	98	65	a	18-Jan-15
13	49M05SW	Resourcesat-2	LISS-IV	98	65	c	18-Jan-15
14	49M05SE	Resourcesat-2	LISS-IV	98	65	c	18-Jan-15
15	49M06NE	Resourcesat-2	LISS-IV	98	65	d	23-Jan-14
16	49M10NW	Resourcesat-2	LISS-IV	98	65	d	23-Jan-14
17	49M10SW	Resourcesat-2	LISS-IV	98	65	d	23-Jan-14
18	49M11NW	Resourcesat-2	LISS-IV	98	65	d	23-Jan-14
19	49M11NE	Resourcesat-2	LISS-IV	98	65	d	23-Jan-14
20	49M11SE	Resourcesat-2	LISS-IV	98	65	d	23-Jan-14
21	49M15SW	Resourcesat-2	LISS-IV	98	65	d	23-Jan-14
22	49M16NW	Resourcesat-2	LISS-IV	98	65	d	23-Jan-14
23	49M16SW	Resourcesat-2	LISS-IV	99	66	a	23-Jan-15
24	49N13NW	Resourcesat-2	LISS-IV	99	66	a	23-Jan-15
25	49N13NE	Resourcesat-2	LISS-IV	99	66	a	23-Jan-15
26	49N13SE	Resourcesat-2	LISS-IV	99	66	a	23-Jan-15
27	49N14NE	Resourcesat-2	LISS-IV	99	66	a	23-Jan-15
28	49N14SE	Resourcesat-2	LISS-IV	99	66	c	23-Jan-15
29	58B02SW	Resourcesat-2	LISS-IV	99	66	c	23-Jan-15
30	58B03NW	Resourcesat-2	LISS-IV	99	66	c	23-Jan-15
31	58B03SW	Resourcesat-2	LISS-IV	99	66	c	23-Jan-15
32	58B03SW	Resourcesat-2	LISS-IV	99	66	d	16-Feb-15
33	58B03SE	Resourcesat-2	LISS-IV	99	66	d	16-Feb-15
34	58B04NE	Resourcesat-2	LISS-IV	99	66	d	16-Feb-15
35	58B04SE	Resourcesat-2	LISS-IV	99	67	b	05-Apr-15
36	58C01NE	Resourcesat-2	LISS-IV	99	67	b	05-Apr-15
37	58C05NW	Resourcesat-2	LISS-IV	99	67	b	05-Apr-15
38	58C05SW	Resourcesat-2	LISS-IV	99	67	b	05-Apr-15
39	58C06NW	Resourcesat-2	LISS-IV	99	67	b	05-Apr-15
40	58C06SW	Resourcesat-2	LISS-IV	99	67	b	05-Apr-15

41	58C07NW	Resourcesat-2	LISS-IV	99	67	b	05-Apr-15
42	58C07SW	Resourcesat-2	LISS-IV	99	67	d	16-Feb-15
43	58C07SE	Resourcesat-2	LISS-IV	99	67	d	16-Feb-15
44	58C08NE	Resourcesat-2	LISS-IV	99	67	d	16-Feb-15
45	58C08SE	Resourcesat-2	LISS-IV	99	67	d	16-Feb-15
46	58C12SW	Resourcesat-2	LISS-IV	100	67	c	26-Feb-15
47	58D09NW	Resourcesat-2	LISS-IV	100	67	c	26-Feb-15
48	58D09SW	Resourcesat-2	LISS-IV	100	68	a	28-Jan-15
49	58D09SE	Resourcesat-2	LISS-IV	100	68	a	28-Jan-15
50	58ED10NE	Resourcesat-2	LISS-IV	100	68	a	28-Jan-15
51	58D14NW	Resourcesat-2	LISS-IV	100	68	a	28-Jan-15
52	58D14SW	Resourcesat-2	LISS-IV	100	68	b	04-Jan-15
53	58D14SE	Resourcesat-2	LISS-IV	100	68	b	04-Jan-15
54	58D15NE	Resourcesat-2	LISS-IV	100	68	b	04-Jan-15
55	58D15SE	Resourcesat-2	LISS-IV	100	68	b	21-Feb-15
56	58H03SW	Resourcesat-2	LISS-IV	100	68	b	21-Feb-15