Coastal Erosion: A case study of Trivandrum Coast, Kerala, India

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Aim

The study aims to understand the influence of coastal structures on coastal erosion.

Objectives

- Studying the rate of coastal erosion using Remote Sensing data.
- Identify the impact of coastal structures on coastal erosion.
- Analyse the performance of coastal protective structures

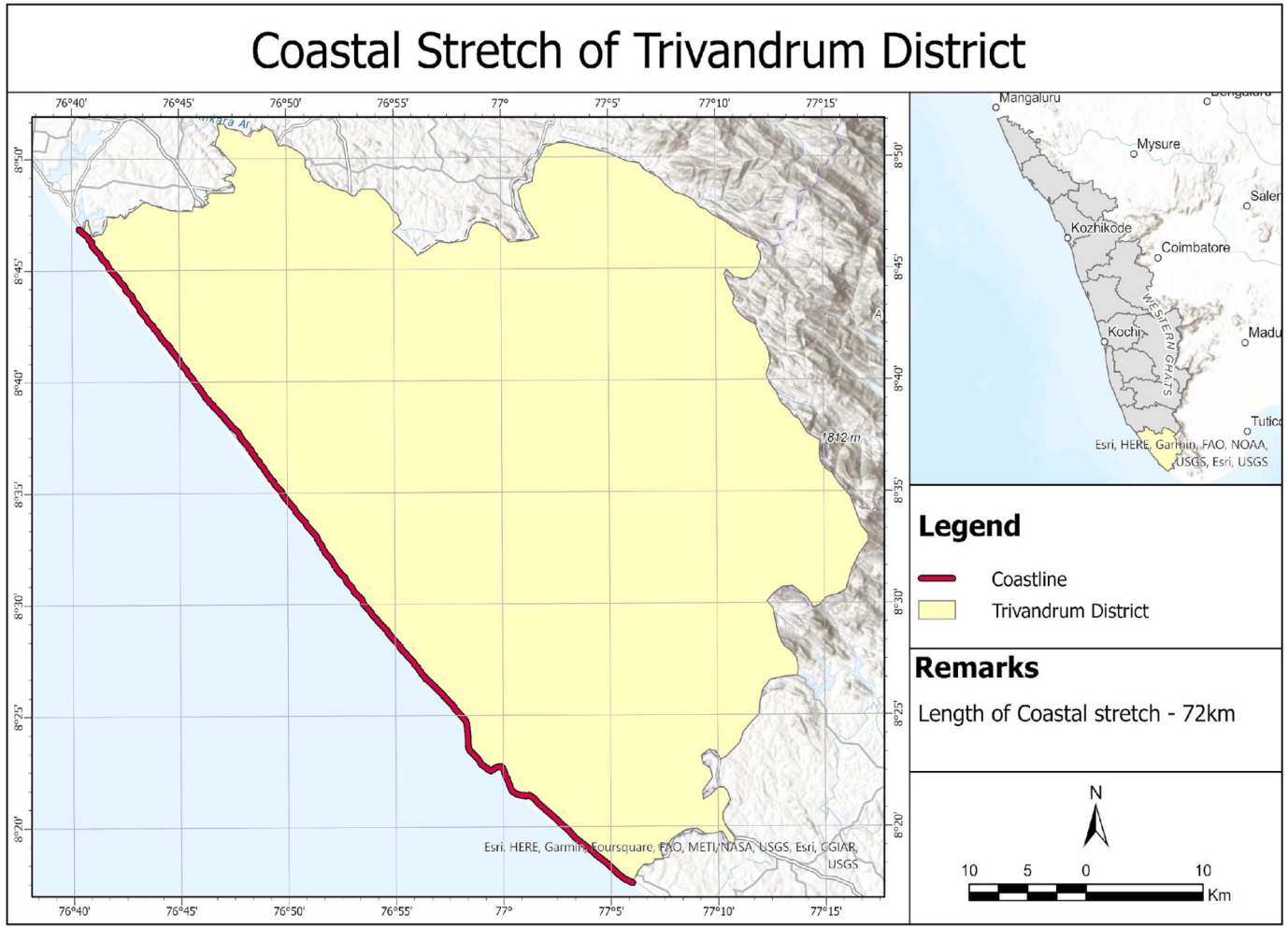
- The study area covers the coastal stretch of 72 km of the Trivandrum district shoreline in Kerala, India.

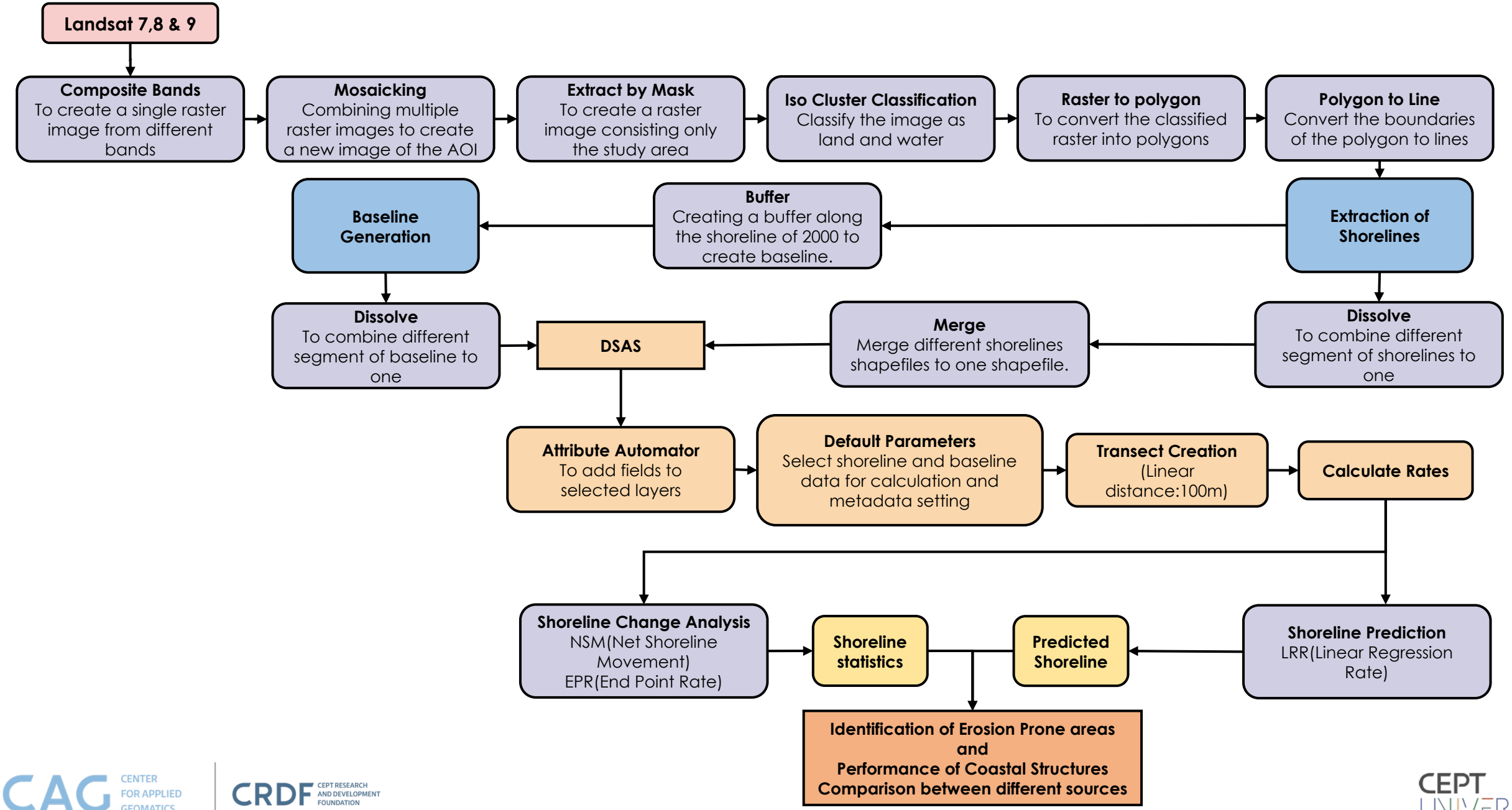
- Kerala's economy largely depend on tourism. The beaches in Trivandrum is one of the major tourist attraction in India.

- Currently those beaches are depleting.

- The study area covers both erosional and accretional landforms. Tidal variations are not considered in this study because it is less than 4 m.

- The littoral currents trends northerly in the study area.




Landsat 7,8 & 9
Composite Bands
To create a single raster image from different bands
Mosaicking
Combining multiple raster images to create a new image of the AOI
Extract by Mask
To create a raster image consisting only the study area
Iso Cluster Classification
Classify the image as land and water
Raster to polygon
To convert the classified raster into polygons
Polygon to Line
Convert the boundaries of the polygon to lines
Extraction of Shorelines
Dissolve
To combine different segment of shorelines to one
Merge
Merge different shorelines shapefiles to one shapefile.
DSAS
Dissolve
To combine different segment of baseline to one
Baseline Generation
Buffer
Creating a buffer along the shoreline of 2000 to create baseline.
Attribute Automator
To add fields to selected layers
Default Parameters
Select shoreline and baseline data for calculation and metadata setting
Transect Creation
(Linear distance:100m)
Calculate Rates
Shoreline Change Analysis
NSM(Net Shoreline Movement)
EPR(End Point Rate)
Shoreline statistics
Predicted Shoreline
Shoreline Prediction
LRR(Linear Regression Rate)
Identification of Erosion Prone areas and
Performance of Coastal Structures
Comparison between different sources

Digital Shoreline Analysis System (DSAS)

DSAS is an add in software developed by USGS for ArcGIS Desktop. With the help of this addin the user will be able to calculate shoreline statistics and changes using multiple shoreline positions and a baseline.
Using DSAS the following measurements and more can be calculated.

- Net Shoreline Movement (NSM)
- End Point Rate (EPR)
- Linear Regression Rate (LRR)
- Shoreline Change Envelope (SCE)
- Weighted Linear Regression Rate (WLR)

For this study NSM, EPR and LRR calculations are used.

(USGS, 2022)

- **Net Shoreline Movement(NSM)**

Net shoreline movement is the difference between the youngest and oldest shoreline. It provides how much the shoreline has moved over the given time period. The negative values in NSM represents erosion and positive values indicates accretion.

- **End Point Rate (EPR)**

EPR is calculated by dividing the distance of shoreline movement by the time elapsed between the oldest and the most recent shoreline. Similar to NSM, the negative values in NSM represents erosion and positive values indicates accretion.

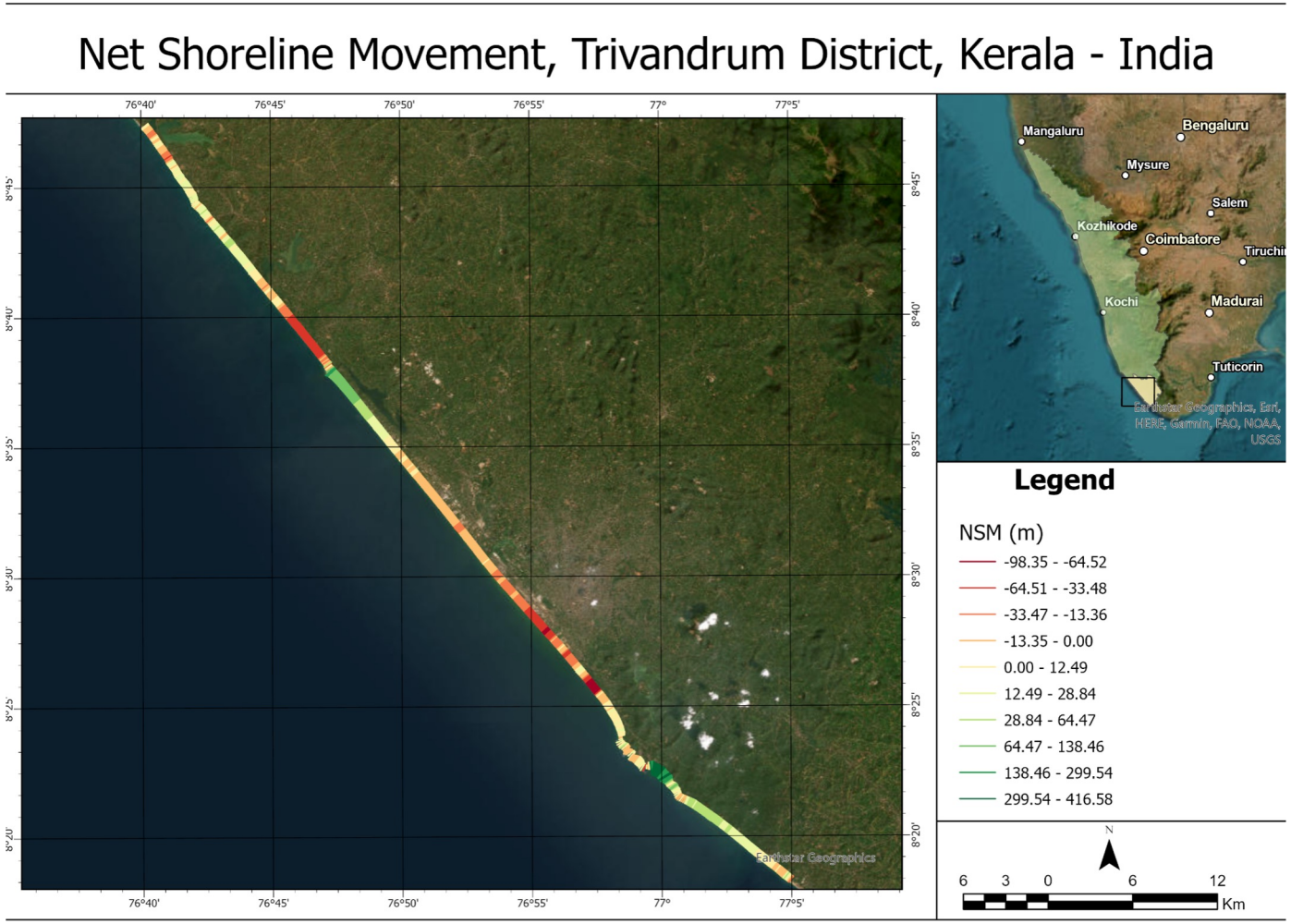
- **Linear Regression Rate (LRR)**

Least Square Regression Rate (LRR) was calculated for shoreline prediction. LRR is obtained by fitting a least squares regression line to multiple shoreline position points for a particular transect.

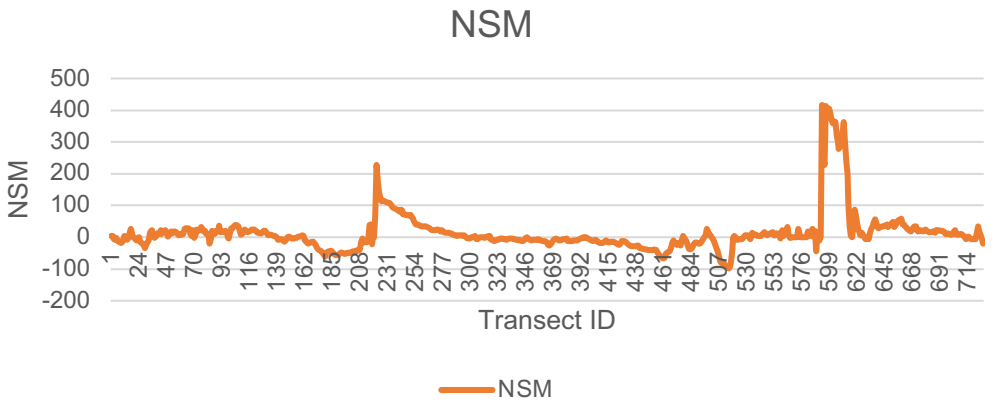
(Yuan, Yongming, Ruofan, & Jialin, 2021)

Data	Year	Resolution (m)	Source
Landsat 07	2000	30	USGS Earth Explorer
	2005	30	
	2010	30	
Landsat 08	2015	30	
Landsat 08	2020	30	
Landsat 08	2021	30	
Landsat 09	2022	30	

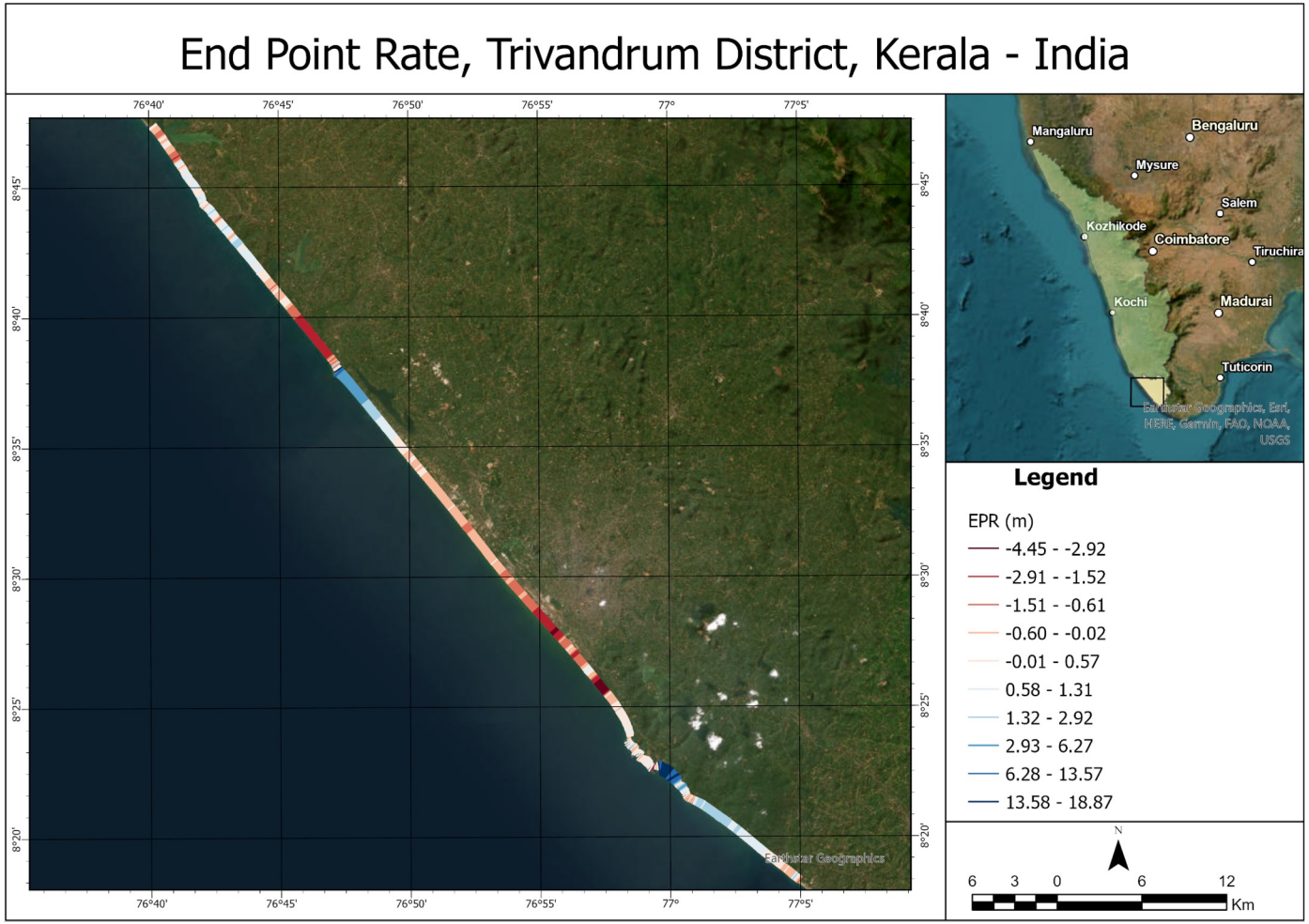
Basemap	Source	Resolution
World Imagery	ESRI	Up to 0.3-meter

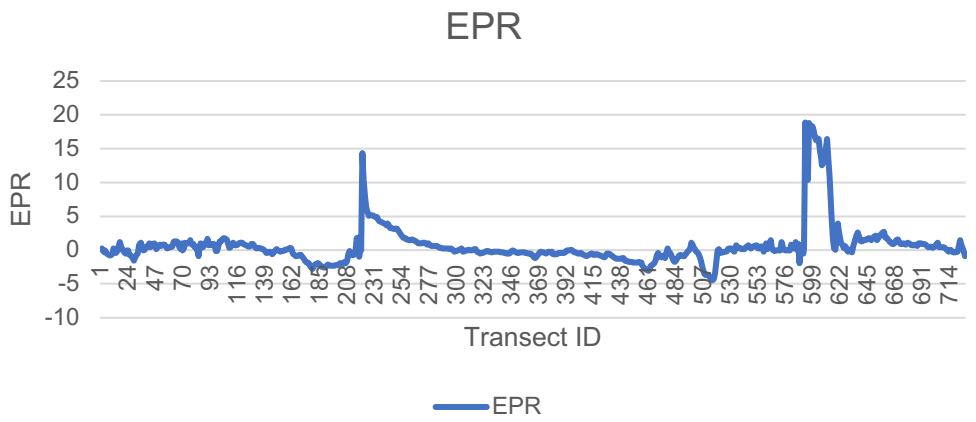


- Negative values indicate accretion while positive values indicate erosion.



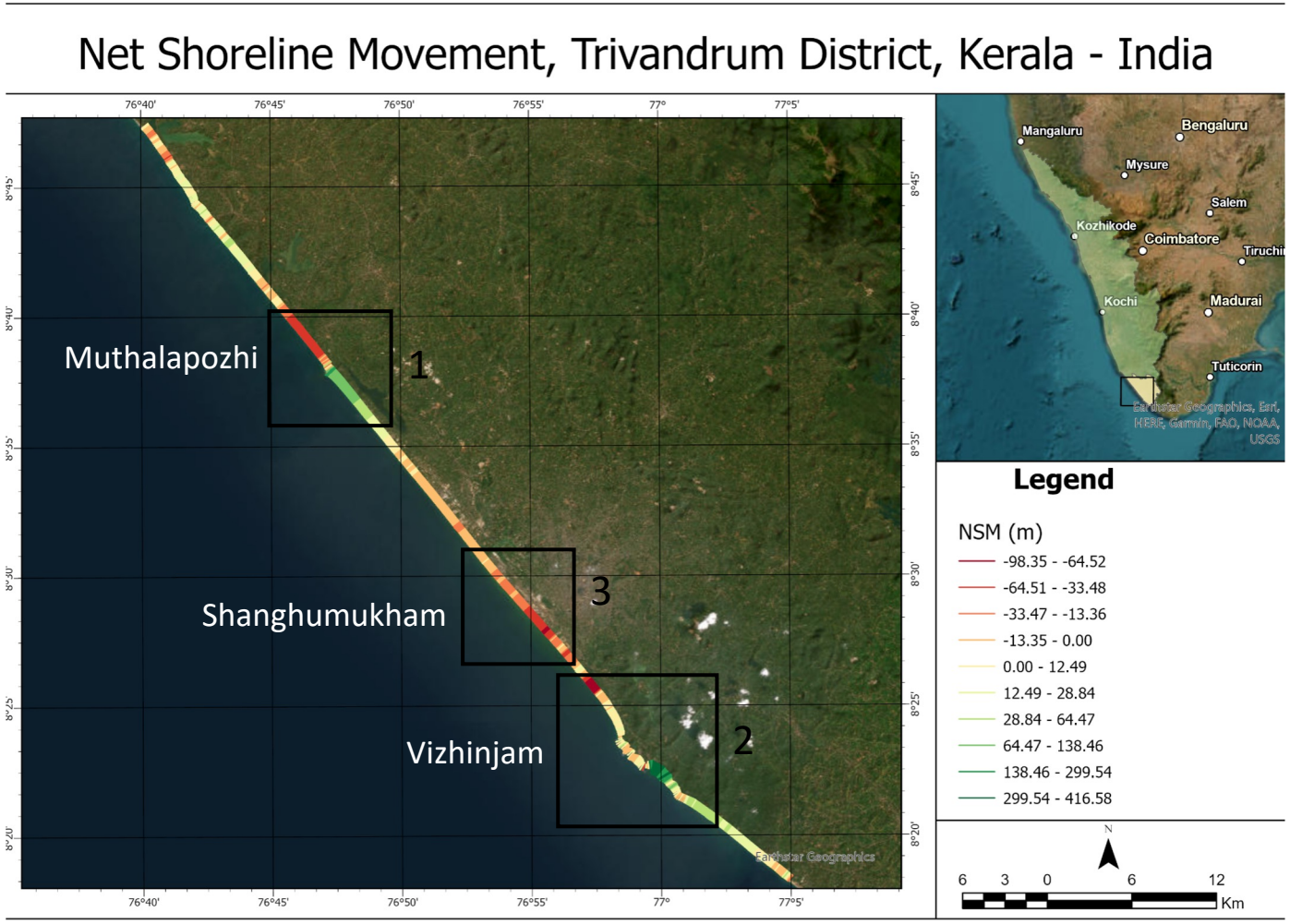
- Maximum erosion distance: 98.35m
- Maximum accretion distance: 416.58m
- Both values show a large amount of shoreline variations.





- Maximum erosion: 4.45m/year
- Maximum accretion: 18.87m/year

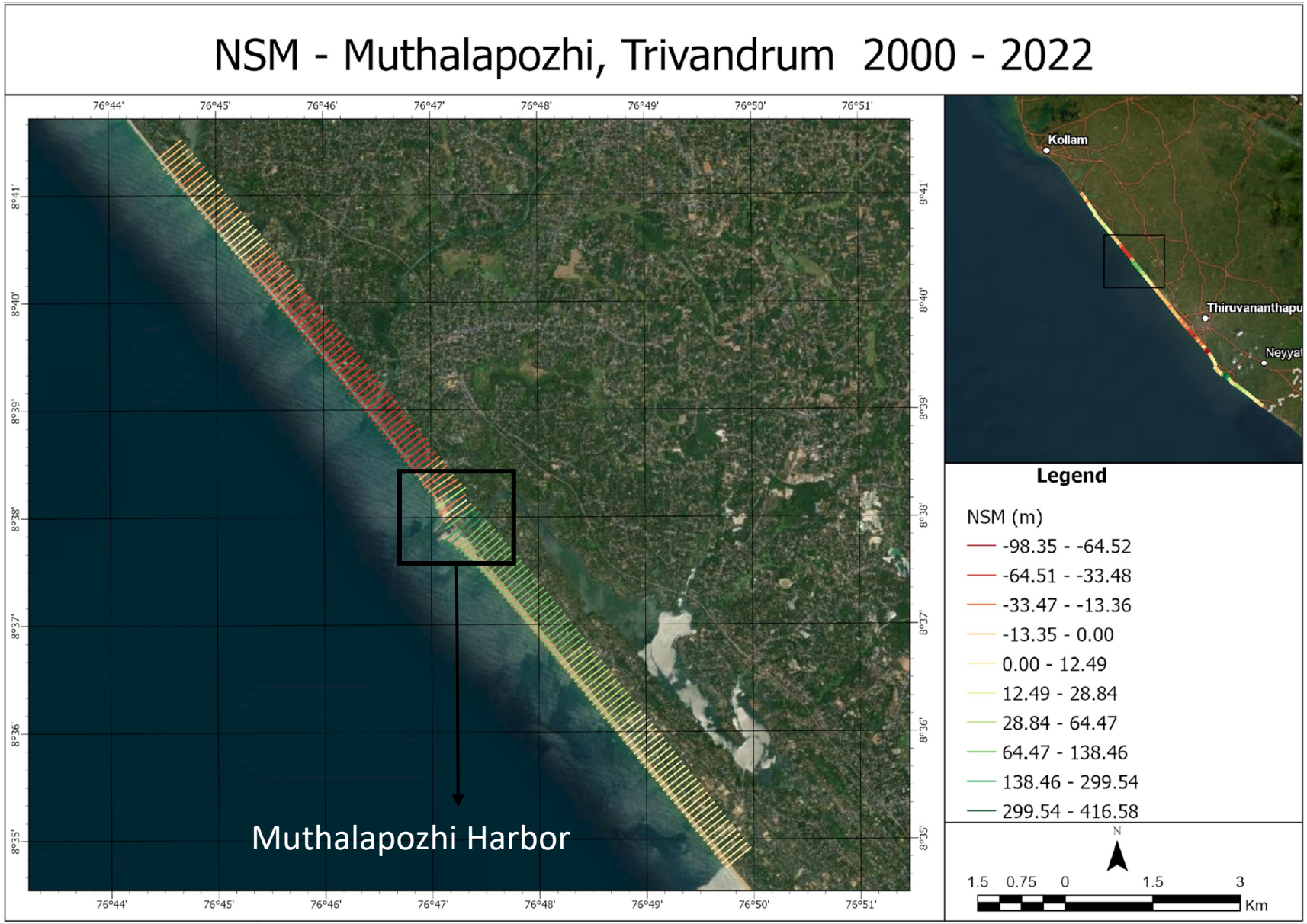
- EPR provides average annual change in coastlines



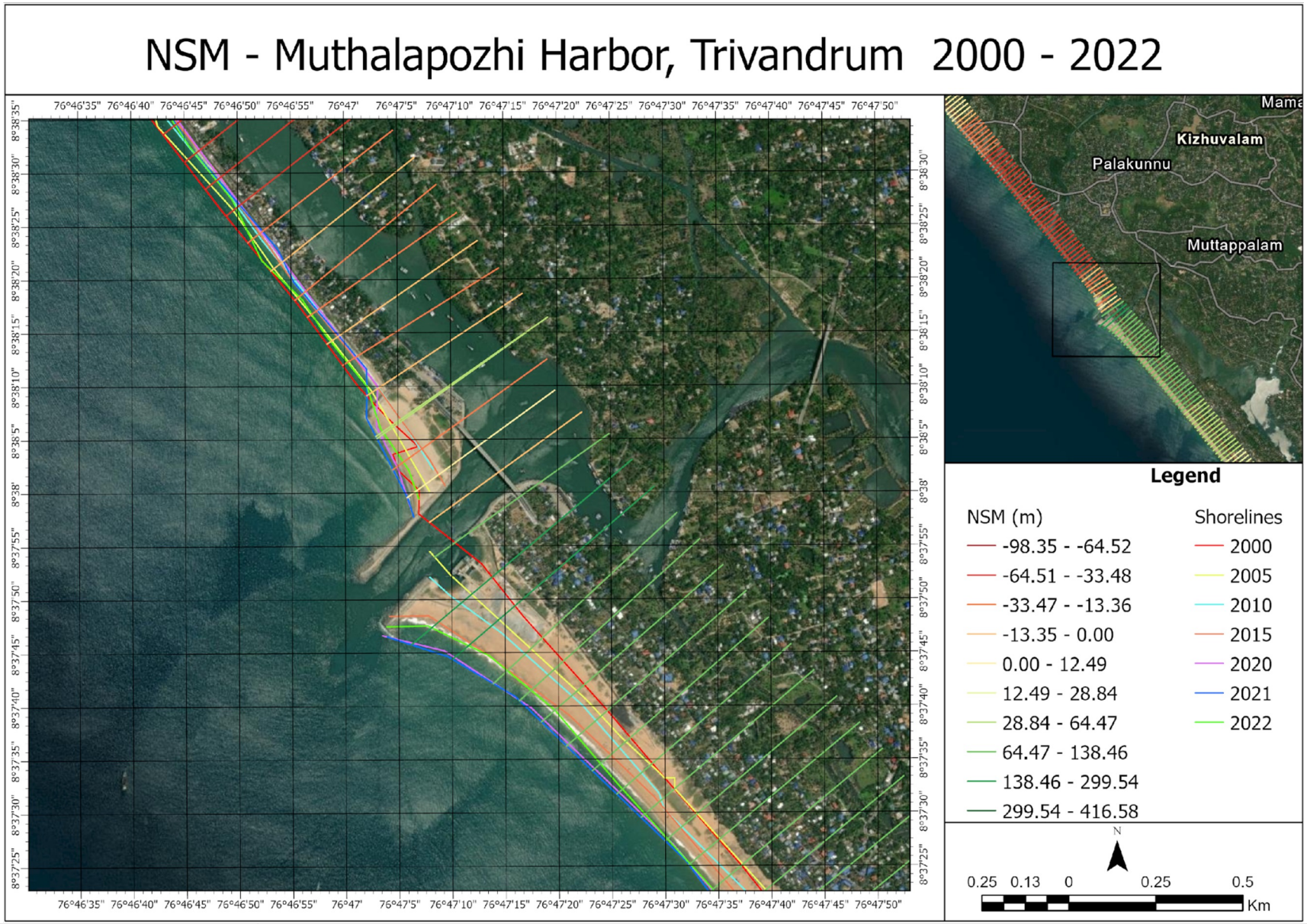
- Negative values indicate accretion while positive values indicate erosion.

- 342 transects have negative distance out of total 720 transects
- Percent of all transects that have a negative distance: 47.5%
- Percent of all transects that have statistically significant erosion: 21.53%
- 378 transects have positive distance
- Percent of all transects that have a positive distance: 52.5%
- Percent of all transects that have statistically significant accretion: 32.5%

Muthalapozhi

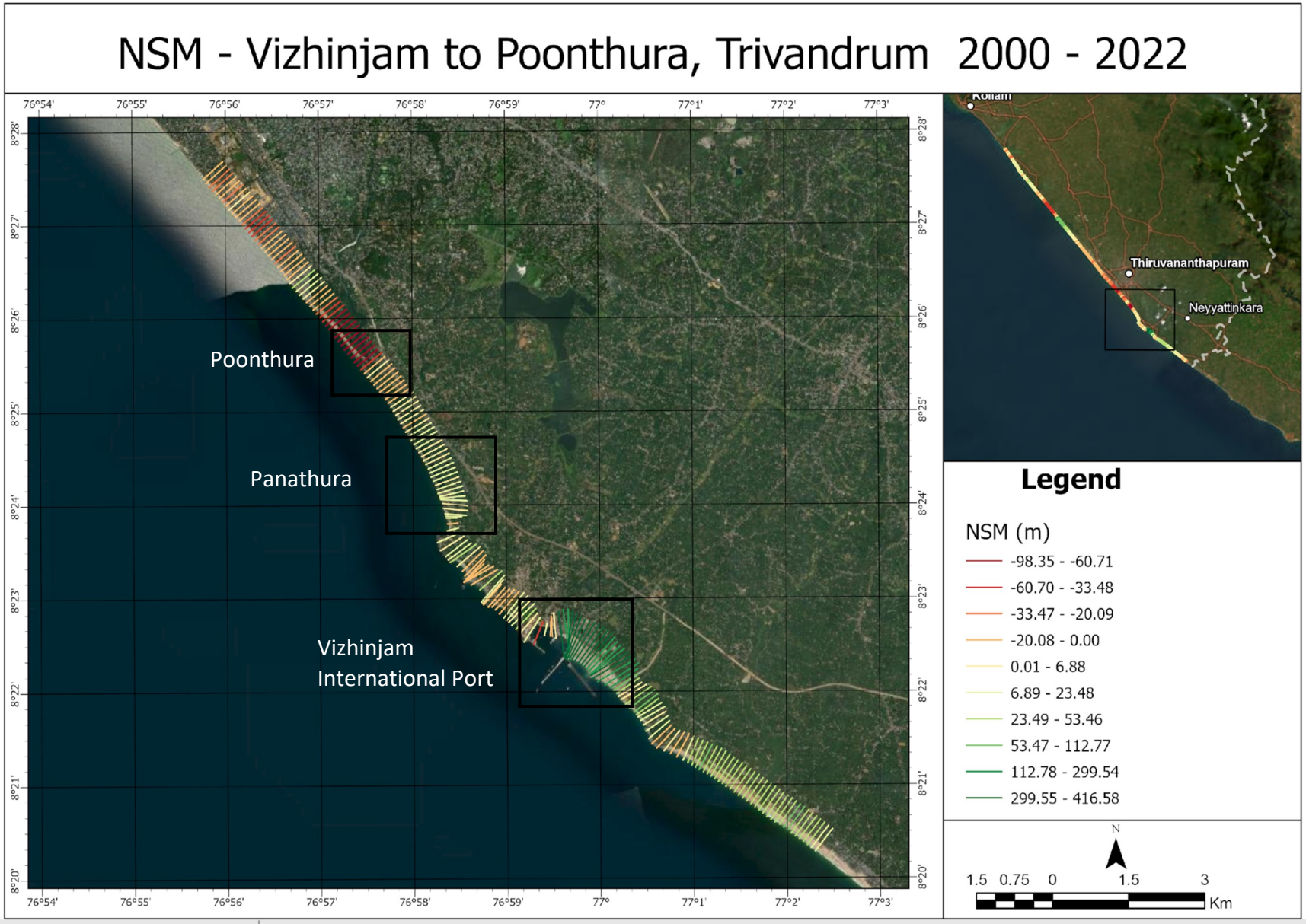


- Maximum erosion distance: 60.74m
- Maximum accretion distance: 226.94m
- Maximum erosion: 2.75m/year
- Maximum accretion: 10.28m/year
- Towards the north of the harbour there is intense erosion and towards the south extensive accession is observed.

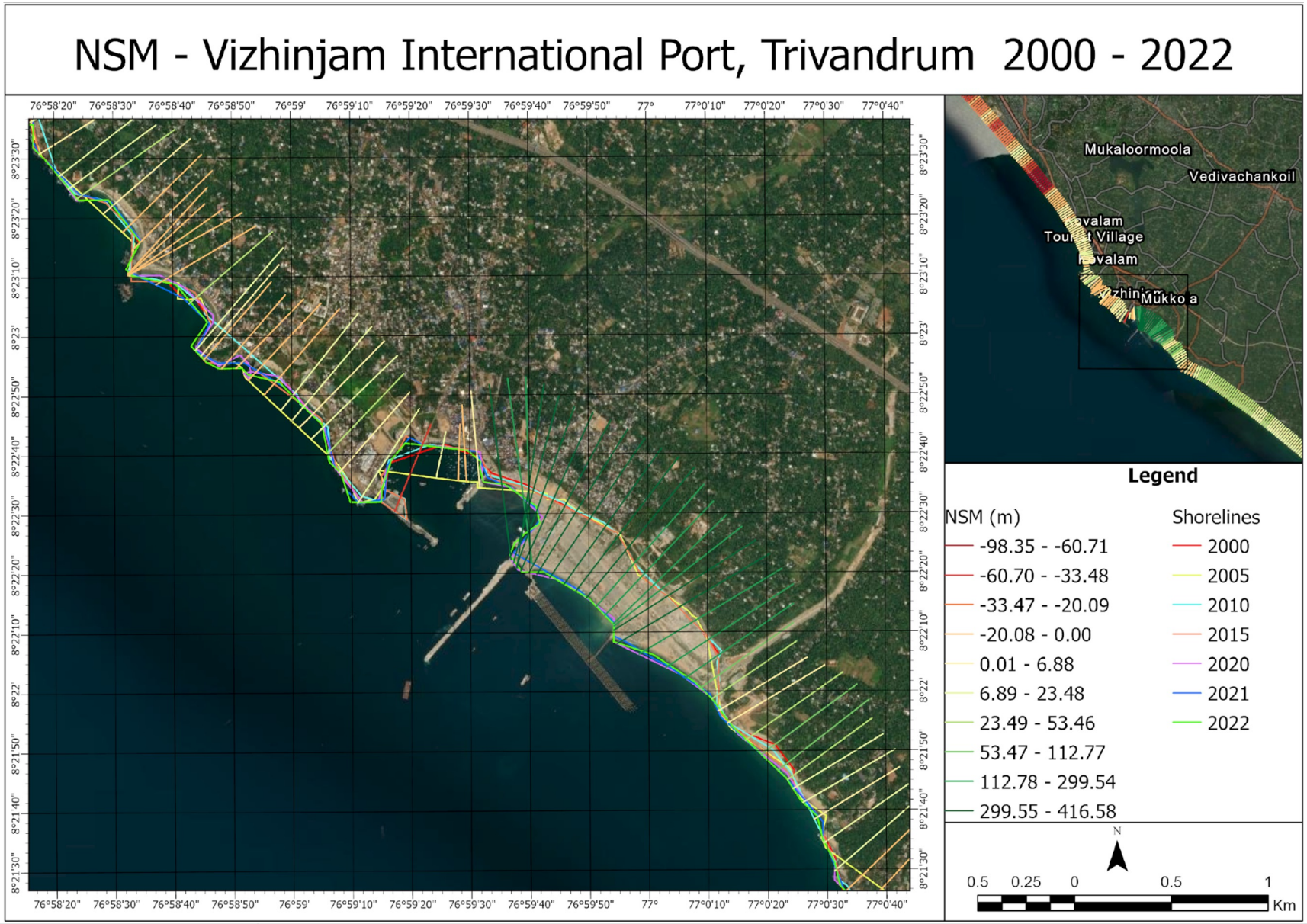


- The littoral currents trends northerly
- Intense erosion towards the north and accretion towards the south of the harbor
- Construction of Harbor changed the Erosion Accretion Cycle
- The construction Harbor affected the littoral current, causing intense sedimentation on the south side of the harbor.
- Towards the north the erosional activity increased after harbor construction

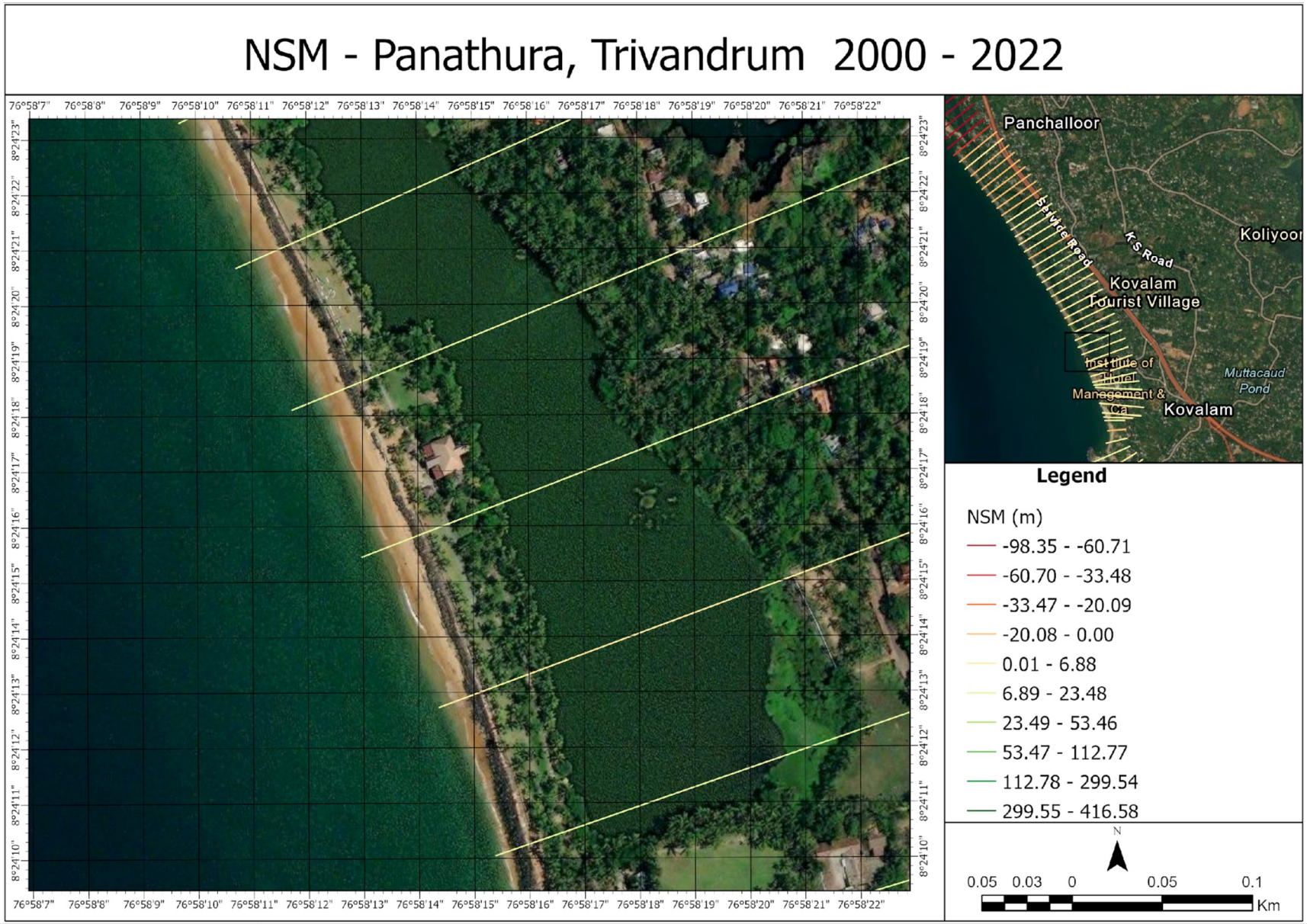
Vizhinjam



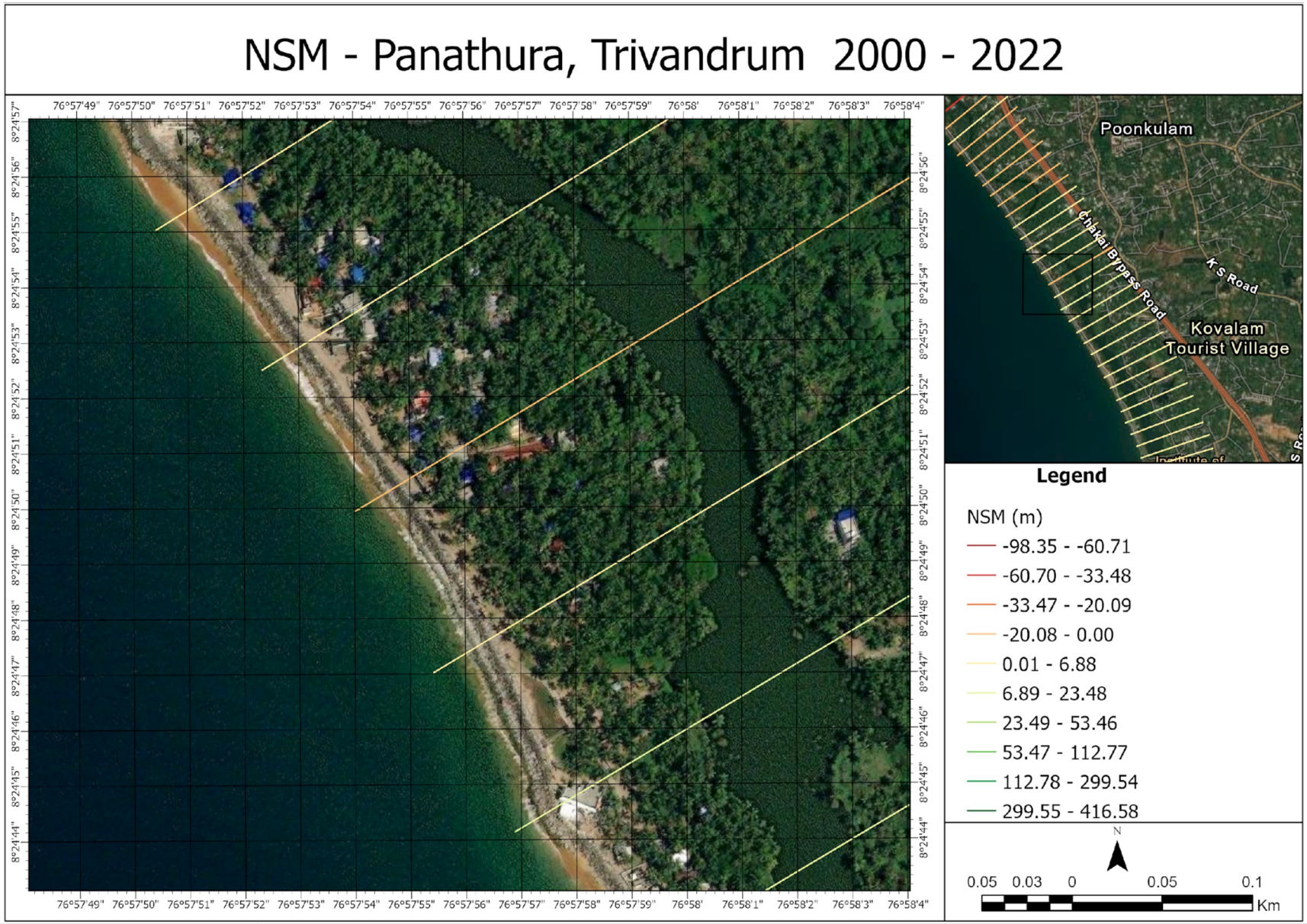
- Maximum erosion distance: 98.35m
- Maximum accretion distance : 416.58m
- Maximum erosion : 4.45m/year
- Maximum accretion : 18.87m/year
- Highest erosional and accretional rates can be observed here.



- Construction of Vizhinjam Port resulted in the sudden change of shoreline after 2015. which is causing manmade accretion towards the south.
- Similar to the Muthalapozhi harbor region erosion was expected towards the north of the port.
- But there is no significant erosion towards the north observed in Vizhinjam port area.



- Seawalls which is a Manmade structure has been protecting the shore from erosion
- Seawalls has been stopping the erosion towards the north of the port



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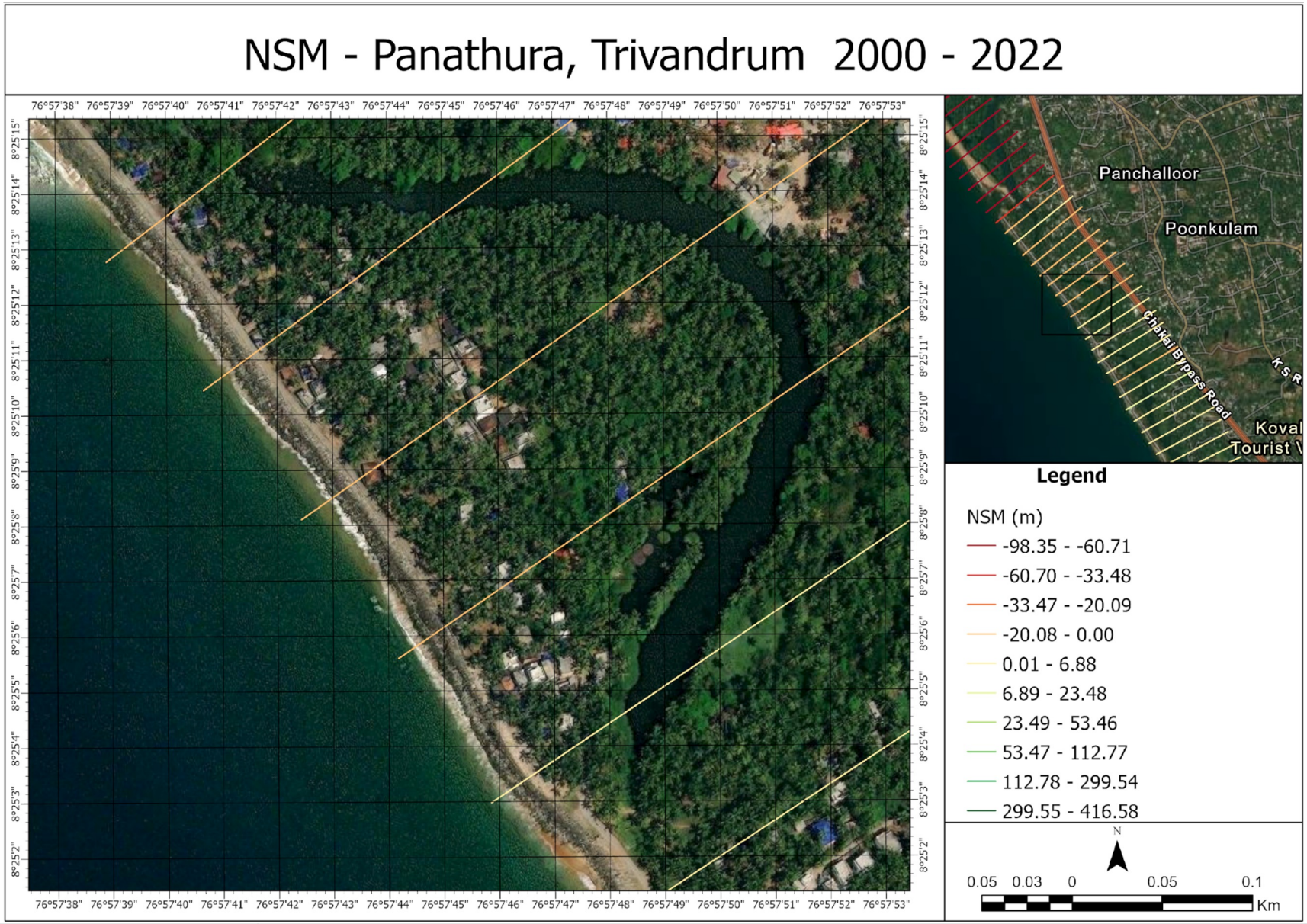

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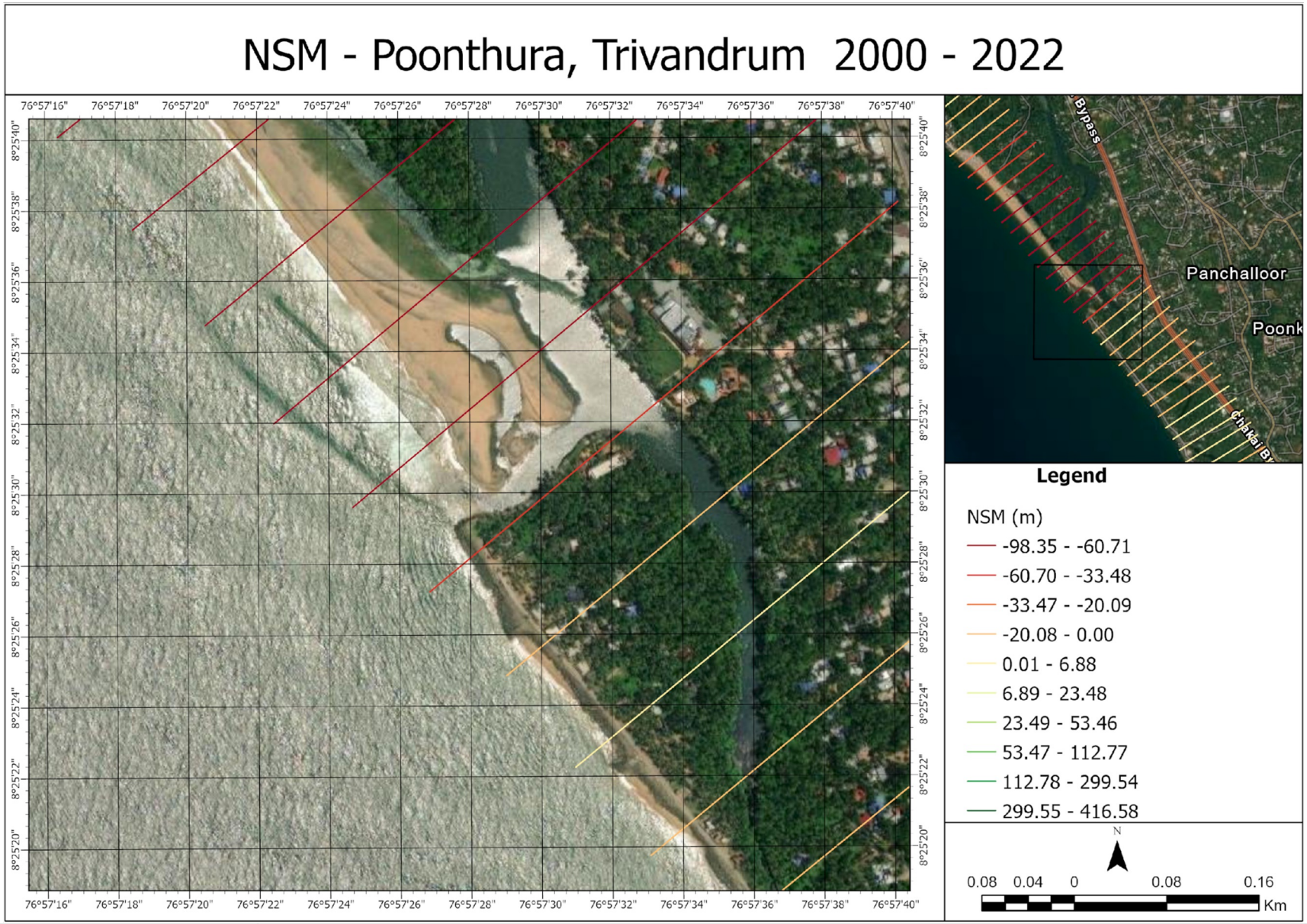
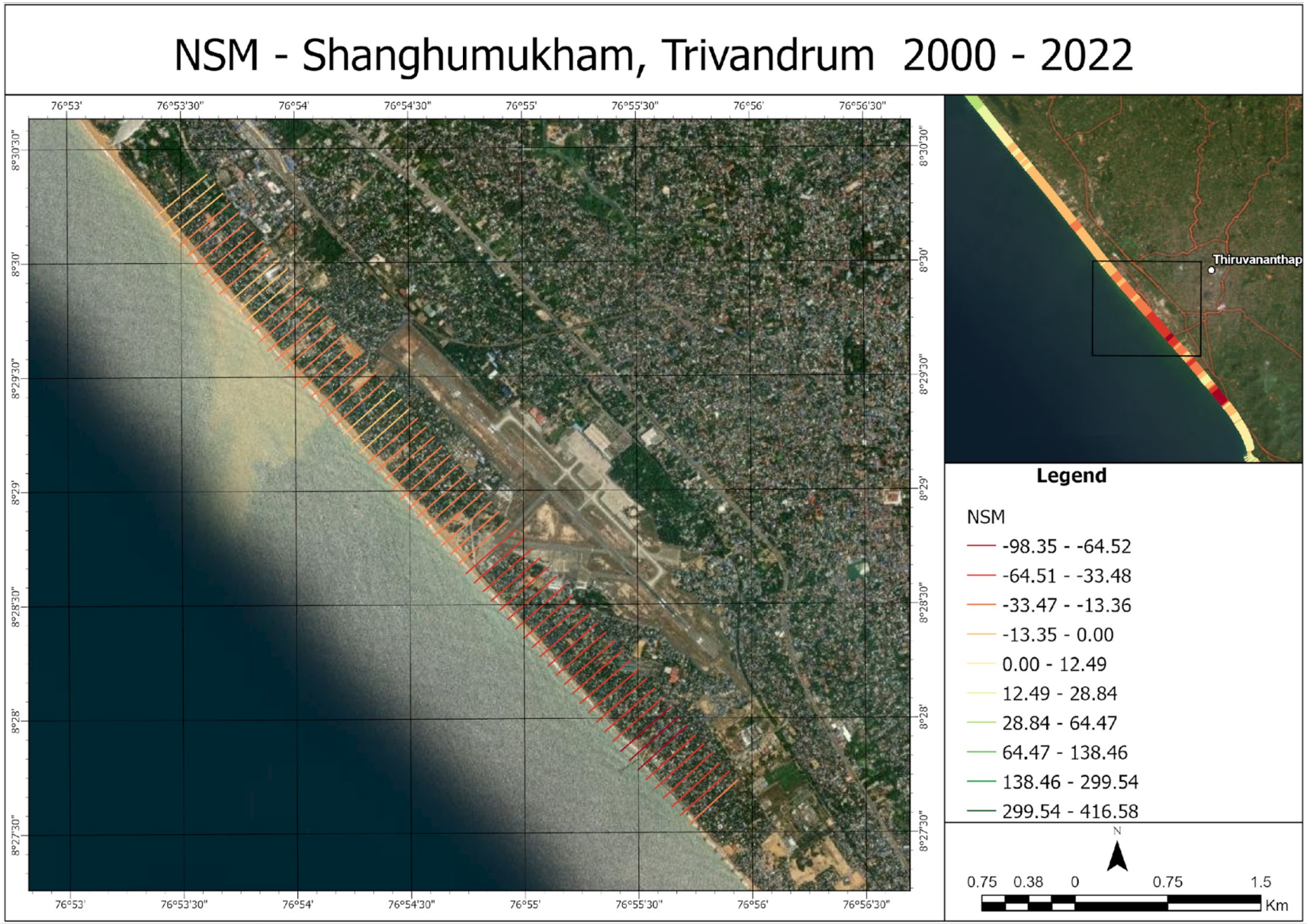


- As we can see seawall stops in the middle of the last picture.
- Intense erosion can be observed right after the seawall ends at Poonthura
- Highest erosion up to 98.35 m from 2000 - 2022 has been observed.
- Annual average erosion up to 4.45m/year is observed in Poonthura

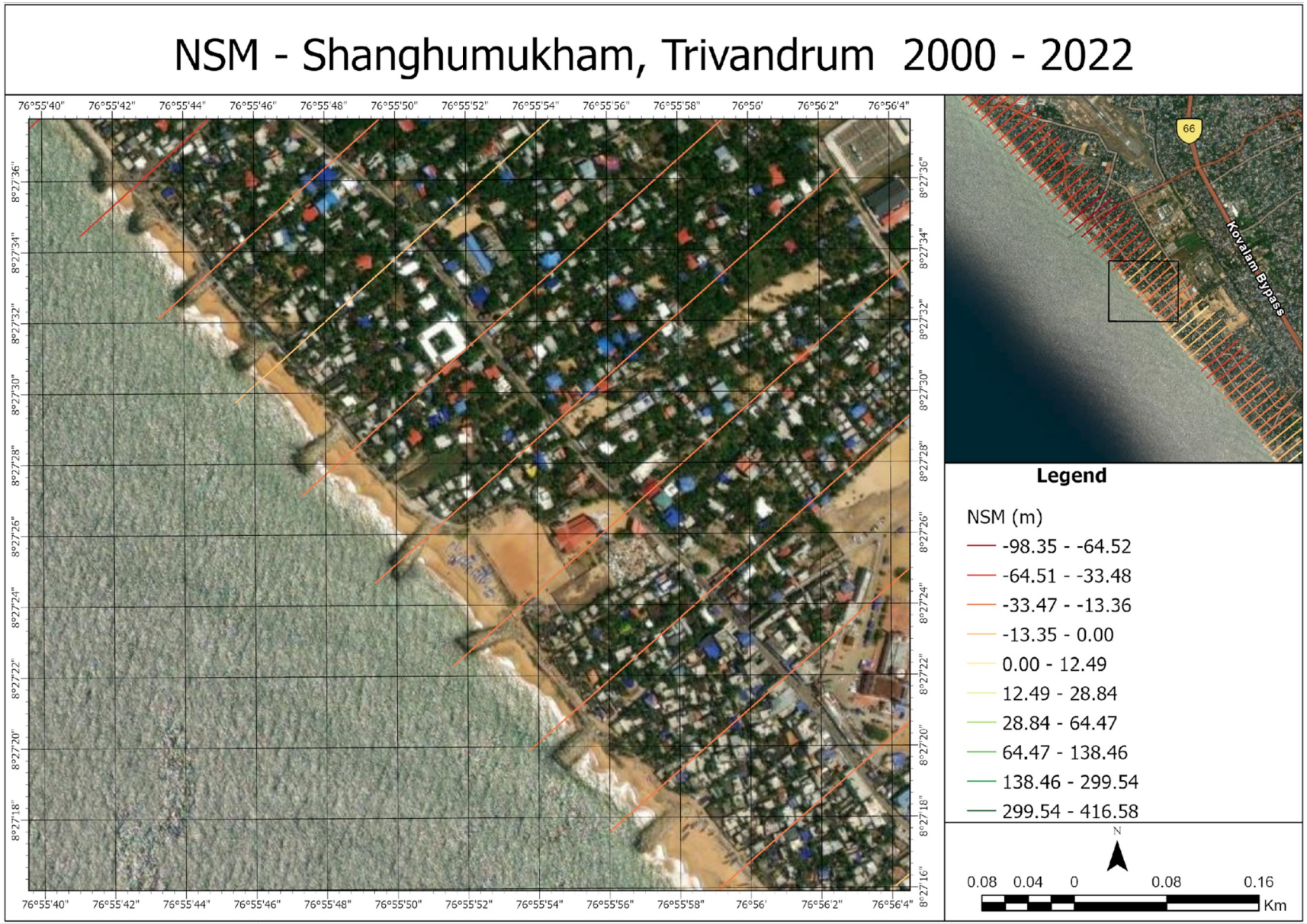
Shanghumukham



- Shannghumukam is of the well known beaches in the district.
- Maximum erosion distance: 67.16m
- Maximum accretion distance: 4.4m
- Maximum erosion: 3.04 m/year
- Maximum accretion: 0.2m/year

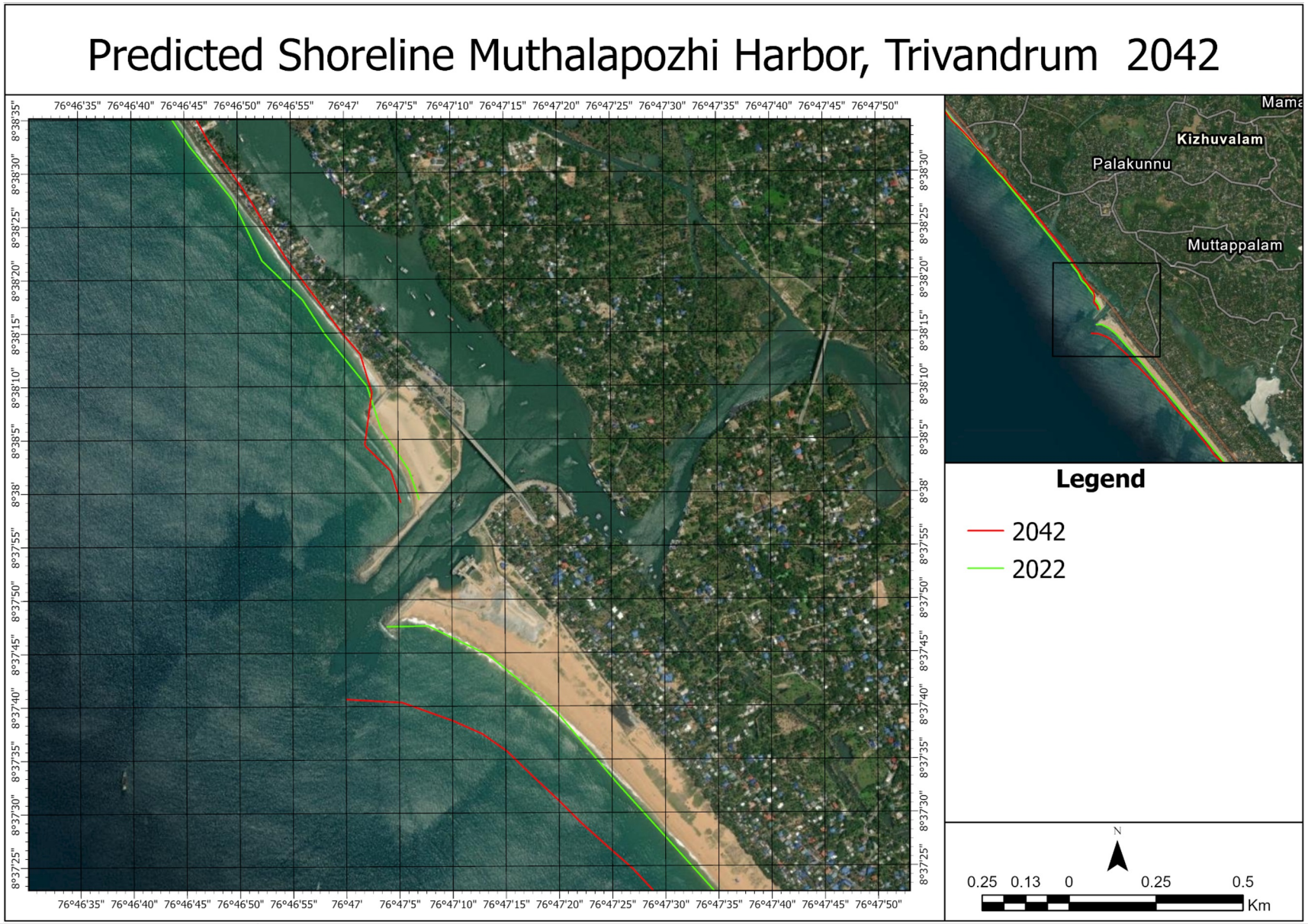
Road destructed due to coastal erosion(Times of India,2021)

Passengers walking from Trivandrum Domestic Airport , Shangumukham (The News Minute,2021)

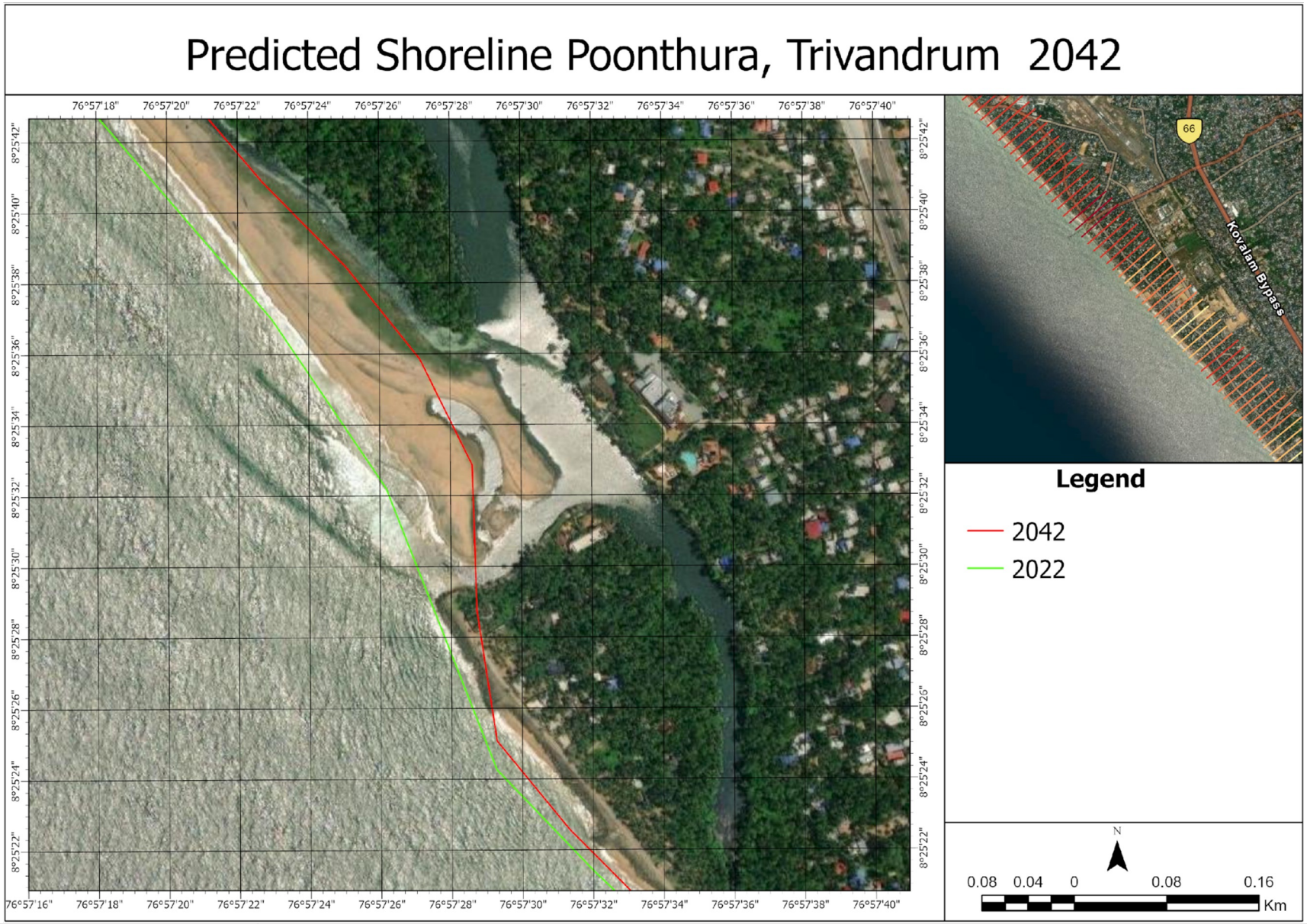


- Groins are built here as a protective measure.
- However, they are observed to be ineffective.
- It is observed that the Shoreline is getting dangerously close to human habitat in Shanghumukham.

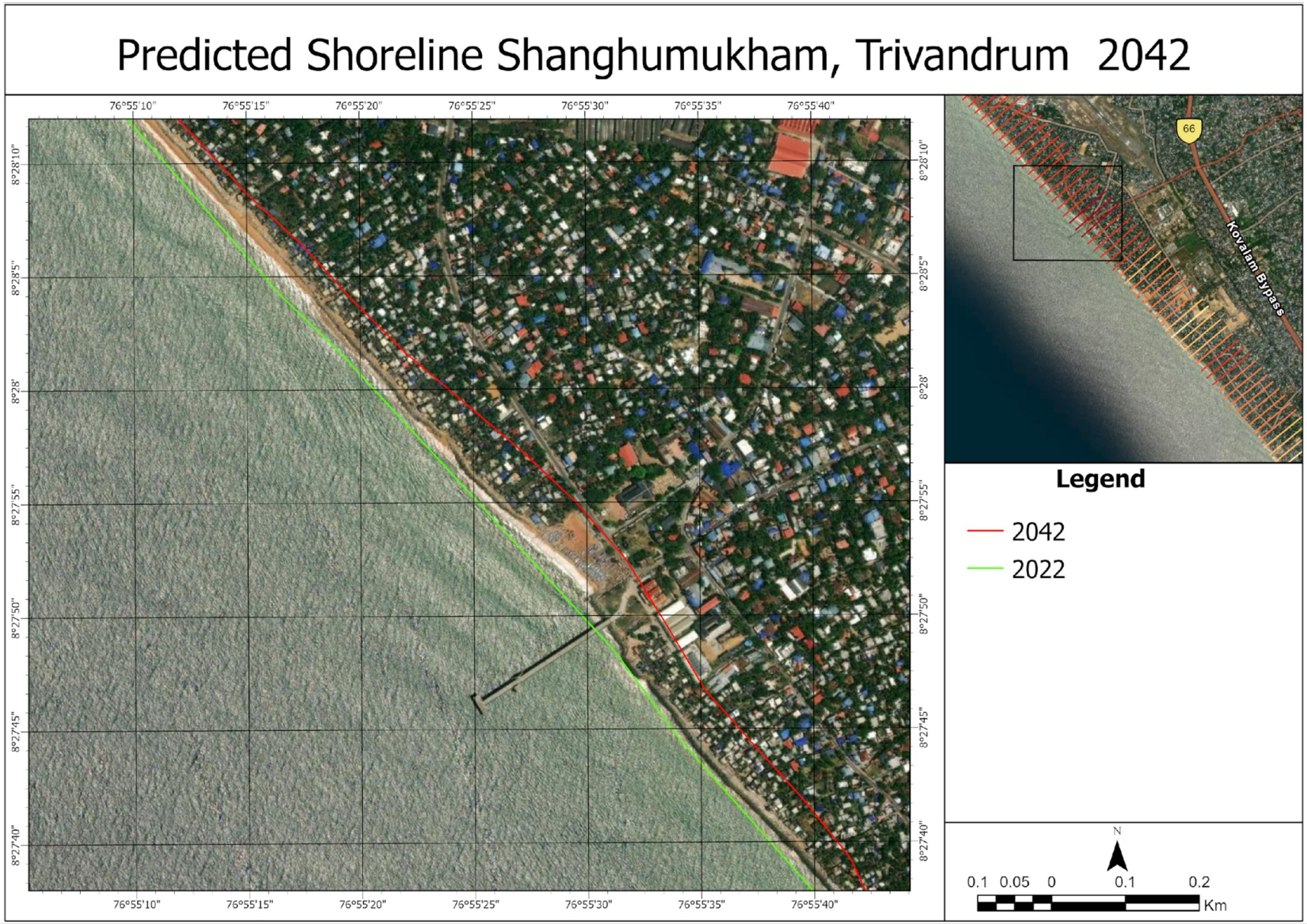
Shoreline Prediction



- Towards the south of the harbor the shoreline is expected to move 200m towards the sea.
- Which will lead to intense siltation on the harbor entrance channel, which will require efforts and time to rectify.
- Towards the north upto 50m of erosion is expected by 2042



- Shorelines will shift 92 m toward the land by 2024.
- River moth is expected to be widened.
- Nearby human habitat is under threat in Poonthura.



- Shorelines will shift 102m toward the land by 2024
- Shoreline would encroach in areas of human habitats
- In 20 years relocation of the residents on the southern part of shanghumukham will be required.

- Of the 72 Km coastal stretch 52.5% is accretional and 45.5% is under the erosion of which 21.53% is under severe erosion.
- From the study it is observed that seawalls protect the coast from extensive erosion
- Seawalls are protecting the coast effectively while groins are found to be ineffective. Near Shanghumukham, where groins are built, are facing intense erosion.
- Coastal structures like ports and harbors possess a great role in the coastal erosion-accretion cycle. The study shows that the study area's coast faces severe erosion along the north of these structures(Muthalapozhi Harbor, Vizhinjam International Port) and intense accretion along the south.
- The placement of coastal structures and protective structures along the erosion-prone regions needs to be addressed on priority.

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THANK YOU