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GEOSPATIAL TECHNIQUES ON IMPACT OF SHORELINE CHANGE AND LAND USE PATTERN CRITICAL ANALYSIS, AT IN AND AROUND SOUTH WEST COAST

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ABSTRACT
In recent decades, human and marine activity have had an impact on the land use and land cover of the South West coast. Changes in land use and land cover, which affect the economic well-being of coastal residents, are influenced by physical, climatic, and sociocultural factors. This study, which is a continuation of earlier shoreline research, focuses on the local land use and land cover. From 1988 to 2021, data for this study were collected in March to avoid seasonality. Every three to four years, monitoring was performed to track the trend. In the early 1990s, there was abundant vegetation, although the territory had been developed. In the 2000s, coastal development increased, although forest restoration has led to a vegetation comeback. Due to the degradation of 18 square kilometres of coastline, LULC extraction within a buffer zone of 3 kilometres has a direct influence on coastal LULC. The 10-kilometer buffer zones are low-threat areas. Analyses of the baseline and LULC indicate that more developed regions have evolved since 2000. The urbanisation of the north and south-west has increased since 2015. Between 2000 and 2018, the volume of shallow water grew. This programme uncovers LULC maps and information on coastal environmental changes, which may be used to identify vulnerable locations, apply safeguards, and build more effective coastal clean-up solutions.
Keywords: Shoreline; LULC; ecology; monitoring; coastal

1. INTRODUCTION

The South West coast's land use and land cover have changed significantly in recent decades due to human and marine action (Chandrasekar et al., 2013). Land usage and land cover are influenced by physical, climatic, and social factors, which in turn affect the economic well-being of coastal residents. Rapid population growth, urbanisation, and tourism growth are altering patterns of land use and land cover (Clark, 1982, Jaiswal et al., 1999, Chilar, 2000, Yuan et al., 2005, Joshi et al., 2011, Rawat et al., 2013). Demand for agricultural, mineral, soil, and water land is rising as a result of land use changes that don't prioritise environmental sustainability (Gibson and Power, 2000, Lu et al., 2004, Zoran, 2006, Santhiya et al., 2010). The world's beaches are experiencing an increase in long-term sustainability issues as demand outpaces sustainable production (Xiuwan, 2002). Global land cover evaluations estimate that humans squander 20% to 40% of the planet's potential net primary biological productivity (Richards, 1990, Nemani and Running, 1995, Brown et al., 1999, Small and Nicholls, 2003). Over 24% of Earth's surface may now have less ecosystem function and output due to human-induced deterioration (Meyer and Turner, 1994; Kalensky et al., 2003). (Daily, 1995).

Ecology, forestry, geology, hydrology, and agriculture all depend on changes in land use and cover (Weng 2001). These entries mentioned things like lost farmland, degraded soil, urban runoff, etc. International initiatives to study land use change, according to Lambin (1997), have picked up steam. The research looks into the causes of land use change. These initiatives promoted study into identifying and simulating environmental processes.

According to UNDP (2007), the population of coastal areas will triple in 40 years. Due to habitation and infrastructure expansion, rapid population growth has accelerated land alteration (Mujabar and Chandrasekar, 2012). Concerns regarding human-caused changes in coastal land use and land cover are widespread (Luong, 1993, Jaiswal et al., 1999, Misra et al., 2013). The susceptibility of locations and populations to local climatic, economic, or sociopolitical upheavals is impacted by such unfavourable swings (Nicholls and Small, 2002, Yagoub and Kolan, 2006, Kaliraj et al., 2014). Coastal land usage and land cover are impacted by waves, winds, tides, seawater, saltation, sea level rise, storm surge, cyclones, and human activity (Weismiller and Momin, 1977, Meyer and Turner, 1994, Nemani and Running, 1995, Muttitanon and Tripathi, 2005, Li et al., 2010, Mani Murali and Dinesh Kumar, 2015). Between 1991 and 2014, the population of the Indian coast increased by 14.20%. Land resources are harmed, and urbanisation, community development, and leisure pursuits are accelerated (Coppin et al., 2004, Bhatta et al., 2010). To better manage and oversee the nation's natural and biological resources, the Indian government has launched a number of landuse and land cover change assessment efforts (ICMAM, 2002). The landforms along the South West coast of Tamil Nadu's Kanyakumari district are drastically changing as a result of changes in landuse and landcover (Chandrasekar et al., 2000, Choudhary et al., 2013). Over the past ten years, beachface landforms, sand dunes, agriculture, and vegetation cover have changed due to the expansion of communities and other infrastructure along the shore. The land use and land cover near the shore are altered by waves, storm surge, cyclones, erosion, and subsidence (Nayak, 2002, Short and Trembanis, 2004, Zhang, 2011, Kaliraj and Chandrasekar, 2012, Mujabar and Chandrasekar, 2013).

For the purpose of managing and tracking the growth of cities and natural resources, change detection provides quantitative population distribution data. There are numerous tactics, and modifications to them can be connected to change (Singh 1989; Yuan et al. 1999). Transitions in land cover or use are described by "from-to" analysis. To analyse and evaluate the environmental effects of land cover changes, accurate and current information is crucial (Giri et al. 2005).

Because of their precise georeferencing, digital format, and iterative data gathering methods, satellite remote sensing and GIS are frequently employed to quantify, map, and detect LULCC patterns (Lu et al., 2004; Chen et al., 2005; Nuez et al., 2008; Rahman et al., 2011). To find changes in digital attribute values in LULC, several time series of remotely sensed data were used. Data can be utilised to identify sudden, unusual changes over time. Researchers have frequently kept an eye on LULCC (Singh 1989; Muchoney and Haack 1994; Chan et al. 2001). Dry, semiarid ground that is productive for agriculture has undergone change. Ethiopia's lake regions were studied by Rembold et al. (2000) using Landsat TM data from 1972 and 1994. Shalaby and Tateishi (2007) identified the LULC categories for Egypt using Landsat data. Computerized analysis was utilised by Gao and Liu (2010) to identify soil salinization and waterlogging in northeast China.

Numerous coastal crops and wooded vegetation were damaged by the 2004 tsunami. I.e. (Chandrasekar, 2005; Hentry et al., 2010). (Chandrasekar, 2005; Hentry et al., 2010). Landuse and land cover are under stress from population growth and climate change, which has negative environmental effects on plant cover, shoreline change, landform degradation, biodiversity loss, groundwater pollution, and soil and air pollution in coastal regions (Chandrasekar et al., 2001, Chauhan and Nayak, 2005, INCOIS., 2009, Mahapatra et al., 2013, Kaliraj et al., 2014). Assessments of coastal risk in academia and policy must take LULC movements into account (Brown et al., 1999, Benoit and Lambin, 2000, Ayad, 2004, Baby, 2015). Under conditions of high population demand, the LULC change research supports effective national or regional coastal resource management planning (Weismiller and Momin, 1977, Wu et al., 2002, Zoran, 2006, Zhang and Zhu, 2011, Butt et al., 2015a). LULC features can be mapped to user specifications using remote sensing and GIS (Jaiswal et al., 1999, Chandrasekar et al., 2000, Yagoub and Kolan, 2006, Kawakubo et al., 2011, Misra et al., 2013, Rawat and Kumar, 2015). Records, maps, and field surveys are used to map the LULC traits. The process is difficult, expensive, and time-consuming, and the maps that are created quickly lose their value (Anderson et al., 1976, Wickware and Howarth, 1981, Singh, 1989, Nemani and Running, 1995, Nayak, 2002, Wang et al., 2004, Wang et al., 2008, Rawat et al., 2013). We can better understand environmental changes by combining spatial and temporal resolutions, especially in coastal seas (Misra et al., 2013). The spatial and temporal data of LULC characteristics are the main focus of integrated GIS and remote sensing for decision-making (Rawat et al., 2013, Misra and Balaji, 2015). Maps, aerial photographs, and satellite images are combined with GIS and remote sensing to create quantitative, qualitative, and descriptive geo-databases (Kaliraj & Chandrasekar, 2012). Remote sensing can identify local, regional, and global LULC changes, according to academics (Wickware and Howarth, 1981, Avery and Berlin, 1992, Jaiswal et al., 1999, Chandrasekar et al., 2000, Alam et al., 2002, Jayappa et al., 2006, Santhiya et al., 2010, Mujabar and Chandrasekar, 2012). LULC change detection uses MSS, TM, and ETM+ Landsat imagery worldwide (Baby, 2015). More LULC data is available from Landsat pictures with sufficient spectral features than from in-situ point data (USGS., 2004, Muttitanon and Tripathi, 2005, Kawakubo et al., 2011). Researchers use Landsat TM and ETM+ images to study LULC change (Toll, 1985, Vogelmann et al., 1998, Dwivedi et al., 2005, Akbari et al., 2006, Dewidar and Frihy, 2010, Hereher, 2011).

Recent methodologies, tools, and approaches improve the identification and transformation of LULC features (Richards and Jia, 2006, Amin and Fazal, 2012, Mohammady et al., 2015). Image classification algorithms like SVM, ANN, and ABC misclassify or overlap pixels at the 4th order polynomial level when there is insufficient training data (Jayanth et al., 2015). When employing self-organizing map clustering to create dinoflagellate cyst images, Weller et al. (2006) found that ANN performed best. As the knowledge engine, the MLC classifier uses per-pixel signature files of real-world training samples to group pixels based on their maximum probability digital numbers (DN) (Afify, 2011, El-Asmar et al., 2013, Iqbal and Khan, 2014, Butt et al., 2015b). Landsat pictures provide precise change detection findings when employing the supervised classification method of the MLC algorithm (Anderson et al., 1976, Joshi et al., 2011). This study is the extension work of the paper Sushmita et.al, where the study was about the shoreline and this study is more about the nearby environmental feature status of the coast or the shoreline.

2 STUDY AREA

For the purpose of this study, a coastal location that is located to the north of the Godavari River was chosen. Within the scope of the current investigation, the districts of Kakinada and Visakhapatnam lie directly adjacent to the coast. The whole length of the coastline is approximately 253 kilometres, excluding the ports and the sand bars that have been constructed. The study is performed for the entire scene and later for analysis the near by environment of the shoreline is been considered.

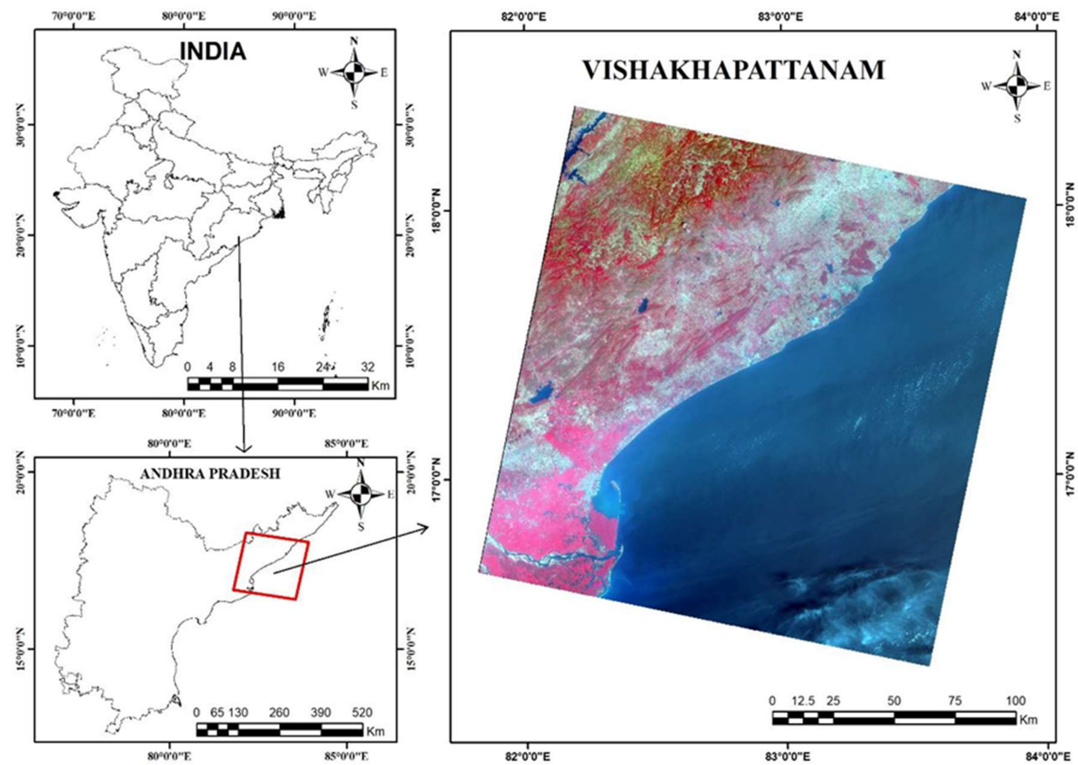

Figure 1: Study Area

3 DATA AND MATERIALS

This research made use of multi-resolution, multi-temporal satellite data from the Landsat TM and OLI/TIRS instruments. The data sets were gathered at different times over the specified time period, on days with minimal or no cloud cover (1988 to 2021). This study's methodology is split up into sub-sections discussing the specific methods and processes used for gathering each type of data. Information was collected from LANDSAT 5 and LANDSAT 8 satellites. There are seven spectral bands in the data that makes up a Landsat 4-5 TM image. Bands 1-6 have a resolution of 30 metres, whereas band 7 was resampled from 120 metres in thermal infrared (references). Eleven spectral bands are included in the.dat files that make up Landsat 8 OLI/TIRS images. Bands 1-3 have a resolution of 30 m, band 8 (the panchromatic band) has a resolution of 15 m, bands 10 and 11 (the thermal infrared band) have a resolution of 100 m.

(reference). The USGS website was scoured for LANDSAT 4-5 TM Level-1 pictures from 1988 to 2011 and for LANDSAT 8 OLI/TIRS C1 Level-1 images from 2014 to 2021. The data collection dates are listed in Table 1.

Coastal change research necessitates meticulous data selection. Selecting multi-date images reduces the impact of seasonal climate changes. Changes in the earth's surface must produce significant variations in radiance, necessitating a multi-date image capture time. This study collected the majority of its data from 1988 to 2021 in March to exclude seasonal impacts. In addition, the monitoring interval was maintained between three and four years so that the changing trend could be observed.

Table 1: Datasets used for the study

Sensor	Year	Month
Landsat 5 TM	1988	March
	1992	
	1996	
	2001	February
	2005	April
	2008	
	2011	March
Landsat 8 OLI/TIRS	2014	
	2018	
	2021	

4 METHODOLOGY

By entering the Path and Rows of the research area (141and 48, respectively), satellite images of the area were obtained from the USGS earth explorer website, https://earthexplorer. usgs.gov/. If the cloud cover was less than 10% for the time from 1988 to 2021, then the datasets were downloaded. Additionally, ensure that the percentage of cloud cover in the "Additional Criteria" section is less than 10%. When we're done, we'll select the "Result" menu item to receive the desired satellite photos. Once you've followed the steps above and clicked the Result icon, a satellite image will load. To make sure there are no clouds over the land, click the MetaData Set icon. After selecting Level-1 Geo TIFF Data Product as the target, the download will start (252. MB). Since a satellite's MB determines how precise its images are. Finally, a working directory is where you should keep the compressed data for subsequent examination.

Unlike other methods of change identification, pre-processing satellite images has the specific purpose of creating a more direct connection between the data and biophysical phenomena. In developing this study's approach, we accounted for a wide range of image pre-processing procedures, such as geometry correction, atmospheric correction, image enhancement, and interpretation. Before the classification was done, the downloaded satellite photos were pre-processed. Layer staking has been done on the gathered photos. However, the region of interest in many of the photographs utilised by IMAGINE can only be seen by zooming in on a very small section of the whole. To reduce storage needs and processing times, we generated fresh images from a smaller data set.

The enhancement of raw, remotely sensed data makes key aspects more easily discernible by the human eye. In order to investigate and locate regions and things on the ground, as well as derive meaningful information from photos, enhancement techniques are frequently utilised instead of classification techniques.

Radiometric correction, spectral augmentation, and principal component analysis were used to improve the images in this study so that different types of land cover could be more easily identified. Options for Spectral Enhancement are a group of image processing methods developed for data with multiple bands. Using these settings, you can isolate more human-readable data bands.

Visual analyses are the primary use of these improved images, while automated studies rely on the original images. Here, we used contrast stretching to make the studied images easier on the eyes. Before images could be classified, LULC features were broken down into six categories: barren, agricultural, urban, forest, aquatic, and grassland. These six categories were established via human interpretation of satellite images and subsequent field observation. Bare land is defined as undeveloped or unforested territory. Agricultural land is defined as areas where food, fibre, fodder, or ornamental plants are grown.

For the most part, two distinct picture classification methods are used for identifying different types of land covers. The sample polygons from the known land cover categories are used in a supervised classification, one of several methods for classifying land cover types. When the number of different types of land cover in a given area is unknown, the second type of classification, unsupervised classification, is used to categorise satellite image data for that area. By syncing images from ERDAS Imagine and Google Earth, a supervised classification method was employed for this investigation, which relied on the presence of known ground truth locations. In Supervised Classification, the Signature Editor is used to create, manage, evaluate, and modify signatures in order to regulate the classification process. During supervised categorization, names are typically associated with signatures, which are defined as distinct domains. We utilise signatures to divide broad categories like "forest," "cultivated," "water," and "the like" into as many "subclasses" as needed for our purposes. Layers can be generated in the layer creation option, and this is necessary for several products like the Signature Editor. The merge signatures option was used to accomplish complicated classifications using signatures derived from a variety of training methods (supervised and/or unsupervised, parametric and nonparametric). Most often, land use/cover data is gleaned through supervised categorization.

In this investigation, a training sample was chosen using spectral characteristics following data preprocessing. Land use/cover was mapped using maximum likelihood classification instead of more traditional categorizations. To ensure the accuracy of the supervised classification, random points were used after the image was segmented.

5 RESULTS AND DISCUSSION

By employing a systematic approach to detection and quantification on satellite pictures, we were able to generate land use and land cover maps for 1988 to 2021. In order to quantify the rate of change at the watershed level, define the underlying patterns of land use, and land cover across the study period, spatial analysis was performed. LULC maps were presented together with statistical summaries of the various LULC types for two reference years. Using Landsat series, ERDAS IMAGINE 2014 was able to determine the land cover change that had occurred between the two years. Four distinct classifications of land cover were distinguished from the satellite imagery. The identified land cover classes are Water body, Vegetation, Built-Up and

Other Land.

If the generated data is to be relevant in a change detection analysis, then it must first be assessed for classification accuracy . Using the ERDAS programme and a stratified random approach, 600 random points were identified and located to represent the various LULC classes in the area, and the software's classification accuracy was evaluated on the basis of these points. Accuracy evaluations necessitate a sample size of at least 250 randomly generated points. Our research included 600 points, which represented checkpoints (google earth data). Error matrices were used to compare and statistically assess the ground truth data and the classification findings

Classification errors caused by the base field, cities, and classes with a similar response, such as some agriculture areas and wetlands, are mitigated through post-classification improvement. Because the majority of the area depicted in the image was considered to be farmland at the time it was taken, even if some of it was technically fallow and thought to be extracted at the time. Grasslands are abundant in the research area, and their spectral response is comparable to that of tiny grains grown in agricultural regions.

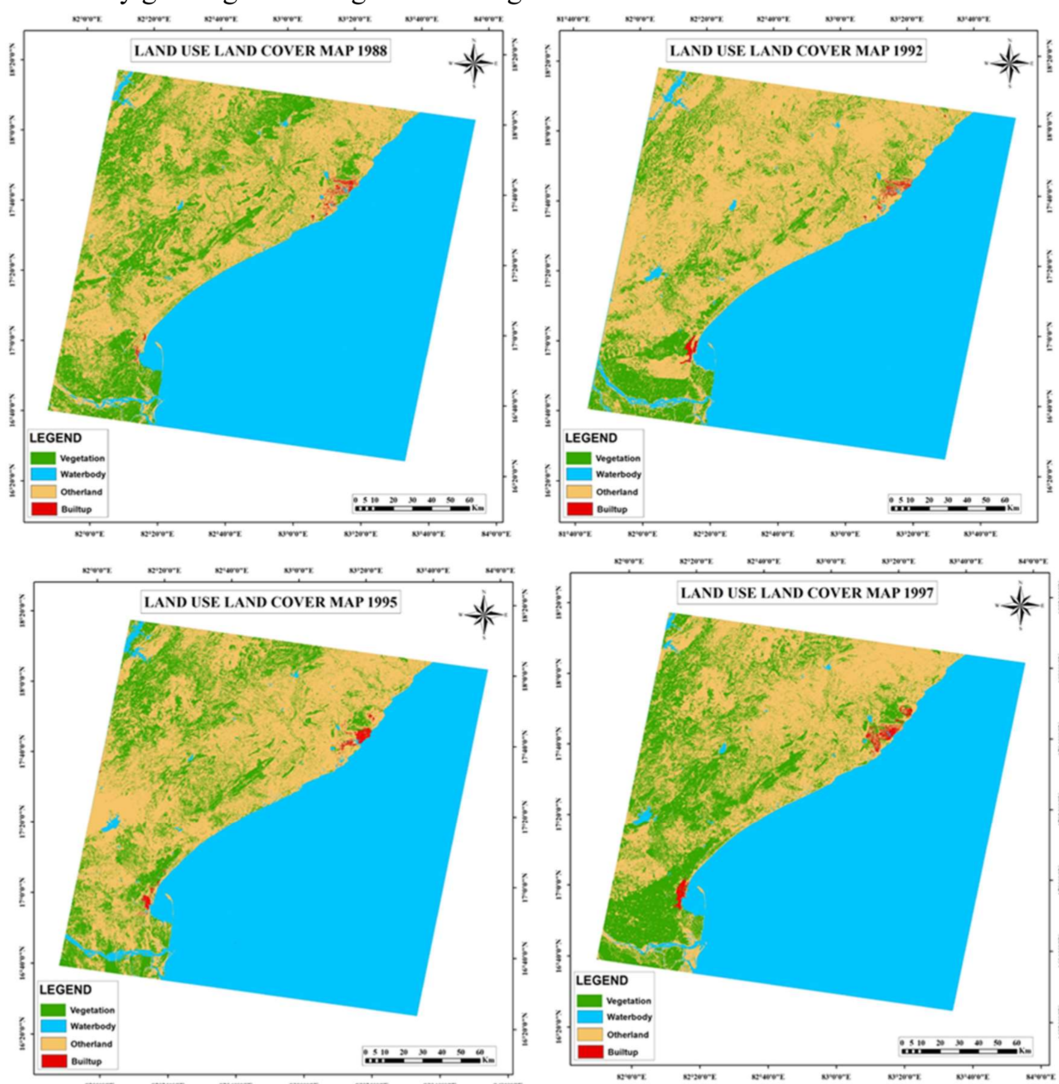

Figure 2: 90's LULC of the study area

The is good amount of vegetation was present in early 90's and later it was converted into built up in the subsequent years. (Figure 2). Whereas, restoration of forest (vegetation) was initiated in early 2000's, thus good amount of vegetation is been interpreted in figure 3 but the coastal built up was increasing for every year. To understand the area of LULC feature classification, area statistics was tabulated in Table 2

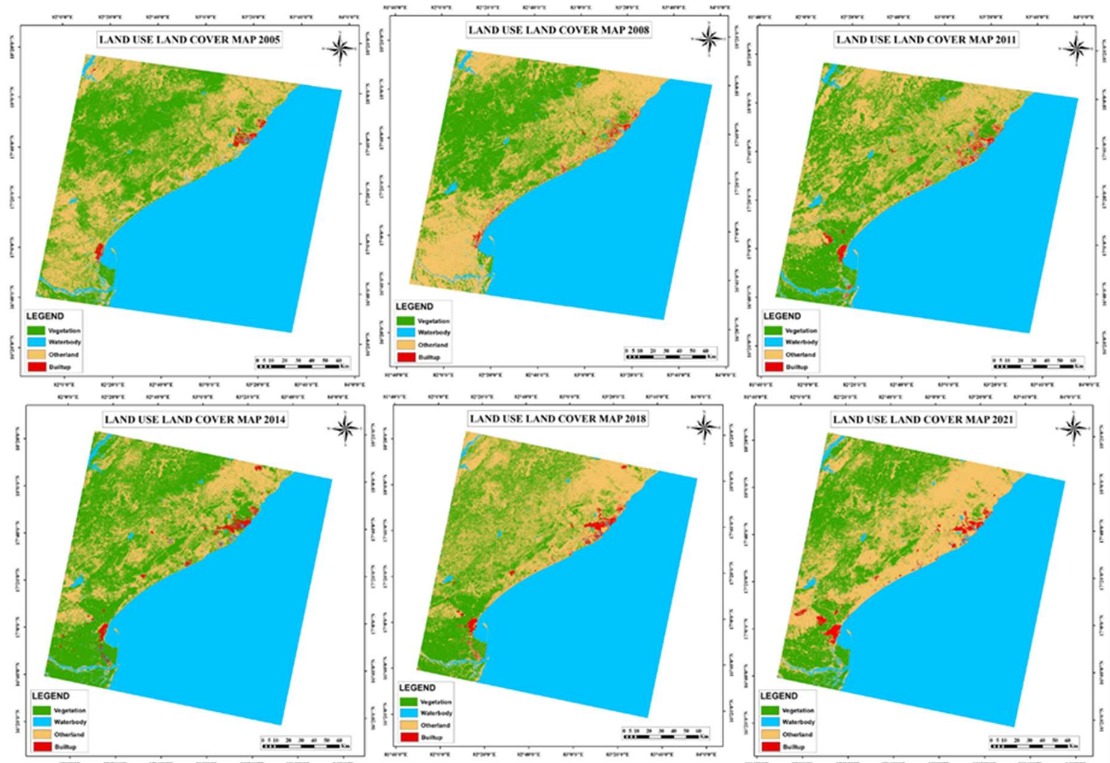

Figure 3: Current Era LULC of the study area

The accuracy of a producer can be defined as the ratio of the number of correctly produced pixels in a given category to the total number of pixels in that category as determined by the reference data. The user's reliability is measured by how likely it is that a pixel labelled on the map corresponds to that category in reality. Users' accuracy is measured by dividing the number of correctly identified pixels in a given category by the entire amount of pixels in that category (row total). The precision can be calculated by dividing the number of right pixels (diagonal) by the number of wrong ones in the error matrix. With an overall accuracy and kappa coefficient value of 0.74 to 0.81 (all the image classification) has demonstrated very strong classification accuracy. This proved the categorization strategy and the applied google earth random points were effective.

Table 2: Area Statistics of all years

TABULATED AREA (in Sq km)				
YEAR	**VEGETATION**	**WATERBODY**	**OTHERLAND**	**BUILTUP**
1988	6135.178	18342.83	10430.53	71.6517
1992	4609.042	17198.37	13193.87	86.8536
1995	5043.994	18754.48	11339.34	94.0464
1997	6426.286	18888.46	9497.665	133.1424

2005	8584.797	18751.86	7885.545	140.4711
2008	7989.007	18918.67	8942.638	201.474
2011	8495.151	19114.55	8150.185	261.2466
2014	10396.66	19962.63	6654.779	288.639
2018	5893.787	20002.41	9373.52	327.3615
2021	7590.107	20025.26	9311.309	378.6156

Change detection analysis uses post-classification comparison (Foody 2002b). This method involves reclassifying many photographs and comparing their labels or themes to spot changes. Because data from two dates are categorised individually, climatic and sensor changes between dates are easier to compensate for, and many images show land cover change (Lu et al. 2004, Jensen 2005, Naumann, Siegmund 2004, Teng et al. 2008). Comparing pixels creates pixel, percentage, and area conversion matrices. Accuracy depends on image quality (Jensen 2005, Corresponding et al. 2004, Civco et al. Variations in the radiometric properties of the photographs used to build thematic maps could also give erroneous findings when using multi-date or multi-sensor photos (Foody 2002b, Foody 2002a). Dewidar (2004) mapped and monitored land cover and land use changes in Egypt's northwestern coastal zone. Sun, Ma, and Wang (2009) used multi-temporal Landsat data to study China's Datong basin. Fan, Weng, and Wang (2007) used the Maximum Likelihood (ML) approach, Landsat TM and ETM+ post-classification pictures, and socioeconomic data to analyse dynamic land use and land cover changes. Post-classification is used to quantify land cover change, improve spectral categorization, reduce classification error propagation, and improve land use and land cover change classifications. The table below shows urban growth. Vegetation is expanding and restoring from previous years.

Table 3: The change detection analysis

Change Detection 1998-2021					
	2021				
		VEGETATION	**WATERBODY**	**OTHERLAND**	**BUILTUP**
1998	**VEGETATION**	**15.2001**	17966.6928	54.8856	3.7854
	WATERBODY	3710.8881	**274.2093**	1933.304	52.8786
	OTHERLAND	2588.0607	534.6414	**6779.19**	475.9533
	BUILTUP	1.7073	4.0167	22.3029	**536.7033**

The final two shift detections guarantee that the discrepancy is not due to sensor variation. Methods used to compare changes to the 1988 shoreline as a baseline. To reduce confrontation, a 200-meter buffer zone was established. We set the maximum distance at 200 metres to lessen the disparity between the two ways. Second, this safety distance precludes counting near-shore internal water bodies. Changes based on vectors were clipped, and the area of change was calculated. The overall area change is calculated by multiplying the number of pixels converted to or from water by the area of each pixel. The erosion and accretion status is been graphed in figure 5.

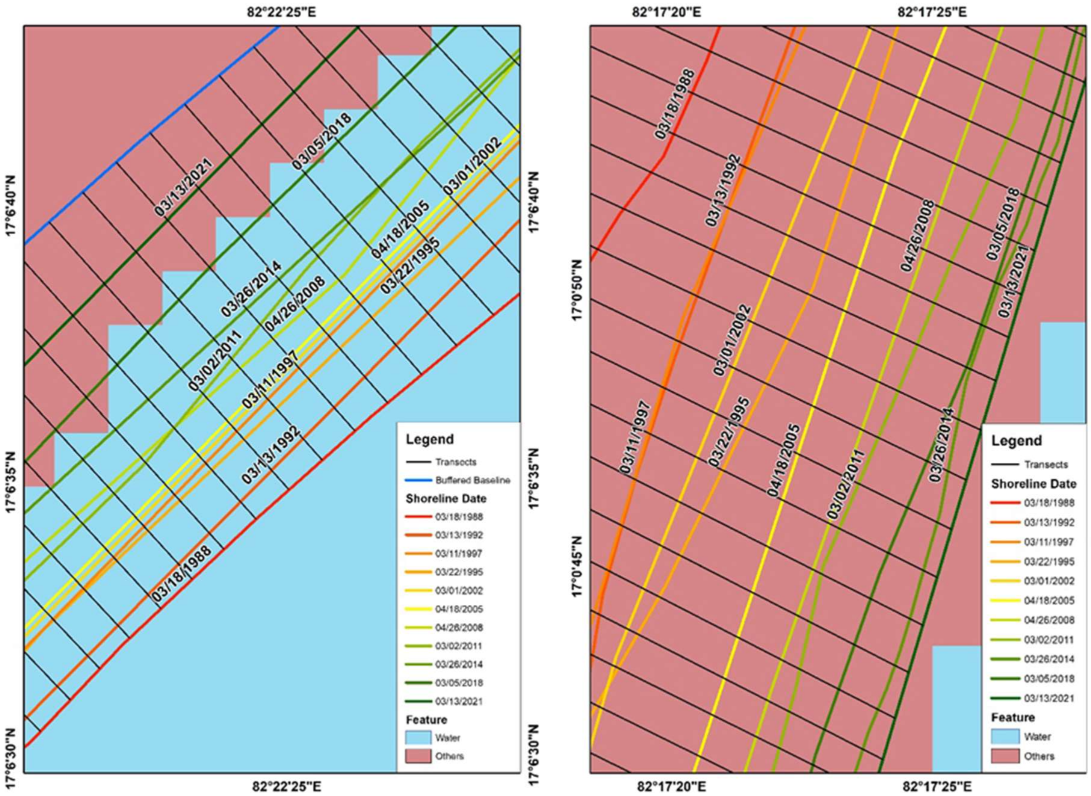

Figure 4a: is a picture showing the eroding environment captured by the image difference approach, and the GIS-based shorelines mapped. Figure 4b: Both the image difference and the GIS-based mapping capture the accretion clearly in this image. In order to understand when the shoreline changed from 1988 to 2021, those years are provided.

The shoreline depletion was for 200m circumference from the baseline but the influence of it will be for a larger kilometre. For better understanding of the coastal environment and change statistics, three buffer zones (3km, 5km and 10km) were created. This helped to interpret the near shoreline land cover and their area demarcation (Figure 6 and Table 4).

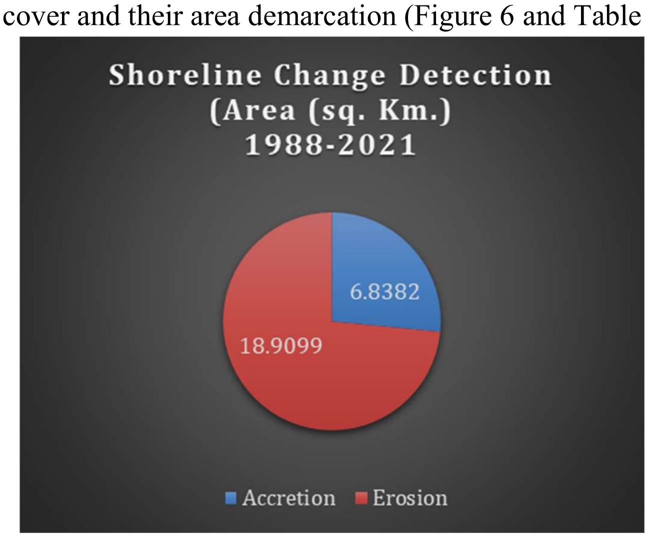

Figure 5: Shoreline Change Detection.

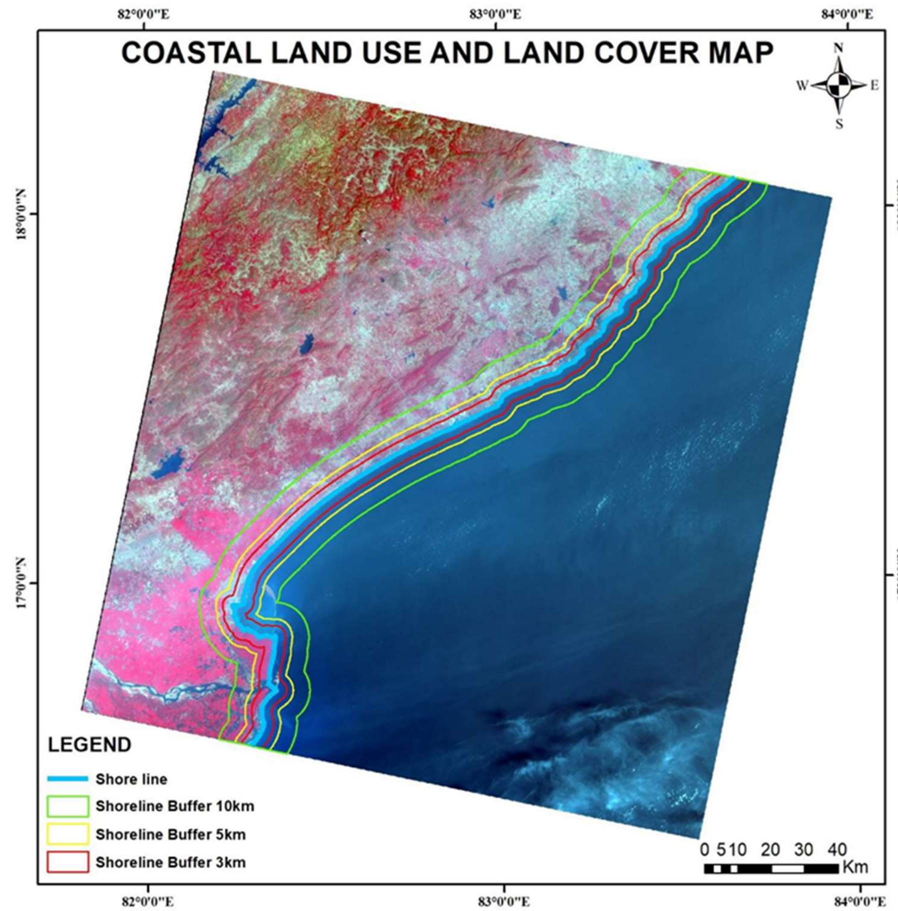

Figure 6: Buffer zones around the shoreline

Table 4: Area statistics in and around the shoreline

SHORE LINE TABULATED AREA 2021				
BUFFER AREA	**VEGETATION**	**WATERBODY**	**OTHERLAND**	**BUILTUP**
3 KM	96.9453	857.754	534.1383	102.717
5 KM	103.3128	538.9254	329.8104	60.1209
10 KM	397.9755	2175.7194	1366.7642	189.828

Based on the fact of 18sq km erosion in the shoreline the 3km buffer LULC extraction has a serve immediate impact on the costal environment and the 10km buffer zones are low vulnerable regions.

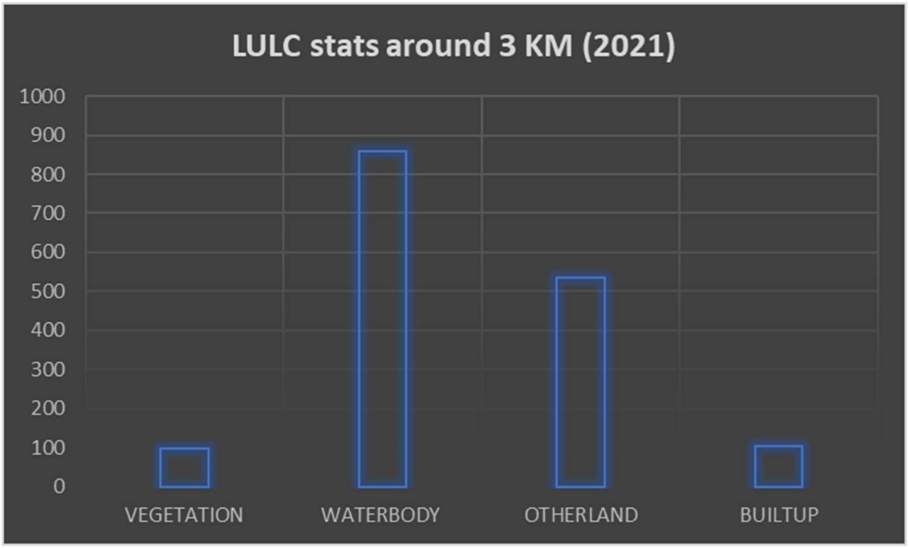

Figure 5: 3km shoreline buffer zone

6 CONCLUSION

Remote sensing creates Land Use and Land Cover maps. "Land usage" describes why land was surveyed. Recreation, wildlife habitat, agriculture, urban development, or any other land-impacting activity. Understanding land use helps us manage conservation, conflicting uses, and development pressures. Deforestation, urban sprawl, and agriculture degradation need correction. Land Cover refers to vegetation, water, barren soil, urban development, etc. Land cover identification, delineation, and mapping are crucial for global monitoring, resource management, and planning.

This paper describes the use of remote sensing data to account for erosion and accretion patterns and LULC variations to understand environmental trends along the shore. Without port regions, the study area covered 253 km, and the research examined LULC in that area over time. The coastal ecosystem has degraded during the previous two decades due to coastline advance and retreat. The investigated territory is segmented annually. Both the baseline and LULC studies reveal that the number of developed regions has expanded since 2000. Since 2015, the north and south west have seen significant urbanisation. The volume of shallow water grew between 2000 and 2018. The current effort reveals changes to the shoreline environment and provides LULC maps, both of which can help decision makers find vulnerable sites, protect them, and build more effective coastal remedies. Most remote sensing experts believe that certain system and environmental requirements must be met. Geometry, registration, radiometric and atmospheric calibration, and phonological state similarity are multitemporal image processing techniques. If possible, choose photographs with the same spatial and spectral resolution to avoid unwarranted assumptions.

Conflicts of Interest:

The authors declare that they have no known competing financial interests or personal relationships that could
have appeared to influence the work reported in this paper.

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