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Land use land cover change detection in Kanchipuram coastal stretch in Tamilnadu, using Geo special techniques

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ABSTRACT: Change detection analysis by using multi-temporal satellite imagery by visual interpretation helps in understanding landscape dynamics. The present study illustrates the spatio-temporal dynamics of land use/cover of Coastal shores of Kanchipuram district, Tamil Nadu India. Landsat satellite imageries of two different time periods, i.e., Landsat Thematic Mapper (TM) of 2001 and 2016 were acquired by Global Land Cover Facility Site (GLCF) and earth explorer site quantify the land use / land cover changes for Kanchipuram coast for the period of 15 years (2001 to 2016). The images of the study area were categorized into seven different classes namely forest, agriculture, wasteland, built-up, beach sand and water body as per USGS classification system. The results indicated that during the last fifteen years classes such as forest, built-up, beach sand and wasteland have been increased steadily while agriculture area decreased disproportionately. The paper highlights the importance of visual change detection techniques for nature and location of change of the Kanchipuram coast.

KEYWORDS: Landuse/ land cover, Change detection, Landsat data, Kanchipuram coast.

INTRODUCTION

The study of land use land cover is very important to understand the natural and manmade resources on the surface of the earth. The knowledge of this can be used to determine their utilization, conservation and sustainable management of land resources. The land use refers to mans activities and the varied uses to which land is put to, and to land cover which refers to natural vegetation, water bodies, rock/soil, artificial cover and other uses observation on the land (NRSA, 1989). Land use and land cover change is always caused by multiple interacting factors. The mix of driving forces of land use land cover changes varies in time and space and according to specific physical and human environmental conditions. The increasing population and their socio economic needs create pressure on land use land cover, and this pressure result in unplanned and uncontrolled growth. Land use land cover changes are usually caused by the growth of rural and urban land uses, mismanagement of agriculture, forests and water bodies, which lead to several environmental problems.

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Although non-coastal communities also have pressing environmental issues, maintaining sustainability in coastal development is particularly important because "more than half of the world's population lives within 60 km of the shoreline, and this could rise to three quarters by the year 2020" (UNCED, 1992). At the advent of the 21st century, there are 20 cities in the World with a population of over 10 million, of which sixteen of those cities are along coastlines. Growing populations not only put a greater strain on already depleting resources, but are also responsible for the degradation of marine habitats. Coastal zones are still of crucial importance for coastal states today. They are home to the bulk of the population, and account for a considerable share of the country's economic activities, being highly valued by society for the non-marketable goods and services they provide. A wide range of human activities takes place in the coastal zones like industry, tourism, fishing, aquaculture, etc. When these activities develop together on the narrow coastal strip, problems tend to arise, creating conflicts. Due to its highly dynamic character, even development work with clear local objectives may have adverse effects elsewhere along the coast.

The natural threats for the coastal zones are also tidal surges and sea-level rise (FAO, 1998), which sometimes are interrelated. Sea level rise is a 'natural process' as greenhouse gases mainly CO2 emissions indeed the consequent climate changes caused by human activities, contributed to the melting of the glaciers and, finally to the sea level rise. The most serious impacts of the sea level rise identified in the meeting of 'Global and regional sea-level change and hydrological. The purpose of this study is to examine and assess the land use and land over changes over a stretch of the coastal area in Kanchipuram district, using multi date, remotely sensed data covering coastal regions of Kanchipuram district.

STUDY AREA DESCRIPTION

In order to demarcate the coastal zone of Kanchipuram district, towards writing up a geographical profile, a 10 km buffer zone has been created from the coastline landward, the village that fall entirely in the buffer zone have been selected for the study. The geographical coordinate system of the study area is 12°50'3.02"N to 12 58' 21.74"N Latitudes and 79°42'13.1"E Longitudes. The study area is bounded by Chennai city on the north, Villupuram on the south, Bay of Bengal on the east, and other villages of Kanchipuram district on the west. This geographical area rather the bounded space within the 10 km buffer zone, is the area of concern in this study and the changes within it in land uses and land cover are the concern of analysis and interpretation in this study in figure 2. A total of 171 villages were within the 10 km buffer zone, of which 27 villages were in Tambaram Taluk, 56 villages were in Chengalpet Taluk, and 88 villages in Maduranthagam Taluk. The total geographical area of the study area is 1638 sq.km.

Agricultural is main occupation of the people in the coastal zone under study. Paddy is the major crop cultivated in the district. Groundnut, sugarcane, cereals, millets and pulses are the other

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major crops. Kanchipuram district is part of the composite east flowing river basin and spread over a part of Palar and Cheyyar sub-basin. Palar and Cheyyar are the important rivers. The drainage pattern in general is sub-dendrite and radial that flows through study area. All the rivers are seasonal and carry substantial flows during monsoon period. Kanchipuram district generally experiences hot and humid climatic conditions. The district receives the rain under the influence of both southeast and northeast monsoons. Most of the precipitation occurs in the form of cyclonic storm caused due to the depressions in Bay of Bengal chiefly during northeast monsoon period. The southwest monsoon rainfall is highly erratic and summer rains are negligible. The normal annual rainfall over the district varies from 1105 mm to1214mm. It receives a minimum in the western and northwestern parts of the district is places of Uttiramerur (1105 mm) and it is the maximum around Kovalam (1214.2 mm). High relative humidity between 58 and 84% prevail throughout the year.

The prominent geomorphic units identified in the district through interpretation of satellite imagery are i) Chingleput-Tirukkalukkunram Surface (Erosional) ii) Palar Surface (fluvial and iii) Mamallapuram (Mahabalipuram) surface (Marina) etc. The elevation of the area ranges from 100 m amsl in the west to a sea level in the east. The major part of the area is characterized by an undulating topography with innumerable depressions, which are used as irrigation tanks.

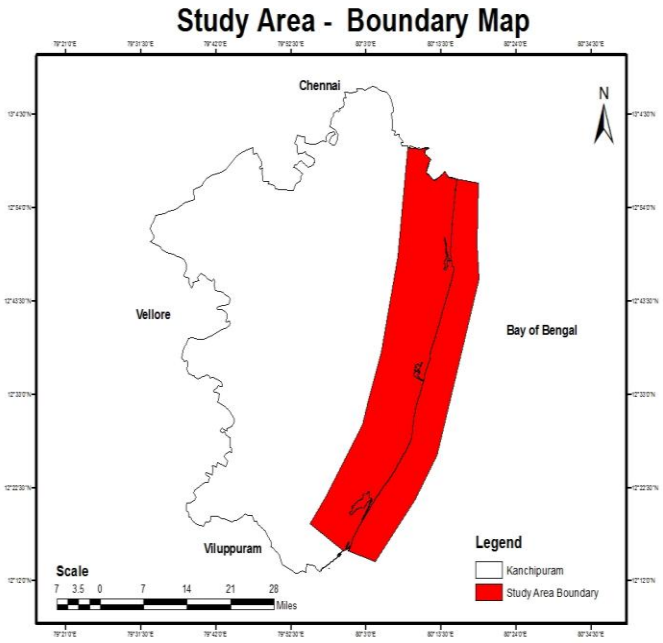

Figure ;1.Study area map of Kanchipuram Coast

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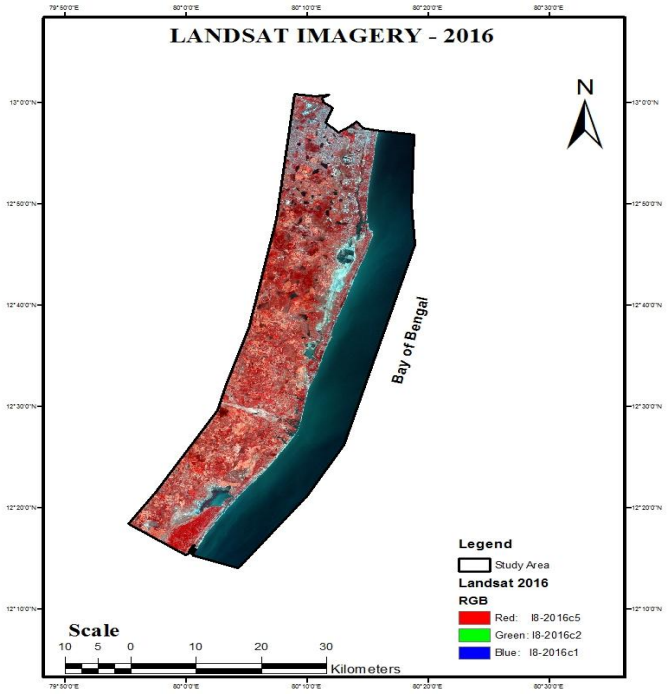

Figure :2. Landsat imagery of the year 2016

METHODOLOGY

The study has been conducted to understand and assess the existing land use land cover detection changes over a period of 15 years from 2001 to 2016, using remote sensing and GIS. Land use refers to human activities in relation to land (Clawson and Stewart., 1965) land cover on the other describes the elements for example vegetation and human activities, built up area or human constructions (Burley 1961). There is a considerable diversity of opinion about land use (nobi et. 2009 and Manonmani et al., 2010) although present use of land is one of the characteristics that are widely recognized as significant for planning and management purposes.

The United States Geological Survey (USGS) devised a land use and land cover classification system to use remote sensing data in the mid 1970s (Anderson et al., 1976). This classification system designed to use are at four "levels" of information could be drawn from aerial photos and satellite images, depending on the sensor system and image resolution. Levels I and II

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are principally of interest to users who desire to get information on a nationwide, interstate, or statewide basis. Levels III and IV can be utilized to provide information on regional (district), taluk, or local planning and management activities.

The study utilizes remotely sensed data by visual interpretation technique and by field checks. The spatial themes are classified based on United States Geological Survey (USGS) devised a land use and land cover classification system and derived 6 land use classes (Level I), suitable to the local condition. They are Built-up lands, Agricultural lands, Forests, Wastelands, Sandy area, Water bodies in the Kanchipuram coastal zone. Since the data is of medium resolution, higher level classification were attempted but in vain due the pixel resolution of the image is of (30m) of Landsat imagery.

Change detection of land use land cover category for 2001 and 2016 of LANDSAT TM and LANDSAT ETM has been taken up to understand the dynamics of change for a span of one and half decade. The hierarchical structure of the land use / land cover classes allows logical class aggregation, and hence abstract mapping. The derived land use / land cover classification system builds upon two different themes of datasets such as feature class and shape file (*.shp) format in the GIS environment.

LANDSAT ORBITAL CHARACTERISTICS OF ETM

S.No	**SENSORS**
1	Enhanced thematic mapper plus (ETM+)
2	Eight spectral bands, including pan and thermal band
3	Band 1 visible (0.45 – 0.52 um) 30 m
4	Band 2 visible (0.52 – 0.60 um) 30 m
5	Band 3 visible (0.63 – 0.69 um) 30 m
6	Band 4 near infrared (0.77 – 0.90 um) 30 m
7	Band 5 near infrared (1.55 – 1.75 um) 30 m
8	Band 6 thermal (10.40 – 12.50 um) 60 m low gain / high gain
9	Band 7 mid infrared (2.08 – 2.35 um) 30 m
10	Band 8 panchromatic (PAN) (0.52 – 0.90 um) 15 m
11	Ground sampling interval (pixel size); 30 m reflective, 60 m thermal

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12	Added the band 6 low and high gain 60 m thermal bands On board calibration was added to landsat 7; a full aperture solar calibrator (FASC) and a partial aperture solar calibrator (PASC), in addition to the 2 calibration lamps

Table: 1. Landsat Orbital Characteristics of ETM

RESULT AND DISCUSSION

As mentioned earlier, United States Geological Survey (USGS) devised a land use and land cover classification system has been adopted for the present study. The LANDSAT, geocoded data (2001) was downloaded from USGS website. This website contains Landasat data of multidate of different sensors. Satellite data correspond to the year 2001 was used as base year. Landsat ETM data for the year 2016 was downloaded from USGS website for assessing land use for current status. The detailed description of the satellite orbital characteristics and the sensor characteristics are listed in table 1. By visual image interpretation, land use / land cover were classified into six classes: 1) Built-up lands, 2) Agricultural Lands, 3) Forests, 4) Wastelands, 5) Water bodies and 6) Others.

LAND USE AND LAND COVER ANALYSIS

For the better comprehensive development and management of the Kanchipuram coast and its surrounding areas, it is needed to have proper information on LU/LC and the driving forces that affect the urban ecosystem. Landsat TM data of 1:50,000 scales for the year 2001 and ETM data for 2016 were visually interpreted for the delineation of LU/LC categories of the study area. The various LU/LC classification levels based on visual interpretation in the study area includes Built-up land, Agricultural land, Forest land, Water bodies, Wastelands. The aerial distribution of LULC categories of Kanchipuram coast area was depicted in Table 1 and the land use/land cover map of Kanchipuram coast area is shown in figure 4. The present analysis of changes in land use shows that area of agriculture land, waste land and water bodies is shrinking during 2011 to 2016. It clearly shows the increasing trend of built up areas and declining trend of agricultural land, water bodies and wasteland categories. The land and water resources in the sub urban areas are in high demand for non agricultural activities and the farmer's interest towards agriculture is also getting reduced. This is mainly due to the proximity to the city and related employment opportunities. Hence, cautious developmental activities are needed to balance the relationship between the livelihood of poor farmers and environmental protection (Ren-Qiang et. al, 2007).

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BUILT-UP LAND

The built-up land is described as an area of human habitation developed by virtue of non-agricultural use. It consists of buildings, transport, and communication, utilities in association with water, vegetation and vacant lands. Rural and urban built-up lands are the main sub categories identified under this category. Built-up land is composed of areas of intensive settlements with much of the land covered by concrete structures/ thatched roofs/ tiles and other buildings and it covers an area were 176.73 sq.km for the year 2001and (237.99 sq.km) in 2016. It is observed that major changes have been found in the proximity of settlements. The particular study period is really experiencing the best boom in industries and institutional and residential sectors in the study area. Due to rapid expansion of land use land cover themes particularly cities, towns, villages, industrial and commercial complexes and institutions are in crowded in this category for the year 2016 has led to the increase in built up structures.

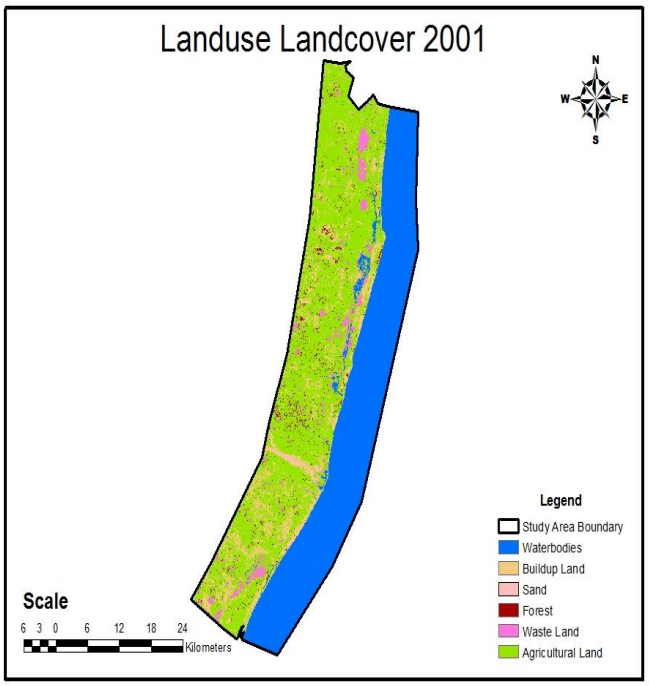

Figure :3. Land use land cover 2011

AGRICULTURAL LAND

Agricultural land is described as the land primarily used for farming and for the production of food, fiber, and other commercial and horticultural crops. It includes land under crops (irrigated and un-irrigated, fallow, plantations etc). A rapid land transformation has not only brought about an

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ecological crisis in the region but has also threatened the agricultural economy of the watershed, through accelerated soil erosion, deforestation and reduction in groundwater recharge. Also the new industries and factories are continuing to establish in the periphery areas of the city and have contributed in the process of land transformation. The possible contributing factors behind this change are penetration of the developmental activities from the urban areas to the rural and sub-urban area, where agriculture is the prime economic activity. Change in the area under vegetation/forest cover is associated with change in agricultural land and built-up area.In the study area, agricultural land includes agricultural plantations and croplands, agriculture area was (753.54sq.km) in 2001and (330.08 sq.km) in 2016.

WATER BODIES

The water bodies include both natural and man-made water features such as ponds, lakes, tanks and reservoirs flowing as streams, rivers, and canals etc. This category comprises areas with surface water, either impounded in the form of ponds, lakes and reservoirs or flowing as streams, rivers, and canals etc. Water bodies are represented by light blue to dark blue in tone and smooth to mottled texture on satellite imagery. Water bodies appear dark on satellite imagery due to absorption of incoming IR radiation. Surface water bodies such as tanks/reservoirs and river/stream/drains are identified in the study area and their geographical distributions are (624.18 sq.km) in the year 2011 and (634.97 sq.km) in the year 2016. This decline in water bodies is mainly a consequence of the increase in the built-up land to fulfil the demand of infrastructural facilities for the increasing population and to provide the space to the industries, mainly the IT-industries.

Land use Land Cover - 2001		
Sl. No.	**Land use Features**	**Area {Sqkm}**
1	Water bodies	624.18
2	Buildup Lands	176.73
3	Sand	5.62
4	Forest	22.60
5	Wasteland	55.09
6	Agricultural	753.54

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	Total	**1637.77**

Table: 2. Land use land cover 2001

These are the areas bearing an association predominantly of trees and other vegetation types (within the notified forest boundary). In the satellite image, such forest is identified by red to dark red in tone with a coarse texture. This class is distributed in the northern part of the study area. Forest land contributed the predominant land cover category in the study area and it covers an area of (22.60 sq.km) in 2011, and (260.43 sq.km) in 2016.

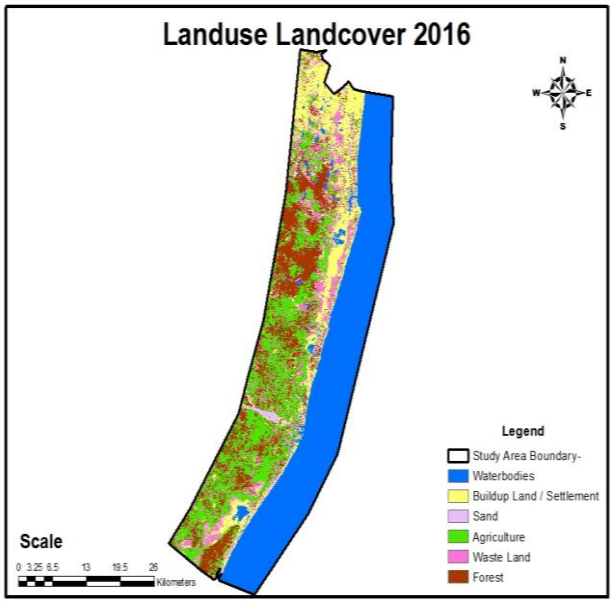

Figure :4 Land use land cover 2016

WASTELAND

Wasteland may be described as degraded land underutilized lands most of which could be brought into productive use with proper soil and water management practices or the land which is deteriorating due to lack of appropriate water and soil management or on account of natural causes. Wastelands can result from inherent/imposed disabilities such as by location, environment, chemical and physical properties of the soil or financial or management constraints. In the study area, three main wasteland categories are predominantly observed. Barren rocky, salt affected, scrubland are listed under this category. The area was (55.09 sq.km) in 2011, and (162.54 sq.km) in 2016.

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Land use Land Cover - 2016		
SL.No	**Land use Features**	**Area {Sqkm}**
1	Water bodies	634.97
2	Buildup Lands	237.99
3	Sand	11.75
4	Forest	260.43
5	Wasteland	162.54
6	Agricultural	330.08
	Total	**1637.77**

Table: 3. Land use land cover 2016

CONCLUSION

Kanchipuram coast was chosen as a study area to quantify the LU/LC pattern for the year of 2001. The three level hierarchic based configurations reveal that the Forest land is the major LU/LC category in the Kanchipuram area covering 260.43 sq.km, followed by agricultural land, wastelands, built up land and water bodies respectively, contributing 330.08 sq.km , 162.54 sq.km , 237.99 sq.km and 634.97 sq.km of the total geographical area. The study concludes that in the Kanchipuram coast area forest contributed the highest (260.43sq.km), while the lowest was contributed by agricultural (330.08 sq.km) in 2016.

In all of these land uses, there were both transformations and transitions from one land use to another. Built up area has gained considerably with almost a third of the total geographical under built environments (residences, institutional and industrial buildings). Agricultural lands were almost halved from what they were three decades ago. Similarly water bodies were either encroached upon or gradually built over in the years passed.

The driving forces for the resulting spatial extent of this land use/land cover classes and their changes could be attributed to population growth, global issues such as climate change in this study area. Moreover, future climate changes will potentially affect where humans live and how they use the land for various purposes. Our projection of human population growth suggests that urbanization will continue. This urbanization could further decrease the forests and croplands in the study area.

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