ASSESSMENT OF LAND USE/ LAND COVER CHANGES AND SEA LEVEL RISE IN PARTS OF SOUTHERN TAMIL NADU, INDIA.

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Abstract

Copious population growth and anthropogenic activities on earth is changing the natural environment extremely. Hence, an attempt has been made in this paper to determine and identify changes in land-use/land-cover changes and tidal Inundation has been carried out using Remote Sensing (RS) and Geographical Information System (GIS). To distinguish the land-use/land-cover changes and tidal inundation to prepare Geomorphology, drainage, Lithology, soil and contour maps, Satellite Data of Landsat ETM+[1999], IRS-P6-LISS-3[2007], OLI [2014], SRTM data has been used. An attempt has been made to prepared LU/LC maps from remotely sensed data (Land sat ETM+ [1999], IRS-P6-LISS-3[2007], OLI [2014]). Change detection techniques to determine the changes in different types of land-use/land-cover features. The results exposed that totally 18 features were identified. Obviously this entire study from the year of 1999 to 2014 has find out settlement (20.69 sq.km) and salt pan (10.61 sq.km) were increased and land without scrub (-13.08 sq.km), sandy area (-6.57sq.km) were decrease. In addition to that, the tidal inundation of Geomorphic landforms like 5.13, 9.66, 16.74, 23.63 and 32.11 in sq.km , In Land-use/Land-cover features the affected area are 5.17, 9.75, 17.28, 24.11 and 32.02 in sq.km from 1 to 5 meters range. From the study, the mitigation measures (engineering measures) and Coastal Zone Management practices that can be taken to protect human life and property from sea level rise are suggested.

Keywords: Land use /Land cover changes, tidal inundation, Remote Sensing and GIS.

Introduction

Climate change was projected to impact tropical countries more negatively than the temperate ones. IPCC (2007) stated that anthropogenic global warming is expected to continue to contribute to an increase in global mean sea level during this century and beyond. Sea level rise is a serious threat to the countries with heavy population with wide economic activities. Human induced increases of atmospheric concentrations of greenhouse gases (GHG) such as CO2, CH4, N2O and CFCs may result in unparalleled increases in global temperature (Houghton 1995; Bush1997). Sea level rise is accounted by an increase in the volume of the ocean with change in mass mainly due to the thermal expansion of ocean water and melting of continental ice (IPCC 2001). The global mean sea level has risen at a rate of 1 to 2 mm per year during last century (Church and White 2006). Analysis of tide-gauge data indicates a rate of global-mean sea level rise during the twentieth century recently updated to 17 cm (±5 cm) by the IPCC (2007). The global atmospheric concentration of CO2 has increased from280 ppm to 375 ppm in 2005. Multi-model averages by IPCC show that the temperature increases during 2090–2099, may range from 1.1°C to 6.4°C and sea level rise from0.18 to 0.59 m. Reductions in the polar ice volume lead to 4–6 m sea level rise (IPCC 2007).

The objectives of this paper were to identify and quantify the vulnerable low lying coastal areas to the adverse effects of sea level rise for parts of Southern Tamil Nadu coastal zone. We have employed four projected sea level rise scenarios for assessing the impacts of sea level rise for the study area. In this study, we assessed the impacts on the coastal fishing villages, Land-use, sensitive areas and tourist spots that maybe at risk. The results derived from the study can be used for taking policy decisions and adaptation measures regarding the land-use/land-cover changes and sea level rise issues. Hence, an attempt has been made in this paper to determine and identify changes in land-use/land-cover, particularly in forest areas relative to time in order to prevent and control deforestation and degradation of forests in the study area.

Study area Description

Thoothukudi district is situated in between latitude 0.8 and 45 and longitude 78° and 11°. Maximum temperature is

41°C and the minimum is 26°C. The normal rainfall of the district is 662.2 mm. The lifeline of the district is Tamiraparani River which feeds the district and quenches the thirst of residents. Tirunelveli district lies between 8°.05'and 9°.30' of the Northern latitude and 77°.05' and 78°.25' of Eastern longitude. Maximum temperature is 37.1 to 45°C and minimum is 22 to 23°C. The average rain fall in the district is 814.8 mm per annum. Kanyakumari district lies between 77° 15' and 77° 36' of the Eastern Longitudes and 8° 03' and 8° 35' of the Northern Latitudes. Minimum temperature is 24°C and maximum temperature is 34°C. The average rain fall is 32.6 to 42.5%.

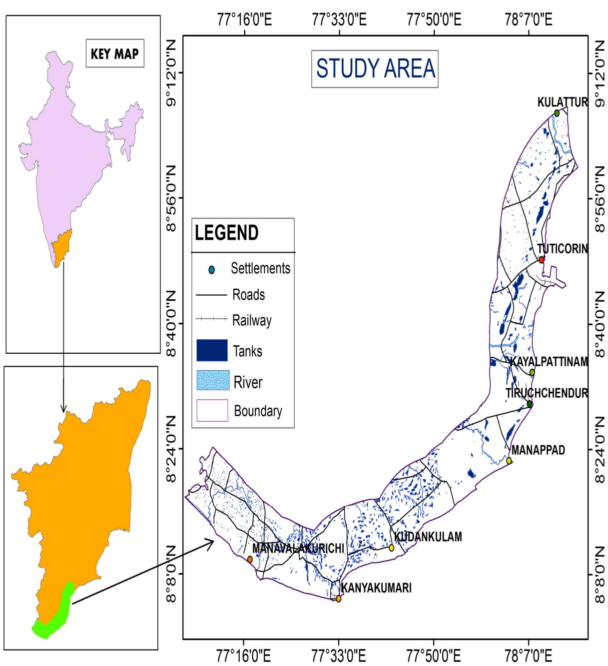

Figure 1, Study area Location Map

Methodology

Land-use/land-cover variation could complicate regularity in image classification between scenes. Therefore, selected cloud free images of 1999 (Landsat ETM+), 2007 (IRS-P6-LISS-3) and 2014 (Landsat 8) to analyze the tangible land-use/land-cover changes in the study area. Arc GIS software was used to process the vector data. A First-order estimate of potential losses of land to SLR was arrived at by integrating digital elevation data with the above sea-level rise scenarios using a geographical information system. The first step was to prepare the contours from the topographic maps. The second step was to generate the Digital Elevation Model for the identification of the inundation zones for the projected SLR scenarios. The third step was to prepare theme maps for coastal village, Land-use, tourist spots and sensitive areas, and to overlay with the inundation zones. The analysis then determined the area and inundation distance that could be exposed to various SLR.

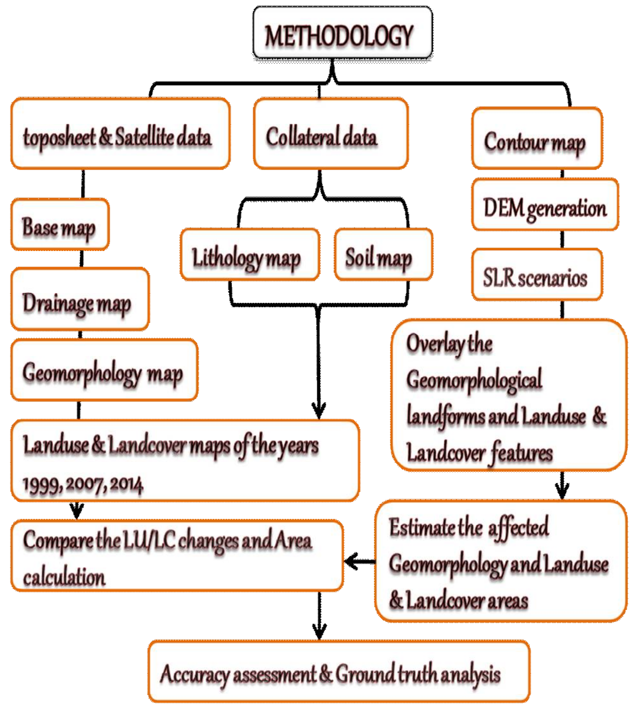

Figure 2, Methodology

Results and Discussion

Land-use/land-cover changes during 1999-2014

Land-use/Land-cover variation could complicate consistency in interpretation between scenes. Distribution of various categories of the land use/land cover derived from the satellite imagery has been identified. LUCC study was conducted for 15 years from 1999 to 2014 and the data for land-use/land-cover changes were obtained from the satellite imageries and toposheet. The images of 1999 (Landsat ETM+), 2007 (IRS-P6-LISS-3) and 2014 (Landsat 8) were used to analyze the actual land-use/land-cover changes in the study area. Prior to the assessment of land use/ land cover changes, these images are georeferenced on the basis of rectified toposheets using ERDAS image processing software. Then, geometrically corrected images are calibrated for radiometric and atmospheric correction to minimize the error if any. ARCGIS 10.2.1 software is used to prepare the land-use/land-cover map of the study area. For the land-use/land-cover classification the methodology of NRSC level two classifications is carried out and 6132 polygons were created for in-depth study.

After the mapping, change detection of the each and every class was analyzed. The land area has been classified into 18 different categories viz., Aqua culture, crop land, fallow land, reserved forest, Ravenous land, industrial area, land with scrub, land without scrub, mud land, plantation, salt affected land, salt pan, sandy area, settlements, tank, water logged area, river. The land-use/land-cover map for the study area was prepared with the help of image interpretation keys such as tone, texture, Drainage, structure fabric and relief using Landsat ETM+ (1999), IRS-P6-LISS-3(2007), Landsat OLI (2014). In the study area, 258.57-278.57 sq.km of land is Settlements, salt pans occupy 196.56-207.17 sq.km and 427.05- 429.89 sq.km is covered with plantations.

Besides 180.19-183.53 sq.km is covered with tanks and other water bodies and 289.15- 284.41 sq.km is covered with Land with scrub. In addition to 125.02-131.59 sq.km covers an area about Sandy area.

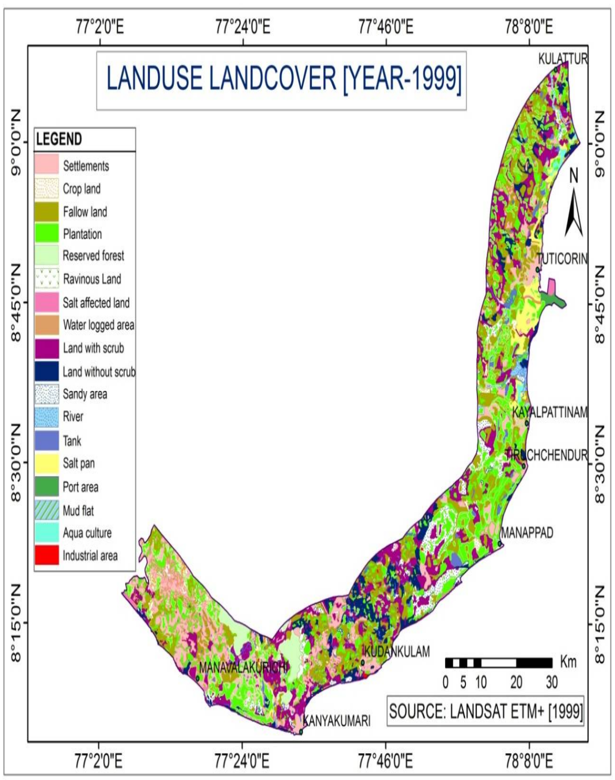

Figure 3, Land use /Land cover map of 1999

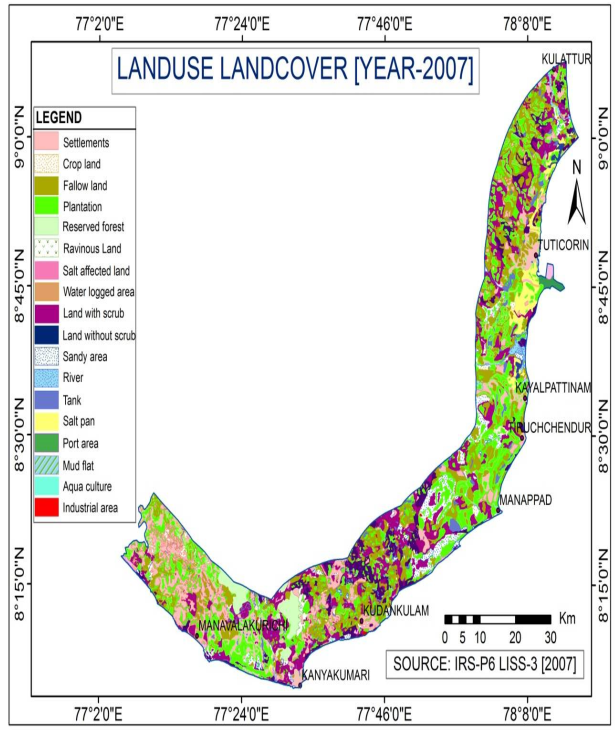

Figure 4, Land use /Land cover map of 2007

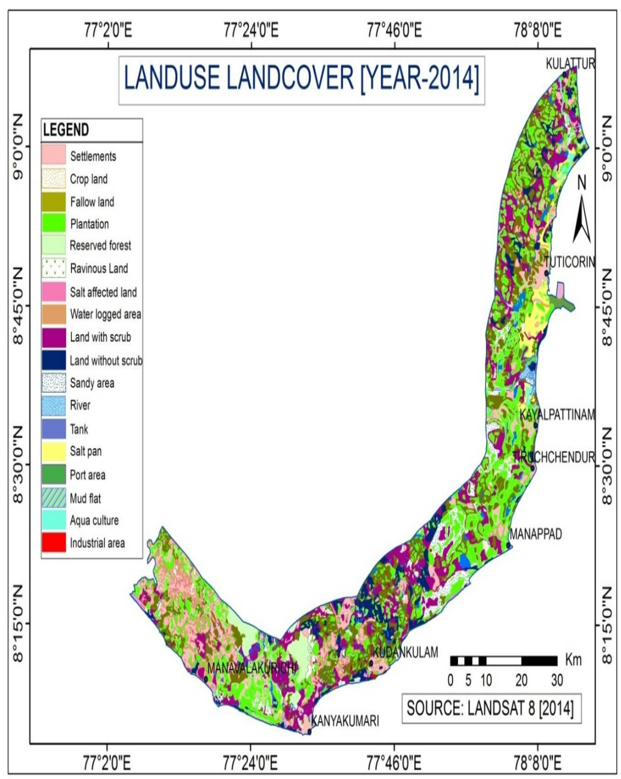

Figure 5, Land use /Land cover map of 2014

Table 1, Land use/land cover changes during 1999-2014

Feature	1999	2007	2014	Amount of Changes in (Sq.Km) between 1999 to 2007	Amount of Changes in (Sq.Km) between 2007 to 2014	Amount of Changes in (Sq.Km) between 1999 to 2014
Settlements	258.57	273.81	278.26	15.24	5.45	20.69
Crop land	152.13	157.86	160.74	5.73	2.88	8.61
Fallow land	389.06	385.12	383.37	-3.94	-1.75	-5.69
Plantation	429.05	426.89	425.57	-2.16	-1.32	-3.48
Reserved Forest	64.74	64.76	64.76	0.02	0	0.02
Ravenous land	12.48	12.61	12.36	-0.21	-0.07	-0.32
Salt affected Land	173.37	168.91	166.84	-4.16	-2.04	-6.2
Water Logged Area	98.34	96.79	95.65	-1.55	-1.42	-2.97
Land with scrub	289.15	286.07	284.41	-3.18	-2.64	-5.82
Land without scrub	208.47	196.63	194.71	-11.88	-1.92	-13.8
Sandy Area	131.59	128.68	125.02	-2.91	-3.66	-6.57
River	78.61	78.36	78.08	-0.25	-0.32	-0.56
Tank	183.19	181.41	180.53	-1.78	-0.88	-2.66
Salt pan	196.56	203.63	207.17	7.07	3.54	10.61
Port Area	8.61	8.93	8.86	3.02	-0.09	0.23
Mud Land	82.5	81.82	80.61	-4.02	-1.28	-0.6
Aqua culture	146.02	148.46	151.58	2.44	3.12	5.56
Industrial area	43.38	46.51	48.26	3.33	1.78	5.11

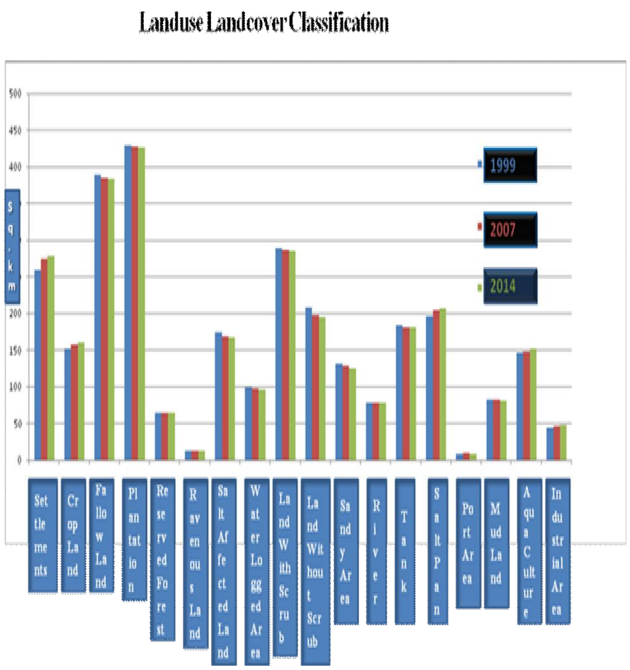

Figure 6, Land use /Land cover changes during 1999-2014

Run-up Tidal Inundation Analysis

The contour intervals are calculated for the study area using the SRTM data, Resolution of 90 Meters. The contour value interval of 10 meters is generated used by the Arc-GIS software. From 1 to 5 meters Run-up Tidal inundation areas were indentified, both geomorphic landforms and Land-use/Land-cover Features.

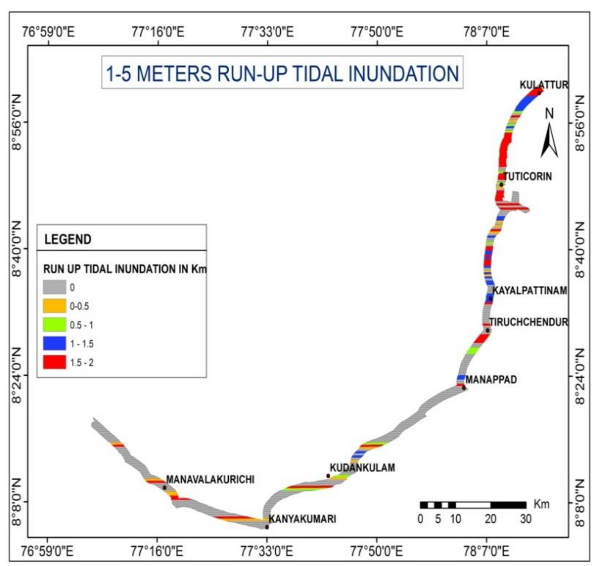

Figure 7, 1-5 Meters Run-up Tidal Inundation

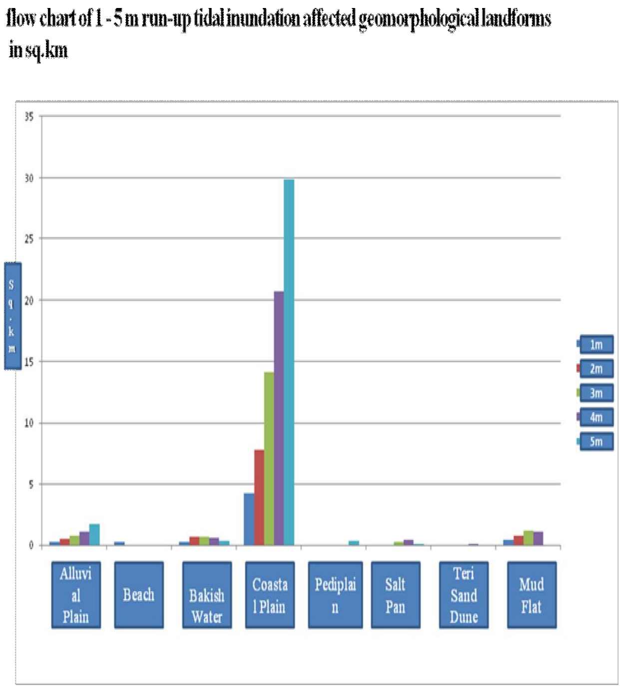

Figure 8, 1-5 Meters Run-up Tidal Inundation Affected Geomorphological Landform

Table 2, 1-5 Meters Run-up Tidal Inundation Affected Landforms

Run up tidal inundation affected geomorphological landforms in sq.km

Feature	1M	2M	3M	4M	5M
Alluvial plain	0.27	0.49	0.78	1.1	1.74
Beach	0.21	0.01	0.02	0.03	0.05
Brackish water	0.28	0.63	0.65	0.59	0.31
Coastal plain	4.18	7.75	14.13	20.73	29.92
Pediplain					0.31
Salt pan			0.24	0.41	0.06
Teri sand dunes				0.12	0.01
Mud flat	0.39	0.76	1.14	1.14	
Total	5.13	9.66	16.74	23.63	32.11

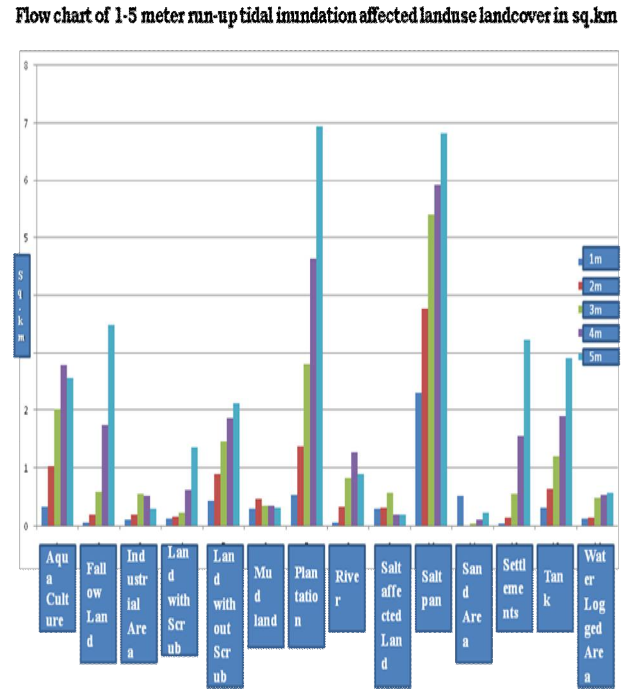

Figure 9, 1-5 Meters Run-up Tidal Inundation Affected Land use/Land cover features

Table 3, 1-5 Meters Run-up Tidal Inundation Affected Land use/Land cover features

Feature	1M	2M	3M	4M	5M
Aqua culture	0.34	1.03	2.03	2.8	2.57
Fallow Land	0.06	0.19	0.59	1.76	3.49
Industrial Area	0.12	0.19	0.57	0.53	0.31
Land with Scrub	0.13	0.17	0.23	0.63	1.37
Land without Scrub	0.44	0.89	1.47	1.87	2.12
Mud land	0.3	0.47	0.35	0.36	0.33
Plantation	0.55	1.38	2.81	4.64	6.95
River	0.06	0.33	0.84	1.27	0.91
Salt affected Land	0.31	0.31	0.58	0.2	0.21
Salt pan	2.31	3.78	5.42	5.92	6.83
Sand Area	0.52	0.01	0.05	0.12	0.24
Settlements	0.05	0.15	0.57	1.56	3.23
Tank	0.33	0.64	1.21	1.91	2.91
Water Logged Area	0.13	0.15	0.49	0.55	0.58
Total	5.17	9.75	17.28	24.11	32.02

Conclusion

Attempts were made to identify the accurate as possible land-use and land-cover as they change through time. The part of southern Tamil Nadu has witnessed extraordinary extension, escalation and development activities such as urban cover enlargement and alteration of land in settlement, saltpan and Industrial area. Typically the participators for the developments are identified as waste land. The extent of inundation of the coastal plains of the study area was identified using digital elevation model. Even if greenhouse gas emissions were stabilized in the near future, thermal expansion and melting of glaciers would continue to raise the sea level for many decades. Expected SLR would impact on the vulnerability of the coastal areas in parts of southern Tamil Nadu and become a potential hazard to those areas both physically and economically. Broad range of population and land-use will suffer from extended coastal inundation due to SLR. Disaster preparedness and mitigation measures at all government levels, such as potential hazard and loss assessment program on the coastal area must also concern the possible impacts of SLR. The result provided from the study is used for the state governments to develop the adaptation plans and appropriate policies to avoid the losses in future.

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