Land Use/Land Cover Change Detection And Delineation of Teri Land In Sathankulam Taluk In Thoothukudi District, Tamilnadu, India Using Remote Sensing And GIS

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Abstract- *The land use/landcover (LULC)map of Sathankulam Taluk in Thoothukudi District, Tamil Nadu, India is famous for its Teri soil. The study area covers the cultivable land, fallow land, barren land, shrub vegetative cover, woody vegetative cover, teri land, eroded land, river, water bodies, wetland, salt pan and settlement. This study was focussed to delineate the teri land and to assess the temporal changes in Sathankulam taluk area. The terisoil area was delineated and extracted the Teri land using multi temporal LISS-III imagery. The study revealed that the declination of teri land area from 46.73 km^2 to 33.08 km^2 in the study area over the desired period.*

Keywords- Land use/land cover, Teri soil, Remote sensing, GIS

I. INTRODUCTION

Land was considered to be the original and inexhaustible gift of nature. About 70.8% of the Earth's surface is covered by water, 29.2 % of it is land.

A) Land Use

The term land use relates to the human activity or economic function associated with a specific piece of land (Lillesand and Kiefer, 2000). Land use is the human use of land (Rimal 2011). The critical element in land use is the human agent.

B) Land Cover

The term land cover relates to the type of feature present on the surface of the earth (Lillesand and Kiefer, 2000). Land cover refers to physical and biological cover on the surface of land (Rimal 2011).

C) Land use and Land Cover change

Land use and land cover change has been recognized as an important driver of environmental change on all spatial and temporal scales (Adepoju et al., 2006).At a global scale, land-use changes are cumulatively transforming land cover at an accelerating pace (Turner et al., 1994; Houghton, 1994).It is widely accepted that LULC have an important effect on both the functioning of Earth's systems as a whole (Lambin et al., 2001). Knowledge of land cover and land use change is important for many planning and management activities (Lillesand and Kirfer 1999). Factors driving LULC change include an increase in human population and population response to economic opportunities (Lambin et al., 2001).The land use/land cover mapping is an important tool for sustainable development.

D) Call for preservation and enhancement of human environment worldwide

The United Nations Conference on the Human Environment held at Stockholm, from 5 to 16 June 1972, insisted the peoples of the world in the preservation and enhancement of the human environment. The necessity of land resource planning information, need of a systematic approach for identifying land uses and the need to develop databases and geographical information systems are respectively stressed by section 4.d, section 14.34 and 14.40(a) of United Nations Conference on Environment and Development (UNCED) Rio de Janerio, Brazil, 3 to 14 June 1992. The necessity of land-resource planning information (section 4.d of UNCED) was stressed by the United Nations Conference on Environment and Development (UNCED) Rio de Janerio, Brazil, 3 to 14 June 1992. Section 14.34 of UNCED speaks about the need of a systematic approach for identifying land uses. Section 14.40 (a) suggest to develop databases and geographical information systems.

E) Focus of the present study

We concentrated the landuse/land cover study in Sathankulam taluk of Thoothukudi district where coastal red sandy dunal soil is abundantly found. They are locally called as teri soils. Itis available in the Thoothukudi and Tirunelveli districts of TamilNadu, with an extent of 20,171 hectares (Jawahar 1996).From which, the Thoothukudi district has the highest teri soil of 16,978 hectares (Jawahar etal., 1999). Using remote sensing and GIS tool, qualitative and quantitative information on land-cover changes can be accessed from LISS III data.

II. STUDY AREA

Thoothukudi District is located in the extreme south-eastern corner of TamilNadu state and bounded on the

(i) on the east and south-east by Gulf of Mannar,
(ii) west, and south-west by the district of Tirunelveli,
(iii) north by the districts of Tirunelveli, Virudhunagar and Ramanathapuram

It lies between 8^0 and 22' of the Northern longitude and 77^0 and40^0 of the Eastern longitude.

Thoothukudi District was formed on 8th September 1986 with its headquarters at Thoothukudi, by bifurcating the erstwhile Tirunelveli District. The district is divided into 8 taluks for administrative purpose.The Eight taluks are Sathankulam, Ottapidaram, Kovilpatti, Srivaikuntam, Thoothukudi, Ettayapuram, Tiruchendur and Vilathikulam. In this district, an agriculture is the main employment and 70% of the people depends on it. The district constitutes 70 % of the total salt production of Tamil Nadu and 30 per cent of that of India. Tamil Nadu is the second largest producer of Salt in India next to Gujarat. The district has a wide coastal length of 163.5 km. Geographical area of this district is 4621 Sq.km. From the eight taluks, the Sathankulam taluk was selected for the present study which is indicated in Figure 1.

The Latitude and Longitude of Sathankulam is 8.4413102 and 77.9138889 respectively. It is 25 km away from Tiruchendur and 59 km from Tirunelveli. It is well-connected with Tiruchendur, Tirunelveli and Thoothukudi by road. An airport is located at Thoothukudiwhich is 45 km from the study area.

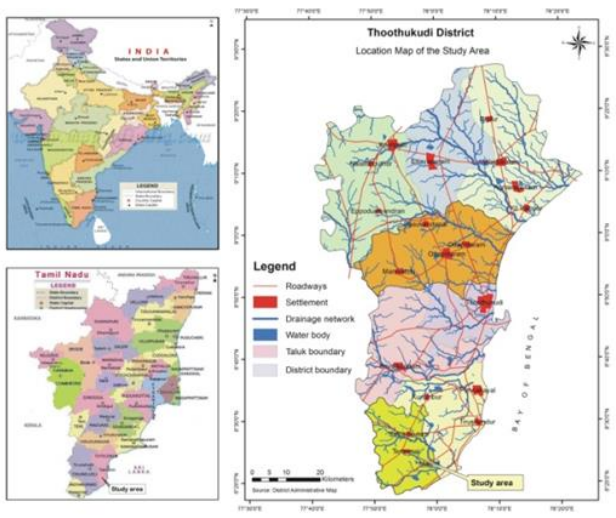

Figure 1. Map showing the location of the Study area

A) Climate and Rainfall in Thoothukudi district

The climate in Thoothukudi district neither too hot nor not too cold. The relative humidity is high. Summer season falls in the months of April, May and June. Winter season falls in the months of December and January. The average rainfall is 657.7 mm. The seasonal rainfall is due to both the northeast and southwest monsoons. The average maximum and minimum temperature are 35.7^0C and 25.4^0C mm respectively.

B) Teri Lands in the Study area

The red sands covered in vast areas of south coastal of TamilNadu are called teri sands. In tamil literature five types of lands are classified on the basis of almost the modern 'agro-climatic' regions. They are Kurinji (hills), Mullai (forests), Marutham (farm lands), Neithal (Sea Coast) and Palai (desert and waste lands). Teri lands falls under the category of Palai region (desert). Teri sands are most commonly found in Satankulam taluk in Thoothukudi district.

C) Classification of Teri land dunes

A conspicuous feature that occurs on the southeast coastal Tamil Nadu, in southeast India covering vast areas is the red sand, known as teri red sands. On the basis of geomorphic setting and optical ages, the teri sands can be broadly classified into three main types: (i) the inland fluvial teri sands, (ii) the coastal teri sands, and (iii) the near-shoreline teri sand dunes. The inland teri sediments have the highest percentage of clay and silty-sand components, indicating that these were brought and deposited by fluvial process during stronger winter monsoon 15 ka. Luminescence

dating of the coastal teri dunes reveals their deposition was prior to 11 ka, and the near-shoreline dunes were laid down at around 5–6 ka. These coastal dunes were formed during a period of lower sea level and the near-shoreline dunes were formed during a period of comparatively higher sea level. Red coating of the sand grains was post-depositional and occurred after 11 ka for the coastal teri dunes and after 5–6 ka (mid-Holocene) for the near-shoreline teri dunes.(Jayangondaperumal, 2014).

D) Physical properties of Teri soil :

Teri sands are the result of easterly and north-easterly winds during the winter monsoon and thus the teri sand is the product of aeolian process. The physical properties of Teri sand are given in Table 1. (Babuetal, 2011).

Table 1 Physical Properties of Teri sand

PROPERTY/CONSTITUENTS	VALUE
Bulk density	1.45 g/cc
True density	2.89 g/cc
Porosity, %	49.8 %
Moisture content	0.5 %
Total Heavy Minerals (THM) Wt., %	5.5 %
Total Magnetic Minerals (TMM) Wt., %	3.9 %
Very Heavy Minerals (VHM) Wt., %	4.8 %
Light Heavy Minerals (LHM) Wt., %	0.7 %
Quartz, Wt., %	94.5 %

III. MATERIALS AND METHODS

LISS-III , the satellite data for the year 2004 and 2013 is used to prepare Landuse / land cover map.

A) Linear Imaging Self-scanning System (LISS III)

It is an optical sensor working in four spectral bands (Green, red, near infrared and short wave infrared). It covers a 141 km-wide swath with a resolution of 23.5 meters in all spectral bands. The specifications of LISS III sensor is shown in Table 2.

Table 2 Specifications of LISS III

Band	Wavelength (micrometer)	Resolution (m)	Swath width (km)	Revisit time (days)
Band – 1 (Green)	0.52 – 0.59	23.5	142	5
Band – 2 (Red)	0.62 – 0.68	23.5	142	5
Band – 3 (NIR)	0.77 – 0.86	23.5	142	5
Band – 4 (SWIR)	1.55 – 1.7	70.5	148	5

B) Software Used

The following software are used for preparing various layers,

- ENVI 4.8
- Arc GIS 10.2.1
- ERDAS

C) Role of Remote Sensing and GIS

Remote sensing is one of the excellent tools for inventory and analysis of environment and its resources, owing to its unique ability of providing the synoptic view of a large area of the earth's surfaces and its capacity of repetitive coverage. A Geographic Information System (GIS) is a computer system capable of assembling, storing, and manipulating, analyzing and displaying geographically referenced information. Geographic Information System (GIS) is used in this study to create Landuse/Landcover map and for creating spatial distribution of teri sand.

IV. METHODOLOGY FLOW CHART

The Methodology implemented for the land use/ land cover changes and the delineation of teri land from satellite image using GIS tool consists of number of sequential steps such as extraction of study area, formation of training sites, supervised classification, LULC change detection and the delineation of teri land. The sequential steps are represented in the form of flowchart as shown in figure 2 for clear understanding.

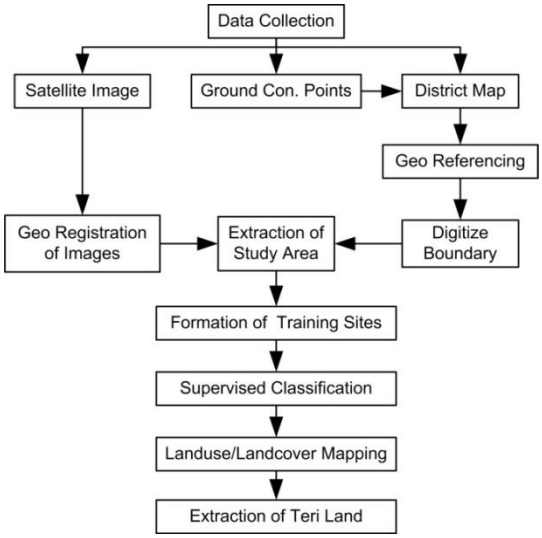

Figure 2. Methodology flowchart

V. RESULTS AND DISCUSSION

Using the LISS-III image for the year 2004 and 2013. Land use / land cover map, prepared and its results are discussed.

A) Land use / Land cover

Using supervised classification technique level II, land use / land cover map was prepared.

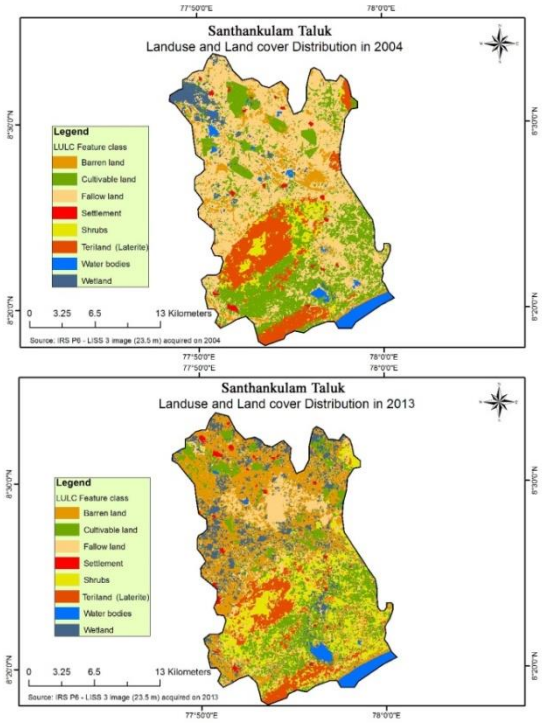

Figure 3 LULC changes in Sathankulam taluk

The study area covers the cultivable land,fallow land,barren land, shrub vegetative cover, woody vegetative cover, teri land, eroded land, river, water bodies, wetland, salt pan and settlement. The total study area is(Sathankulam taluk) 399.42 km^2 . The landuse/land cover percentage of distribution in study area I (Sathankulam taluk) is shown in Figure 3. The corresponding LULC values are shown in Table 3.

Table 3. Landuse and Land cover change in Sathankulam Taluk

LU/ LC	Area in 2004 (km^2)	% Distribution in 2004	Area in 2013 (km^2)	% Distribution in 2013	LU/LC change during 2004-2013 (km^2)	% of LU/LC change during 2004-2013
Cultivable land	82.35	20.62	52.6	13.17	-29.75	-7.45
Fallow land	184.41	46.17	38.14	9.55	-146.27	-36.62
Barren land	34.91	8.74	133.61	33.45	98.7	24.71
Shrub vegetative cover	19.2	4.81	66.84	16.73	47.64	11.93
Teri Land	46.73	11.70	33.08	8.28	-13.65	-3.42
Water bodies	6.93	1.74	8.85	2.22	1.92	0.48
Wet land	3.09	0.77	4.62	1.16	1.53	0.38
Settlement	21.8	5.46	61.68	15.44	39.88	9.98

B) *Land Use/Land Cover Distribution*

The LULC cover distribution for the study area during is shown in Figure4.

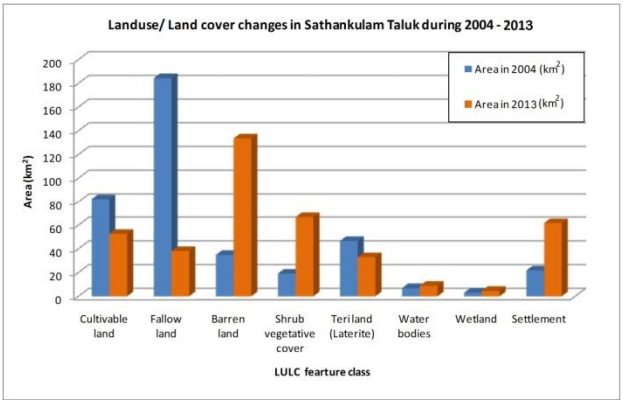

Figure 4 Landuse/Land cover Distribution in 2004 and 2013.

This comparison diagram indicates the decrease of Cultivable land, Fallow land and Teri land during the period. For the same period, increase in the area of baren land and the wet land were observed. The shrub vegetative cover increased

from 19.2 km^2 to 66.84 km^2. The settlement area increased from 21.8 km^2 to 61.88 km^2.

C) Spatial Distribution of Teri sand

The teri land spread area in sathankulam taluk are decreased from 46.73 km^2 to 33.08 km^2.The spatial distribution of Teri land in the study area is shown in figure 5.

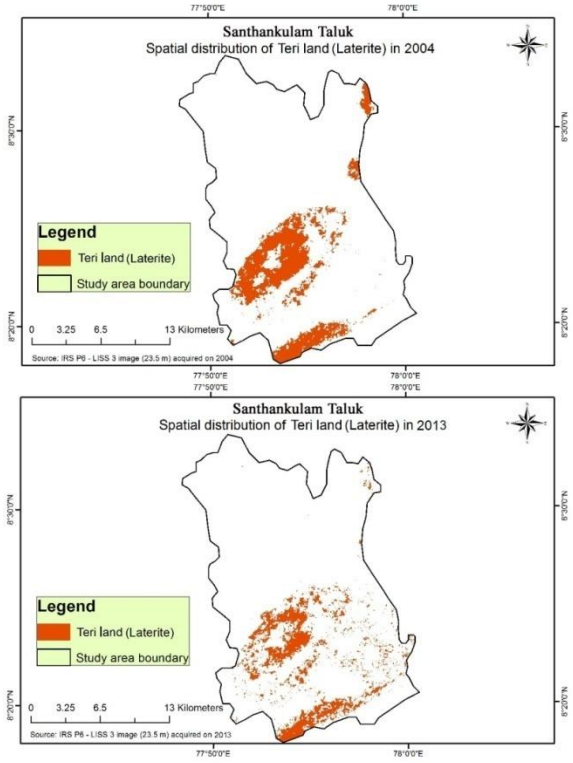

Figure 5 Spatial distribution of Teri land in study area I

VI. CONCLUSION

This study was focused on Land use/Land cover changes and the delineation of Teri land using remote sensing and GIS techniques. The study revealed the declination of teri land area from 46.73 km^2 to 33.08 km^2 in the study area over the period. During the period, Cultivable land declined from 82.35 km^2 to 52.6 km^2, Fallow land declined from 184.41 km^2 to 38.14 km^2. The spatial distribution of teri land over the period in both the study area are observed. The feature of Sathankulam high mineral content Teri soil land lies only in the hands of people and the action to be taken by government to prevent the export activities for the heavy metals present in it.

REFERENCES

[1] Adepoju, M.O., Millington, A.C., Tansey, K.T, "Land Use/Land Cover Change Detection in Metropolitian Lagos (Nigeria): 1984-2000", in AASPRS Annual Conference, Reno Nevada, May 1-5, 2006, Maryland: American Society for Photogrammetry and Remote Sensing.

[2] Babu N., Vasumathi N and BjimaRao, "Recovery of Illmenite and Other Heavy Minerals from Teri Sands (Red Sands) of Tamilnadu, India', National Institute of Interdisciplinary Science and Technology, 2011.

[3] Houghton, R.A, "The worldwide extent of land-use change", Bioscience, vol.44, pp.305- 313, 1994

[4] Jawahar. D, Studies on the sand dunes in the coastal belt of Tuticorin and Tirunelveli districts, TamilNadu Agricultural University Ph.D Thesis, Coimbatore, TamilNadu. 1996

[5] Jawahar. D. Chandrasekaran. A and Arunachalam.G, "Soil survey interpretation for land use planning in the Theries (red sand dunes) of coastal Tamil Nadu", Agricultural College and Research Institute, Killikulam, VaIlanad, 1999.

[6] Jayangondaperumal R., "Teri Red Sands, Tamilnadu", Springer science business media Dordrect, 2014.

[7] Lambin, E.F., Baulies, X., Bockstael, N., Fischer, G., Krug, T., Leemans, R., Moran, E.F., Rindfuss, R.R., Sato, Y., Skole, D., Turner, B.L. II, Vogel, C., "Land-use and land-cover change (LUCC): Implementation strategy. IGBP Report No. 48", IHDP Report No. 10, Stockhold: IGBP,1999.

[8] Lillesand, T.M. and Keifer, R.W., "Remote Sensing and Image Interpretation", John Wiley and Sons. Inc., New Jersey, 2000.

[9] Rimal, B., "Urban growth and land use/land cover change of Biratnagar sub-metropolitan city, Nepal", Applied Remote Sensing Journal, vol.2, iss.1, pp. 6-15, 2011.

[10] Turner II, B.L., W.B. Meyer and D.L. Skole, "Global Land-Use/Land-Cover Change: Towards an Integrated Program of Study", Ambio, vol.23, iss.1, pp. 91-9