Detection Of Change In Vegetation Intensity For A Period 2004-2013 In Sathankulam Taluk , Tamilnadu, India Using LISS III Data And Gis

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Abstract- *Thirty percent of our Earth's land surface is covered by vegetation. Plants can provide food, clothing, shelter, medicines, etc., They are indispensable to human life. Life could not exist on Earth without trees. Human impact on the environment causes severe effects on vegetation. Over-exploitation of natural resources leads to exhaustion. Such a change on vegetation can be determined using satellite data and Geographical Information System. An attempt has made to calculate change in vegetation intensity during the period 2004-2013 by Normalized Difference Vegetation Index (NDVI) method in Sathankulam Taluk in Thoothukudi District, TN, Indiaand its impact on the teri land (Wasteland) was studied. The negative impact of Phreatophytes plants in the study are also documented. The suitable crops for wasteland in the study area suggested based on its soil properties and the rain fall data.*

Keywords- Vegetation intensity, Remote sensing, NDVI, GIS

I. INTRODUCTION

Vegetation is the Earth's natural linkage of soil, atmosphere and moisture (Chuai, 2013). Vegetation displays obvious seasonal and annual changes (Cui and Shi, 2010; Zhang *et al*., 2011). Climatic factors, land use changes, the fertilization effect of CO_2 and so on could make different impacts on vegetation; among them, temperature and precipitation are the main indicators used to describe climate conditions, and they can affect vegetation growth in an obvious manner (Fang *et al*., 2004; Ji and Peters, 2004). According to World Health Organization (WHO), 4.6 million people lose their lives to air pollution-related diseases each year. WHO also published research which showed that nine out of ten people in the world live in places where air pollution exceeds the recommended safe limit. Plants are indispensable to human life. Life could not exist on Earth without trees. Trees absorb carbon dioxide from the atmosphere and release oxygen using the process of photosynthesis. Forests act as giant air filters for the world. Trees also acts as noise filters. The natural environment should be protected and preserved. In Western US, birds act as indicators of Riparian Vegetation Condition. Wetlands and riparian areas comprise <1% of the land area in the western U.S., yet they support a tremendous diversity and abundance of wildlife. In the Interior Columbia River Basin, 64% of neotropical migratory land birds depend on riparian vegetation during the breeding season. This habitat may harbor from 2-10 times as many individual birds as does adjacent, non-riparian, vegetation (U.S. FreeEbook, 1998). The influence on the vegetation can be measured using Remote sensing and GIS. NDVI is a quantitative indicator of the relative abundance and activity of green vegetation. It is well correlated with several biophysical characteristics of vegetation like leaf area indeed, green cover, green biomass and chlorophyll content. (Goward et al., 1985, Justice et al., 1985; Prince et al., 1995). NDVI is the most common combinations of spectral bands of remotely sensed imagery for estimating green vegetation cover (Tucker, 1979; Goward et al., 1985; & Justice et al., 1985). Normalized difference vegetation index (NDVI) is the surface characteristic parameter of remote sensing data, which reflects the distribution characteristics and changes of vegetation, and is the basic data of vegetation research (Zhao, 2012; Marchetti et al., 2016; Wu et al., 2017; Birtwistle et al., 2016).

II. MATERIALS AND METHODS

A) 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 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 and 40' of the Eastern longitude. The district is divided into 8 taluks for administrative purpose.

B) Location of the study area

Sathankulam taluk was the chosen study area in Thoothukudi district as shown in Figure 1.

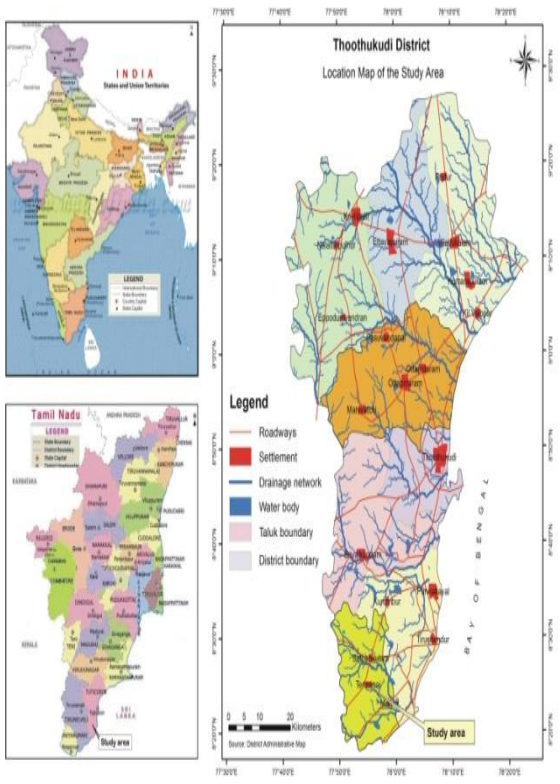

Figure 1 Map showing the location of the Study area.

(i) Sathankulam

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 Tuticorin by road. An airport is at Tuticorin 45 km from there. Sathankulam means the pond associated with local deity Sathnar who is generally known as Ayyanar.

C) 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^{0}C and 25.4^{0}C mm respectively.

D) Data Collection

LISS-III, the satellite data for the year 2004 and 2013 is used to prepare Normalized Differential Vegetation Index.

E). 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 1 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

F). Software Used

The following software are used for preparing various layers,

- ENVI 4.8
- Arc GIS 10.2.1
- ERDAS

G). 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.

III. METHODOLOGY FLOW CHART

The Methodology implemented for the calculation of Normalized Difference Vegetation Index is shown in Figure 2.

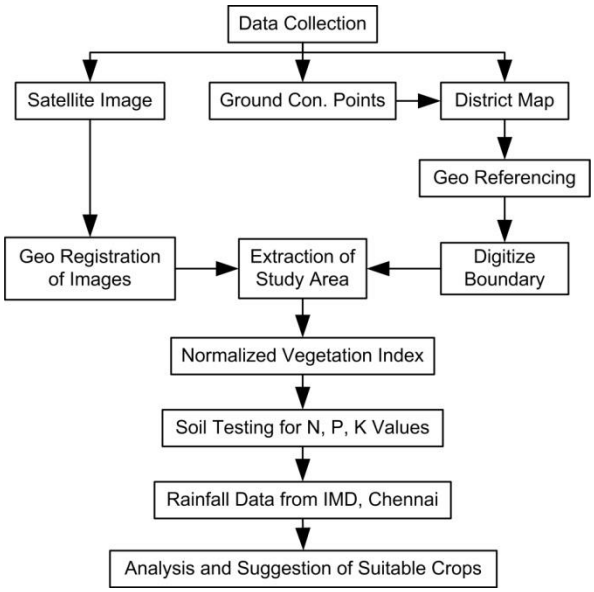

Figure 2. Methodology flowchart

IV. NORMALIZED DIFFERENCE VEGETATION INDEX

The normalized difference vegetation index (NDVI) was proposed by *Rouse et al.* (1974). Mathematically is given by

$$NDVI = (NIR-RED)/(NIR + RED)$$

Where RED and NIR stand for the spectral reflectance measurements acquired in the visible (red) and near-infrared regions, respectively.

Vegetation tends to absorb strongly in red wavelengths of sunlight and reflect in the near-infrared wavelengths. The Normalized Difference Vegetation Index (NDVI) gives a measure of the vegetative cover on the land surface over wide areas. The Normalized Difference Vegetation Index (NDVI) gives a measure of the vegetative cover on the land surface over wide areas. Vegetation tends to absorb strongly in red wavelengths of sunlight and reflect in the near-infrared wavelengths. NDVI is a measure of the difference in reflectance between these wavelength ranges.

$$NDVI = (NIR-RED)/(NIR+RED)$$

NDVI takes values between -1 and 1.

Case 1: For dense vegetation

For dense vegetation, NDVI values is greater than 0.5.

Case 2: For less vegetation

For less vegetation, NDVI is less than 0.5

Case 3: For no vegetation

For no vegetation, NDVI is less than zero.

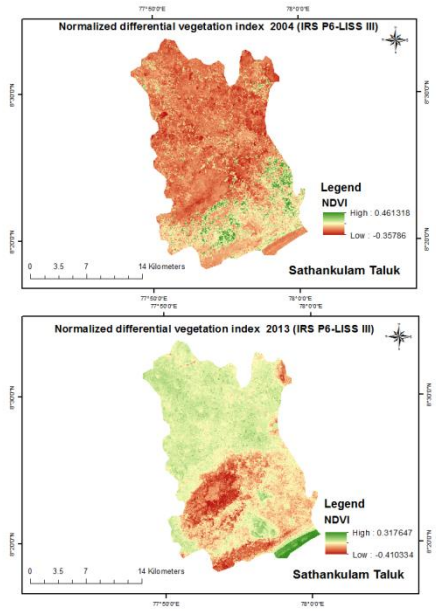

Fig. 3 NDVI in Sathankulam taluk

The calculated NDVI for Sathankulam taluk during the year 2004 and 2013 are Figure and tabulated in Table 2.

Table 2 NDVI values for Sathankulam for the year 2004 and 2013

2004	2013
NDVI : -0.357 to 0.461 Inference : Very less vegetation areas to Normal vegetation areas.	NDVI : -0.410 to 0.317 Inference : Very less vegetation areas to Normal vegetation areas.

V. STUDY OF NITROGEN, PHOSPHOROUS AND POTTASIUM CONTENT IN THE SOIL SAMPLES IN STUDY AREA.

Nitrogen, Phosphorous, and Potassium levels are the basis for determining healthy plant growth.

A) Role of Nitrogen :

Nitrogen is an important nutrient for plants and it is a fundamental part of the chlorophyll molecule. It is the element that plants use to make their proteins and DNA. Nitrogen helps plant foliage to grow strong.

B) Role of Phosphorous :

Phosphorous is needed by plants to promote root, fruit, flower and seed production.

C) Role of Potassium :

Plant uses potassium in Photosynthesis, in carbohydrate transport, in water regulation, and in protein synthesis. The other benefits are improved disease resistance, vigorous vegetative growth, increased drought tolerance and the quality of seeds and fruit. Soil samples were collected in the study area and the soil test report is presented in Table 3

Table 3 N,P and K values for the soil samples collected in Sathankulam study area

S.No.	Sample No/ Location	Lattitude / Longitude	LAB. Report No.	NPK values in kg/acre			Ph
				N	P	K	
1	1/Sirappur	8.411751, 77.919975	E532	67	6.9	43	5.84
2	2/ThanjaiNagar	8.412098, 77.884553	E587	56	4.2	96	6.12
3	3/ThanjaiNagar	8.413509, 77.885519	E588	56	5.6	83	6.58
4	4/Sirappur	8.398726, 77.919851	E589	62	5.6	79	5.43
5	5/Vagaineri	8.382878, 77.840600	E51	56	5.6	24	8.26
6	6/(S. Kudiyiruppu)	8.407378, 77.852818	E52	56	7.5	24	8.13
7	7/Pudukkulam	8.437005, 77.873228	E53	70	6.9	245	8.09
8	8/Pudukkulam	8.458232, 77.866283	E54	56	6.3	125	8.09
9	9/Keelakulam	8.458233, 77.866283	E55	67	7.5	280	7.88
10	10/Periyathalai	8.339842, 77.982727	E65	73	8.8	444	7.63
11	11/Periyathalai	8.338866, 77.982052	E66	36	6.3	104	8.09
12	12/Cheettivilai	8.339378, 77.958818	E67	70	6.3	96	7.69
13	13/Adisayapuram	8.339515, 77.925549	E68	56	8.8	96	5.91
14	14/Tharuvai temple	8.335608, 77.937213	E69	67	8.1	108	6.14
15	15/Padukkapathu	8.368338, 77.985731	E70	56	7.5	96	7.55
16	16/Idaichivilai	8.347669, 77.890844	E71	56	7.5	138	7.22
17	17/Poochikadu	8.358709, 77.916869	E72	70	7.5	129	4.50

VI. MONTHLY RAIN FALL DATA (in mm) FROM IMD, CHENNAI

The monthly rainfall data in the study area for the year (i) 2004, 2013 and (ii) 2014 were collected from Regional Meterological centre, Chennai are given in Table 4.

Table 4: Rainfall (in mm) data in Sathankulam taluk

Year	Jan	Feb	Mar	Apr	May	Jun
2004	-	-	-	-	-	-
2013	5.0	63.4	31.3	34.0	13.0	1.5
2014	39.0	8.0	85.2	0.0	140.7	0.0

Year	Jul	Aug	Sep	Oct	Nov	Dec
2004	0.0	5.0	132.8	243.3	268.0	63.2
2013	4.0	0.0	0.0	35.5	224.5	118.5
2014	0.0	14.2	32.2	314.7	467.1	94.2

VII. VISIT TO STUDY AREA

A) Positive observed facts

Numbers of visits are made for collecting soil samples and to know the status of the vegetation cover and the parameters which influences.

The positive observed facts on vegetation in the study are listed as follows.

(i) Crops in Clay soil area in Sathankulam Taluk

Paddy, Sugarcane and Cotton cultivation is common in Vagaikulam, Pudukkulam and the surrounding villages having clay soil. The location details are tabulated in table 5 and the same are shown in figure 4 and figure 5.

Table 5. Location details of crops in clay soil area in study area

S.No	Crop	Place	Location details	Fig. No.
1	Paddy, Sugarcane	Vagaikulam, Pudukkulam	(8.43263301, 77.8750651).	1
2	Cotton	Vagaikulam, Pudukkulam	8.4582328, 77.8662836)	2

Fig 4. Sugarcane field

Fig 5. Cotton cultivation

(ii) Fruit Trees In The Teri Waste Land

Fruit trees such as Mango, Jack, custard apple, sapota, gooseberry and jamun are found in many places of the study area. For example, the place of location visited and photographed is tabulated in table 6 and the figures 6 to 11.

Table 6. Fruit Trees in Teri Soil (Waste Land) Area:

S.No	Name of Fruit tree	Example for a location in study area	Fig. No.	Place of location in study area
1	Mango	(8.358360, 77.916730),	1	Poochikadu
2	Jack	(8.348753, 77.890822)	2	Idaichivilai
3	Custard apple	(8.348753, 77.890822)	3	Idaichivilai
4	Sapota	(8.418303, 77.884359).	4	Thanjai nagar
5	Gooseberry	(8.339690, 77.924547)	5	Adisaya Puram
6	Jamun	(8.340122, 77.958722)	6	Chettikulam

Bats, the fruits eating flying mammals with larger group are found in big Banyan trees located near Idaichivilai in Sathankulam taluk and it simply confirms the availability of seasonal fruits in the study area.

(iii) Big Lake In Wasteland

It is obvious that Teri soil has high porosity. A big lake is present in such a Terisoil area at Chettikulam in Sathankulam taluk is shown in Figure 12 and its location lies on the latitude 8.369216 and longitude 77.947272. The adjacent Teri soil area with Cashew nut trees is shown in Figure 13 and its location lies on the latitude 8.339378 and longitude 77.958818.

Fig. 12 Chettikulam big lake in Sathankulam taluk.

Fig. 13 The adjacent area of Chettikulam big lake

(iv) Drumstick Cultivation in Teri Soil and its Export

Drum stick cultivation is commonly found in Sathankulam taluk and it is shown in Figure 14 and one of its location lies on (8.413509, 79.885519). The produced drum stick vegetable and leaves are exported to foreign countries.

Fig 14 Drum stick Cultivation in Sathankulam study area.

(v) Oil seeds cultivation :

In Tuticorin District, the normal area under oilseeds is about 6000 hectares. The productivity in oilseeds is about 552 kgs/ hectarge. Tuticorin District Agricultural plan for the year 2008 prepared by TamilNadu Agricultural University, Coimbatore year 2008 mentioned the potentials for increasing the yield of oilseeds. Groundnut cultivation are commonly found in Sathankulam taluk. Figure shows a location of oilseeds cultivation. (8.412098, 79.884553).

Fig. 15 Ground nut cultivation

Fig. 16. Coconut farm

(vi) Neera and Jaggery production from Palmyra trees :

Sathankulam taluk is very famous for Palmyra trees. People in rural areas are involved in tapping of Neera (Pathaneer), collecting unripe fruits from trees for Young jelly like seeds (nungu), Jaggery production from Neera, etc.. Palmyra trees are densely populated in Sathankulam taluk (Fig 17) and its location lies on (8.337060, 77.938006).

Fig 17 Palmyra trees in Tharuvai, Sathankulam taluk.

B) Negative observed facts on Vegetation :

The negative observed facts on vegetation in the study are as follows.

(i) Sand factory to export mineral content soil

Private own sand factory is functioning to separate the minerals from Teri soil and seashore soil. It is the main reason for declination of Teri soil and its export to other countries by shipping. It causes negative impact to the fertility of the soil and the well being of society.

(ii) Domination of Phreatophytes plants

Not only the less rainfall in the study area, the growth of Phreatophytes plants severely produces warm condition and water scarcity to agricultural activities. The Chennai high court branch in Madurai ordered to remove such plants throughout the state. After certain period of time, the court withdrawn its imposed order.

VIII. FACTS ON PHREATOPHYTES (WATER-LOVING PLANTS) IN STUDY AREA

Prosopis juliflora is a shrub or small tree. The species came from Australia in the 1950s as a thorny plant, good for fencing farms. Since the plants were free from cattle attack, farmers preferred it for fencing. It is widely used for firewood and to make barriers. In Tamil Nadu, in Tamil language it is known scheemai karuvelam. A vernacular Tamil name is velikathan (fence protector). The facts on Phreatophytes (water-loving plants) are listed below.

- The phreatophytes or water-loving plant has the ability to suck water from as deep as 100 feet. “It absorbs not only the water in the soil, but also the moisture, making it difficult for any other crops to grow nearby. It causes land erosion due to the loss of the grasslands that are habitats for native plants and animals.
- Livestock which consume excessive amounts of seed pods are poisoned.
- It absorbs more than four litres of water to obtain one kilogram of biomass.
- It cannot even shelter birds as it produces less oxygen and more carbon dioxide.
- If it does not have sufficient water it begins absorbing ground water. If there is no ground water, it absorbing humidity from the surroundings. It can turn the ground water poisonous. In tamilnadu, this issue was brought to the attention of the court for eradicating Karuvelam. The Madras High Court in a recent judgement has made it clear that there is a much more serious issue affecting the groundwater table. That is, the Prosopis juliflora, or ‘seemai karuvelam’ menace.

IX. SUGGESTION OF SUITABLE CROPS

Based on the NPK content and the rainfall data, the suggestion of suitable crops are listed in Table 7.

Table 7 Suitable Crops suggested for the study area.

Study area	Monsoon period	After Monsoon period	Tree plantation at any time of the year
	July-Dec Period	Janu-Jun Period	
Study area having clay content soil	Paddy, Sugarcane, Cotton.	Vegetables, Flower cultivation	Palmyra, Coconut Teak
Study area having Laterite soil.	Banana, Groundnut	Drum stick, Groundnut	Coconut, Cashew nut, Mango, Jack, Sapota, Jamun,Palmyra, Drum stick.

X. CONCLUSION

The Wastelands are the resultant of deforestation, over-cultivation, over grazing, unskilled irrigation and improper developmental activities like dumping of wastes, mine wastes, etc., Our study was focused on 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 I (Sathankulam taluk) over the period 2004-2013. The NDVI values for the Sathankulam study area during the year 2004 are -0.357 to 0.461. For the year 2013, NDVI for the same study area are -0.465 to 0.317.

NDVI values can be considerably increased in these study area only by the elimination of the phreatophytes plants. Our field survey witnesses that it is a man made wasteland. Eventhough it is a wasteland, it consists of number of orchids and other useful plantations.

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