Monitoring Subtleties of Vegetation Pattern – A Case Study of Udhagamandalam and Kundah Tehsils of Nilgiri District, Tamil Nadu: Web GIS based Interactive Mapping

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Abstract— Change detection analysis is process to identify and analyze the changes of different features over a period of time. Landuse Landcover is dynamic characteristics of a region or an area which use to change their coverage area due to natural and man-made phenomenon over a period of time. This study is to analyze the dynamicity of vegetation pattern in Udhagamandalam and Kundah tehsils, Nilgiri District, Tamil Nadu. This study has been performed with eight parameters are barren land, cultivated land, forest, scrub land, shrub land, settlement, deposition and water body where cultivated land, forest, scrub land, shrub land have been considered as vegetation in this paper. Corrections of SLC errors of Landsat 7 ETM+ satellite data have been performed using preprocessing technique. Five years of satellite images following 2005, 2010 and 2015 have been collected to classify the above mentioned vegetation parameters using supervised classification. After performing classification processes of all respective year, change detection analysis of vegetation pattern of study area have been done. Finally, the classified output of 2015 is exported to the web GIS platform and web application have been developed for interactive mapping.

Keywords— Dynamicity, Landsat 7 ETM+, SLC, Vegetation, Web GIS, Web application.

I. INTRODUCTION

Temporal Change Analysis is a process to determine the changes of phenomenon of a region or area over a period of time.

Change detection can be defined as the process of identifying differences in the condition of a phenomenon by observing it at different period of times [1]. Changes in landuse and land cover is a dynamic process which occurs on the surface [2]. Different features of earth surface are always changing due to influence of various natural agent. The satellite images are useful for forest classification and changes due to deforestation, urbanization etc [3]. This paper includes the discussion of temporal change analysis of vegetation pattern for which LANDSAT 7 ETM+ satellite image of 2005, 2010 and 2015 have been downloaded. After accomplishing of final results, outputs have been published as Web service in ArcGIS Online. Web service is a standard pattern and significant process for next generation internet application where web GIS map can be used as informative inventory report[4,5].Web Map Service or WMS is a standard protocol where georeferenced map or image are published in internet and geodatabase can be created. Web-based GIS can support unlimited users and can be accessed from anywhere at any time using internet [6].The advantage of web service is multi-platform, multi-architecture and multi-programmed-language and it provides layers of abstraction above existing software. [7, 8]. Web GIS plays significant role since its capable to offer GIS functionality via internet and it provide GIS service for analyzing and displaying spatial data with a friendly user interface [9, 10].

II. STUDY AREA

The study area is Udhagamandalam and Kundah tehsil of Nilgiri District of Tamil Nadu State as shown in Figure 1. Nilgiri District which is western part of Tamil Nadu state, is a part of Niligiri Mountain. Udhagamandalam, also known as ooty, is popular hill station among tourist. Kundah, a tehsil of Nilgiri District, is famous for generating hydro-electric power. The longitudinal extension of study area is 76° 41' 45.3732"E and latitudinal extension of study area is 11° 24' 12.9636"N.

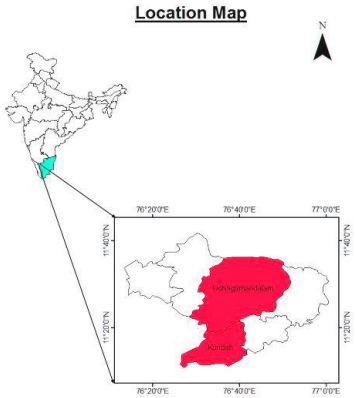

Fig. 1: Location map of study area.

III. MATERIALS AND METHODOLOGY

The LANDSAT 7 ETM+ satellite image of 2005, 2010 and 2015 has been downloaded to perform the study. These satellite images contain SLC error which has been corrected using Landsat gapfill operation of ENVI software. After correcting of SLC errors of satellite images using specific operation, the boundary of study area has been extracted using specific boundary. The satellite images of respective year has been classified using supervised classification method. Then they have been reclassified and converted to polygon and classes have been defined. Area of each class has been calculated and final analysis has been performed.

After final analysis of vegetation pattern, web GIS has been performed using ArcGIS online. Features have been published as service in capabilities of feature access to create web application of map viewer which have been useful to access the attribute and perform other operations. The flowchart of methodology

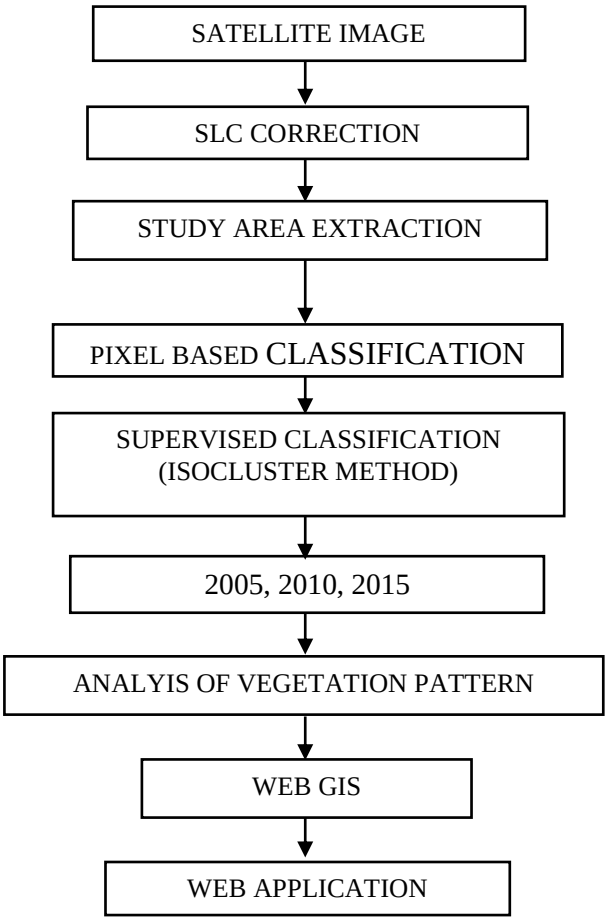

Fig. 2. Methodology

IV. RESULT AND ANALYSIS

In aim of accomplish the objective of study, satellite images of five years have been classified using isoclustersupervised classification method with8 classes from each year satellite images. The outputs have been reclassified for defining the each classes.

These reclassified outputs have been converted to polygon and specific colours have been assigned for aiming to calculate the coverage area of each classes of respective year. Six thematic maps including base map have been prepared to depict temporal change of vegetation pattern of study area from 2005 to 2015Authors and Affiliations

A. Base Map

The base map of the study area depicts basic information regarding the project boundary. In Figure 3, the basic information about Udhagamandalam and Kundah tehsil have been shown.The study area covers 1190.61sq.km area. A distinct tehsil boundary have been drawn to show boundary of the study area. So, many important places like Masinagudi, Manthada, Kuruthukulli, Pykara, Elkhill, Naduvattam, Chembakolli, Ottabettu, Kandal, Fernhill, T R Bazaar etc. have been shown. National Highway 181 has been crossed 57.62km and State Highway has been crossed 17.62km through Udhagamandalam tehsil.Railway track has been crossed 8.11km length through study area and other roads also have been shown in the base map. The water bodies have been covered totally 32.63 sq.km area.

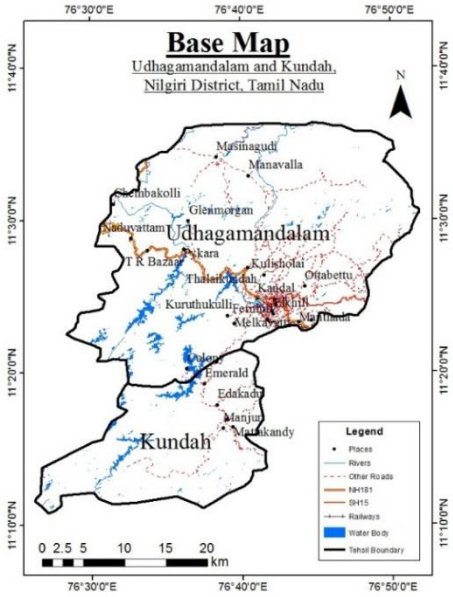

Fig. 3. Base Map of the Study Area

B. Landuse Landcover Classification of 2005

Landsat 7 ETM+ satellite images are classified into 8 parameters and classes have been defined. Classes which belongs to vegetation parameter has been given higher priority. Area of each specific class have been calculated in sq.km and percentage. In 2005, Forest covered 463.46km^2 (38.93%) area, shrub land covered 298.65km^2 (25.08%) area, scrub land covered 137.30km^{2}area and cultivated land covered 39.14km^2 (3.29%) area. Sufficient Water supply is important phenomenon for irrigation of crops. Figure 4 has been shown the vegetation pattern of 2005 and its attribute has been illustrated by Table I.

Table I: Details for Landuse Landcover of 2005

	CLASS	Area	
		km²	*%*
	Barren Land	146.14	12.27%
	Deposition	22.90	1.92%
	Settlement	43.43	3.65%
	Water Body	39.58	3.32%
Vegetation	**Forest**	**463.46**	**38.93%**
	Cultivated Land	**39.14**	**3.29%**
	Scrub Land	**137.30**	**11.53%**
	Shrub Land	**298.65**	**25.08%**
	Total	**1190.61**	**100.00%**

Table II: Details for Landuse Landcover of 2010

	CLASS	Area	
		km²	*%*
	Barren Land	196.70	16.52%
	Deposition	64.57	5.42%
	Settlement	26.71	2.24%
	Water Body	43.06	3.62%
Vegetation	**Forest**	**559.00**	**46.95%**
	Cultivated Land	**94.85**	**7.97%**
	Scrub Land	**158.08**	**13.28%**
	Shrub Land	**47.65**	**4.00%**
	Total	1190.61	100.00%

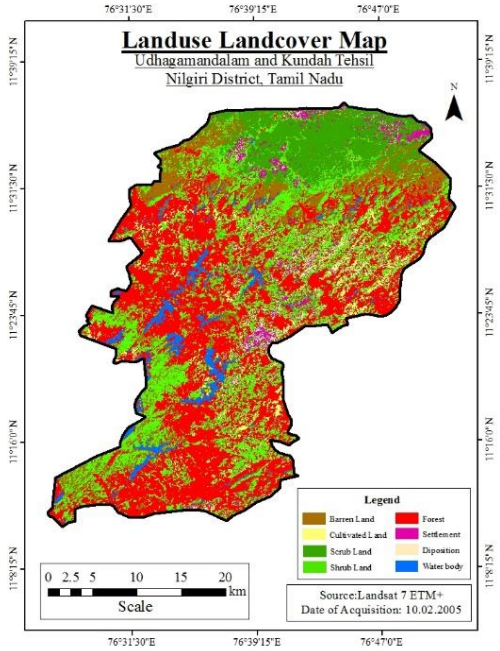

Fig. 4. Landuse landcover of 2005

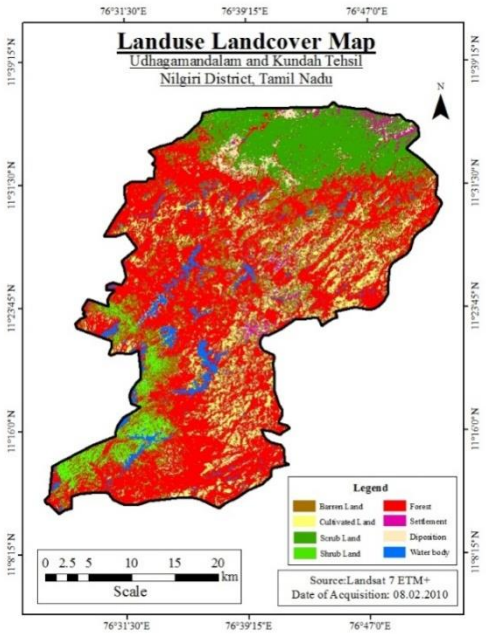

Fig.5. Landuse landcover of 2010

C. Landuse Landcover Classification of 2010

In aim of analysis of vegetation pattern, landuse landcover classification of 2010 has been performed using supervised classification method. Many significant changes have been observed in vegetation pattern of landuse landcover map compare to landuse landcover of 2005 and 2007.According to Table II, forest, cultivated land, scrub land and shrub land have been covered 559km^2 (46.95%), 94.85km^2 (7.97%), 158.08km^2(13.28%) and 47.65 km^2 (4%) area of vegetation pattern which shown in Figure 5.

Table III: Details for Landuse Landcover of 2015

	CLASS	Area	
		km²	*%*
	Barren Land	89.70	7.53%
	Deposition	2.49	0.21%
	Settlement	176.79	14.85%
	Water Body	34.80	2.92%
vegetation	**Forest**	**498.09**	**41.84%**
	Cultivated Land	**45.32**	**3.81%**
	Scrub land	**120.13**	**10.09%**
	Shrub Land	**223.29**	**18.75%**
	Total	1190.61	100.00%

D. Landuse Landcover Classification of 2015

By comparing with landuse landcover map before ten years, it can be easily identified that statistics and coverage vegetation pattern of 2015 is also changed.Forest covered 498.09km^2 (41.84%) area, shrub land covered 223.29km^2 (18.75%) area, scrub land covered 120.13km^2 (10.09%) area and cultivated land covered 45.32km^2 (3.81%) area has been illustrated by Table III and Figure 6 has been shown the vegetation pattern.These classes of vegetation pattern is following its dynamic characteristics over the period of time.

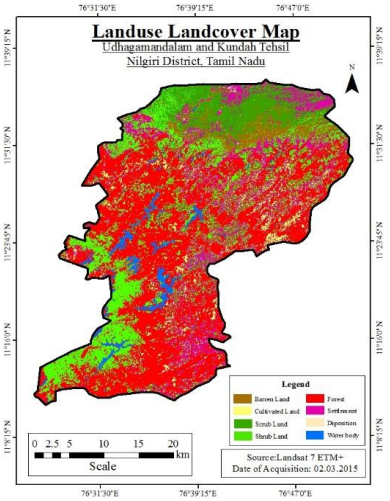

Fig. 6. Landuse landcover of 2015

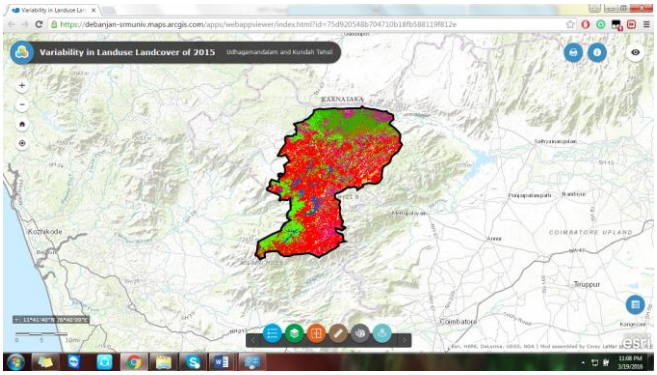

Fig. 7. A web application

E. Web GIS Application

Web GIS application is a platform which provides opportunity to publish thematic maps and publish various web application using internet. In this study, a web GIS has been performed. The features i.e. water body, settlement, barren land, deposition, forest, scrub land, shrub land and cultivated land are enable to create, delete, query, sync and update after adding layer to new map with full editing control provided by ESRI. These features have been published as a web application.

V. DISSCUSSION

Initially Landsat 7 ETM+ satellite images for respective years has been downloaded from usgs earth explorer website. Satellite images of Landsat 7ETM+ contain SLC error due to sensor failure of Landsat 7 ETM+ satellite in 2003. SLC errors have been corrected using landsatgapfill tool of ENVI Software. After Correction of SLC error, isocluster supervised classification method has been performed to preapare landuse landcover map for 2005, 2010, and 2015 to concentrate on the changes of vegetation pattern. Vegetation pattern include the discussion of forest, cultivated land, scrub land and shrub land. It has been noticed that vegetation pattern is changing every year. Forest has been covered 38.93% in 2005, 46.95% in 2010 and 41.84% in 2015. So forest has been increased throughout three respective years. Cultivated land have also been increased i.e. 3.29% in 2005, 7.97% in 2010, 3.81% in 2015. Scrub land has been covered 11.53% in 2005, 13.28% in 2010 and 18.75% in 2015. Shrub land have been increased and decreased throughout three years. It have been covered 25.08% in 2005, 4.00% in 2010 and 18.75% in 2015. Table VI has been analyzed the vegetation pattern of study area for five years and Figure 11 has been graphically analyzed the vegetation pattern of study area.

Table IV: Details for Analysis of Vegetation Pattern

	CLASS	2005	2010	2015
		Area in %	Area in %	Area in %
	Barren Land	12.27%	16.52%	7.53%
	Deposition	1.92%	5.42%	0.21%
	Settlement	3.65%	2.24%	14.85%
	Water Body	3.32%	3.62%	2.92%
Vegetation	**Forest**	**38.93%**	**46.95%**	**41.84%**
	Cultivated Land	**3.29%**	**7.97%**	**3.81%**
	Scrub Land	**11.53%**	**13.28%**	**10.09%**
	Shrub Land	**25.08%**	**4.00%**	**18.75%**
	Total	100.00%	100.00%	100.00%

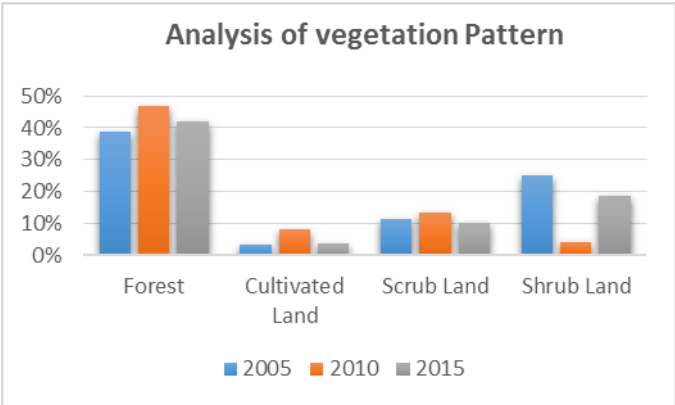

Fig. 8. Analysis of Vegetation Pattern

The published web GIS application is enabled to access all the tools where can check attributes, layers, legends etc. User can also print this layout as map layout or other given formats.

VI. CONCLUSION

In this paper, landsat 7 ETM+ satellite images of ten years have classified to analyze the subtleties of vegetation pattern over period of ten years. This analysis can be useful to develop future predicted vegetation pattern. Web GIS is advanced in GIS technology which can be motivated an average person to be interacted with GIS technology.

Published web application is enable to access by any person around the world at any time by using laptop, mobile, tablet etc.

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