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Applications of Remote Sensing and GIS in Geospatial Terrain Evaluation of Thrissur Forest Division, Kerala, India

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Abstract:

The present study focuses the assessment of changes in forest cover, between 1990 to 2015, in the Thrissur forest division, a tropical forest region of Southern western Ghats, Kerala, India by using remote sensing and Geographical Information System (GIS). Terrain representation is based on the digital elevation model (DEM).The Landsat 7 TM and ETM+ images of the study area were processed and interpreted to extract information about forest vegetation and cover in the region. It is noticed that forest cover has increased between 1990 and 2015 by 10% and 139.69 Sq.km but there is a decrease in forest cover between 2001 to 2015 by 10% .This study helps to generate geospatial terrain evaluation using remote sensing data products, covering forest type distribution and magnitude.

Keywords — **Remote sensing and GIS, Terrain evaluation, Land use/Land cover, Digital Elevation Model**

1. INTRODUCTION

The forest of Kerala lies on the western slope of the Western Ghats at different altitudes rising up to 2694 meters. The steep slopes and often abrupt falls in topography create variations in climate and soil, resulting in high levels of biodiversity and local endemism. The state possesses extensive areas of tropical evergreen forests (1937 km2), tropical semi evergreen forests (1,543 km2) and tropical moist deciduous forests (4,100 km2) which are repositories of abundant and valuable biodiversity.

The transformation of the Western Ghats landscape is believed to date back to the 1800s accelerating through the early twentieth century and continuing today. More Than 40 percent of the original natural vegetation of the Western Ghats was lost or converted to open/cultivated lands, coffee plantations, tea plantations, and hydroelectric reservoirs. The remnant natural ecosystems of the Western Ghats are currently subject to a plethora of threats that vary widely in the nature and intensity of their impacts on biodiversity

2. STUDY AREA

The area selected for the present study, Thrissur forest division of Central Circle (Fig. 1) lies between North latitude 10°26' to 10°46' and East longitudes 75°57' to 76°28'.TheThrissur division comprises of Wadakkanchery,Pattikkad, and Machad Ranges (Fig. 2).The extent of Thrissur Division is 210 km2. The extent of Wadakkanchery, Pattikkad and Machad Ranges are 58.66 km2, 59.44 km2 and 92.34 km2 respectively. Since the region lies in the south western coastal state of Kerala, the climate is tropical with only minor differences in temperatures between day and night, as well as over the year .The area is drained in the monsoonal season by heavy showers. The average annual rainfall is 3000 cm.

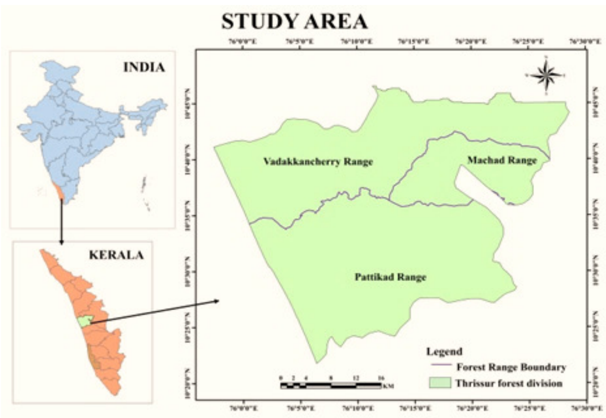

Figure 1: Location map showing forest Range Boundary

Geologically the area is composed of sand and silt, charnockite group of rocks and migmatite complex. The geomorphology of the area includes coastal plain, floodplain, Pedi plain, denudational hills, denudational structural hills, piedmont zone, and plateau. . The major vegetation types met within the district are West Coast Tropical Evergreen forest, West Coast Tropical Semi evergreen forests and South Indian Moist Deciduous forest

3 .OBJECTIVES

The objectives of the study are: (i) To carry out geospatial terrain evaluation using remote sensing data products, covering forest type distribution and magnitude; (ii) 2.To evaluate different time series satellite data (Landsat) of 1990, 2001 and 2015 for change detection.;(iii) To quantify the forest status in the study period and its significance.

4. METHODOLOGY

Satellite data acquired for forest analyses are Landsat TM of January 1990, Landsat ETM+ of January 2001 and February 2015.The image preprocessing is executed using ERDAS IMAGINE (version 9.1). The Survey of India (SOI) toposheet of 1:50000 scale were used for base map preparation. The three series of Landsat images was georeferenced to the coordinates system of the study area (WGS84, projection: UTM zone43). For visual interpretation, different band combination were performed, satellite images were enhanced through the use of Contrast Tool, Smooth, Sharpen and Convolution Filtering in ERDASIMAGINE software. Also, supervised image classification was carried out for land cover maps of 1990, 2001 and 2015 using Arc GIS 10.1, with the help of maximum likelihood classifier tool.

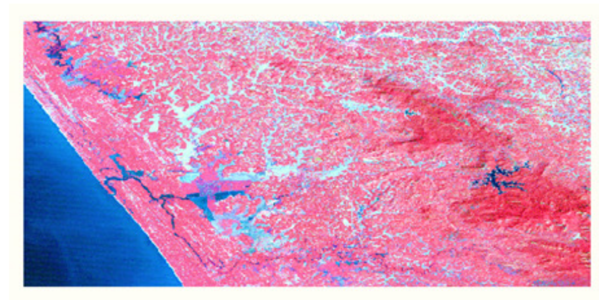

Fig: 2 Landsat satellite data

The classification based on maximum likelihood algorithm is performed using purified signature sets. Classified image is standardized for required number of land-cover classes and are subjected to image smoothing using majority 3 x 3 filter to dampen spurious noise. The area statics is generated for spatial evaluation. Change matrix is created for further statistical analysis with the help of java script matrix calculator .The classification was cross-checked with digital elevation model (SRTM DEM 30m) data and corrected. The changes with respect to biodiversity and other ecosystem parameters were noted and spatial evaluation is done. Based on the classified imagery of the older dates, changes in the forests were analyzed and change detection maps for the various regions were prepared.

5. RESULTS AND DISCUSSIONS

4.1Land Use /Land Cover Mapping

The total area of 1462.78sq.km is distributed to various land use/cover like forest, water bare soil, wetland vegetation, crops built up/urban areas. The area and percentage of total of these land covers are shown in Table 1. Figure 4 shows the pie chart of area distribution in the study area for the years 1990,2001 and 2015.Statistical report of land use /land cover maps reflects small variation on the percentage of forest areas in between 1990 to 2015, but wetland vegetation area is showing 21% increment. bare soil was utilizing for extending forest area for future expansion.

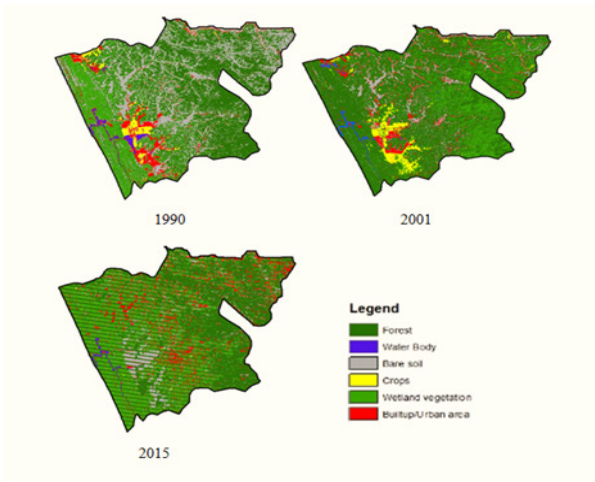

Fig: 3 Land use/Land cover map each class for years 1990, 2001 and 2015

Table 1: Summary statistics of area

DESCRIPTION	1990		2001		2015	
	Area(sq.km)	% of Total Area	Area(sq.km)	% of Total Area	Area(sq.km)	% of Total Area
Forest	631.1	43.00	927.92	63.0	770.8	53.0
Water body	15.33	1.00	14.63	1.00	6.46	0.40
Barren soil	403.6	28.00	109.72	8.00	105.4	7.20
Wetland Vegetation	300.1	21.00	247.49	19.0	43.61	30.0
Crops	34.89	2.00	48.63	3.00	5.99	0.40
Built up/Urban Area	77.65	5.00	87.39	6.00	138.4	9.00
Total	**1462**	**100.00**	**1462**	**100**	**1462**	**100**

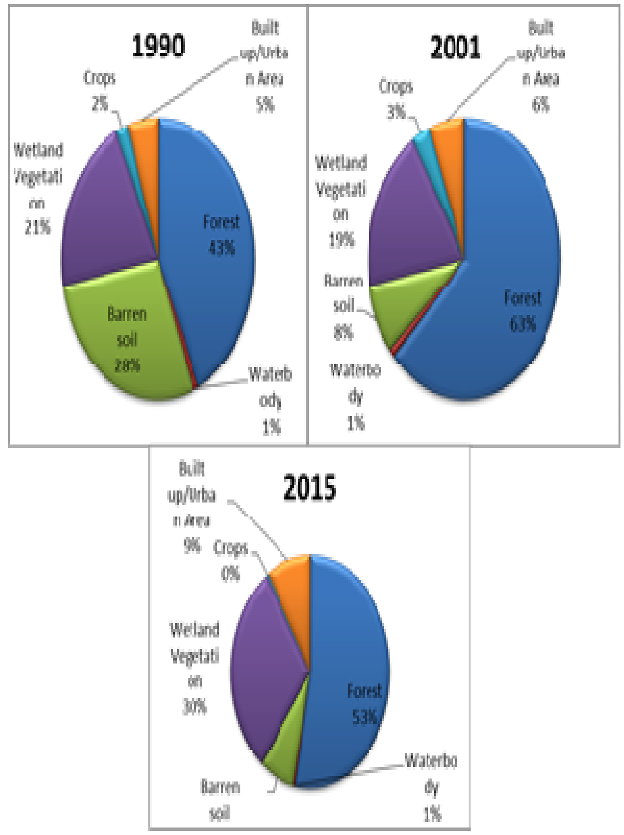

Fig: 4 Land use/Land cover pie chart by each class for years 1990, 2001 and 2015

4.2 Comparison of land use /Land cover map

The percentage of area of landuse/land cover between two periods is obtained and found that there in an increase in forest,wetland vegetation and built up /urban area.On other hand waterbody,barren soil crops are decreased.(Table2)The change in area is represented by bar chart as shown in Figur4.2a,4.2band4.2c..Figures 4.2a, 4.2b and 4.2c.

Table 2 Summary of comparison area statistics

LU/LC	% Change		
	1990-2001	2001-2015	1990-2015
Forest	-20.00	-10.00	10.00
Water body	0.00	-0.6	-0.6
Barren soil	-20.00	-.8	-20.8
Wetland Vegetation	-2.00	11	9
Crops	-1.00	-2.6	-1.6
Built up/Urban Area	1.00	3	4

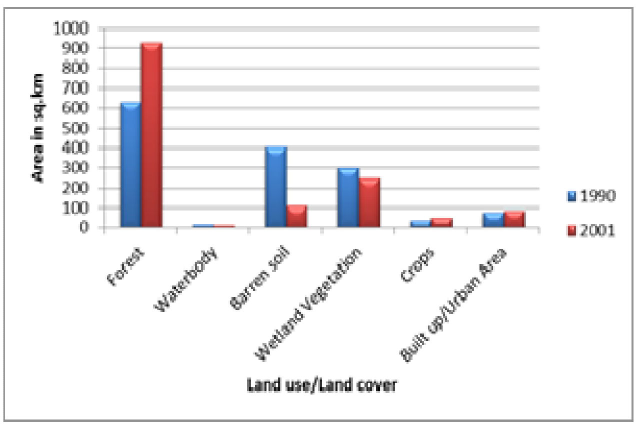

Fig: 4.2 a Comparison of land use for two periods 1990 and 2001

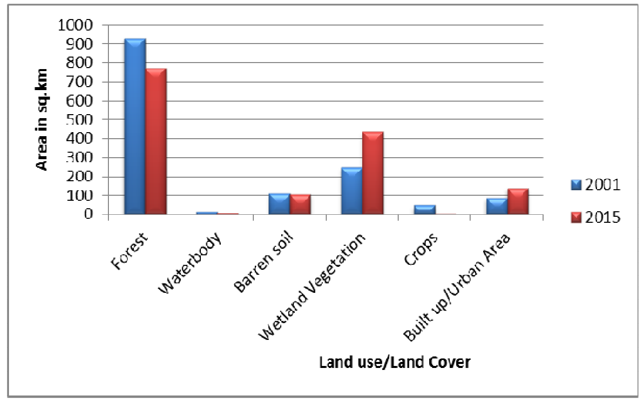

Fig: 4.2 b Comparison of land use for two periods 2001 and 2015

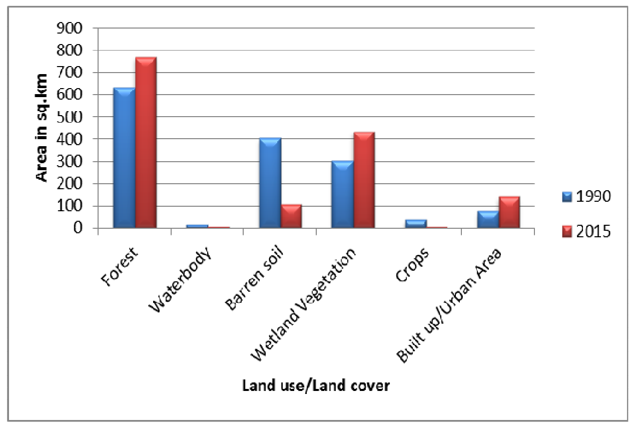

Fig: 4.2 a Comparison of land use for two periods 1990 and 2015

4.3 Change matrix

The change matrix prepared in between two time periods, 1990 and 2015 (Table 3). Rows represent the land uses in 1990 and columns represent that in 2015. The sum of an entire row is total land in a particular land cover in 1990. Likewise, the sum of each column is total land in a particular land cover in 2015. The total area of forest in 1990 is 631.11 sq. .km that in 2015 was 770.80 sq.km. Forest of 631,11 sq.km in 1990 was later used as forest for 432.19 sq.km,for water body 2.68sq.km, wetland vegetation196.24 sq.km, scrub 2.71 sq.km.

Table 3 Land use change matrix.

	2015 (Area in sq. km)							
	LAND USE	**FOREST**	**WATER BODY**	**BARREN SOIL**	**WETLANDVEGETATION**	**CROPS**	**BUILT UP /URBAN AREA**	**1990**
1990 (Area in sq. km)	FOREST	432.19	2.68	0	196.24	0	0	631.11
	WATERBODY	0	2.78	9.55	3.00	0	0	15.33
	BARREN SOIL	240.95	1.00	95.89	0.01	4.99	60.83	403.67
	WETLAND VEGETATION	97.66	0	0	202.47	0	0	300.13
	CROPS	0	0	0	33.89	1.00	0	34.89
	BUILT-UP/ URBAN AREA	0	0	0	0	0	77.65	77.65
	2015	770.80	6.46	105.44	435.61	5.99	138.48	1462.78

4.4 Digital Elevation Model

Elevation Zone Map is derived from SRTM DEM 30 m resolution. The altitude zones ranges from -20 meters to 620 meters above sea level. The derived DEM in 2D &3D shown in Figure 5 . Integration was done on DEM with 2015 land cover map, and the result shows that forest area is situated in the elevation range in between 120m to 190m. The major vegetation types met within the district are West Coast Tropical Evergreen forest, West Coast Tropical Semi evergreen forests and South Indian Moist Deciduous forest.

4.4.1Slope map

Slope map is prepared in percentage class. Variations in the climate and soils is due to steep slopes and abrupt falls in topography, resulting changes in biodiversity and local endemism. Figure 6 shows the slope greater than 70 as very dense forest, 20-40% as moderately dense forest, and10-20% open forest, all forest land with poor tree. Soil loss is prevented by forests in the hill slopes. Forest cover was spatially spread in three ranges as like shown in Figure 7

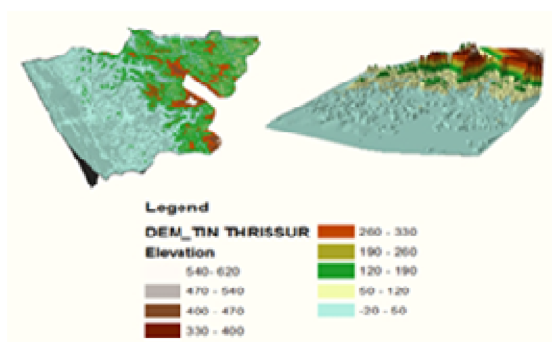

Fig: 5 2D&3D view to SRTM DEM (TIN)

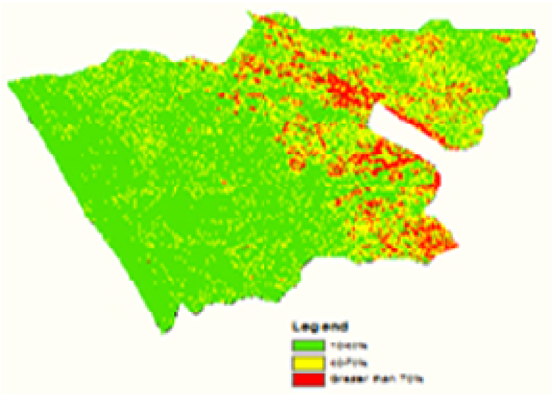

Fig: 6.slope map

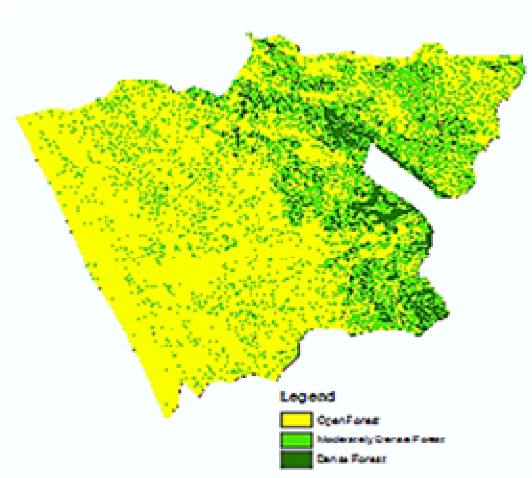

Fig: 7.slope map

4. Conclusions:

It can be concluded from the above study, Remote sensing and GIS techniques was power full tool for geospatial Terrain evaluation of forestry. The study revealed that the forest cover is 631.11 sq.km, sq.km and 927.92 sq.km in 1990, 2001 and 2015 respectively. It is observed that forest cover has increased between 1990 and 2015 by 10% and 432.19 Sq.km, but there is a decrease in forest cover between 2001 to 2015 by 10% .The steep slopes and abrupt falls in topography create variations in microclimate and site quality, resulting in changes in biodiversity. Non-conversion of natural forests is a positive indication towards sustaining the status of the natural ecosystem which in turns also improves the indigenous biodiversity of the State.

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