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LANDSCAPE DYNAMICS IN WESTERN GHATS

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ABSTRACT

Geospatial data helps in identifying and determining different landscapes in remote and unreachable areas. The knowledge of landscape dynamics aids in the sustainable management of natural resources. The current study emphasizes on landscape dynamics of Western Ghats from 1985-2018. Using an open source software program GRASS, supervised classification technique was carried out based on maximum likelihood classifier algorithm for the land use analysis. The Western Ghats, one among the 35 global biodiversity hotspots. Currently due to extensive anthropogenic activities, the conserved and protected areas are getting affected leading to changes in the landscapes. The results showed that there is decrement of evergreen forest from 12.27% (1985) to 10.01% (2018). On the other hand, there are changes in plantations and built-up activities which has triggered the environmental balance in the ecosystem. Especially the regions of Pune and Coimbatore have faced extensive urbanization during the study period.

Keywords: *Western Ghats, landscape dynamics, spatial data and temporal data analysis.*

1.0 INTRODUCTION

Land is an important natural resource, which mainly comprises of soil, water, flora and fauna, thus involving the total ecosystem. Landscape is a montage of heterogeneous interacting dynamic elements, i.e., manifestations of natural and anthropogenic processes. The functioning of the landscape is affected by the flow of nutrients, minerals, energy etc., based on interaction of landscape elements [1]. Forests are integral part in the socio-economic, ecological, and cultural fabric of tropical regions [2]. Humans depend either directly or indirectly on forests to an extent of 80% in developing world [3]. The structure of a landscape affects its functional aspects such as bio-geo chemical cycling. Hydrologic regimes play a decisive role in ecosystem function. This necessitates the understanding of landscape structure (size, shape, and configuration) and constituent's spatial patterns (linear, regular and aggregated) through land use analysis. Land use [LU] provides the usage of land by humans as per requirement, e.g., habitations, agricultural lands, etc. Accelerated LU changes in the recent years by the increased human activities have been playing a decisive role in altering climate and biogeochemistry patterns at global as well as at regional scales [4] [5]. These anthropogenic activities have caused a destructive role in the environment, degrading the natural resources beyond the requirement leading to the haphazard, uncontrolled urban development leading to the deterioration of environment [6] quality over a period of time effecting soil erosion, watershed degradation and agrochemical pollution (World Bank 2008), an increase in impervious surface area and landscape fragmentations. Availability of multiresolution temporal remote sensing (RS) data has helped in analyzing the areas at various spatial, spectral and temporal resolutions in addition to the collateral data (spatial as well as statistical) to assess land use pattern [7].

Remote sensing satellite data acquired through space borne sensors plays a pivotal role in differentiating the different land use categories, based on the spectral reflectance curve [8]. The advantage of this remote sensing data is that temporal data could be achieved for the same area periodically which could be analyzed to determine the alterations in the area. This data helps in decision making and environmental management approaches. The objective of the current study is to determine the landscape dynamics in Western Ghats using temporal and spatial remote sensing data. An attempt is also made to give appropriate solutions to curtail the insignificant activities.

2.0 MATERIAL AND METHOD

2.1 STUDY AREA

Western Ghats considered as one of the eighth hottest hot-spot in the world by UNESCO and one among 35 global biodiversity hotspots by IUCN. Western Ghats ranges from Gujarat to Tamil Nadu covering an area of 164280 km^2, spread across 63 districts. The region with exceptional biodiversity of endemic flora and fauna of 4,600 species of flowering plants with 38% endemics, 330 butterflies with 11% endemics, 156 reptiles with 62% endemics, 508 birds with 4% endemics, 120 mammals with 12% endemics, 289 fishes with 41% endemics and 135 amphibians with 75% endemics [9]. Anshi-Dandeli Tiger reserve, Sharavathy wildlife sanctuary, Mookambika wildlife sanctuary, Someshwara wildlife sanctuary, Kudremukh national park, Bhadra tiger reserve, Pushpagiri wildlife sanctuary etc. are the major national parks in this region. Regarding vegetation types commonly seen are tropical evergreen forests, moist deciduous forests, scrub forests, sholas, and savannas including the high rainfall savannas. Western Ghats has numerous watersheds that feed perennial rivers of peninsular India [10]. It forms the basis for major watersheds in the Deccan plateau with major rivers as Cauvery, Bedthi, Aghanashini, Sharavathi etc. It comprises of east and west flowing rivers which meets up at Arabian Sea and Bay of Bengal respectively forming the catchment for the Deccan Plateau. This region receives an average rainfall of 3000-4000 mm with localized extremes to about 9000 mm. The latitude and longitude are as shown in the Figure 1. The ecological and biological richness of this region is highly being influenced with the developmental pressures in these regions.

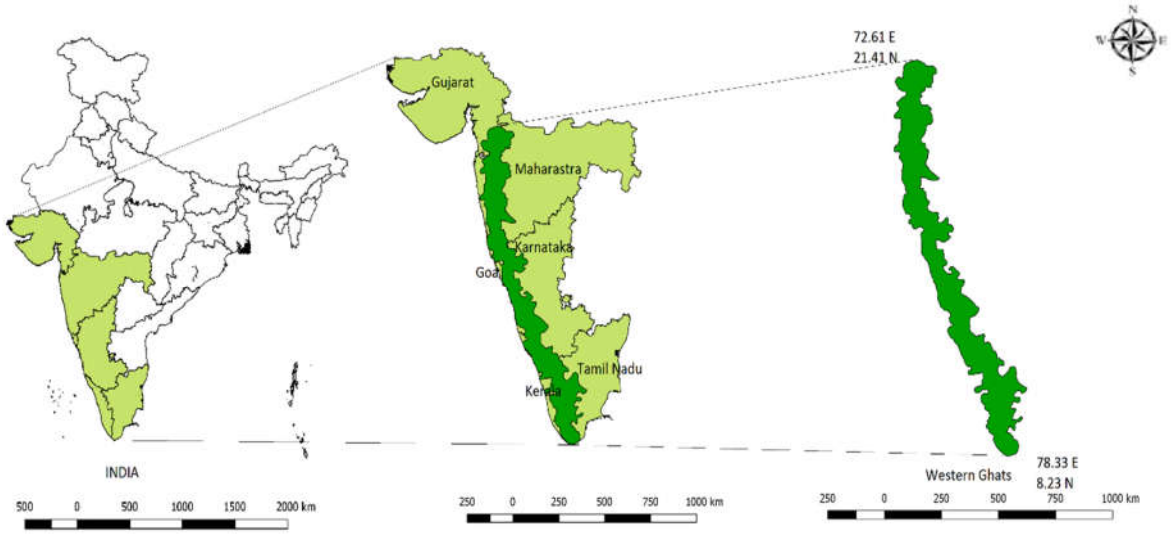

Figure 1: Study area - Western Ghats, India

2.2 METHOD:

Figure 2 explains in detail the method employed for this process. Land use classification is done through supervised classifier based on Gaussian Maximum likelihood algorithm considering remote sensing data with ground truth (field) data.

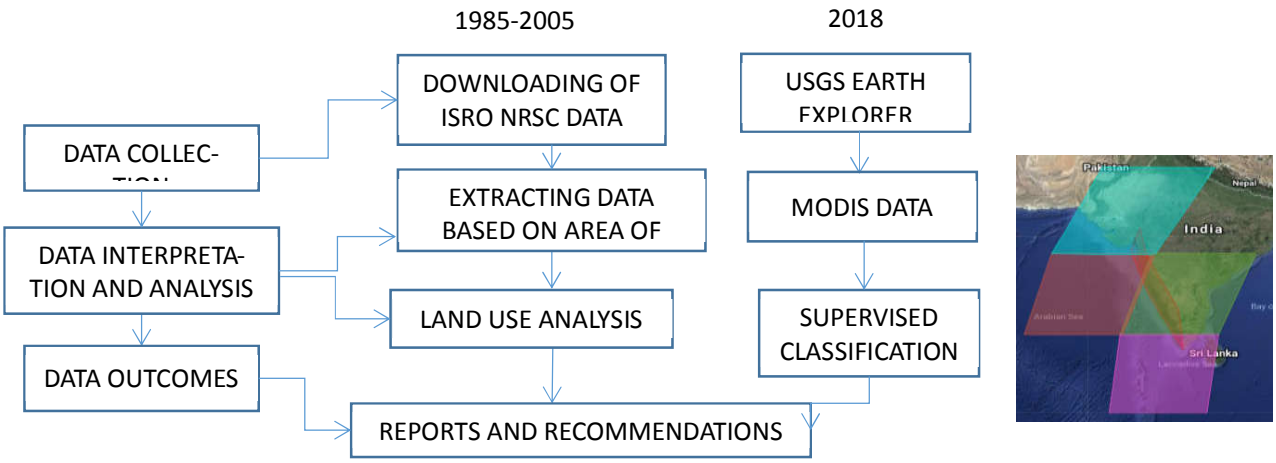

Figure 2: Method of land use dynamics analyses

The data for the period 1985-2005 was obtained from decadal data by ISRO and NASA of 100 m resolution with a minimum mapping unit of 2.5 hectares. The data were derived from Landsat 4 and 5 Thematic Mapper (TM), Enhanced Thematic Mapper Plus (ETM+), and Multispectral (MSS) data, India Remote Sensing satellites (IRS) Resource-sat Linear Imaging Self-Scanning Sensor-1 or III (LISS-I, LISS-III) data, ground truth surveys, and visual interpretation. The data were classified according to International Geosphere-Biosphere Programme (IGBP) classification scheme. (Roy et al., 2015; Meiyappan et al., 2016 in review).

The data of 2018 was obtained from USGS [11]. MODIS data was also used for the analysis of landscape dynamics. MOD09A1 product was used for the study. Initially the data for the study area of Western Ghats was extracted with no or minimum cloud cover, which was covered in 4 scenes. Using MODIS re-projection tool the data was projected to WGS 84. Land use classifications using temporal data were carried out through the open source program GRASS - Geographical Resources Analysis Support System. The process involved (i) generation of FCC, from band 1(250 m-red), 2 (250 m- near infrared), 4 (500 m-green; resampled to 250 m) (ii) selection of training sets covering at least 15 % of the study area which is uniformly distributed over the study region. Of the selected data, 60 % of the data was used for classification while the remaining 40% for validation.

Supervised classification was carried out using Gaussian maximum likelihood algorithm [12] to classify the data which preserves the land use characteristics through statistical classification techniques using a well distributed training pixels. The following different classes were examined i.e., Evergreen Forest, Deciduous forest, Scrub land, Cropland, Plantations, Water Bodies, Open spaces and Built-up Land. Accuracy assessment is used to assess the classification of data. This assessment was carried out with the generation of confusion or error matrix and kappa statistics.

3.0 RESULTS AND DISCUSSIONS:

The dynamics in the Western Ghats from 1985-2018 are tabulated in Table 1. The statistics helps in identification on how the landscapes have undergone transformation. Analysis of Western Ghats for four decades elucidated that there's a decrement in the forest area about 10% from 1985-2018, leading to the loss of diversified species. As a result, the climate change has become a key factor [13]. Built up has increased drastically to about one and half times the earlier, especially in the regions of Pune, Coimbatore etc., from 1985-2018. The vegetation cover decremented about 11% in Southern Western Ghats

and 7% in Northern Western Ghats. On the same pace, the decrement of open spaces is more in Southern Western Ghats over Northern Western Ghats. Plantations have increased for commercial purposes (trading) etc. like coffee, tea, teak, acacia, rubber etc. by clearing the hotspot areas. The forest products such as pulpwood, hard and soft wood etc. have been used by industries for commercial purposes. The study revealed of deforestation process in the Western Ghats.

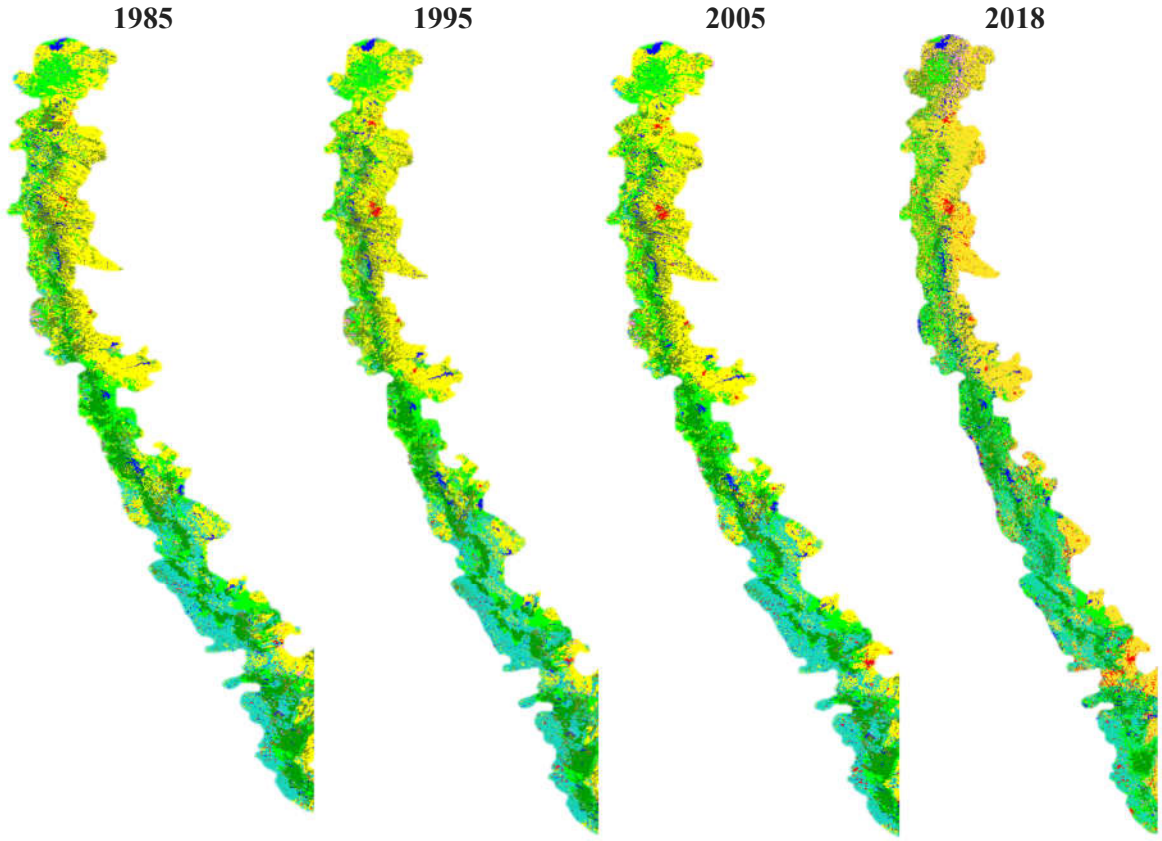

Figure 3: Landscape dynamics in Western Ghats (1985-2018)

Land Use (in %)	**1985**	**1995**	**2005**	**2018**	**1985-2018**
Evergreen Forest	12.27	12.02	11.45	10.01	-2.26
Deciduous forest	19.75	18.37	17.97	16.58	-3.17
Scrub land	12.66	11.53	11.14	7.06	-5.60
Cropland	34.48	34.72	35.95	38.34	3.86
Plantations	16.60	18.17	18.32	18.14	1.54
Water Bodies	2.85	3.44	3.20	3.67	0.82
Open spaces	0.79	0.65	0.48	1.78	0.99
Built-up Land	0.60	1.10	1.49	4.41	3.81

Table 1: Landscape dynamics of Western Ghats (1985-2018)

4.0 CONCLUSION:

Changes in land use analysis show the decrease in forest cover over from 1985-2018 with increase in demand leading to demographic pressure with the shortage of natural resources. Anthropogenic

activities like the developmental projects, which includes the railway lines, hydroelectric power projects etc. also add to degradation of natural resources, which have been increased in this vicinity of the biodiversity hotspot affecting the habitat of flora and fauna posing a serious threat to ecosystem. Land use analysis was done using supervised classification approach using Gaussian maximum likelihood algorithm. Overall accuracy of the classification varied from 80 % to 95% and kappa from 0.78 to 0.94. An increase of 3.81% in the built up activities is noticed, especially in the regions of Pune, Coimbatore etc. Agricultural activities have increased by 3.86%. Deforestation has led to forest loss, fragmentation and degradation of natural habitat causing threat to the ecosystem. The analysis showed the large scale conversion of natural habitat to man-made ecosystem. This necessitates an immediate action to curtail the insignificant activities by appropriate and sustainable management approaches.

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