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Two decadeal land use land cover of Kodagu district of Western Ghats, South India

S.S. Ravishankar and B.C. Nagaraja

Department of Environmental Science, Bangalore University, Bangalore 560 056, Karnataka, India

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ABSTRACT

The present study is focused on assessing two decadeal land use land cover using Remote Sensing and Geographical Information System for the year 1999 and 2019. Simultaneously, the Landsat 5 imagerires for February 1999 and Landsat 8 for February 2019 were used , Pre-processing of the acquired geocoded sub-scene of selected study area for 1999 and 2019 was performed using ERDAS Imagine. The study revealed that Evergreen forests have decreased by 9.4%, on the other hand, the area of Semi-evergreen forest, Moist Deciduous Forest, Dry Deciduous forest, Scrubforest and Forest Plantation has increased by 1.21%, 1.17%, 1.03%, 0.10% and 0.56% respectively. The water bodies have decreased by 0.8% from 1.2% to 0.4%. The change of barren land is negligible from 0.16% to 0.17%. The area of Grasslands, Agricultural plantations, Built-up and mining areas have increased from 2.73%, 28.26%, 0.37% and 0.03% to 3.76%, 36.38%, 1.79% and 0.06% respectively.The information maps generated out of this study will help will help the fron-tline forest officials to trace back the degraded areas and undertake site specific conservation plan.

Key words : *Land use, Land cover, Wastern ghats, India*

Introduction

The land-use changes result in alteration of land cover which in turn alters the carbon stocks and biodiversity of the region (Guo and Gifford, 2002; Lai *et al.,* 2016). Land Use land cover (LULC) is one of the greatest environmental concerns due to its negative impact on ecology, climate, water, soil, water and other ecosystem services. These changes have significant implications on human health and resilience of natural ecosystems and human society and its also an important driver of climate change at the local, regional and global scale and timescales inter-decadal and beyond. Globally, in the past 300 years, agriculture and its associated land-use changes have been the key driver of deforestation and have affected 42-68% of the global land surface. In the span of 1970 to 2011, carbon emissions increased by about 90%, and agriculture, deforestation, and other land-use changes have been the second-largest sources of global carbon emissions, next to the use of fossil fuels (Hailemariam *et al.,* 2016; Halder *et al.,* 2016; Sahana *et al.,* 2016). Globally, over the last 25 years, the carbon stock in forest has decreased by almost 17.4 Gt, equivalent to a reduction of 697 million tonnes per year or about 2.5 Gt of carbon dioxide equivalent due to landuse changes (FAO, 2015; FSI, 2019).

Several studies have been done to understand the correlation between LULC and regional climate over India. Land cover data show a significant decrease in the forest and an increase in crop over central, south, and northwest part of India between 1950 and 2005 (Halder *et al.,* 2016). In 1980s, the predominant LULC type in India was woody savannah, which was mostly forest land over Central India, major portions of Peninsular India and Northeast India. These regions experienced huge deforestations due to the intensification of agricultural activities which resulted in the conversion of woody savannah to cropland (Paul *et al.,* 2016). From 1951 to 2005, the observed mean surface temperature over India has increased by a maximum of 1.11°C (1.48 °C) during the summer monsoon season. There have also been significant changes in the rainfall distribution during those 55 years (Halder *et al.,* 2016).

The Western Ghats in India is one among the 34 global hotspots of diversity. Like other parts of the tropics, Western Ghats are also subjected to rapid land-use changes transforming forest lands into agriculture and monoculture plantations. Other than that encroachment, hydroelectric projects, mining, and extraction of the forest products has also altered the landscape to a greater extent. The deforestation rate in the Western Ghats is estimated to be 0.57% annually during 1920 to 1990 (Menon and Bawa, 1997; Jha *et al*., 2000; Kumar *et al.,* 2010). Kodagu region of Western Ghats has a number of UNESCO sites and is known for its rich evergreen forests (Kumar *et al.,* 2010). Numerous studies have documented the rich biodiversity, ecology and sacred groves of Kodagu district (Parcal and Pelissier, 1996; Elouard *et al.,* 1997; Ambinakudige and Sathish, 2009; Sunil *et al*., 2012; Karun *et al*., 2014). With this concern, efforts have been done in this paper to understand the land-use changes for two decades using remote sensing data.

Methodology

Study area

Kodagu is a hilly district in Karnataka with a geographical area of 4,108.88 km^2 located on the eastern slopes of the Western Ghats with an elevation varying from 900m to 1715m. It lies between 75.22′ to 76.12′ longitude and 11.56′ to 12.50′ latitude (Kalyanasundaram, 1995; Kumar *et al.,* 2010). The district is encircled by Dakshina Kannada district to the northwest, Hassan district to the north, Mysore district to the east, Kasaragod district of Kerala in west and Kannur district of Kerala to the southwest, and Wayanad district of Kerala to the south. The highest peaks found in the district are Tadiandamol (5,740 ft) and Pushpagiri (5,627 ft). The main river in Kodagu is the Cauvery, which originates at Talakaveri, located on the eastern side of the Western Ghats, and with its tributaries, drains the greater part of Kodagu.

Kodagu has a typical tropical climate characterized by medium to high humidity, heavy rainfall and cool summer. The most important climate characteristics of Kodagu district is the strong rainfall gradient with annual rainfall decreasing in less than 50 km from over 5000 mm in the Evergreen Western part to 1200 mm in the Moist Deciduous eastern part. A major part of the year consists of rainy season as the monsoon period starting in June lasts till the ends of September. Even during the post-monsoon months of October and November certain parts of the district receive a significant amount of rainfall. (Sachin *et al.,*2012).

Methodology

The Survey of India (SOI) toposheets of 1:50,000 scale pertaining to the study area were geo-referenced mosaiced and sub-setted to aid further analysis. These toposheets were used for geo-referencing of satellite images, creation of cultural features and ground truthing. The forest administrative boundaries extracted from the working plan and were to topomaps. Simultaneously, the Landsat 5 satellite imageries for February 1999 and Landsat 8 for February 2019 were downloaded from online web portal of USGS Global Visualization Viewer (http://glovis.usgs.gov), Pre-processing of the acquired geocoded sub-scene of selected study area for 1999 and 2019 was performed using ERDAS Imagine (version 9.1). Map to image geo-rectification process was adopted for geometrically correcting the satellite images by obtaining ground control points (GCP) from geo-referencing, SOI toposheets employing polyconic projection parameters. Selection of points was done by referring to the image and choosing prominent landmarks. The geo-rectified images were later fine tuned to account for greater degree of details and attribute informa-tion were labelled separately. Later land use land cover were digitized from SOI toposheets and fine tuned with respective satellite images, using GIS mode of Arc GIS (version 9.2) and ERDAS Imagine (version 9.2) software.

Results and Discussion

A number of studies across the world have shown that the change of LULC has a significant impact on the local, regional and global climate (Kim *et al*., 2013; Wang *et al* ., 2014; Halder *et al.,* 2016; Hengade and Eldho, 2016; Clerici *et al*., 2019; Chaubey *et al.,* 2019), which is also true for Kodagu (Kale *et al.,* 2009; Nayak and Mandal, 2012; Ramachandra *et al*., 2019). The number of climate extreme events are increasing in Kodagu and other parts of the Western Ghats where LULC changes acts as one of the key factors.

The landscape of the Kodagu is classified into 13 LULC classes for two decades. The LULU classes include Evergreen forests, Semi-evergreen forest, Moist Deciduous Forest, Dry Deciduous forest, Crop Land, Scrub, Agricultural Plantation, Forest Plantation, Barren Area, Water Bodies, Settlement, Mining Area, Cropland and Grassland. It can be seen that there is a significant decrease in overall forest area from 1999 to 2019 levels from 50.3% to 45.01% respectively. The Evergreen forests have decreased by 9.4%, on the other hand, the area of Semi-evergreen forest, Moist Deciduous Forest, Dry Deciduous forest, Scrubforest and Forest Plantation has increased by 1.21%, 1.17%, 1.03%, 0.10% and 0.56% respectively. The water bodies have decreased by 0.8% from 1.2% to 0.4%. The change of barren land is negligible from 0.16% to 0.17%. The area of Grasslands, Agricultural plantations, Built-up and mining areas have increased from 2.73%, 28.26%, 0.37% and 0.03% to 3.76% , 36.38%, 1.79% and 0.06% respectively (Table 1).

The evergreen forests which was the dominant landcover in 1999 has been replaced by monoculture agricultural plantations by 2019 which has a severe impact on the biodiversity of the region. It can be observed that except the forest areas under the protected area have been subjected to degradation. Many cropland have been converted to agricultural plantations. The Cauvery basin water bodies has considerably decreased due to the encroachments coupled with decreased in e-flows (Fig. 1 and 2). From the studies of Kumar *et al.,* 2010 it was found that by 2010, 291.6 ha of forest land was under encroachment, having a key contribution to the land-use change.

Conclusion

Kodagu acts a 'nerve point' of Western Ghats with its rich native forests, lavish natural resources, lush green valleys, numerous water bodies, wildlife, croplands and plantations with its unique cultural heritage. The development of the agrarian economy (agriculture, horticulture, livestock) through cash crops and monocultural practices has created distress over forest land and water bodies. Along with that growing tourism industry, urbanization, devel-

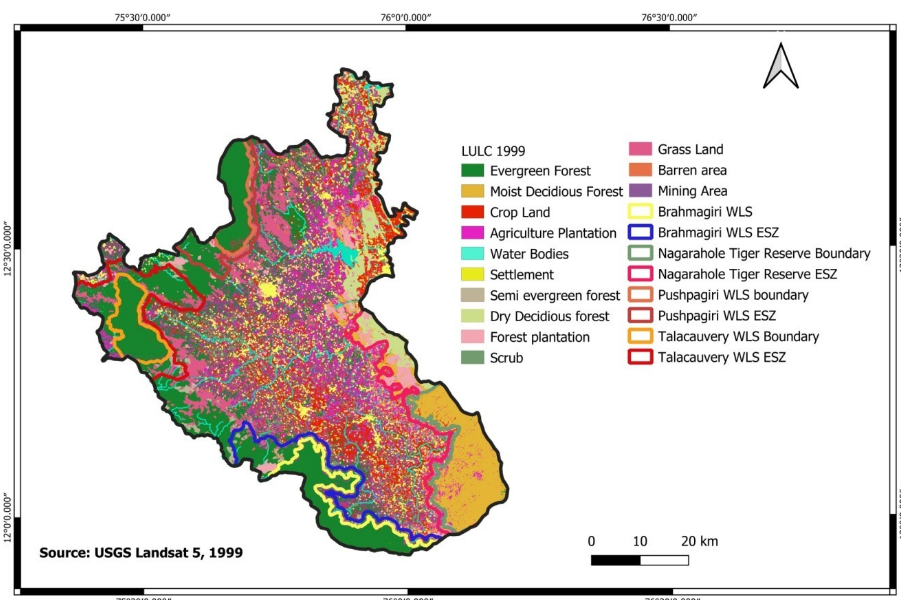

Fig. 1. Land use land cover of Kodagu district for the year 1999

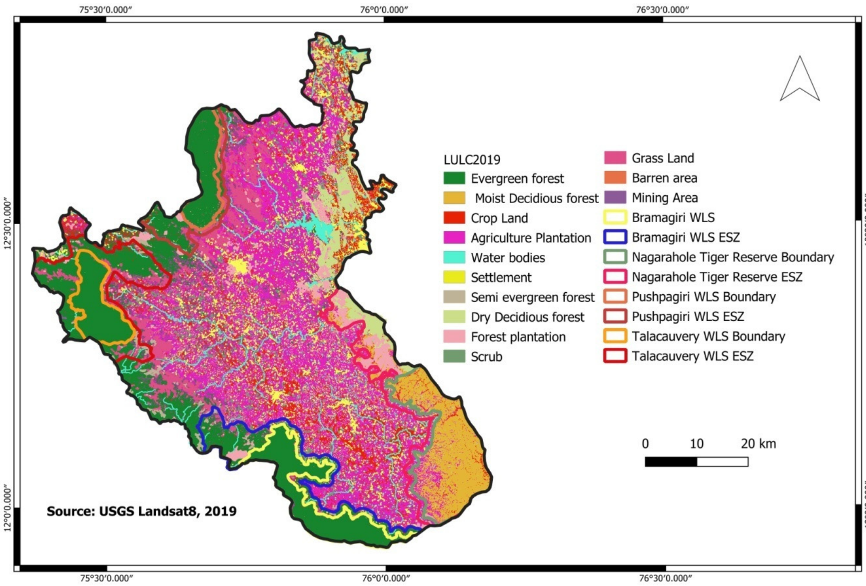

Fig 2. Land use land cover of Kodagu district for the year 2019

Table 1. Two decadeal Land Use land cover of Kodagu district of Western Ghats

Sl. No.	LULC	Area in 1999 %	Area in 1999 Area (ha)	Area in 2019 %	Area in 2019 Area (ha)	Difference %
1	Evergreen Forest	30.55	1255.11	21.17	869.86	-9.38
2	Semi-evergreen forest	0.62	25.44	1.83	75.23	1.21
3	Moist deciduous forest	13.39	549.99	14.56	598.25	1.17
4	Dry deciduous forest	2.25	92.55	3.29	135.04	1.03
5	Grassland	2.73	112.17	3.76	154.61	1.03
6	Scrub forest	0.89	36.50	0.99	40.50	0.10
7	Forest Plantations	2.62	107.57	3.18	130.50	0.56
8	Agricultural Plantations	28.26	1161.36	36.38	1494.93	8.12
9	Crop land	16.98	697.75	12.47	512.48	-4.51
10	Built-up	0.37	15.10	1.79	73.37	1.42
11	Water body	1.15	47.29	0.35	14.40	-0.80
12	Mining/Quarry	0.03	1.16	0.06	2.50	0.03
13	Barren rocky/Stony waste	0.17	6.89	0.18	7.21	-0.01
	Total	**100.0**	**4108.88**	**100.0**	**4108.88**	**-100**

opmental projects and mining/Quaring activities have equal detrimental effect. The evergreen forests area has been significantly reducing in the past twenty years which pose threats to its unique shola forests which hosts the aquifers of Cauvery river. Whose direct impacts can be seen in the reduction of water bodies from 47.29 km^2 to 14.40 km^2. It can also be noted that monocultural agricultural plantations are protruding into the edges of eco sensitive zones of Talacauveri WLS and Nagarhole tiger reserves having huge impacts on the biodiversity also leading to increased instances of human-animal conflicts.

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