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ASSESSMENT OF LAND USE/LAND COVER CHANGE IN COTIGAO WILDLIFE SANCTUARY, CANACONA-GOA, INDIA

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ABSTRACT

Wildlife Sanctuaries are vital because they are established by law to protect endangered and threatened species of plants and animals. They play a precious role in balancing the ecology of a region. Routine assessment of Land Use Land Cover is imperative in Wildlife Management because landuse and land cover change studies indicate variations and help to detect dominant changes over the region. This study aims to understand land use land cover changes in Cotigao Wildlife Sanctuary with the use of remotely sensed data from IRS, LISS III satellite images for 2008 and 2018.

Primary data, as well as secondary data, is used in various forms. GPS surveys have been conducted for ground-truthing and collection of new geospatial data as a primary data source. LISS III satellite imageries are processed and analysed using remote sensing image processing software ERDAS IMAGINE 2014 (HGM, US), and ENVI 5.3 (Harris Geospatial, Colorado, USA). For mapping of the final output, ArcGIS 10.3 (ESRI, California, USA) software is used.

During 2008-2018, the area under Dense Mixed Jungle has decreased by 11.74 per cent. The area under settlement and agriculture has shown an increase by 3 and 2.08 per cent respectively. During the study period, the area covers water bodies, grasslands and plantations depicts a negative change with -0.33, -2.5 and -0.93 respectively. Two land classes namely Fairly Dense Mixed Jungle and Open Scrub have increased by 5.16 and 5.26 per cent respectively for the same period.

Keywords: Land use land cover, utilization, geospatial, remote sensing, Wildlife, built-up area

INTRODUCTION

Forests are an important resource of other natural resources, which poses a threat of logging due to extreme poverty in India (Agarwal *et al*., N.D., 2010). The Western Ghats play an important role in maintaining the world's balanced ecosystems and are one of the world's hotspots of biodiversity and dwelling for forest communities. The recent studies indicate that there are rapid land cover changes in the recent past as a result of human meddling and related factors in the tropical forests of Western Ghats (Asok *et al*., 2016).

Land use and land cover are disticnt words mostly used reciprocal study of the region (Kumar Ranjan *et al*., 2016).The Land Use Land Cover (LULC) is an associated terms that consists of each class of LU and LC variation is a basic criterion that evaluates the materials of the earth as a vital component which influences the situatio n and operations of the ecosystem (Ahmad *et al*., 2015) Land cover is a physical state of the planet's surface that can be used to estimate the interaction of biological diversity with the encompassing environment. The usage of land resources by human beings and land cover changes often reflect the most significant impact on the environment due to excessive human activities is called Land use. Land cover changes can be the most important pointers of ecological changes on various spatial and temporal scales (Polykretis *et al*., 2020).

The influences of LULCC on the sustainability of the ecosystems are becoming more and more vital issues in world modification research (Islam *et al*., 2018). This study aims to understand land use landcover changes in Cotigao Wildlife sanctuary using remotely sensed data from IRS, LISS III satellite images to analyse the changing land use patterns between 2008 and 2018.The digital change detection process is widely used to determine common changes in LULC properties based on multitemporal remote data (Hassan *et al*., 2016). With the help of GIS and Remote Sensing we can have a better understanding of land use land cover changes (Banerjee *et al*., 2016). In order to take this into account, information on the quantitative assessment of changes compared to the baseline period has the highest priority. Because remote sensing is cost-effective and is used around the world, it can be a great tool in this regard (Islam *et al*., 2016).

Forests is a home to most world's species but huge deforestation in the last century decreased the world's wooded area cover (Rahman *et al*., 2016). The loss of woodland cover has growing pressure on earth and is considered to be one of the

global issues because of its consequences on biodiversity, terrestrial ecology and local weather change (Kitina Nyamasyo & Odiara Kihima, 2014).

The drivers of land cover adjustments include local and attached physical, socioeconomic, and demographic elements (Changkakati & Guwahati, 2017).The chief influencer towards land use land cover (LULC) change on a worldwide scale is the human interventions (Kemboi, 2018). People in poornations depend on physical and natural resources for their livings. As a result of the growing struggle between the utilization and sustainable management of land resources, there is a need to monitor land use and land cover changes over time (Mundia & Murayama, 2009). This tends to reduce wildlife at all levels due to human meddling, repeated droughts, changes in landuse, and encroachment into wildlife habitats (Kitina Nyamasyo & Odiara Kihima, 2014).

LULC changes can put intense pressure on the structure and function of the earth's ecosystems (Khalid Kija *et al*., 2020). Hence, it is indispensable to apprehend howland cover modifications may menacefutureland cover trai ts and natural world environment loss, even in protected areas too (Billah *et al*., 2021). The LULC alterations are mostly caused by mismanagement of agricultural, city region, range and forest lands which lead to severe environmental issues such as floods, landslides etc. (Reis, 2008). Remote sensing is proved to be a genuine progressive tool for LULC variation detection (John *et al*., 2020).

Global conservation groups, such as the World Wildlife Fund and the Wildlife Conservation Society, have studied key threats to habitat integrity and launched various projects to combat these threats. The Ministry of Environment and Forest, Government of India has monitored many shifts in the climate, variations in land use, destruction of forests and expansion of agricultural practices (T. Banerjee, N.D., 2017). Land resources are shrinking due to immense agricultural and anthropogenic pressure. The Government of India has declared several protected areas such as National Parks, Sanctuaries, and Reserved Forests to conserve forest resources and control deforestation and degradation of forest ecology (Mahato *et al*., 2021). To prevent forest degradation and to protect the wildlife we need to focus on measures to ensure the sustainability of forest resources.

Area of Enquiry

The Cotigaon Wildlife Sanctuary covers a geographical area of 85.65 sq. km, is one of the highly diversified biodiversity zones of Goa which intern is a slice of the Western Ghats: the hotspot of biodiversity located in

Canacona taluka in the extreme South of Goa State (Nadaf, 2019). To protect the remote and vulnerable area of forest lining the Goa-Karnataka interstate border, this sanctuary was established in 1969.

The topography of the sanctuary is hilly with undulating uplands. Sanctuary is a source region of many rain-fed rivers. Both the Galgibaga and Talpona rivers of Canacona taluka originate from the sanctuary. West Coast Tropical Evergreen Forest, West Coast Semi-evergreen Forest, and Moist Deciduous Forest is the most dominant vegetation of this region. On the higher altitudes and riversides, evergreen forests are mainly concentrated. (Rahman *et al*., 2016). Some of the ancient tribes of Goa like the Velip and the Kunbi are inhabitants of this sanctuary (Nadaf, 2019).

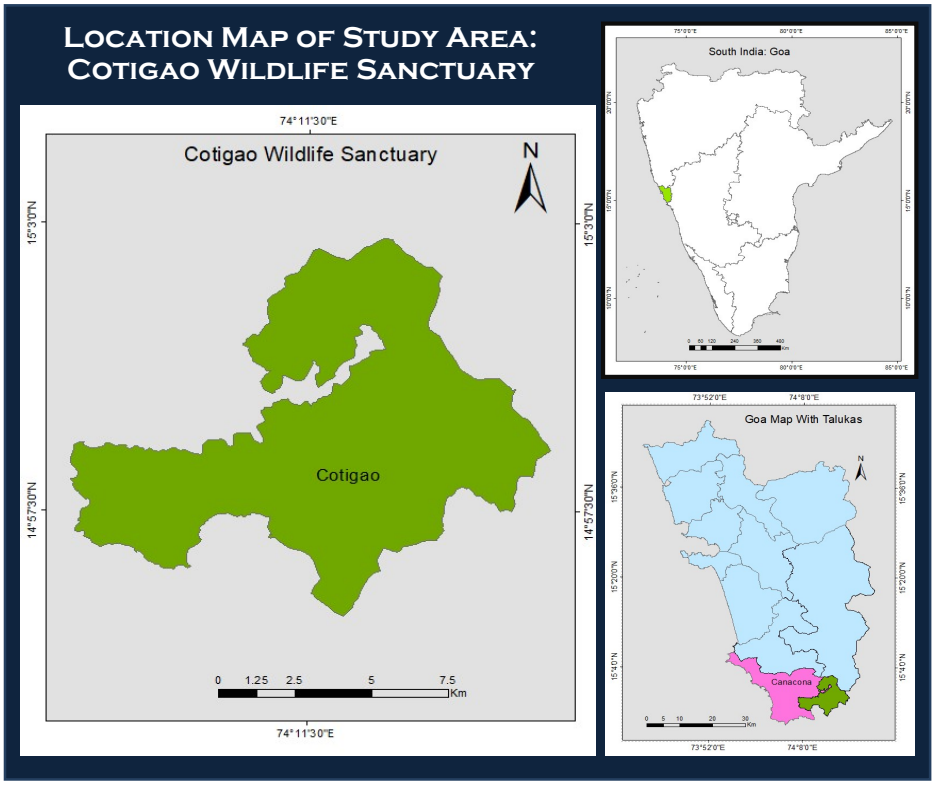

Fig 1: Location map of Cotigao Wildlife sanctuary- South Goa, India

MATERIALS AND METHODS

Primary data as well as secondary data is used for the analysis of results. GPS surveys have been conducted for ground truthing and collection of new geospatial data as a primary data source. In secondary data source, Census Maps, and Regional Plan of Goa are used for references beside this, multi-temporal satellite data set observed by Landsat 8 (ETM+SLC on) images with 30 m spatial resolution from US Geological Survey (USGS) website (http://eartheplorer.usgs.gov/), Survey of India toposheets of 1:50,000 scales have been used for the analysis and IRS based data i.e; IRS 1C LISS III with 23.5 m resolution acquired on 08 October 2008 and 12 November 2018 are also

used as a source of data. Methodology consist of LISS III satellite imageries (table 1), which are processed using remote sensing image processing software ERDAS IMAGINE 2014 (Hexagon Geospatial, Madison, US), ENVI 5.3 (Harris Geospatial, Colorado, USA). For mapping of the final output, ArcGIS 10.3 (ESRI, California, USA) software is utilized. The scheme selected for land use/land cover classification is the level I of NRSA with local modification. The Cotigao Wildlife Sanctuary region. accordingly divided into eight classes namely, 1. Settlement, 2. Waterbodies, 3. Agricultural land, 4. Grassland, 5. Plantation, 6. Open Scrub, 7. Fairly Dense Forest, and 8. Dense Mixed Jungle. The overall change of the total area is determined using an onscreen digitization approach, combined with the calculation of change detection of the area under land use/land cover categories.

Table 1: Remote Sensing data sets used

Sr. No	Satellite	Sensor	Date of pass	Resolution	Path	Row	No of bands
1	Resourcesat-2	LISS-III	18-10-2008	23.5 m	096	062	4
2	Resourcesat-2	LISS-III	12-11-2018	23.5 m	096	062	4

Source: National Remote Sensing Agency (NRSC), India

RESULT AND DISCUSSION:

For the assessment of the changes occurring in LULC from 2008 to 2018, the area of enquiry is delineated into 8 classes using supervised classification such as Settlement, Waterbodies, Agricultural land, Grassland, Plantation, Open Scrub, Fairly Dense Forest, and Dense Mixed Jungle.

LISS-III Image interpretation (2008)

It is obvious from **Table-1** and **Figure-2** that the Dense Mixed and Fairly Dense Mixed Jungle cover accounts for 79 per cent of the total area of the Cotigao Wildlife Sanctuary. The built-up area makes about 2.13 per cent of the entire region. Whereas, Open Scrub and Farming and related activities account for 9.44 and 3.89 per cent of the space respectively.

Table 2: Land Use Land Cover-2008

ID	Land use Category	Land use (2008) in SqKm	Landuse(2008) in %
1	Settlement	1.955686	2.13
2	Water Bodies	1.238804	1.36
3	Agricultural Land	3.561049	3.89
4	Grassland	2.63379	2.87
5	Open Scrub	8.658895	9.44
6	Plantation	0.891676	0.97
7	Fairly Dense Mixed Jungle	7.235302	7.88
8	Dense Mixed Jungle	65.557142	71.46
Total		91.732344	100

The main crops include Red Amaranth (Tambdi bhaji), Long beans, Egg Plant, Chillies, and paddy (Ukade-Tandul) which are cultivated in both Rabi and Kharif seasons.

Coconut Plantation, Rubber Plantation, cane Plantation, and banana Plantation accounting about 0.97 percent of the total area of the sanctuary.

Within the jurisdiction of Cotigaon Wildlife Sanctuary, there are many hamlets and villages such as Kuske, Avem, Bade, Eda, Dabel, Astagal, Tirval, Cotigaon, Nadke, Endrien, Morphond, Bupal, and Sheshaval which are inhabited by the tribal communities who are considered the aboriginals of Goa. The settlements and structures located within the sanctuary make about 2.13 percent of the total physical area. The number of visitors to this sanctuary are on the rise due to the booming tourism business and the presence of world-famous beaches like Palolem, Agonda, Patnem, Rajbag at a distance of about 10 km. Hence, efforts are being made by the Department of Forest to develop this region in terms of better roads and tourist accommodations.

LISS-III Image interpretation (2018)

During 2008-2018, the area under Dense Mixed Jungle has decreased from 71.46 per cent in 2008 to 59.72 per cent in 2018 indicating a negative change of 11.74 per cent **(Table 3)**. Such a trend in a sanctuary is highly disturbing because it indicates the degradation of the forest. Similarly, another disturbing act is the increase in the area under the settlement and agricultural land. In 2008 areas under settlement accounted for 2.13 per cent and agriculture in 3.89 which further increased to 5.13 per cent and 5.97 per cent in 2018 correspondingly showing an increase of 3 per cent in settlement and 2.08 per cent in agriculture.

Table 3: Land Use Land Cover-2008

ID	Land use Category	Landuse(2018) in SqKm	Landuse (2018) in %	Land use (2008) in %	Change in % from 2008 to 2018
1	Settlement	4.704378	5.13	2.13	+3.00
2	Water Bodies	0.936059	1.03	1.36	-0.33
3	Agricultural Land	5.475961	5.97	3.89	+2.08
4	Grassland	0.339707	0.37	2.87	-2.5
5	Open Scrub	13.492654	14.70	9.44	+5.26
6	Plantation	0.028624	0.04	0.97	-0.93
7	Fairly Dense Mixed Jungle	11.970588	13.04	7.88	+5.16
8	Dense Mixed Jungle	54.784373	59.72	71.46	-11.74
		91.732344	100	100	

In the last one decade i.e., between 2008 to 2018, a negative change has been observed with -0.33, -2.5 and -0.93 of the areas covered with water bodies, grasslands and plantations. Two land parcels namely the area under Fairly Dense Mixed Jungle and Open Scrub has increased by 5.16 and 5.26 per cent respectively for the same period **(Table 2 & Figure 2& 3)**.

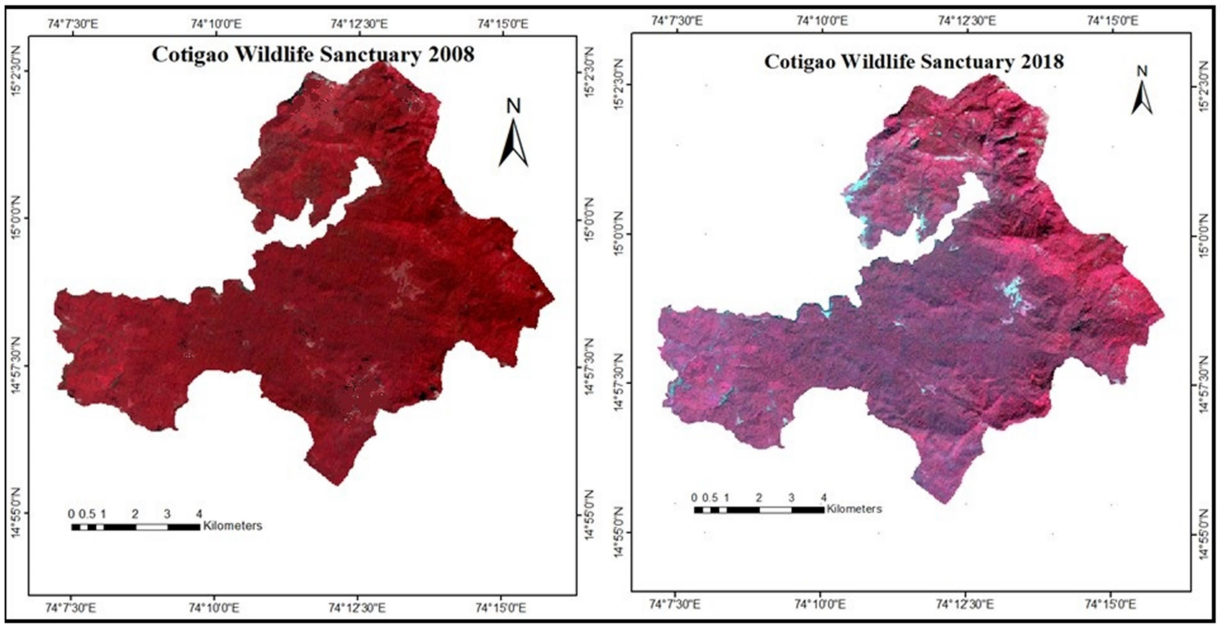

Fig 2: LISS III images of Cotigao Wildlife Sanctuary (2008 and 2018)

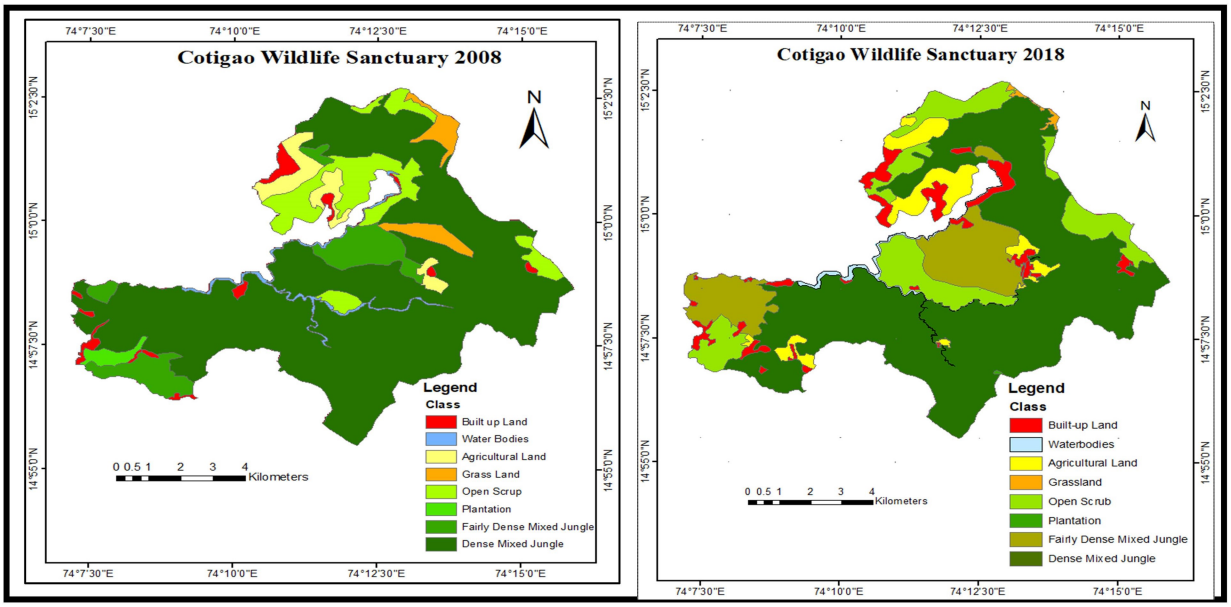

Fig 3: Land Use Landcover Map of Change in Cotigao Wildlife Sanctuary (2008-2018)

The study region's land use/land cover maps from 2008 and 2018 is shown in **Figure 3** and the change detection is shown in **Table 3 & Figure 4**.

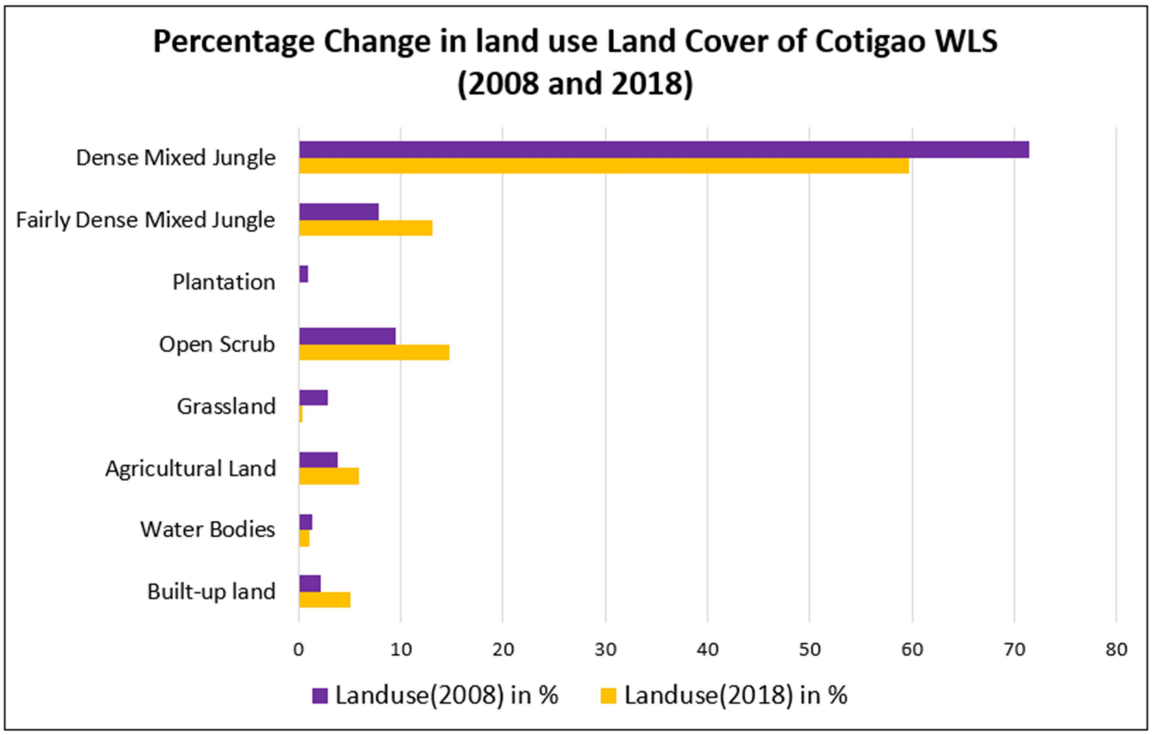

Fig 4: Percentage Change in land use Land Cover of Cotigao WLS (2008 and 2018)

Change Detection Analysis

Change detection was performed for classified land use and land cover classes using ENVI 5.1 software (ESRI, 2013) by correlating both images from different time periods i.e., 2008 and 2018). The result suggests variation in two categories 1. Big increase: 53,418 points (6.199 percent) and 2. Big decrease: 8,656 points (1.005 percent) out of a total of 799,622 points (approximately 93percent).

CONCLUSION

The land use land cover is rapidly getting altered in the Cotigaon Wildlife Sanctuary mainly because of anthropogenic activities. In one decade i.e., between 2008-2018, the area under Dense Mixed Jungle has declined by 11.74 per cent at the cost of an increase in area under settlement and agriculture. Further, Dense Mixed Jungle has also turned into Fairly Dense Mixed Jungle and Open Scrub for the same period. Change in the land use land indicates that there is a degradation of Dense Mixed Jungle, which is ecologically not a great sign. For the sustainability of the area, the protection and conservation of forestsis highly necessary. Efforts must be made to involve all the forest stakeholders in Wildlife Management.

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