CHANGE DETECTION OF LAND USE/LAND COVER IN ZUNHEBOTO SADAR BLOCK OF ZUNHEBOTO DISTRICT, NAGALAND

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Abstract

The use of Geoinformatics in mapping land use/land cover is adopted for its cost-effective and efficiency in studying temporal changes over a large scale. Interaction of Man and its environments has greatly changed the appearance of our surroundings in time. The change detection of land use/land cover has been carried out in Zunheboto Sadarblock of Zunheboto district, Nagaland. The reason for choosing this area is that it is the most populated place in Zunheboto District and there need of proper information to the residents about the changing land use/land cover for maintaining sustainable environments. Supervised classification of Landsat Satellite image for year 2009 and 2019 were carried out and 7 classes were delineated for both the years and compared. The 7 classes are River, Jhum cultivation, Settlements, Terrace cultivation, Sparse vegetation, Dense Vegetation and Moderate Vegetation. The topography of the study area is hilly where Jhum and Terrace cultivation are often practiced. The study shows that the area of Settlements and Sparse vegetation has increased from 524ha to 722ha and 692ha to 1530ha respectively, Moderate vegetation has increased from 3329ha to 3615ha and Dense vegetation has decreased from 6692ha to 5478ha in the span of 10 years.

Keywords: Landuse, Landcover, Lansat, LULC, Change detection matrix, Zunheboto.

1. INTRODUCTION

The term land use can be defined as the activities of mankind on the terrestrial portion of the earth which shapes and transforms the topography by various uses such as Agriculture, settlements industries etc. whereas land cover means those materials which are naturally present on the terrestrial part of the earth e.g. Water bodies, vegetation, rocks, soils and their products. Both land use and land cover are related closely and can be interchanged often [*5*].

The information of LULC changes is very important in understanding the natural resources, their utilization, conservation and management of the natural resources [*14*]. The LULC of an area can be monitored and, evaluate their temporal difference with the help of the available processed remote sensing data [*10*].

Human activities such as urbanization, deforestation, Intensive agricultural etc. attribute to the change in LULC. This change is due to the interaction between social, economy and biophysical elements. Most of the LULC changes are due to the activities of human and much less on the natural components. The natural cause can be slow, continuous or an abrupt catastrophic event where both of which differ in time and contributes to change. LULC development can be result of heterogeneous climate and physiographic conditions of an area which need to be evaluated [*14,1*].

In Supervised classification techniques prior knowledge about the field is used, which is very much helpful in LULC classification [*9*]. Supervised classification can be used in classifying images pixels by giving specific training areas which represent land use and land cover present in the image. It is usually preferred by various researchers because it gives more accuracy than the unsupervised classification [*7*].

In Unsupervised classification, the image pixel classification is based on similar classes, cluster in the feature space. By applying suitable algorithm the clustering of pixel is done on the bases of spectral signature which generate spectral class representing class on the ground. There are numerous statistical techniques for clustering which yield good result [*9*].

The practice of Land use and land management has a great impact on natural resources like water, plants, animals, soil and nutrients[*3*]. Land use involve the management of its natural environment and it modification into Settlements, arable fields, pasture and managed woods. Land use by human has a long history for more than 10,000 years ago [*9*].

2. GEOLOGY OF THE STUDY AREA:

The rocks of Zunheboto district belongs to the Barail Group and the Disang Group. Disang is the older lithounit and is a thick monotonous sequence of splintery and nodular grey shale with minor interbands of sandstone, siltstone and local intraformational conglomerate beds [*12,8*]. Based on two distinct lithological units, a basal argillaceous and an upper arenaceous stratum, Sinha et al., 1982 [*11*] divided the disang group into Upper and lower Disang Formations. The Lower Disang formations is represented by argillaceous shale of dark grey to greenish grey in colour intercalated with thin bands of grey siltstone and fine grained sandstone while the Upper Disang formation comprises of arenaceous dark grey splintery shale intercalated with sandy shale and siltstone . In comparison with its thickness the Disang formation show poor in fossil, however the fossils reported like foraminifera, bivalve and gastropods indicate upper cretaceous to Eocene age [*2*]. The Disang group litho units are overlain laterally and vertically by the Barail group [*6*].

The Barail group comprises of thick sequences of sandstone intercalated with very thin papery shale, ranging in age from Upper Eocene to Oligocene. The Barail group which overlain the Disang group is represented by Laisong Formation lithounits which comprises of multistoreyed sandstones with variable shale-siltstone interbands. In the mapped area only Laisong Formation lithounits of Barail Group are exposed. Both Disang and Barail group exhibit shallow sedimentary depositional features and structures such as ripple marks, sole marks, load casts, flute marks, gradded bedding, cross bedding and current bedding [*2*]. According to Vidyadharan et al., 1989 [*13*], the Disang and Barial sediments were deposited in the distal shelf and on the continental margin, respectively, in an epicontinental Sea.

3. MATERIALS AND METHODS

3.1. Study Area

The study area i.e. Zunheboto sadar, is situated in Zunheboto district of Nagaland state, India **(Fig. 1)**. The study area falls under the part of Toposhet No. 83 J/8, 83 J/12, 83 K/5 and 83 K/9. The coordinate of the study area is Latitude from 25º56'40'' to 26º 6'16''North and Longitude from 94º 27'50'' to 94º 37'15''East. The study area is a mountainous terrain trending NNE-SSW and a part of Naga Hills. The Zunheboto district covers an area of about 1255 Km^2 with altitude ranging from 300m to 2500m above mean sea level. Due to its elevation, the area enjoys a moderate humid subtropical climate with cool winters and hot, very rainy summers. The average rainfall of the district is about 200 cm with highest rainfall in the month of July to August and occasional rain from September to October. November to April has a dry season. In winter the temperature falls down to 1ºC.

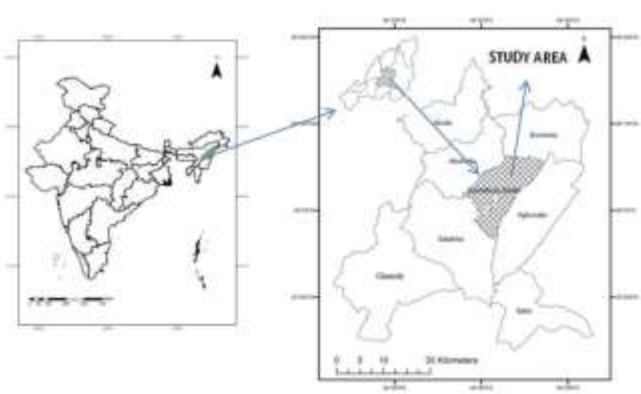

Figure 1: Location of the study area.

December and January are the coldest month of the year. The summers are moderately warm with the temperature recorded as high as 22ºC. Adapting to the hilly terrain, the people mainly depends on shifting cultivation (slash and burn type) posing great threat environmental. Terrace cultivation is also practiced especially along the riverbanks [*4*]**.** As per 2011 Census, the total population Zunheboto District is 153955 with density population density of 123 persons per square km.

3.2. Methodology

In the study ArcGIS 10.2.1 and ERDAS imagine 14 were used to meet the above objective. The satellite imageries of Landsat 5 **(Fig. 2)** and Landsat 8 **(Fig. 3)** were acquired from the Earth explorer of USGS Archive. The data acquired were imported into ERDAS Imagine 2014. Different bands were imported individually into ERDAS Imagine 2014 software to meet the layer stacking and to produce FCC image of both the satellite imageries.

Shape file of the study area is acquired by digitizing and geo-referencing the District boundary map. This shape file is projected to WGS-1984_UTM_zone_46N and using the mask tool in Arc Map, the study area is clipped from the satellite imageries by using the shape file of the study area.

For the purpose of this study Image pre-processing which includes radiometric and geometric corrections, and also image enhancement was performed on the Satellite imageries in ERDAS Imagine 2014 Software [*9*]. Sufficient number of training set for each class has been given to the satellite images which represents different surface cover to carry out supervised classification. In supervised classification the analyst has a sufficient available known pixel which generates representative parameters for all the classes of interest and this process is called as training.
After the training the classifier labels the image pixel with respect to the trained parameters. Maximum Likelihood Classification (MLC) is commonly used in supervised classification where each assumed spectral class is described by a multivariate normal distribution.
MLC take account of the mean vectors and also the multivariate spreads of each class so that it can identify those elongated classes. However for the effective MLC it depends on the precise estimation of covariance matrix and mean vector for each spectral class data [*9*]. Supervised classification was carried out and 7 classes were delineated for both the satellite imageries and compared. The 7 classes are River, Jhum cultivation, Settlements, Terrace cultivation, Sparse vegetation, Dense Vegetation and Moderate Vegetation.

Accuracy assessment was carried for the supervised classification of Land use and land cover generated from LANDSAT imageries 2009 and 2019. This accuracy assessment was carried out in ERDAS Imagine software and the result shows the overall accuracy of 80.22% with kappa statistics of 0.7692 in 2009 land Use and Land cover Classification, similarly 90.11% with Kappa Statistics of 0.8846 in 2019 Land use land cover classification.
Change of each class from 2009 to 2019 were calculated and compared

4. RESULTS AND DISCUSSION

4.1. LULC Change Detection

The classes are named generally and it is divided into River, Jhum cultivation, settlements, Terrace cultivation, Sparse vegetation, Dense vegetation and Moderate vegetation **(Table 1)**. In **Fig. 2** and **Fig. 3** the spatial distribution of LULC map for the given years is provided. The classified image from 2009 **(Fig. 4)** is divided into seven classes, with 0.23% (0.2835 Km^2) of the area covered by river, 5.44% (6.6978 Km^2) by Jhum cultivaton, 4.26% (5.2461 Km^2) by settlements, 2.97% (3.6594 Km^2) by Terrace cultivation, 5.26% (6.921 Km^2) by sparse vegetation, 54.39% (66.9276 Km^2) by dense vegetation and 27.06% (33.2982 Km^2) by moderate vegetation. In 2019 **(Fig. 4)** image the area covered by river is 0.22% (0.2736 Km^2), 3.56% (4.3857 Km^2) by Jhum cultivation, 5.87% (7.227 Km^2) by settlements, 3.98% (4.9059 Km^2) by Terrace cultivation, 12.43% (15.3018 Km^2) by sparse vegetation, 44.53% (54.7875 Km^2) by dense vegetation and 29.38% (36.1521 Km^2) by moderate vegetation.

LULC	Area Km. square 2009	Area Km. square 2019
River	0.2835	0.2736
Jhum Cultivation	6.6978	4.3857
Settlements	5.2461	7.227
Terrace Cultivation	3.6594	4.9059
Sparse Vegetation	6.921	15.3018
Dense vegetation	66.9276	54.7875
Moderate vegetation	33.2982	36.1521

Table 1: Land use and land cover change direction (2009-2019)

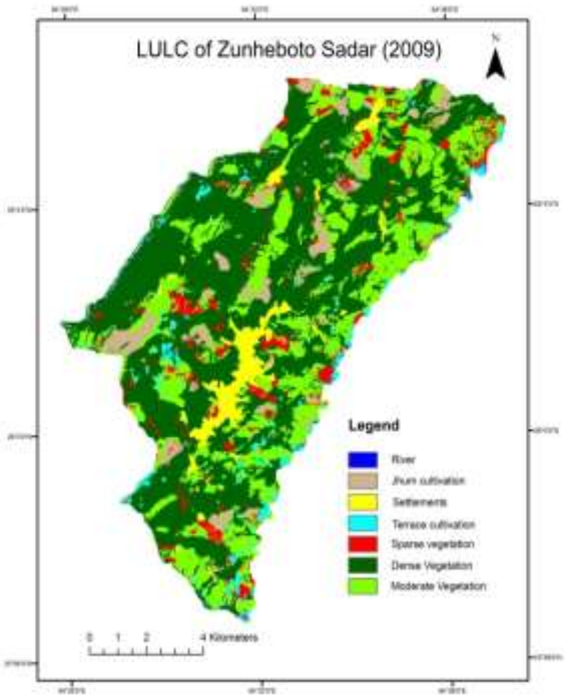

Figure 2: Land use and land cover map 2009 (Classification by LANSAT 5).

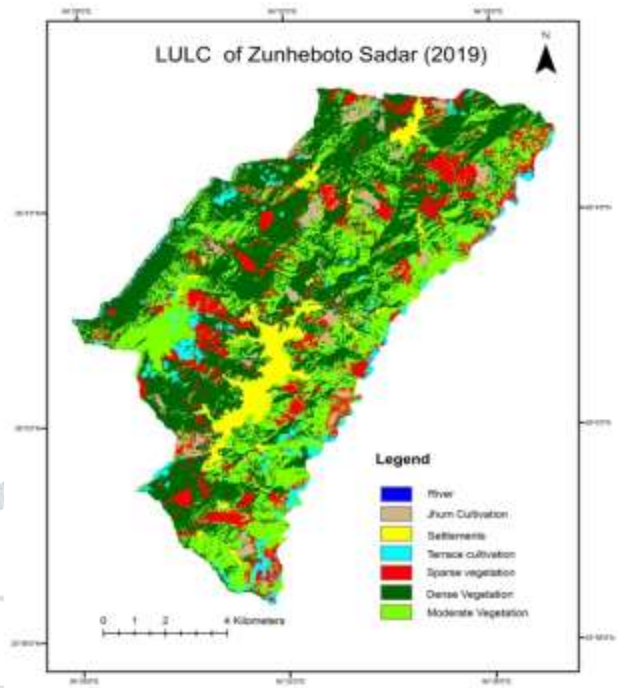

Figure 3: Land use and land cover map 2019 (Classification by LANSAT 8).

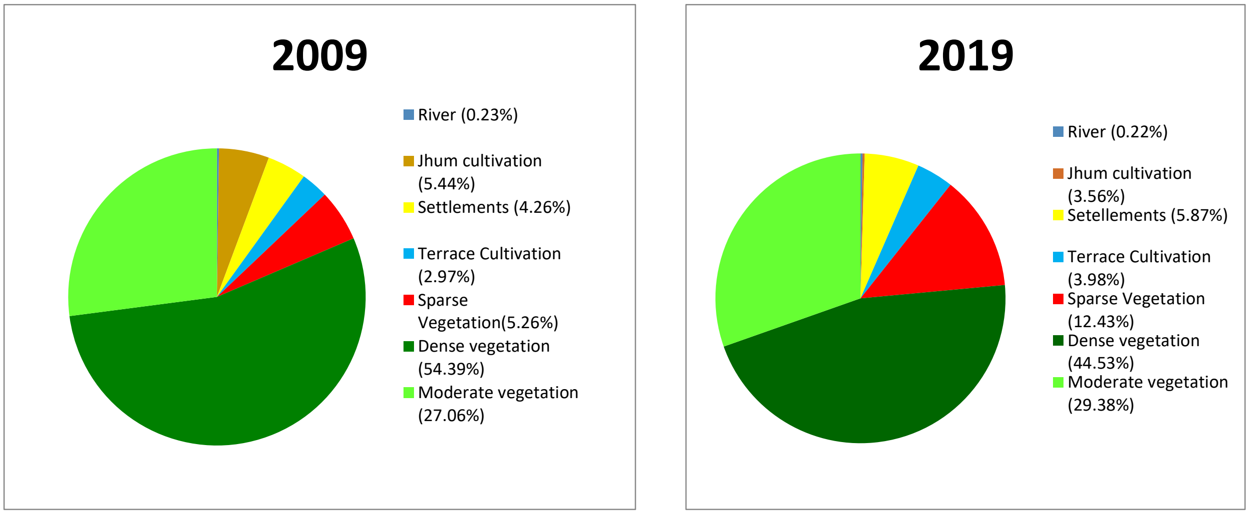

Figure 4: Pie-chart representation of land use and land cover changes detection in Zunheboto sadar, Zunheboto district, Nagaland, India.

Table 2: Change Detection matrix between initial and final state. Class total represents the total area landcover or landuse during the initial state 2009. Row total represents the total landcover or landuse during the final state 2019. Class changes is difference between the selected class total and the selected landuse/landcover. State difference is the difference between row total and class total and represents the amount of landuse or landcover added or loss during the given period. Data collected from Zunheboto sadar, zunheboto district, Nagaland, India.

		INITIAL STATE 2009 (AREA SQUARE Km.)							
	LANDUSE/LANDCOVER	River 2009	Jhum Cultivation 2009	Settlements 2009	Terrace Cultivation 2009	Sparse Vegetation 2009	Dense Vegetation 2009	Moderate Vegetation 2009	ROW TOTAL (Total 2019)
Final State 2019 (Area Square Km.)	River 2019	0.26	0.00	0.00	0.00	0.00	0.00	0.009	**0.269**
	Jhum 2019	0.00	0.93	0.00	0.02	0.20	1.49	1.7577	**4.3977**
	Settlements 2019	0.00	0.05	4.76	0.00	0.20	1.34	0.8721	**7.2221**
	Cultivation 2019	0.00	0.09	0.00	3.38	0.03	0.97	0.4446	**4.9146**
	Sparse Vegetation 2019	0.00	0.87	0.03	0.06	5.15	4.83	4.3578	**15.2978**
	Dense Vegetation 2019	0.01	1.97	0.37	0.08	0.68	46.38	5.3064	**54.7964**
	Moderate Vegetation 2019	0.01	2.79	0.09	0.12	0.66	11.92	20.5506	**36.1406**
	CLASS TOTAL **(Total 2009)**	0.28	6.88	5.25	3.66	6.92	66.93	33.30	123.0382
	CLASS CHANGES	0.02	5.59	0.49	0.28	1.77	20.55	12.7494	
	STATE DIFFERENCE	-0.011	-2.4823	1.9721	1.2546	8.3778	-12.1336	23.3912	

The results achieved after processing the two multispectral datasets of LANSAT 5 TM and 8 OLI for change detection are given in Table 1. A decline occurred in the classes of River, Jhum cultivation and dense vegetation, whereas the classes of settlements, terrace cultivation, sparse vegetation and moderate vegetation were increased Table 1. The river class decreased from 0.2835 Km^2 to 0.2736Km^2,Jhum cultivation areas from 6.6978 Km^2 to 4.3857 Km^2 and dense vegetation from 66.9276 Km^2 to 54.7875 Km^2. The settlements class increased from 5.2461 Km^2 to 7.227Km^2, Terrace cultivation area from 3.6594 Km^2 to 4.9059Km^2 , sparse cultivation class from 6.921 Km^2 to 15.3018 Km^2 and Moderate vegetation class from 33.2982 Km^2 to 36.1521 Km^2.Comparison of the data from 2009 and 2019, show noticeable changes in the Zunheboto sadar during this last 10 years. In the Jhum class the percentage of the Jhum decrease by 1.88% showing a declination on the practice and dependence of the primitive

cultivation. A majority of the percentage for the decrease in the Jhum class can be contributed to the increase in the terrace cultivation class from 2.97% (2009) to 3.98 %(2019). This 1.01% increase in the Terrace cultivation area in 2019 support the change in method of cultivation from Jhum to Terrace cultivation. However the remaining declination of 0.87% in the Jhum class is explain by the change in profession of the cultivator population. It is important to note that the agricultural area (Jhum and Terrace cultivation) has decrease by 0.87% in 2019.The river class, which includes the streams and springs, show a negligible decreased of 0.01%. The settlement area in the 10 years period have been increased by 1.61%. This is obvious since settlement expansion is related to the number of population. The class under moderate vegetation show an increase by 2.32% while Dense vegetation has been decrease by 9.86%. The sparse vegetation class on the other hand show an increase by 7.17%. The sparse vegetation area in the study area shows more than a double fold increase from 5.26% (2009) to 12.43% (2019).The cases of these three classes of vegetation is effected mostly by deforestation, contributing mainly to lumbering, farming and Jhum cultivation. Although the Jhum cultivation class decrease in the final year 2019, the annual shifting cultivation practice reduces the area of dense vegetation and greatly enhance the area of sparse vegetation. From table 1, it is clearly understandable that a majority of the land use and land cover in 2009 falls under dense vegetation class followed by moderate vegetation, sparse vegetation, Jhum, settlement, terrace cultivation and river. In 2019 the changes in the Land Use and Land cover of the study area shows Dense vegetation, Moderate vegetation, Sparse vegetation, Settlements, Terrace cultivation, Jhum and River, with the Dense vegetation covering the largest area.

4.2. Change detection matrix between initial and final states

The change detection matrix between the initial (2009) and final (2019) states shows the shift of land cover over a 10 year period **Table 2**. The river class from 0.28 Km^2, 0.26 Km^2 remained as the same class in 2019, of which 0.1 Km^2 each have been converted to moderate and dense vegetation during this period. For the Jhum cultivation class from 2009 with the total area of 6.88 Km^2, 0.93 Km^2 has been retained in this class in 2019. Of which,0.5 Km^2 have been retained by settlements, 0.09 Km^2 by Terrace cultivation, 0.87 Km^2 by sparse vegetation, 1.97 Km^2 by dense vegetation and 2.79 Km^2 by moderate vegetation. 4.76 Km^2 from 5.25 Km^2 of settlements remained in this class in 2019, 0.03 Km^2 were converted into sparse vegetation, 0.37 Km^2 into dense vegetation and 0.09 Km^2 into moderate vegetation. There is no significant changes for the Terrace cultivation class as only 0.06 Km^2 were converted into sparse vegetation, 0.08 Km^2 into dense vegetation and 0.12 Km^2 into moderate vegetation. Out of the 6.92 Km^2 of the sparse vegetation, 5.15 Km^2 remained in this class in 2019 and the remaining part of the area are replaced by Jhum cultivation (0.20 Km^2), settlement (0.20 Km^2), Terrace cultivation (0.03 Km^2), dense vegetation (0.68 Km^2) and moderate vegetation (0.66 Km^2). About 11.92 Km^2 out of 66.93 Km^2 for the dense vegetation was converted to moderate vegetation, along with 1.49 Km^2 was converted to Jhum cultivation, 1.34 Km^2 to settlements, 0.97 Km^2 to Terrace cultivation and 4.83 Km^2 to sparse vegetation. 20.5506 Km^2 of moderate vegetation class remained in 2019 from 33.30 Km^2, in which 0.009 Km^2 were converted to river, 1.7577 Km^2 to Jhum cultivation, 0.8721 Km^2 to settlements, 0.4446 Km^2 to Terrace cultivation, 4.3578 Km^2 to sparse vegetation and 5.3064 Km^2 to dense vegetation.

The study had shown that the change detection techniques using remote sensing and GIS can give valuable results about land cover changes over longer periods.

5. CONCLUSION

In Zunheboto sadar the Land Use and Land cover (LULC) have undergone some changes during the 10 years period from 2009 to 2019.Out of the seven classes, three classes- River, Jhum cultivation and Dense vegetation show decrease changes in area while four classes-Settlements, Terrace cultivation, Sparse vegetation and Moderate vegetation have its area increased in 2019. The Land Use and Land cover change has been greatest in the sparse vegetation class, 6.921 km^2 in 2009 to 15.3018 Km^2 in 2019. It should be noted that sparse vegetation in the Zunheboto sadar region is more likely to develop into a moderate or dense vegetation for its geographical location in a tropical zone. Whereas the Moderate and sparse vegetation show an increase in area, the Dense vegetation have been decreased in the final year 2019. The decrease in Dense vegetation is attributed to the deforestation and logging in the study area. The significant changes in the Zunheboto sadar area is the decreasing practice of the Jhum cultivation and dependence on the permanent Terrace cultivation. The decreasing trend on the Jhum cultivation will likely increase the forest area in the region. This study shows that, remotely sensed data combined with ground truth data makes it possible to explore the LULC management in the Zunheboto Sadar.

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