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Forest Cover Change Analysis Based on Remote Sensing & GIS of West Singbhum District, Jharkhand

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Abstract: Forest is a part of the land surface of the earth, with lots of plants and animals, they are need forests to live and survive. The major objective of this study is to detect the magnitude of forest cover change in the duration of the last 20 years (1997 to 2017) in West Singhbhum district of Jharkhand, India. The spectral information of the satellite image is more important to generate forest cover change model using LULC, NDVI and SAVI. The data included a series of topographical sheets, open series maps and satellite imageries from Landsat-5 TM (1997) and Landsat-8 OLI (2017) to recognize forest cover changes during the chosen period. A very useful method used to complete the study, which are generation of Land Use/Land Cover (LULC), Normalized Difference Vegetation Index (NDVI) and Soil Adjusted Vegetation Index (SAVI) model of the study area. The LULC employing the maximum likelihood supervised classification (MLC) algorithm mainly focused on forest cover and other parameters. On the classified map, accuracy assessment is performed, which produced error matrices and overall accuracy, the calculated overall accuracy found 87.18% in 1997 and 86.11% by 2017. The change detection analysis revealed that the area has remarkable changes specifically, the forest covers land reduced 2017.037 km2 (26.17%) of the total study area of 5,364.789 km2 in between 20 years, 5079.723 km2 (65.58%) in 1997 to 3062.686 km2 (40.41%) in the year 2017.
Key words: LU/LC, NDVI, Remote Sensing (RS), Geographic Information System (GIS), Change Detection, Image Differencing, Accuracy Assessment, Error Matrix.

I. INTRODUCTION

Forest cover change mapping LULC serves as a crucial parameter in current strategies and policies for natural forest resource management. Currently, the world is witnessing the importance of LULC changes in world-wide environmental modifications that can lead to adverse effects (Iqbal and Khan, 2014). Changes in LULC signify environmental changes brought about by natural or anthropogenic consequences (Rawat and Kumar, 2015; Sinha et al, 2015). The vegetation or forest cover plays a very significant role in shaping the land surface of the Earth. Information about the vegetation cover is an indirect indicator of land-use and is highly relevant for environmental studies. Changes in land cover induced by human activity have profound implications on climate (Dickinson et al., 1986; Lean & Warilow, 1989). Mapping techniques from the remote sensing domain are superior to conventional ground based methods of vegetation mapping (Defries & Townshend, 1994). Supervised and object-based classification; out of which the most commonly used classification technique is the supervised classification technique (Enderle and Weih, 2005); however, object-based classification has shown better accuracy (Blaschke, 2010). On the other hand, vegetation indices, like Normalized Difference Vegetation Index (NDVI) and Soil Adjusted Vegetation Index (SAVI) can be used as an alternative for the vegetation change modelling (Faris and Reddy, 2010). With the advent of new climate agreements like REDD (Reducing Emissions from Deforestation and Degradation), there has been an ever-increasing demand for accurate forest monitoring methods (Sharma et al., 2013; van Leeuwen et al., 2011). The potential of remote sensing and GIS in the field of forestry becomes established over many years through the use of aerial photos and satellite imagery interpretations in forest cover change detection analysis, for the generation of the coverage map and inventory analysis (Sajjad et al,. 2015).

II. STUDY AREA

West Singhbhum District forms the Southern part of the newly created Jharkhand State and is the largest district in the State. The district bounded by 21^0 58' & 23^0 36' North latitude and 85^0 0' & $86^0$54' East Longitude (Figure 1). The district is situated at a height of 244 Meter above the mean sea level and has an area of 7629.679 Sq. Kilometers. The district is full of hills alternating with valleys, steep mountains and deep forests on the mountain slopes. The Karo & Koina is the main perennial river and other rivers are

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Koel, kuju, Kharkai, Sanjai, Roro, Deo, and Baitarini. The majority of the population of West Singhbhum district is tribal population.

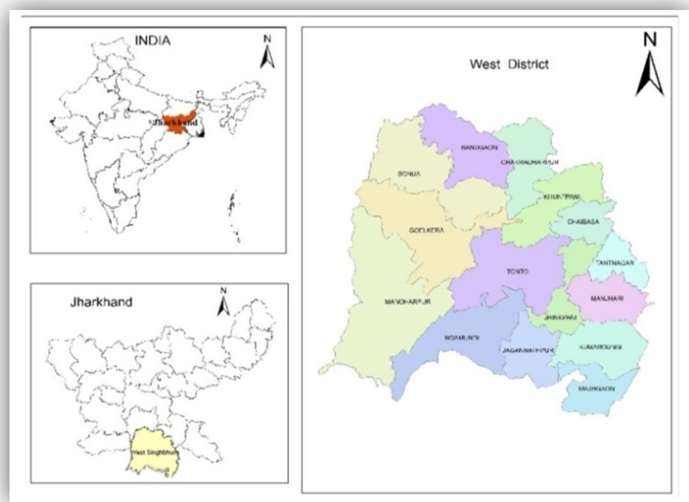

Figure 1: Location Map of the Study Area

III. MATERIAL AND METHODS

A. Datasets

Satellite image of the study area Landsat-5 TM of 23rd May, 1997 and Landsat-8 OLI of 14th May, 2017 download from USGS (<https://glovis.usgs.gov/>). The toposheets also used for classifying the land use/land cover along with the satellite image using ERDAS & Arc GIS software.

B. Methodology

Advance, remote sensing and GIS technique used to detect the forest cover change area of the west singbhum district in between 20 years. The details of the methodology are shown in (Figure 2).

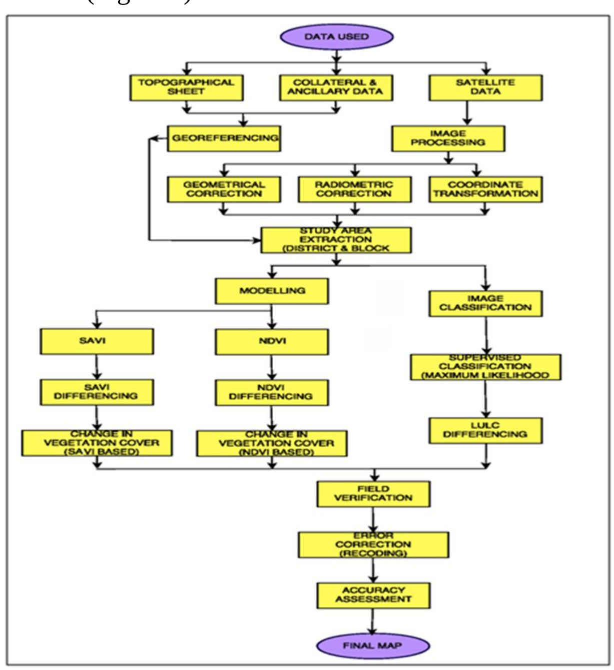

Figure 2: Methodological Flowchart

1) *Image Interpretation for LULC:* Land use / land cover classes are classically chartered sense of digital remote sensing data concluded the process of a supervised image classification (Furtado et al, 2010). The overall image classification is to automatically classify all pixels in the image into land cover / land use classes (Rawat et al, 2013). The spectral signatures for different land use and land cover types were established and False-Colour Composite (FCC) was interpreted based on image elements. The image was processed for classification of the different features on the ground. For supervised classification using maximum likelihood supervised classification (MLC) algorithm, training sets were selected in the FCC imagery based on the collected sample points for respective LULC classes (Sinha et al., 2011a, b). Training sites for LULC classification were selected based on knowledge developed through an extensive ground survey and detailed field study of the area; the study area was taken into account along with the topographical sheets, Landsat-5 TM and Landsat-8 OLI image. The training sites were proportionately selected comprising of pure pixels. 100 random points were generated as sample points that were cross-checked using GPS in the field.
2) *Accuracy Assessment:* Image analysis and accuracy assessment have corrected contract amongst a standard assumed to be correct and a classified image of unknown class. A classification image accuracy assessment is performed using ERDAS IMAGINE which produced error matrices from which overall accuracy is calculated. The overall accuracy of the classified image compares how each of the pixels is classified versus the actual land cover conditions obtained from their corresponding ground truth data (Sophia S et al, 2017)
3) *Land Use / Land Cover Change Detection:* The net change in the different classes of the LU/LC of the study area is obtained by performing the post-classification change detection technique. There are several ways to quantify the land cover change results. The simple and the basic one are chosen here that is to tabulate the total of each Land Use/Land Cover type and examine the trend in between the 20 years
4) *NDVI:* The Normalized Difference Vegetation Index (NDVI) is a numerical indicator that uses the visible and near-infrared bands of the electromagnetic spectrum and are adopted to analyze remote sensing measurements and assess whether the target being observed contains live green vegetation or not (Shahkooeei et al, 2014).

$$NDVI = \{(IR - R) / (IR + R)\}$$

This index outputs values between -1.0 and 1.0, mostly representing greenness, where any negative values are mainly generated from clouds, water, and snow, and values near zero are mainly generated from rock and bare soil

5) *SAVI :* Soil-adjusted Vegetation Index plays a great role in the areas where vegetative cover is low (i.e., < 40%) and the soil surface is exposed, the reflectance of light in the red and near-infrared spectra can influence vegetation index values. The soil-adjusted vegetation index was developed as a modification of the Normalized Difference Vegetation Index to correct for the influence of soil brightness when vegetative cover is low.

$$SAVI = \{(IR - R) /(IR + R + L)\} * (1+L)$$

The output of SAVI is a new image layer with values ranging from -1 to 1. The lower the value, the lower the amount/cover of green vegetation (Rawat et al, 2013).

IV. RESULTS AND DISCUSSION

A. LULC Feature Interpretation

The LU/LC features classified namely forest, vegetation, settlement, barren land, agriculture land, agricultural fallow land, river, surface water (Fig 3 & 4). The percentage of area covered by the different LU/LC class is represented (Table 1).

1) *LULC of 1997:* The spatial extent of 1997 LU/LC classification the vegetation covers found 4364.874 km^2, the highest percentage (56.97%) with scattered distributed approximately throughout the study area (Figure-3). The next to LU/LC class with the highest area coverage is the agricultural fallow land 1494.435km^2 near about (19.59%), which is scattered distributed around the North-East, South-East and Western parts of the study area with well drainage network. Agriculture land covers 601.038km^2, about 7.88%, presence around the North-East and Eastern part of the study area. Forest covers 732.849km^2 about (9.61%), found in mainly South-West part of the study area. The Barren land covers 76.638km^2 about (1.00%) found in western and South-East part with small patches scattered across the study area. River and Surface water covers 64.097km^2 about (0.84%) and 13.557km^2 about (0.18%) presence in Western and Eastern part with scattered distributed across the West Singbhum district. The settlement area covers 14.126km^2 about (0.19%) mainly concentrated in the North-East and Eastern part of the study area.
2) *LULC of 2017:* The spatial extent of LU/LC classification of 2017 (Figure 4), vegetation covers 2851.376 km^2 about (37.37%) which are mainly presence in Western and Eastern part of the study area. Agricultural fallow land covers an area of 2289.478

km^2, (30.01%) which is scattered distributed approximately all around the study area. Barren land occupies 2162.041 km^2 (28.34%) which is found in entire the districts. Forest can be found mainly South-West part of the study area covered with 211km^2 (2.77%). Agriculture land covers 53.770 km^2 (0.70%) found in the North-East, Eastern and Western part. Water bodies consisting river and surface water, cover an area of 28.175.87km^2 (0.38%) in the West and East most ends and 11.400 km^2 (0.15%) found in all over the study area. The settlement area covers 16.925km^2 (0.22%) mainly centered within the North-East and the Eastern part of the west singbhum district.

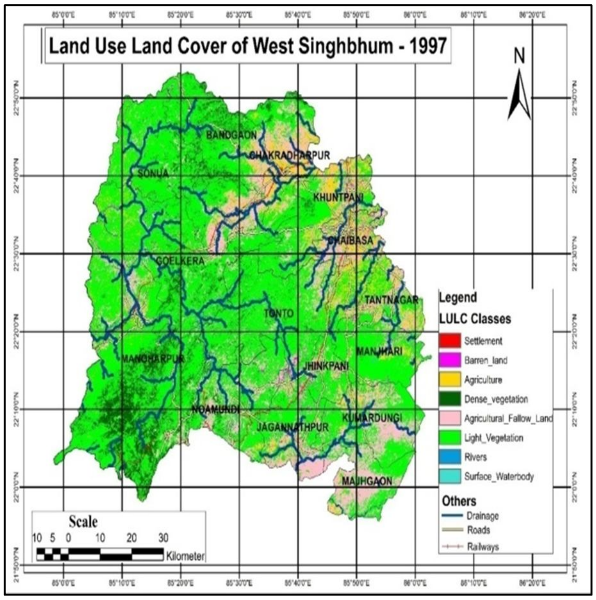

Figure 3: LULC map of 1997

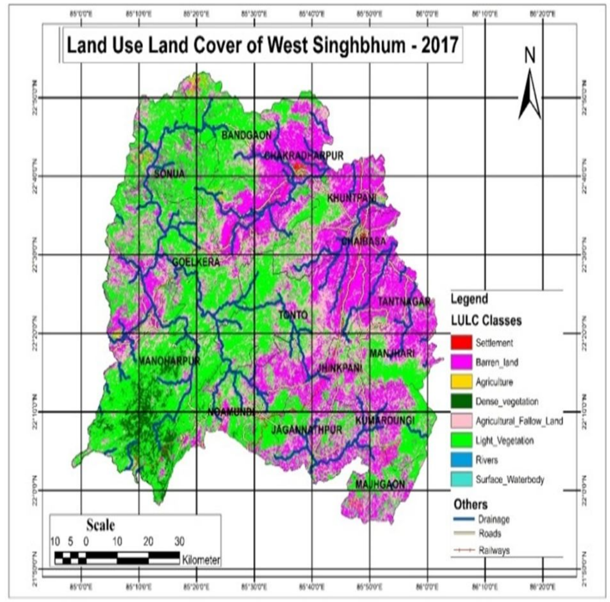

Figure 4: LULC map of 2017

Table 1: Land Use / land Cover Area of 1997 & 2017

Class Name	1997		2017		Changed Area
	Area (sq.km)	(%) of Area in Total Area	Area (sq.km)	(%) of Area in Total Area	Area (sq.km)
Settlement	14.126	0.19	16.925	0.22	2.80
Agriculture Land	601.038	7.88	53.770	0.70	-547.27
Barren Land	76.638	1.00	2162.041	28.34	2085.40
Agricultural Fallow Land	1494.435	19.59	2289.478	30.01	795.04
River	64.097	0.84	28.715	0.38	-35.38
Vegetation	4832.943	63.34	2855.779	37.43	-2041.62
Surface Waterbody	13.557	0.18	11.400	0.15	-2.16
Forest	532.846	6.98	211.565	2.77	-321.28
Total Area	7629.68	100	7629.6722	100.00	

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3) *Accuracy Assessment:* A classification accuracy assessment is performed on the classified map of 1997 & 2017 using an error matrix algorithm. The LULC map indicates overall accuracy 87.18% of 1997 and 86.11% of the 2017 (Table 2 & 3).

Table 2: Accuracy Assessment of 1997 LULC image

Class	Surface Waterbody	River	Settlement	Barren Land	Forest	Vegetation	Agriculture Land	Agricultural fallow	Row Total
Surface Waterbody	2583	400	0	0	0	0	0	0	2983
River	610	1131	0	0	0	4	1	1	1747
Settlement	1	54	722	158	84	34	22	82	1157
Barren Land	0	0	40	4588	0	0	0	142	4770
Forest	0	0	0	0	2158	179	0	0	2337
Vegetation	0	17	23	0	116	3214	191	26	3587
Agriculture Land	0	6	76	0	0	149	598	358	1187
Agricultural fallow	0	0	1	240	0	5	278	7440	7964
Column Total	10194	1398	632	1676	1252	1285	537	7989	
Overall Accuracy = 87.18327374									

B. *NDVI Interpretation*

The NDVI is the most commonly used index for forest vegetation biomass monitoring. The range of the NDVI is from -1 to 1, but the absolute value of NDVI for vegetation change analysis is between 0 and 1. Healthy vegetation yields high positive NDVI values because they have are latively high reflectance in the NIR and low in visible wavelength and the negative values are mainly due to the barren lands, cloud covers etc.

1) *NDVI Map of 1997:* The NDVI map of West Singhbhum district in the year 1997 illustrates that vegetation of different health conditions and various other features like barren land settlement, river, water bodies etc. (Figure 5). The image indicates high to low values, the values vary between 0.628205 to -0.40545. The positive values (0 to 0.628205) show healthy vegetation cover of the study area and the negative values (0 to -0.40545) indicates presence of other features in the study area
2) *NDVI Map of 2017:* The NDVI map of West Singhbhum district in the year 2017 illustrates that different health condition of vegetation covers and other features like barren land settlement, river, water bodies etc. (Figure 6). The image indicates high to low values varies between 0.54677 -0.24464 the positive values (0 to 0.54677) shows presence of healthy vegetation cover in the study area and the negative values (0 to -0.24464) shows other features in the study area.

Figure 5: NDVI Map of 1997

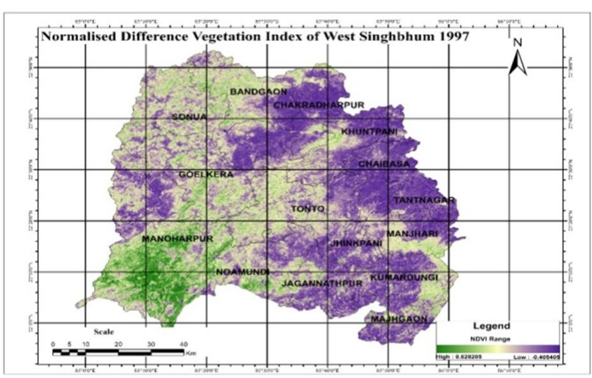

Figure 6: NDVI Map of 2017

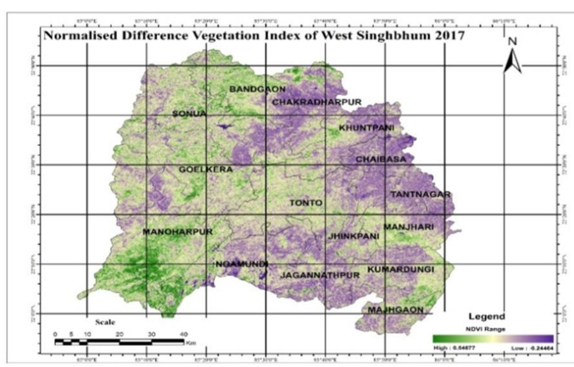

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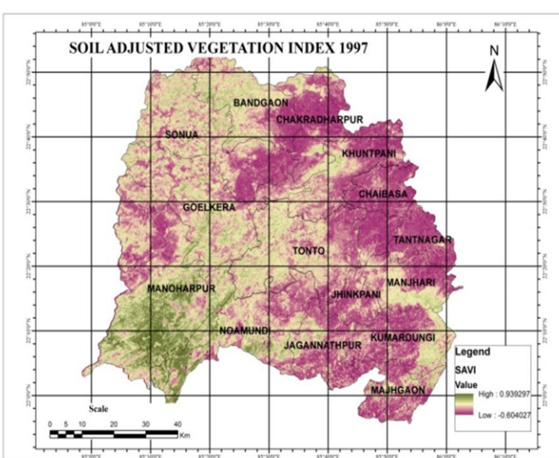
Table 3: Accuracy Assessment of 2017 LULC image									
Class	Forest	Surface Waterbody	River	Agriculture Fallow	Agriculture Land	Vegetation	Barren Land	Settlement	Row Total
Forest	472	0	4	0	9	5	0	4	494
Surface Waterbody	0	350	140	0	0	0	0	0	490
River	0	100	440	0	0	0	0	0	540
Agriculture Fallow	0	0	0	240	50	17	120	0	427
Agriculture Land	0	0	0	20	269	10	0	45	344
Vegetation	6	0	0	0	20	301	0	0	327
Barren Land	30	0	0	1	0	0	1700	0	1731
Settlement	0	0	0	65	0	0	0	235	300
Column Total	508	450	584	326	348	333	1820	284	4653
Producer's Accuracy	92.9134	77.7778	75.3425	73.6196	77.2989	90.3904	93.4066	82.7465	-
Overall Accuracy = 86.11648399									

C. SAVI Interpretation

In areas where vegetative cover is low (i.e., < 40%) and the soil surface is exposed, the reflectance of light in the red and near-infrared spectra can influence vegetation index values. This is especially problematic when comparisons are being made across different soil types that may reflect different amounts of light in the red and near infrared wavelengths (i.e., soils with different brightness values).

1) *SAVI distribution of 1997:* The SAVI map of 1997 is indicates that the value is varies between (-0.604 to 0.939), the positive value indicates the presents of vegetation cover in the south-western part and negative value i
2) ndicates absence of vegetation cover in the north-eastern, south-eastern and the western part of the study area (Figure 7)SAVI distribution of 2017: The SAVI map of 1997 is indicates that the value is varies between (-0.366 to 0.820), the positive value indicates the presents of vegetation cover in the south-western, north and a little part of the middle portion of the study area and negative value indicates absence of vegetation cover and presents of other features in the north-eastern, south-eastern and northern part of the study area (Figure 8).



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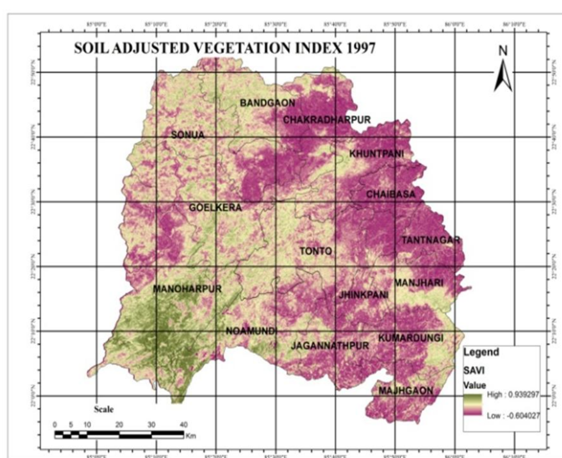

Figure 7: SAVI map of 1997 Figure 8: SAVI map of 2017

D. Spatial Distribution of the Forest & Vegetation Cover:

1) *Distribution of forest and vegetation in 1997:* Using Landsat-5 TM satellite image after the classification the spatial distribution forest and vegetation map illustrate that forest area covers 5079.723 km^2, about 65.58 % of the total study area **(Figure 9)**
2) Distribution of forest and vegetation in 2017: Using Landsat-8 OLI satellite image after the classification the spatial distribution of forest and vegetation map illustrate that forest area covers 3062.686 km^2 about 40.41 % of the total study area (Figure 10).

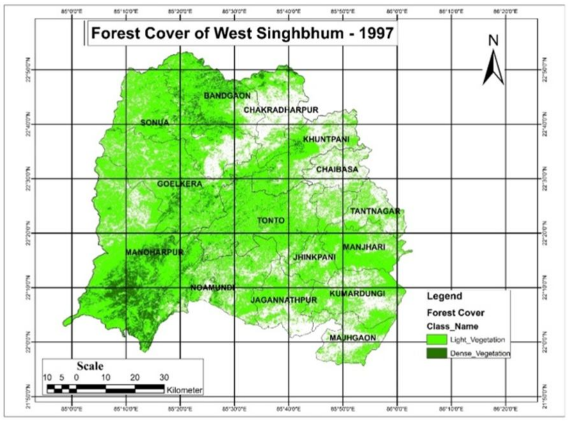

Figure 9: Distribution of Forest and Vegetation in 1997

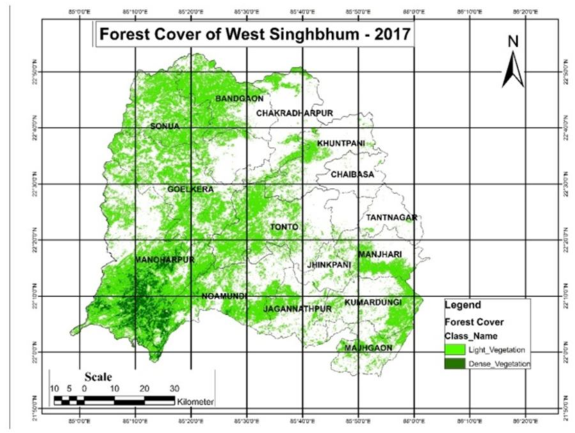

Figure 10: Distribution of Forest and Vegetation in 2017

E. Change Detection Interpretation:

1) *NDVI Change Detection:* The comparing NDVI map of two different years (1997 & 2017), it indicates that the NDVI value range are decreased on the year 2017 interval of 20 years. The decreases positive value of NDVI indicates the change of healthy forest and vegetation. On the other hand, the increase negative values of NDVI indicate increased the non-vegetated areas (Figure 11). The NDVI change map found four different changed zones, namely increase, some increase, some decrease and decrease. NDVI image differencing cannot provide detailed change information, particularly in the study area because it does not have NDVI values in different features. It can only give overall information about the healthiness of vegetation cover area of the earth surface. The negative threshold indicates a loss of vegetation and positive threshold indicates the area of increased restoration or healthy vegetation. The Red colour shows the decreased NDVI value, it indicates the reduced forest & vegetation cover. The blue colour shows increased NDVI value with large extent, it indicates the increased forest & vegetation cover. Whereas areas during Yellow and Green colour represent some decrease and some increase NDVI values which indicates light changes in forest and vegetation covers in the study area
2) *SAVI Change Detection:* The comparing SAVI map of two different years (1997 & 2017), the SAVI value decreased on the year 2017 interval of 20 years. The decreases positive value of SAVI indicates the change of healthy and dense vegetation. On the other hand, the increase negative values of SAVI indicate increased the non-vegetated areas (Figure 12). The SAVI change map found four different changed zones, namely increase, some increase, some decrease and decrease. SAVI image differencing cannot provide detailed change information, particularly in the study area because it does not have SAVI value in different features. It can only give overall information about the healthiness of vegetation covers in the study are based on SAVI value. The negative threshold indicates a loss of vegetation covers and positive threshold indicates the area of increased restoration or healthy vegetation. The Red colour shows the decrease SAVI value it indicates the reduced forest & vegetation cover. The blue colour shows increased SAVI value with large extend it indicates the increased forest & vegetation cover. Whereas areas during Yellow and Green colour represents some decrease and some increase in SAVI values which indicates light changes in forest and vegetation in the study area.

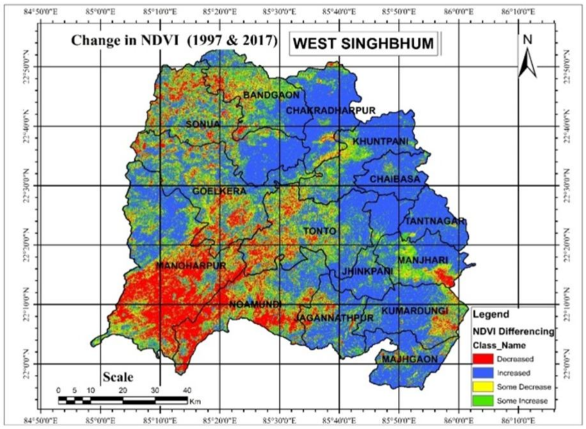

Figure 11: Changed NDVI in Between the year 1997 to 2017

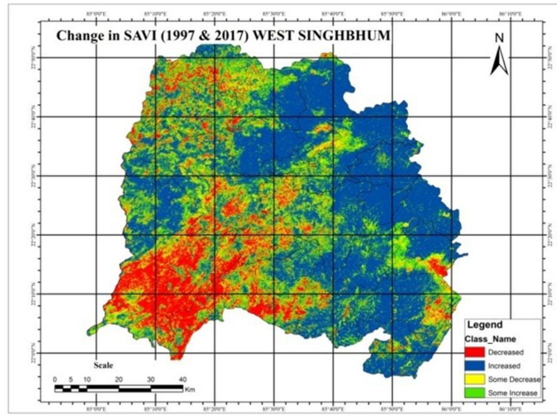

Figure 12: Changed SAVI in Between 1997 to 2017

3) *Forest Cover Change Detection:* The net forest cover change in the study area is obtained by performing the post-classification change detection technique. There are several ways to quantify the land cover change results. The simple and the basic one are chosen here that is to tabulate the total of each Land Use/Land Cover type and examine the trend in between the 20 years. In totality, there are eight different classes of Land Use / Land Cover but according to the requirement of the aim of the study, the main consideration is given to the change in the forest cover that includes the total change in the amount of the forest and the vegetation.

4) *Changed Vegetation Cover between (1997 – 2017):* The study of forest and vegetation cover change using different satellite images of different year in between 20 years (1997-2017). The forest & vegetation covers changed map **(Fig-13, 14)** has been classified in three different classes, namely Increased (green color), unchanged (light brown color) and decreased (red color). The final result finds that the block wise change in forest and vegetation cover is in this manner **(Table 4 & 5).** Tonto block has decreased in the vegetation of 198.438 km^2 (27.4%) and 52.222 km2 (7.2%) in forest. Jhinkpani is associated with the decrease in vegetation of 181.796 km^2 (62.0%) and 11.525 km^2 (3.9%) in forest. Block Jagannathpur has shown a 29.7 % decrease, making 96.675 km^2 of area in vegetation and 3.6%, making 11.855 km^2 of area in the forest zone. In Tantnagar total observed change in vegetation area is 133.469 km^2 (62.5%) and in the forest change area is about 9.790 km^2 (4.6%). Goelkera block has a total area of change 87.778 km^2 (10.8%) in vegetation and 60.582 km^2 (7.4%) in forest. There is an increase in the vegetation cover by 60.837 km^2 (8.1%) and decrease in forest by 50.316 km^2 (6.7%) in the Sonua block. Normandy block has the same fashion of the change as it is in Sanaa, with an increase in vegetation cover by 27.525 km^2 (4.1%) and decrease in forest by 52.348 km^2 (7.9%). Manoharpur being the largest block of study has shown the decrease in both vegetation and forest, 110.403 km^2 (8.9%) in vegetation and 86.935 km^2 (7.0%) in forest. Similarly the Manjhari block has 159.308 km^2 (47.8%) reduction in vegetation and 18.062 km^2 (5.4%) in forest area. Chakradharpur has reflected the decrease of 156.648 km^2 (39.2%) in vegetation and 28.332 km^2 (7.1%) of area in forest. Majhgaon block has decreased in the vegetation of 37.554 km^2 (13.1%) and 14.499 km^2 (5.0%) in forest. Chaibasa is associated with the decrease in vegetation of 96.338 km^2 (42.6%) and insignificant change in forest. Block Kumardungi has shown a 31.1 % decrease, making 131.273 km^2 of area in vegetation and 4.0%, making 16.680 km^2 of area in the forest zone. In Bandgaon total observed change in vegetation area is 5.120 km^2 (1.0%) and in the forest change area is about 81.460 km^2 (16.5%). Khuntpani block has a total area of change 189.059 km^2 (42.7%) in vegetation and 26.928 km^2 (6.1%) in forest.

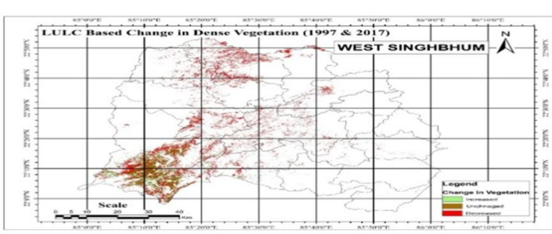

Fig-13: Map showing change in the Dense vegetation cover of 1997 to 2017

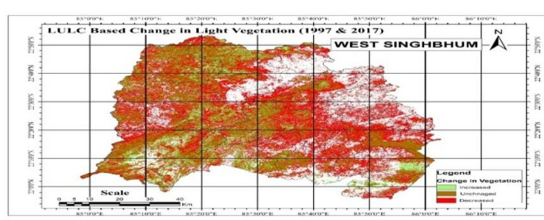

Figure 14: Map showing change in Light vegetation cover of 1997 to 2017

Table 4: Variation in the forest in between 1997 and 2017

Forest cover area					
Block Details		1997		2017	
Block Name	Area (sq km)	Area (sq km)	(%) of Area	Area (sq km)	(%) of Area
Tonto	723.121	53.71193	7.43	1.49	0.21
Jhinkpani	293.304	11.53458	3.93	0.01	0.00
Jagannathpur	325.736	12.03125	3.69	0.176	0.05
Tantnagar	213.599	9.9598	4.66	0.17	0.08
Goelkera	813.647	63.22815	7.77	2.646	0.33
Sonua	752.491	51.28643	6.82	0.97	0.13
Noamundi	666.797	95.2749	14.29	42.927	6.44
Manoharpur	1236.411	247.88618	20.05	160.951	13.02
Manjhari	333.590	18.20598	5.46	0.144	0.04
Chakradharpur	399.765	28.4454	7.12	0.113	0.03
Majhgaon	287.232	15.0867	5.25	0.588	0.20
Chaibasa	226.185	0.012	0.01	0.007	0.00
Kumardungi	421.900	17.16725	4.07	0.487	0.12
Bandgaon	493.359	81.98498	16.62	0.525	0.11
Khuntpani	442.538	27.03398	6.11	0.106	0.02
Total Area	7629.676	732.850	-	211.31	-

Table 5: Variation in the Vegetation in between 1997 and 2017

Vegetation Cover Area					
Block Details		1997		2017	
Block Name	Area (sq km)	Area (sq km)	(%) of Area	Area (sq km)	(%) of Area
Tonto	723.121	498.5542	68.94	300.116	41.50
Jhinkpani	293.304	205.1168	69.93	23.321	7.95
Jagannathpur	325.736	187.8879	57.68	91.213	28.00
Tantnagar	213.599	139.2349	65.19	5.766	2.70
Goelkera	813.647	485.6604	59.69	397.882	48.90
Sonua	752.491	294.8683	39.19	355.705	47.27
Noamundi	666.797	284.3034	42.64	311.828	46.77
Manoharpur	1236.411	729.0327	58.96	618.63	50.03
Manjhari	333.590	269.7563	80.86	110.448	33.11
Chakradharpur	399.765	226.655	56.70	70.007	17.51
Majhgaon	287.232	114.748	39.95	77.194	26.88
Chaibasa	226.185	98.3945	43.50	2.057	0.91
Kumardungi	421.900	267.522	63.41	136.249	32.29
Bandgaon	493.359	276.6113	56.07	271.491	55.03
Khuntpani	442.538	268.528	60.68	79.469	17.96
Total Area	7629.676	4346.874	-	2851.376	-

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F. Forest & Vegetation Cover trends 1997 to 2017:

The forest and vegetation cover trend analysis of West Singhbhum district, between 20 years (1997 to 2017). Two different types of data are observed in (Table 6) & diagrams are shows in (Figure 15 & 16). The positive values describe the reduction of the forest and vegetation cover and the negative values depict the increment in the forest and vegetation cover. The final and overall forest and vegetation cover change is represented in (Table 7).

Table 6: Block Wise Net change in forest and vegetation cover of West Singhbhum district in between 1997 to 2017

Forest & Vegetation Cover Area Changed					
Block Details		Vegetation		Forest	
Block Name	Area (sq km)	Area (sq km)	(%) of Area	Area (sq km)	(%) of Area
Tonto	723.121	198.4382	27.44	52.22193	7.22
Jhinkpani	293.304	181.7958	61.98	11.52458	3.93
Jagannathpur	325.736	96.6749	29.68	11.85525	3.64
Tantnagar	213.599	133.4689	62.49	9.7898	4.58
Goelkera	813.647	87.7784	10.79	60.58215	7.45
Sonua	752.491	-60.8367	-8.08	50.31643	6.69
Noamundi	666.797	-27.5246	-4.13	52.3479	7.85
Manoharpur	1236.411	110.4027	8.93	86.93518	7.03
Manjhari	333.590	159.3083	47.76	18.06198	5.41
Chakradharpur	399.765	156.648	39.19	28.3324	7.09
Majhgaon	287.232	37.554	13.07	14.4987	5.05
Chaibasa	226.185	96.3375	42.59	0.005	0.00
Kumardungi	421.900	131.273	31.11	16.68025	3.95
Bandgaon	493.359	5.1203	1.04	81.45998	16.51
Khuntpani	442.538	189.059	42.72	26.92798	6.08
Total Area	7629.676	1495.498	-	521.53951	-

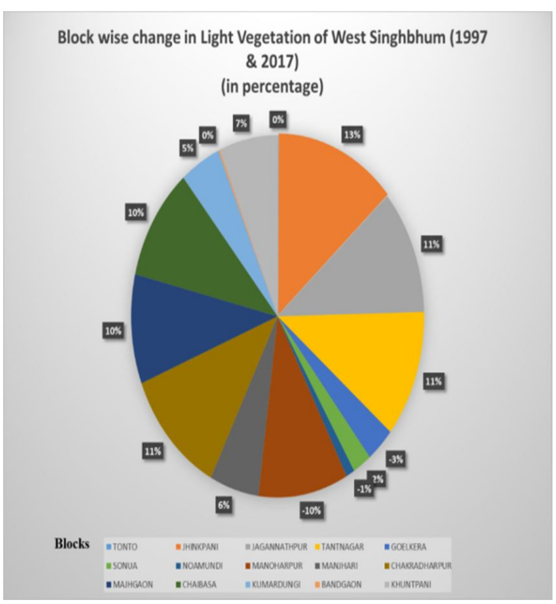

Figure 15: Block wise change in light vegetation

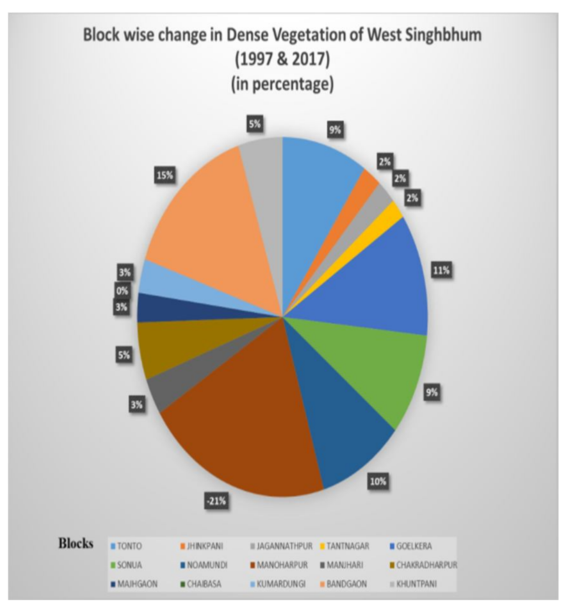

Figure 16: Block wise chang in dense vegetation

The above (Table 7) represented an overall change in forest and vegetation cover in the study area, the change variation divide into two components vegetation cover and forest cover. As per the study findings, change in forest cover in between 20 years 2017.032 sq.km and the rate of forest cover change 100.85 km2 / year within 20 years. Hence, with the help of the data from (Table 8) it can be accounted that about 5079.723 km2 (65.58%) of the study area was covered with forest resources in the year 1997. Meanwhile, in the year 2017 the forest cover land of the district is accounting 3062.686 km2 (40.41%), approximately 26.17% forest area decreased from the total study area. The total changed forest area converted to vegetation, barren land and agriculture land.

Table 7: Quantified change in the vegetation cover

Year	Vegetation		Forest	
	Area in km^2	Area in %	Area in km^2	Area in %
1997	4364.874	56.97	532.846	9.61
2017	2851.376	37.37	211.565	2.77
Difference	1977.764	25.91	321.281	4.21

Table 8: Net change in forest and vegetation cover of West Singhbhum

Year	Area of forest and vegetation cover in km^2	Area of forest and vegetation cover in %
1997	5079.723	65.58
2017	3062.686	40.41
Net change in forest and vegetation cover	2017.037	26.17

V. CONCLUSION

The study significantly focuses on integrated techniques of GIS and remote sensing for forest cover change mapping. The several methods and procedures used to find the forest cover change area in between 20 years. In order to explain forest cover change NDVI, SAVI and Land Use/Land Cover classification techniques are used. The post-classification technique used to classify the different year's satellite image to get the quantitatively changed area of West Singhbhum district. The NDVI and SAVI map does not represent different features of the earth's surface, it only shows forest and vegetation covers with chlorophyll content. The NDVI and SAVI map shows that forest & vegetation cover highly reduced from 1997 to 2017, in the South-West and northeast part of the study area. The LU/LC classifies results conclude that the forest cover (both forest and vegetation) has been changed 2017.037 km2, about 26.17% between the year 1997 and 2017 on the study area. The forest cover area changed 100.85 km^2/ year in the period of 20 years. The total changed forest area converted to vegetation, barren land and agriculture land.

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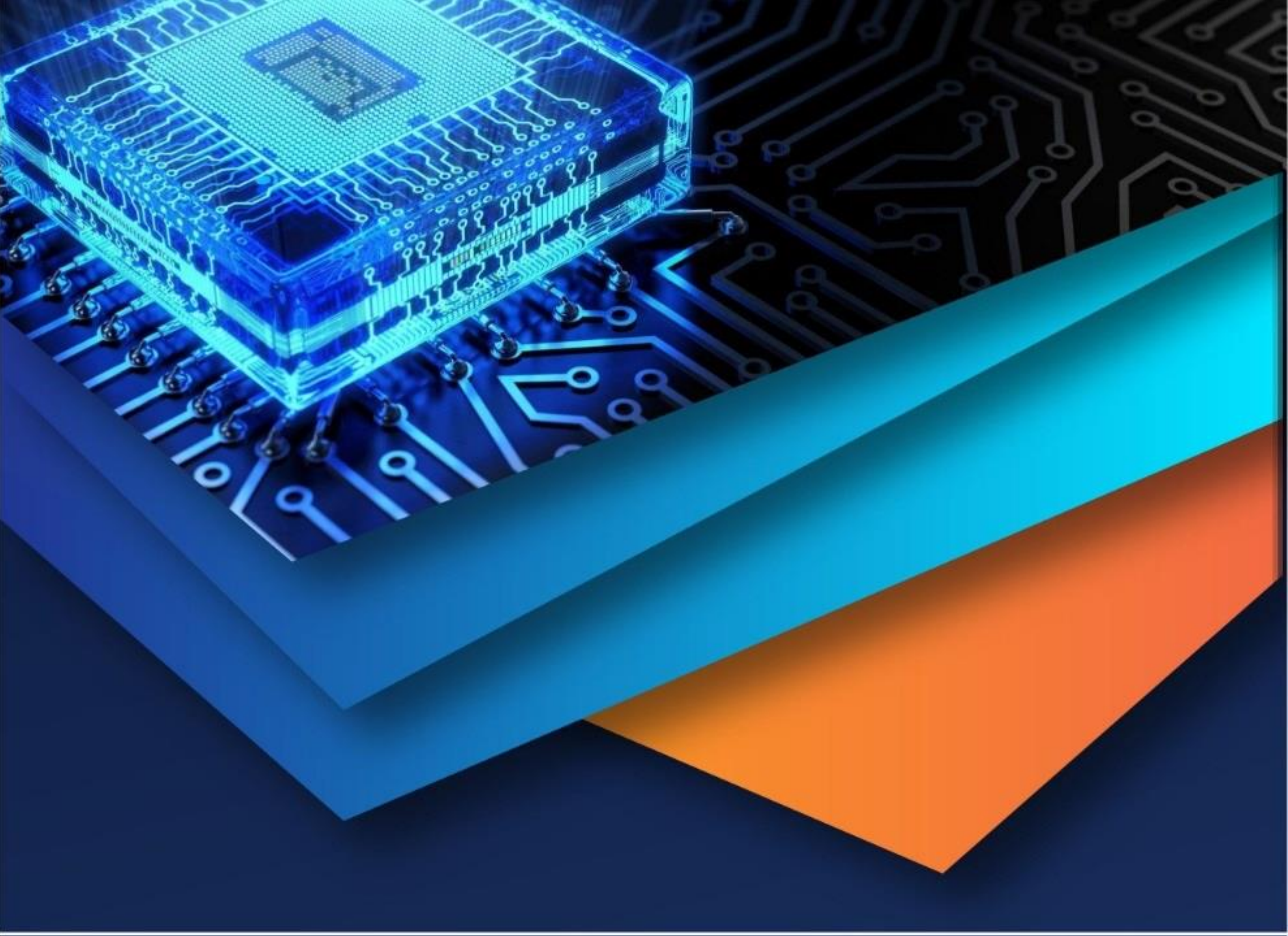

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