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Spatio-Temporal Dynamics of Landuse/Land Cover Around NTPC Using High Resolution Satellite Imagery

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Abstract: *Land is becoming scarce resource due to population growth and industrialization. Rapid growth of human activities can also be attributed as one of the reasons. Thus, it becomes an important task to regulate land resource for sustainable development and environmental protection. LULC change studies have become a central component in current strategies for managing and planning land resources and monitoring environmental changes. In this paper an attempt has been made to bring out spatio-temporal dynamics of LULC patterns of NTPC-Ramagundam and its surrounding environment by using multi-temporal satellite data of Landsat-4, IRS P6 LISS-III and IRS 2 LISS-IV and GIS techniques for the years 1984, 2005, 2011, 2015, 2018. The methodology includes base map preparation having features like Road (SH), Rail, Canal, River, Stream, Tanks, Forest boundary and other administrative boundaries from SOI topo sheet and the features digitized are updated on satellite images. Interpretation of study area for LULC feature extraction on satellite imageries of respective years is carried with Nrsc's standard LULC classification system. Change detection statistics can be generated out of 5 LULC thematic layers obtained and analysed specially with respect to NTPC environs. Results from this study shows the percentage of geographical area occupied by built-up land, agricultural land, forests, wasteland and waterbodies of level-I LULC features were 10.27%, 60.68%, 6.61%, 11.81%, 10.63% respectively in 1984 and were changed into 21.41%, 48.51%, 5.97%, 12.77%, 11.34% respectively in 2018. This analysis shows a rapid growth in built-up land and fall in agricultural land between 1984 and 2018. There is a considerable change in the remaining features from 1984 and 2018.*

Keywords*: Land use/Land cover, LULC classification system, GIS software (ArcGIS 10.1), change detection.*

I. Introduction

Land use is defined as the series of operations on land, carried out by the humans, such as built-up, farms, roads, residential, commercial, industrial, etc., *Land cover* is defined as the natural cover on earth surface such as forests, deserts, mountains, Water, ice, rock, etc., Both types of the data are most often obtained from analysis of either satellite or aerial images.Land resource is one the most important natural resources that possibly will play a dynamic role in the life of not only mankind, but also the entire assemblage of all living being. Interaction of human with environment influence land use/land cover (LULC) change and thus, it is necessary to monitor changes. One of the driving factors of global environment alteration is LULC change [1]. Land cover refers to the features present on the earth surface. Land cover configuration is stated as a united reflection of the existing natural resources and natural processes that are dynamic in nature [2]. Due to anthropogenic activities, the Earth surface is being significantly altered in some manner and man's presence on the Earth and his use of land has had a profound effect upon the natural environment thus resulting into an accelerated growth in settlement expansion [3]. Land use refers to the main activity of man on the land, which is directly related to land and land resources. The study LULC is therefore becomes a very important tool in the hands of the planners of urban, rural or regional, to assess and

forecast land use necessities and to assign apt use to land resources [4]. Land use is the manner in which human beings employ the land and its resources. Thus urban development is strictly depends upon Land use/ Land cover (LULC) of that area [5].LULC maps describe the vegetation, water and natural features on the land surface. Identifying, delineating and mapping land cover is important for global monitoring studies, resource management and planning activities [6]. Land Use Land Cover Changes (LULC) is very important in the global change of population, resources and environment and has been an important cause of global environment change since 1990's. At present, LULC has become a frontier and hotspot in the international global change research. Economic development and population growth have triggered rapid changes to Earth's land cover over last two centuries. LULC data is a fundamental component of the planning and decision-making processes for many communities because it helps them to understand better where to plan for different types of growth and where to preserve [7].Throughout the world, emphasis has been given on LULC studies due to increasing demand for land as it has a limited availability.Efficient management of natural resources is possible to a maximum extent by having proper information about land use and land cover details.To identify these changes, remote sensing datais preferred, because of its repetitive and synoptic coverage capability over a particular area.

II. Material and Methods

The study area of NTPC Ramagundam is a part of National Thermal Power Corporation started in 1983. The study area extends between 18°37'22" to 18°53'44" of North Latitude and 79°18'46" to 79°35'47" of East Longitude. It is about 226 kilometres northeast from Hyderabad, 65 km from Karimnagar, 28 km from Peddapalli district and 1.1 km from Godavarikhani. Its elevation is 175meters above sea level. As of 2011 India Census, Ramagundam had a population of 2, 29,644 of which Males constituted 51% of the population and females 49%. Ramagundam experiences the dry inland climatic conditions with hot summers and cool winters. During summer period temperatures range from a minimum of 25 °C to a maximum of 40 °C. The highest recorded temperature in the area is around 47.3 °C and the humidity is around 50%. The city experiences a highest rainfall of 112mm and an average annual rainfall of 1129.2mm.

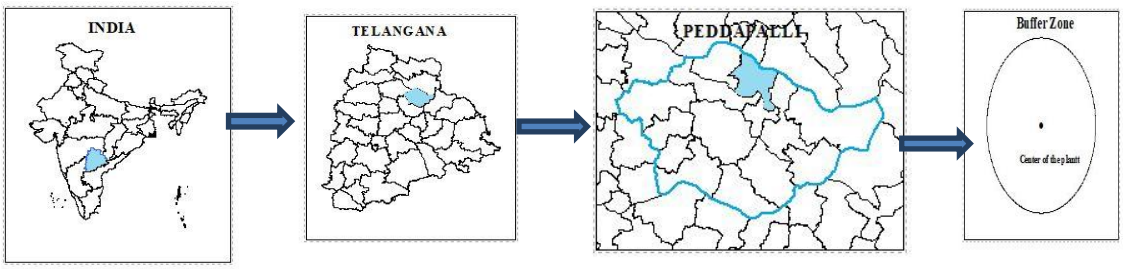

Figure 1: Location map of study area

The study area with a buffer of 15 km radius from centre of plant encompasses Main Plant, Ash-pond, Township, NTPC-Solar Power Plant and its features of environment and covers an area of 707sq.km. It includes parts of Mancherial, Naspur, and Jaipur of Mancherial District. Ramagundam (Full), Anthergaon, peddapalli, Palakurthy, Kamanpur, Ramgiri of Peddapalli District.

III. Methodology

In the present study, we used five data sets which we acquire from USGS; they are 1984, 2005, 2011, 2015, 2018. All these five data sets were rectified geometrically with base map of SOI toposheets on 1:25,000 scale.The digitization technique is employed to delineate the extent of LU/LC classes, on georeferenced satellite images of required time period (i.e., 1984, 2005, 2011, 2015, and 2018).The entire study area is demarcated into various level-III Land Use Land Cover categories based on Nrsc's standard LULC classification. The statistics of each LULC classes is calculated and also the percentage of changes over these time period is calculated. The land use/ land cover datasets of 1984, 2005, 2011, 2015, 2018 were integrated in the GIS(by intersection tool) to extract the data of conversion of each land use/ land cover category into other types in study area as a whole. The conversion of LULC

features is analysed by change detection analysis. Change matrices were prepared for study area, separately. Further, Pivot table is drawn to find out how much area of a feature is transformed into another form.Percentage of a feature present in total geographical area and change percentage can be calculated by using the formula.

$$\%\ \text{of a feature present} = \frac{\text{Area of a feature present}}{Total\ Geographical\ area} * 100$$

$$change\ percentage\ (\%) = \frac{(\text{present LULC area} - \text{previous LULC area})}{\text{previous LULC area}} * 100$$

All the Level-III, Land use and Land cover features are delineated within the buffer of 15Km from the centre of plant by using ArcGIS software for the years 1984, 2005, 2011, 2015 and 2018. Maps of LULC of study years for the years 1984, 2005, 2011, 2015, 2018 are shown below.

Land use/ Land cover in 1984: The total Built-up land in the study area is 7256.64Ha with urban, rural, industrial and mining classes. Mancherial, Ramagundam, Godavarikhani are urban areas and Basantnagar, 8-incline colony comes under rural areas. There are NTPC-main plant, kesoram cement factory, FCI industrial areas covering an area of 361.55Ha and only one mine OCP-I covering an area of 476.36Ha with 33.60Ha of Un-Vegetated Mine Dump. As a part of reducing high temperatures released from the boilers at the plant, NTPC management started an activity of plantation in NTPC surroundings .The total agricultural land in this period is 42885.5Ha of which crop land, agricultural plantation and fallow land covering an area of 37999.52Ha, 860.29Ha, 4025.69Ha respectively. Forest land of 4674.74Ha is in the study area. Waste Lands comprising of Barren rocky and scrub areas are covering a total of 8344.78Ha. There is a flow of river Godavari in the study area with an area of 3879.13Ha. A balance reservoir of NTPC- plant comprising an area of 3442.13Ha is constructed near the plant for water supply to the plant.

Land use/ Land cover in 2005: The total Built-up land in the study area is 11354.24Ha which is increased compared to 1984. There is an increase in the mining area with the opening of two new mines OCP-III, OCP-IV and also because of Vegetation practices on Over-burden, there appears sparse-vegetated mine dump and dense-vegetated mine dump with an area covering 38.84Ha and 13.86Ha respectively. The increase in the industrial area is because of expansion of existing industries. The NTPC-vegetated area is increasing gradually. The total agricultural land in this period is 39852.63Ha of which crop land, agricultural plantation and fallow land covering an area of 33770.66Ha, 856.29Ha, 5225.69Ha respectively which indicates a decrease in this land. There is a small decrease in the Forest land from 4674.74Ha to 4422.91Ha due to increase in built-up and industries.

Land use/ Land cover in 2011: The total Built-up land in the study area is 13730.24Ha which is gradually increasing from the past years. NTPC vegetated area is increased to 3201Ha. One new mine SRP OC-II is started which leads to an increase in the mining area. The area of Un-vegetated dump is decreased as sparse and dense-vegetated dump areas are increased to 91.03Ha and 51.16Ha respectively. SCCL has started an industry named Singareni Thermal Power Project; with this the total industrial area becomes 894.02Ha. The total agricultural land in this period is 37810.1Ha which indicates a decrease in this land. There is a small change in the river and reservoir because of seasonal changes.

Land use/ Land cover in 2015: The total Built-up land in the study area is 14189.14Ha which is gradually increasing from the past years. The area of Mines and Industries increased to 3403.20Ha and 1250.59Ha respectively because of the expansion of existing mines and industries. There is a decrease in the total agricultural land and forest land because of human-induced activities. A new reservoir named SripadaYellampalli Project is constructed at yellampally village for irrigation purpose; with this the total area of reservoir in the study area is increased to 4451.90Ha.

Land use/ Land cover in 2018: The total Built-up land in the study area is 15131.46Ha which is gradually increasing from the past years. The most of the NTPC grown vegetation is reduced because tree felling has taken place to accommodate construction activity for new thermal plant STTP. Correspondingly construction related industrial area increased in place of lost vegetation cover. The area of Un-vegetated dump is decreased due to increase of sparse and dense-vegetation cover over it. Loss of open scrub is mainly attributed to the growth of the industrial area in its place and growth of dense scrub at places over it. A lift irrigation project is started at SripadaYellampalli Projectas a part of Kaleshwaram Lift Irrigation Project covering an area of 218.02Ha.

Table 1: statistics of lulc for all the 5 years and change detection values among 1984&2005, 2005&2011, 2011&2015, 2015&2018.

Land Use / LAND COVER LEVEL(III)	**Area in 1984 (Ha)**	**Area in 2005 (Ha)**	**Area in 2011 (Ha)**	**Area in 2015 (Ha)**	**Area in 2018 (Ha)**	**change in hectares for 1984&2005**	**change in hectares for 2005&2011**	**change in hectares for 2011&2015**	**change in hectares for 2015&2018**
Core-urban	3298.99	3571.53	3578.56	3405.73	3405.73	272.54	7.03	-172.83	0
Mixed built-up	197.07	439.44	504.61	764.52	779.66	242.37	65.17	259.91	15.14
vegetated area	576.46	641.3	872.56	928.61	1589.87	64.84	231.26	56.05	661.26
NTPC-vegetated area	117.9	200	320.12	490	459.01	82.1	120.12	169.88	-30.99
Village	1846.86	1996.86	2672.78	2959.42	2756.06	150	675.92	286.64	-203.36
Hamlets and dispersed households	150	120	120	51.32	50.22	-30	0	-68.68	-1.1
Industrial area	361.55	633.07	894.02	1250.59	1282.13	271.52	260.95	356.57	31.54
Ash pond	197.85	537.02	538	540	542.81	339.17	0.98	2	2.81
Mining active	476.36	3085.73	3862.28	3403.2	3800.65	2609.37	776.55	-459.08	397.45
Un-vegetated mine dump	33.6	76.6	175.69	112.39	83.93	43	99.09	-63.3	-28.46
Dense vegetated mine dump	0	13.86	59.16	107	257.33	13.86	45.3	47.84	150.33
Sparse vegetated mine dump	0	38.84	91.03	124.33	73.04	38.84	52.19	33.3	-51.29
quarry area	0	0	41.43	54.27	54.27	0	41.43	12.84	0
Crop land	37999.52	33770.66	34033.71	30592.19	30112.31	-4228.86	263.05	-3441.52	-479.88
Agriculture plantation	860.29	856.29	862.05	903.01	1112.03	-4	5.76	40.96	209.02
Fallow land	4025.69	5225.69	2914.34	3204.18	3057.05	1200	-2311.35	289.84	-147.13
Forest	3293.98	3153.8	3152.8	3041.33	3014.99	-140.18	-1	-111.47	-26.34
Scrub forest	1363.44	1292.44	1252.42	1176.23	1181.82	-71	-40.02	-76.19	5.59
Tree clad area	17.32	17.31	17.69	17.69	22.55	-0.01	0.38	0	4.86
Dense scrub	2015.23	2001.03	1750.58	2196.02	2207.52	-14.2	-250.45	445.44	11.5
Open scrub	5432.13	5228.13	5199.53	6289.1	6260.81	-204	-28.6	1089.57	-28.29
Barren rocky/Stony waste	897.42	412.53	412.97	559.02	559.02	-484.89	0.44	146.05	0
River/Stream/Drain	3879.13	3879.12	3879.15	3859.08	3859.09	-0.01	0.03	-20.07	0.01
Reservoir/Tanks	3442.13	3290.69	3275.65	4451.9	3741.21	-151.44	-15.04	1176.25	-710.69
Tank-Dry	191.24	192.24	193.03	193.03	193.03	1	0.79	0	0
irrigation	0	0	0	0	218.02	0	0	0	218.02
total geographical area	**70674.16**	**70674.16**	**70674.16**	**70674.16**	**70674.16**				

(-ve sign in above table indicates a decrease in the area of the features.)

IV. Change Detection Analysis

Change detection analysis is performed for classified images for the years 1984&2005, 2005&2011, 2011&2015, 2015&2018 and integrated maps are prepared. To perform change detection analysis, Level-I Land use/ land cover classification is used and all the Level-III classes are merged into Level-I classes. Agricultural land, Built-Up, Forest, Waste-Lands, Water bodies are the 5 Level-I classes of Land use/land cover (Table-3). The changes in the features are represented in different colours (figure: 3).

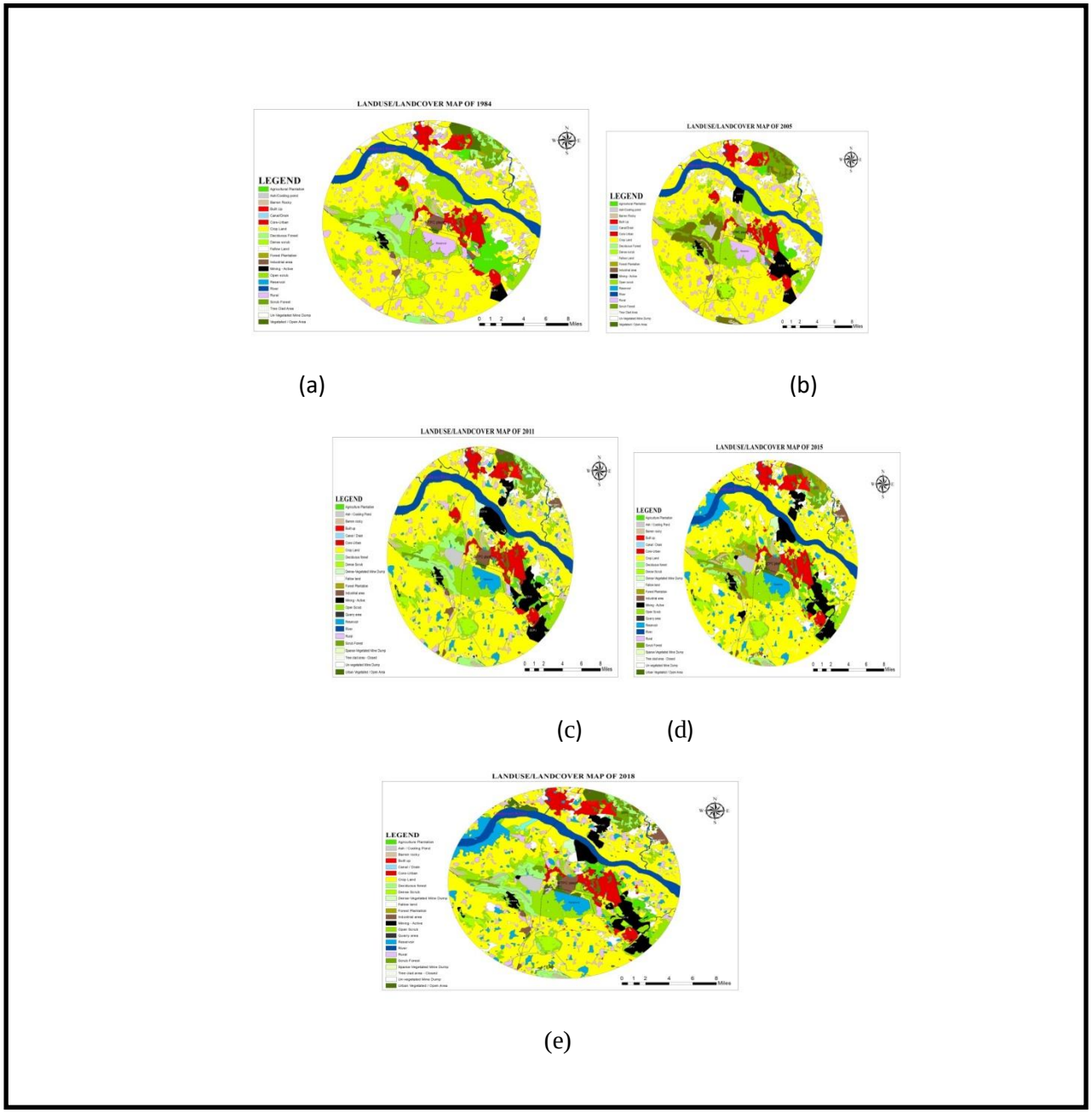

Figure 2: Land use/ Land cover maps of years (a) 1984 (b) 2005 (c) 2011 (d) 2015 (e) 2018

Table 2: Level-I LULC values and % of geographical area for the 5 years:

LULC (LEVEL-I)	**1984**	**%**	**2005**	**%**	**2011**	**%**	**2015**	**%**	**2018**	**%**
Built-up Land	7256.64	10.27	11354.24	16.07	13730.24	19.43	14189.14	20.08	15131.46	21.41
Agricultural land	42885.5	60.68	39852.63	56.39	37810.1	53.50	34699.38	49.10	34281.39	48.51
Forests	4674.74	6.61	4463.55	6.32	4422.91	6.26	4235.25	5.99	4219.36	5.97
Waste-lands	8344.78	11.81	7641.69	10.81	7363.08	10.42	9044.14	12.80	9027.36	12.77
Water bodies	7512.50	10.63	7362.05	10.42	7347.83	10.40	8506.25	12.04	8014.59	11.34
total geographical area	70674.16	100	70674.16	100	70674.16	100	70674.16	100	70674.16	100

V. Results and Discussion

Land Use / Land Cover Change Detection Matrix Analysis:

The main aspect of change detection is to determine what is actually changing to what i.e. which land use class is changing to the other land use class. This process involves a pixel to pixel comparison of the study year images through overlay process.

Land use / land cover change detection matrix or pivot table is prepared to understand the changes occurred in each category over the period of 34 years.

From the table 4, it is found that there is a considerable change in the land use / land cover area during the period of 34 years (1984 to 2018). From the analysis it is found that there is big change in the agricultural land. The crop land has been converted into build up land (about 3418.37Ha area) due to real estate promotion and industrial development in the study area. There is a small change in river and water bodies during the period of 34 years. Waste lands were also changed to agricultural lands and Built up due to increasing of population.

Table 3: Pivot Table show the statistics of land use/ land cover

	Land Use/Land Cover Values of 2018						
Land Use/ Land Cover Values of 1984	Categories	Agricultural Land	Built up	Forest	Water Bodies	Waste Land	Grand Total
	Agricultural Land	32233.80	3418.37	8.70	964.18	1554.90	38179.94
	Built Up	382.13	9475.51	0.43	85.92	743.30	10687.29
	Forest	20.47	352.99	4442.09	0.16	160.05	4975.75
	Water Bodies	55.00	12.95	0.38	7589.71	61.14	7719.17
	Waste Land	560.50	1493.92	4.01	44.03	7008.81	9111.28
	Grand Total	33251.90	14753.74	4455.61	8684.00	9528.19	70673.44

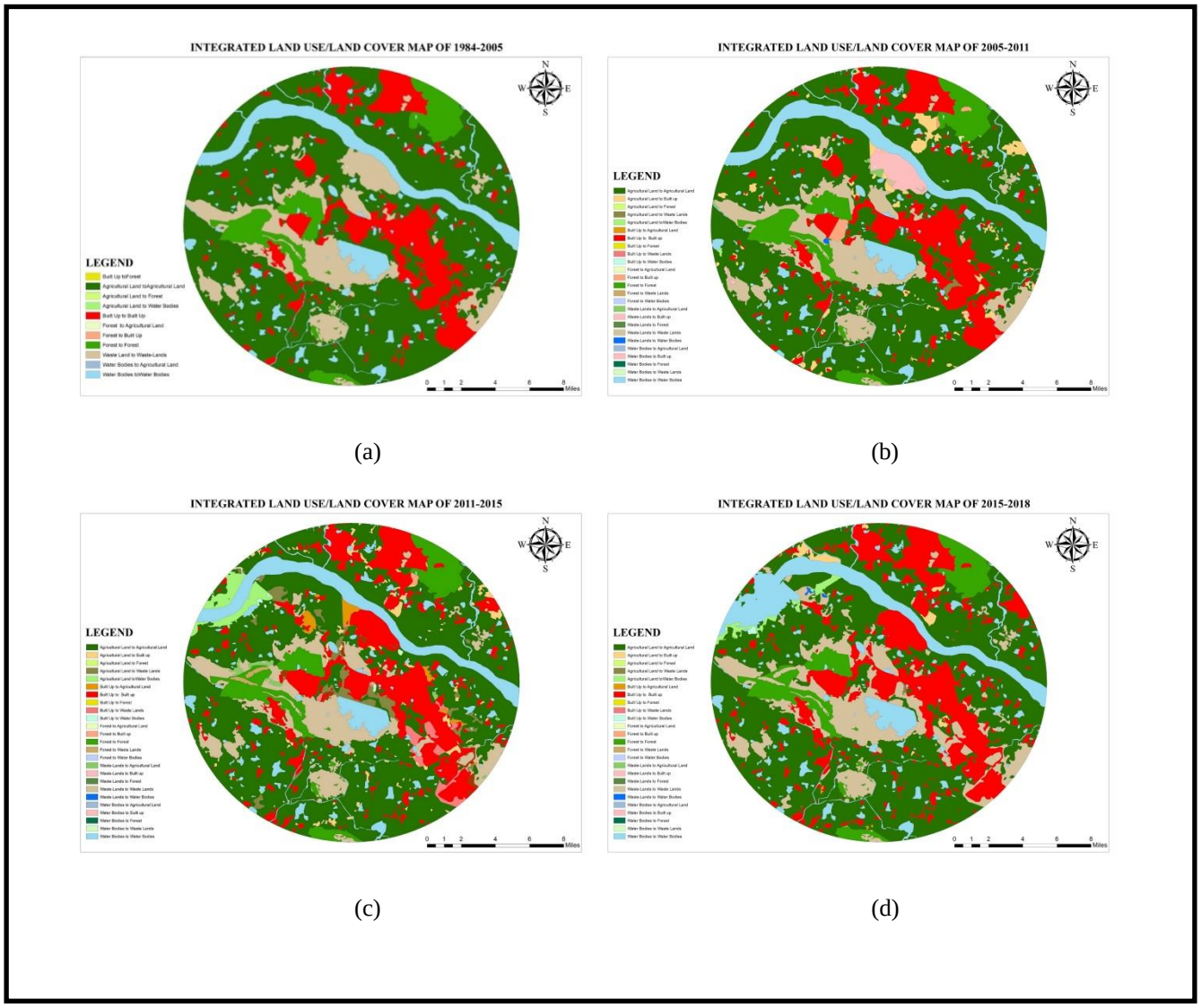

Figure 3: Integrated land use/ land cover maps for the years (a) 1984&2005 (b) 2005&2011 (c) 2011&2015 (d) 20152018

VI. Conclusion

This project work demonstrates the ability of GIS and Remote Sensing in capturing and delineating the spatial-temporal data. Attempt was made to delineate as accurate as possible a total of 26 level-III, land use land cover classes as they change through time. Five classes of Level-I were distinctly produced for each study year. More emphasis taken on built-up land as it is a combination of anthropogenic activities and it is one that affects the other classes.

However, the result of the work shows a rapid growth in built-up land between 1984&2015 while in the period between 2015&2018, no change in this class. Continuous growth and fall in agriculture plantation and crop land respectively. It is also shown from the result that vegetation cover over mining and industrial areas is increasing.

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References

[1]Maya kumari and KiranmaySarma (2017): "Spatio-Temporal Dynamics of land Use/Cover around a Thermal Power Plant in Singrauli District, Madhya Pradesh, India". IOSR Journal of Applied Geology and Geophysics (IOSR- JAGG).

[2]Ramachandra T.V and Bharath H. Aithal (2012): "Land use Dynamics at padubidri, Udupi District with the implementation of Large-Scale Thermal Power Project". International Journal of Earth Sciences and Engineering.

[3] ZubairAyodejiOpeyemi (2008):"Monitoring the growth of settlements in Ilorin, Nigeria (A GIS and Remote Sensing Approach)". National Space Research and Development Agency, Abuja-Nigeria- azubair.

[4] P. Ramamoorthy and DR. S. Sundararaman (January 2016): "Land use and Land cover change detection using Remote Sensing and Gis of Nandhiyar Sub Basin, Tamil Nadu, India". IJSTE- International Journal of Science Technology & Engineering.

[5] V. Venkatraman, Er. P. Selvan, Dr. S. Chandran (June 2014): "Land Use and Land Cover Change Detection of Periyar Main Canal Command through Remote sensing Using Multi-Temporal Satellite Data".

[6] Minal S. Aher and Dr. K.A. patil (2017): "Land Use/ Land Cover change detection using remote sensing and GIS". International Journal of Current Engineering and Scientific Research (IJCESR).

[7] DebashriGarai and A.C. Narayana (9th January 2018): "Land use/ Land cover changes in the mining area of Godavari Coal fields of Southern India". The Egyptian Journal of Remote Sensing and Space Sciences.