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Land use Classification and Change Detection of Bastar District, Chhattisgarh State, India by using GIS and Remote Sensing Techniques

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Abstract: Change detection is one of the landscape ecological objectives to prepare land use land cover. Change detections were performed by using remote sensing and GIS techniques. The study has been done through multitemporal satellite data set by LISS-III Multispectral scanner (MSS), LISS-III (2005 and 2015) matching topographic map. The land use and land cover classification maps were prepared through remote sensing and GIS technology. Ground truth was also performed to check the accuracy of the land classification. There was a significant change in land use and their dynamics. Built up urban (201.07%), rural (2156.23%), agricultural plantation (22.20%), cropland (22.79%) and barren/unculturable/wastelands/sandy area (300.00%) were increased in land use of 2015 as compared to 2005. Similarly agricultural fallow, deciduous forest, forest scrub and barren/unculturable/wastelands scrubland were negative as like -74.43%, -15.23%, -43.23% and -38.10%, respectively. The highest positive change was observed in built up rural area (2156.23%), whereas the lowest change in water body (4.93%)

Keywords: LULC, Change detection, Image processing, GIS and remote sensing

The land is the most dynamic natural resource, which includes soil and water together simultaneously associates the flora and fauna, thus expressing the total earth ecosystem. Information on spatial distribution of land use and land cover is essential for the future planning and management (Riebsame et al 1994). The term land cover describes the types of features present on the surface of the earth. Land use refers to 'man's activities on land, which are directly related to land' (Yuan et al 2005). Land use is characterized by the arrangements, activities and inputs in a certain land cover type to produce change or remain unchanged. Kumar et al (2013) expressed the land cover that establishes a direct link between land cover and the anthropogenic activities in their environment. Land cover does not focus on economic function which is essential to the perception of land use. Land use and land cover changes is a widespread and accelerating process, mainly driven by natural phenomena and anthropogenic activities, which in turn drive changes that would impact natural ecosystem (Ruiz-Luna and Berlanga-Robles, 2003, Turner and Ruscher 2004). Since from beginning of invention of remote sensing (RS) and geographical information system (GIS) techniques, land resource mapping has given useful tools and opened the ways to improve the areas designed for agriculture and other uses of a region (Selcuk et al 2003). El Gammal et al (2010) have used several Landsat images of different time periods i.e. 1972, 1982, 1987, 2000, 2003 and 2008 and processed these images in ERDAS and ARC-GIS software to analyze the changes in the shores of the lake and in its water volume. It was explained that the change analysis based on the statistics extracted from the four land use/cover maps of the Kathmandu Metropolitan by using GIS. Land use is influenced by different factors (economic, cultural, political, historical and land-tenure) at multiple scales. On the other hand, biophysical attributes of the land that affect how ecosystems function (Turner et al 1995). Pontius and Batchu (2003) calibrated on land use change pattern and also validated the disturbance in the Western Ghats of India (1920-1990). IIRS (2004a) has clearly brought out 36 LULC classes with description of 17 vegetation cover and/or other land uses. Inter-institute level collaborative work was also initiated by Indian Institute of Remote Sensing (IIRS), Dehradun, India for study for South Central Asian Region as part of this programme. Earlier studies have demonstrated substantial contribution of RS and GIS techniques to mapping habitats (Roy and Tomar 2001, Amarnath et al 2003, Roy and Behera 2005). Gagas watershed has been quantified the land use and land cover of Almora district using survey of India topographic sheet of the year 1965 and LISS III satellite data for the year 2008 over a period of 43 years (Pooja et al 2012). Rawat *et al.* (2013) have done a study on land use and land cover of Ramnagar, Nainital, Bhimtal, Almora and Haldwani of Kumaun Himalaya in Uttarakhand state of India. Similar study of mapping Srinagar city in

Kashmir Valley with observing the Srinagar city significant changed during 1990 to 2007done by Amin et al (2012). Mehta et al (2012) presented an integrated approach of remote sensing and GIS for land use and land cover study of arid environment of Kutch region in Gujarat during 1999 and 2009. Kumar *et al* (2013) estimated the biomass of Sariska Wildlife Reserve with forest inventory and geospatial approach to develop a model based on the statistical correlation between biomass measured at plot level and the associated spectral characteristics. The data on land use included forest, forest scrub, Barren scrub, water body, agriculture and built up were taken in study for temporal change over the district. The district having 1047000 hectares area covering seven blocks. The different blocks have the range of area from 366.51 to 899.26 sq km as lowest and the highest areas.

MATERIAL AND METHODS

Study area: The study area (Fig. 1) viz., seven blocks (*Bakwand, Bastar, Tokapal, Darbh, Bastanar, Jagdalpur* and *Lohandiguda*) lies in the southern most part of Chhattisgarh, India. It extends between 81°27'03 N to 82°7'58 N latitudes and 18°40'25 E to 19°38'45 E longitudes and encompasses an area of 6795 km^2. Geologically, the blocks are made-up of laterite, basalt, sandstone, shale, limestone, granite, quartzite, charnokite, and gneiss. On an average, the study area receives about 1404.80 mm of rainfall annually. The annual maximum, minimum and average temperature of the study area stands at 42°C, 18°C and 28°C, respectively. The master stream of blocks is Indrawati River which flows from east to west and divides the blocks into two halves. The total length of streams in the Bastar district is about 535 km. The district comprises of 606 villages in seven blocks with total

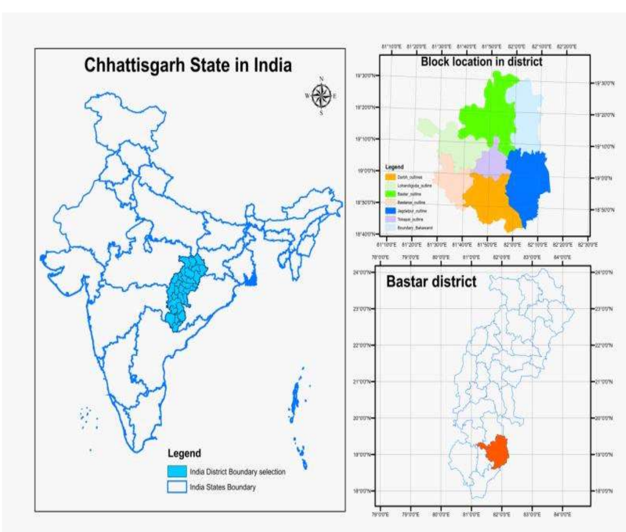

Fig. 1. Location map of Bastar district

population of 1,411,644 (Anonymous 2011). In the present study, nine land use and land cover (LULC) categories were identified namely agriculture field, agriculture field (double crop), forest scrub, barren scrub, moderate dense forest, very dense forest, concrete, river and water body. Description of these land cover classes are presented with the main objective of the study was to analyse and identify the nature and extent of land use and land cover changes.

Database preparation: These data sets were imported in image processing software *i.e.* ERDAS Imagine version 9.3 (Leica Geosystems, Atlanta, U.S.A.) to create a false colour composite (FCC). The layer stack option in image interpreter tool box was used to generate FCCs for the study areas. The sub-setting of satellite images were performed for extracting study area from both images by geo-referenced out line boundary. Multi- temporal satellite data set observed by LISS - III, Multi spectral scanner (MSS), LISS - III, were used for the analysis. The remote sensing data used for this study include: LISS - III (2005) and LISS-III (2015) and other materials used were topographic maps. The change detection techniques by using multi-temporal satellite imagery improve in knowing landscape dynamics. The present study illustrates the spatio-temporal dynamics of land use and land cover of seven blocks of district Bastar, Chhattisgarh, India. Supervised classification technique has been chosen using maximum likelihood technique in ERDAS 9.3 Software. The images of the study area were categorized into nine different classes namely agriculture field, agriculture field (double crop), forest scrub, barren scrub, moderate dense forest, very dense forest, concrete, river and water body.

Land use and land cover detection and analysis: For the land use and land cover classification, supervised classification, method having maximum likelihood algorithm was applied in the ERDAS Imagine 9.3 Software. MLC (Maximum likelihood algorithm) is one of the wide used methods like supervised classification with remote sensing data which is based on the probability means a pixel belongs to a particular class. The spectral distance method calculates the spectral distance between the measurement vector for the candidate pixel and the mean vector for each signature. The misclassified areas were corrected using recode option in ERDAS Imagine after ground truthing. Erdas imagine and Arc GIS software were constructive tools for getting out the land use and land cover layers, toposheets and satellite imageries of Survey of India also used in study of land use and land cover classes including agriculture field, agriculture field (double crop), forest scrub, barren scrub, moderate dense forest, very dense forest, concrete, river and water body. Image processing techniques was used to make visual explanation of land use geometric correction, radiometric correction, mosaicking and clipping of the images.

Land use and land cover change detection and analysis: For performing land use and land cover change detection; a post-classification detection method was employed. A pixel-based comparison was used to produce change information on pixel basis. Thus, interpret the changes more efficiently taking the advantage of "-from, -to" information. A change matrix (Weng 2001) was produced with the help of ERDAS Imagine software. Quantitative aerial data of the overall land use and land cover changes as well as gains and losses in each category between 2005 and 2015 were then compiled. Analysis of remote sensing imagery includes the identification of different marks in image. Visual interpretation using elements (tone, shape, size, pattern, texture, shadow, and association) was used for interpretation. Digital image classifications techniques were grouped pixels represent to land cover features. This area was classified into nine classes: agriculture field, agriculture field (double crop), forest scrub, barren scrub, moderate dense forest, very dense forest, concrete, and river and water body.

RESULTS AND DISCUSSION

Image analysis and accuracy assessment was corrected contract amongst a standard assumed to be correct and a classified image of unknown class accuracy assessment of image classification was approved, using 150 points, 100 points field survey data and 50 points current topographic maps and ISRO Bhuvan land use and land cover maps. The land cover and land use representing of the LISS-III image, auxiliary data and the result of visual explanation was combined with the classification outcome using GIS in instruction to progress the classification accuracy of the classified images.

Land use and land cover of district: Accuracy assessment of the land use and land cover classification results obtained exhibited an overall accuracy of 89.25 for 2005 and 93.51% for 2015. In 2005, area of seven blocks were under unban built up 0.05% (3.10s q km) followed by rural built agricultural plantation, agricultural crop land agricultural fallow, very dense forest (Table 1). The decreasing trend of land use was observed in agricultural fallow land (-187.29 sq km), very dense forest (-582.31 sq km), moderate forest (220.63 sq km) and barren scrub-I (-19.06 sq km) and remaining land uses were increased. The higher degree of increment in rural built up area and less increment was seen under wetlands/water body. The decreasing trend was in land use during ten year span due to conversion of vacant lands into different human activities increasing size and separation of family (Fig. 2-5).

Land use and land cover change: During the last one decade, built up area both in urban (6.23 sq km) and rural (143.05 sq km), followed by agricultural plantation, cropland and barren scrub-II supposed to be increased showing more intense in agricultural crop lands but same time agricultural fallow (-96.34 sq km), very dense forest (-582.31 sq km), moderate forest (-102.10 sq km) and barren scrub-I (-19.05 sq km) were decreased due to harvesting of forest illegally and encroachment with felling activities expanded the existing land covers. Many of the abandoned lands are being converted in commercial crop and vegetable farming which resulted as increased in land use for Built up area both in urban and rural, agricultural plantation, crop land and barren scrub. To assess land encroachment for different land categories during the last two decades, a change detection were given in Table 1.

Built up urban as well as rural, agricultural plantation and cropland and barren/unculturable/wastelands/sandy area were increased in land use of 2015 as compared to 2005, Agricultural fallow, very dense forest, moderate forest and barren scrub-I were decreased due to harvesting of forest

Table 1. Land use change in different classes of Bastar district

LULC	Area (sq km)		Difference	Change as compared to 2005
	2005	2015		
Built up urban	3.10	9.33	6.23	83.16
Built up rural	6.63	149.68	143.05	891.82
Agriculture, plantation	3.54	4.33	0.79	9.18
Agriculture 1	1905.52	2339.70	434.18	9.43
Agriculture 2	251.63	64.34	-187.29	-30.78
Very dense forest	3822.30	3239.99	-582.31	-6.30
Moderate forest	510.35	289.72	-220.63	-17.88
Barren scrub 1	50.02	30.97	-19.06	-15.76
Barren scrub 2	0.20	0.81	0.61	124.08
Water body	42.60	44.70	2.10	2.04

illegally and encroachment with felling activities expanded the existing land covers. The highest positive change in built up rural and the lowest change was recorded in water body. The higher degree of increment in rural built up area and less increment was seen under wetlands/water body. The decreasing trend was analysed in barren/unculturable/ wastelands, agricultural fallow, forest deciduous and forest scrub in 2015 as compared to 2005.

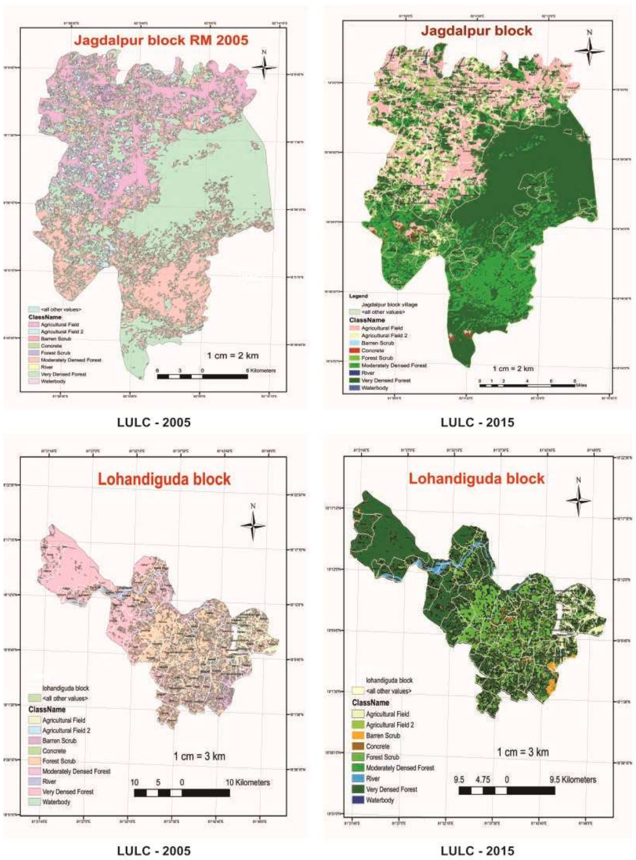

Fig. 2. LULC map of Jagdalpur and Lohandiguda blocks in 2005 and 2015

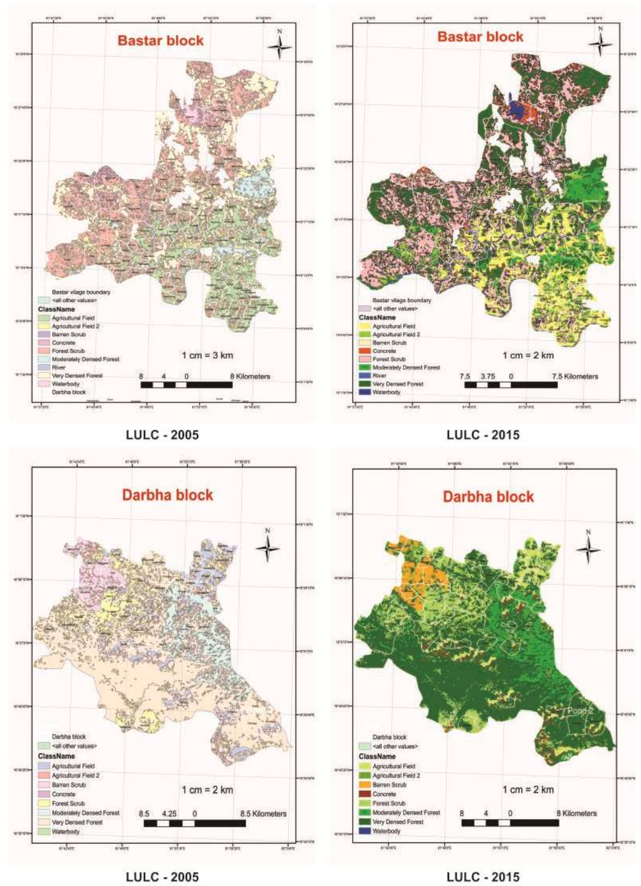

Fig. 3. LULC map of Bastar and Darbha blocks in 2005 and 2015

Table 2. Relative percentage of LULC of Bastar District

Class	LULC (Sq km) 2005		LULC (Sq km) 2015		Differences (Sq km)	
	Area	Percentage	Area	Percentage	2005	2015
Built up, urban	3.10	0.05	9.33	0.14	6.23	300.97
Built up rural	6.63	0.10	149.68	2.27	143.05	2257.62
Agriculture, plantation	3.54	0.05	4.33	0.07	0.79	122.32
Agriculture 1	1905.52	28.89	2539.7	38.52	634.18	133.28
Agriculture 2	251.63	3.81	165.29	2.51	-86.34	-65.69
Very dense forest	3822.3	57.95	3239.99	49.14	-582.31	-84.77
Moderate forest	510.35	7.74	408.25	6.19	-102.10	-79.99
Barren scrub	50.02	0.76	30.97	0.47	-19.05	-61.92
Barren scrub	0.20	0.00	0.81	0.01	0.61	405.00
Wetlands/water body/river/stream/canals	42.6	0.65	44.7	0.68	2.10	104.93

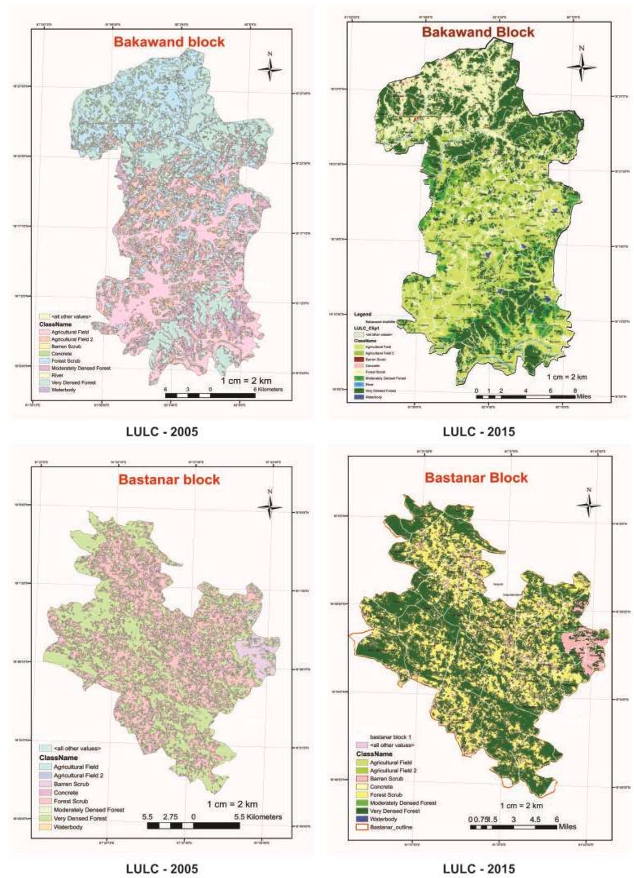

Fig. 4. LULC map of Bakawand and Bastanar blocks in 2005 and 2015

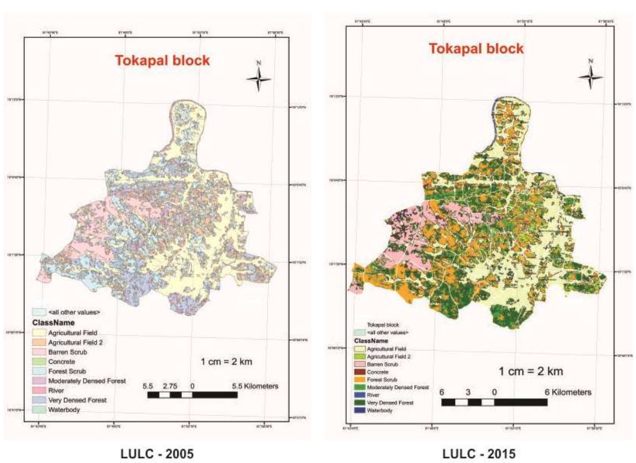

Fig. 5. LULC map of Tokapal block in 2005 and 2015

CONCLUSION

The land use and land cover through remote sensing and GIS can be an easier and fast assessing tool for assessment of land use. The higher degree of increment was recorded in settlement because ever increasing population is driving force for converting maximum available land resource that needs special attention in policy making, otherwise the land resource will shift towards settlement with other associated problems encounters regularly.

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