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Dynamic Change Analysis of Land Use/Land Cover in Birsinghpur Area Using geo-informatics

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Abstract: Land use and Land cover changes have a strong effect on the environment and its surroundings. Land Use Land Cover (LULC) change analysis assists decision-makers to ensure sustainable development and understanding the dynamics of our changing environment. This research study provides a comparative analysis of land use and land cover (LULC) changes and investigates the major factors that have caused these changes. Steep topography, shallow soils, and monsoonal climatic conditions. A classification system is composed of five classes – habitation, waterbody, Agriculture, wasteland, and forest. Digital change detection techniques by using multi-temporal satellite imagery helps in understanding landscape dynamics. In the recent study, we have to use IRS P6 LISS IV satellite imageries that have been downloaded from the USGS website (://glovis.usgs.gov) and WV02 (MAP_IT) Satellite imageries over the 5 years of two different time periods (2011-2017). The present study illustrates the spatiotemporal dynamics of land use/cover of part of Birsinghpur tehsil, district Satna, MP India.

Present study of part of Birsinghpur tehsil land use land cover from 2011-12 to 2016-17 shows rapid change in the LULC as there is high growth in the Wasteland and minor growth in the built-up area only within five years. Wasteland has occupied the Agriculture lands and forest are while forest has reduced marginally and water body is showing almost stagnant condition over time.

Keywords: Remote Sensing and GIS, Land Use and Land Cover Change, Spatiotemporal Pattern, Thematic Maps, Birsinghpur tehsil boundary

1. INTRODUCTION

Land is the mother of all natural resources. It provides the life support system for all living beings. Water resources – stream, lakes and ground water all product of land. Land and water to-gather support plant and animal life. Conservation of these basic resources is the key to food security, fuel and fodder supply, and a healthy environment, social and economic stability. The demands on the limited amount of land we have for agriculture, forestry, industrialization, housing and transportation system are steadily increasing with the burgeoning human population. At the same time, the productivity of the land due to over exploitation is gradually decreasing, leading to its physical, chemical and biological degradation. Deforestation has been regarded as one of the most important factors affecting climate change, biodiversity, and other environmental conditions. Research on LULC change detection has attracted great attention in the past three decades. Multi temporal remotely sensed data have been widely used for examining LULC change. Although many change detection techniques have been developed, most of them are only used to detect binary change and non-change categories. In practice, detailed "from-to" change trajectories are often required for better understanding LULC change patterns and rates. Post-classification comparison is the most common method to examine LULC change trajectories. Traditionally, LULC change detection is implemented at the per-pixel level, but analysis of LULC change at multiple scales may provide new insights on change patterns and rates.

Change in LULC is not only direct removal of forest cover, but also as a result of numerous other factors like infrastructure development, resource exploitation. This leads to reduction in forest area and diminishing of biological diversity in the region. This study is based on the detection of change in the LULC around study area using temporal data of Landsat ETM$^+$ (Enhance Thematic Mapper$^+$). Images of 2012 and Sentinel-2 of 2016 have been considered to analyze the change in that area. Evaluation of the landscape change from 2012 to 2016 can provide important information on decision making processes as it can indicate the increase in urban & Wasteland area's or reduction in vegetated area's, with significant impact on the environment. Change in a particular land cover has been critically analyzed and mapped in this study.

1.1. Statement of the problem

As every living being is dependent on the natural land cover, temporal land cover change in land can reshape the whole scenario of an ecosystem. Study area is facing overwhelming threats due to natural resource depletion, soil erosion, forest degradation, habitat degradation, unbalanced human interference and illegal poaching.

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1.2. Objectives of the study

The main objective of the study was to evaluate the nature, significance, and rate of LULC change from 2012 to 2016. It also aimed to find out the areas of rapid change, magnitude of change and assesses the past and present condition of Land Use & Land Cover to understand the dynamics and trend of change. The study of land use/land cover (LU/LC) changes is very important to have proper planning and utilization of natural resources and their management. Traditional methods for gathering demographic data, census, and analysis of environmental samples are not adequate for multicomplex environmental studies, since many problems often presented in environmental issues and great complexity of handling the multidisciplinary data set; we require new technologies like **Satellite Remote Sensing** and Geographical Information System (**GIS**). These technologies provide data to study and monitor the dynamics of natural resources for environmental management.

Remote sensing not only provides a wide-range scale of the space-time distribution of observations, but also saves time and money (Murthy, 2000; Leblanc et al., 2003; Tweed et al., 2007). In addition it is widely used to characterize the earth surface (such as lineaments, drainage patterns and lithology) as well as to examine the groundwater recharge zones (Sener et al., 2005).

2. STUDY AREA

The study area part of Birsinghpur tehsil of district Satna Madhya Pradeshlies between 24°40' 00" to 25°00' 00" N latitude and 80°50’00“to 81°05'00" E longitudes with geographical area of 37493.38 Ha.. The study area is covered in various Survey of India topomaps63D/13, 63D/14, and 63H/1.

2.1. Climate of the study area

Minimum and maximum temperature recorded in last decades over study area is 19^0C & 32.2^0Cthe difference between maximum and minimum temperature is narrowing, which could be detrimental for agriculture [Easterling et al., 1997]. Significant changes have also been noticed in climate variables (i.e. precipitation and air temperature) across India during the period of 1950-2008 [Mishra et al., 2014a, 2014b]. Declining trends in the observed precipitation during the monsoon season were noticed in Mishra et al. [2012], which were partially associated with the warming in the Indian Ocean [Alory et al., 2007; Brown and Funk, 2008]. An increase in mean air temperature was reported globally [Karl et al., 1996] which is consistent with the trends observed in India [Kumar et al., 1994]. At the regional scale, Mishra et al. [2014] reported that precipitation declined while temperature increased over the majority of India in the last few decades, which caused increased frequency of droughts and reduction in soil moisture for crop growth.

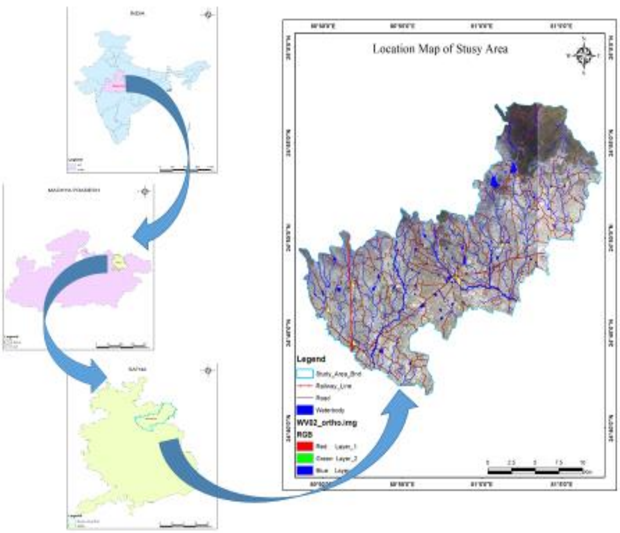

Figure 1: Location map of the study area.

3. EXPERIMENTAL METHODS AND DATA USED OR METHODOLOGY

In the resent study IRS P6 LISS IVsatellite imageries have been downloaded from USGS website (://glovis.usgs.gov) and WV02 (MAP_IT) over the 5 years of time period (2011-2017). The details of the satellite imageries, acquisition date and resolution has shown in table 1Both the data sets are projected in UTM projection with 44 zone, WGS 84 datum and co-registered using first second orderpolynomials model with base data 0.5 pixel (RMSE) accuracy.

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Table 1: Description of data

Sensor type	Acquisition date	Spatial resolution
IRS P6 LISS IV	December2011	5.8 m
WV 02	January 2017	0.5 m

The methodology adopted for the present study is shown in Fig. The base map of Majhagawan block, district Satna was prepared based on Survey of India Topomaps & Said satellite dataon a 1:50,000 scale. Various thematic maps (Drainage, Lineament, Slope, and Land Use/Land Cover etc) were prepared and integrated all in ArcGIS. The drainage network & other thematic layer's for the study area was prepared over satellite data. The slope map was prepared from Carto-DEM (30m) data in ArcGIS 10.4 Spatial Analyst module.

Although image analysis techniques are fast evolving, it requires discrete thematic land surface information from satellite imagery using classification based techniques (Prenzel and Treitz, 2005). In the present study, 15m ETM$^{+,}$ and 10m Sentinel-2data is used for the estimation of land cover Majhagawan area. But high resolution data could be more useful to identify the complex land cover of Majhagawan. However, Landsat& Sentinelimagery isuseful for first levelof classificationof suchurban land cover. Major land cover types are considered and following classes have been chosen -

1. Agriculture Land
2. Built-up
3. Forest
4. Waste Land
5. Water Body

4 RESULT AND DISCUSSION

4.1 Land Use/Land Cover

Land Use/Land Cover mapping is one of the important applications of remote sensing. Land use plays a significant role in the development of groundwater resources. Remote sensing provides excellent information with regard to spatial distribution of vegetation type and land use in less time and low cost in comparison to conventional data (Waikar and Aditya P. Nilawar, 2014). The study area shows that major portion in land use is covered by Agriculture area 77673.36 Ha, wasteland area 12669.02 Ha, forest area 78396.39 Ha, water body's area 1106.70 Ha, built up covered in area 1094.68 Ha.

4.2 LULC change analysis

LULC classification of an area depends upon the available features of that area. Depending upon the existing LULC features of Majhgawan block of district Satna and based on NNRMS classification system (JULY, 2005 ISRO), the study area has been divided into the following LULC classes:

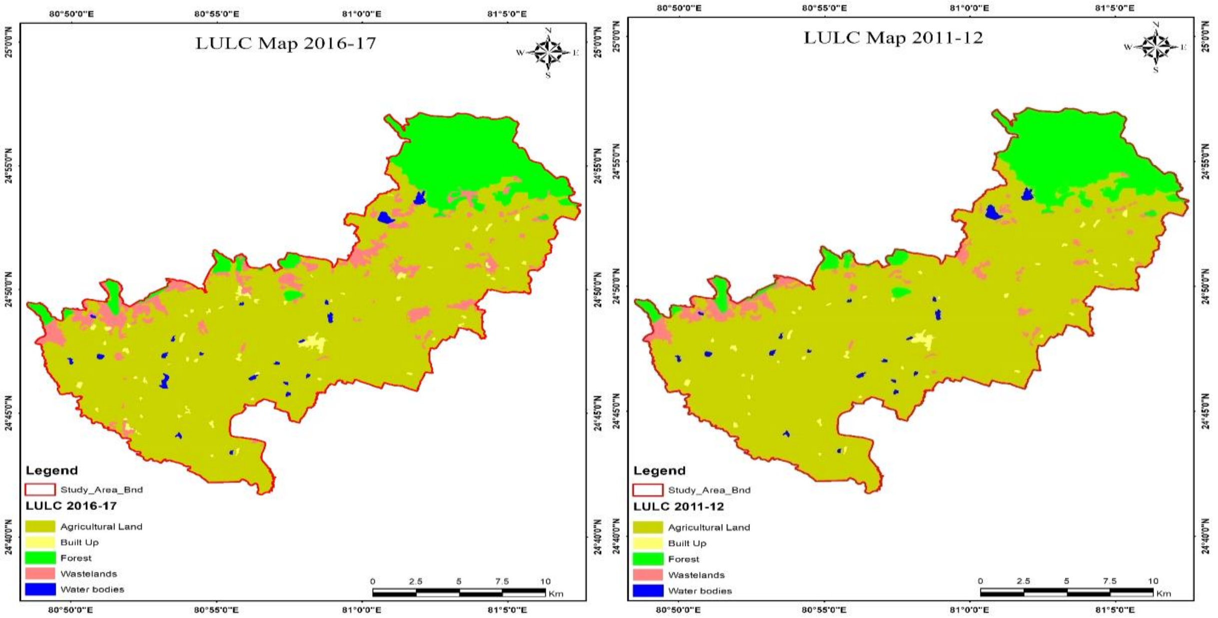

Figure 2: LULC maps of study area

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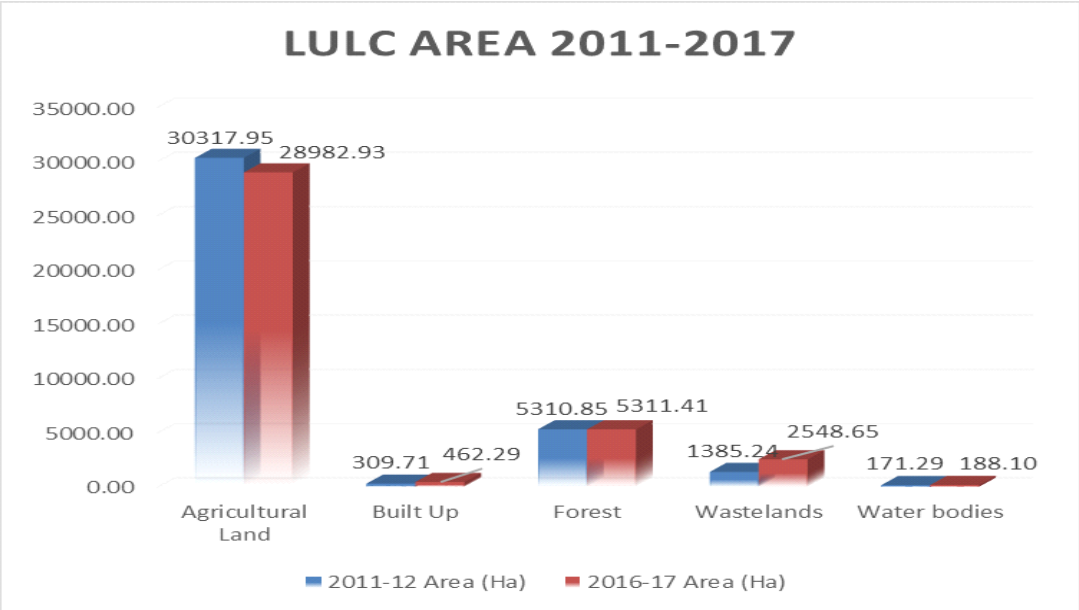
S.N.	LULC Class	LULC 2011-12		LULC 2016-17	
		Area (Ha)	Area %	Area (Ha)	Area %
1	Agricultural Land	30317.95	80.86	28982.93	77.30
2	Built Up	309.71	0.83	462.29	1.23
3	Forest	5310.85	14.16	5311.41	14.17
4	Wastelands	1385.24	3.69	2548.65	6.80
5	Water bodies	171.29	0.46	188.10	0.50

Table 2: Table showing LULC statistics of study area



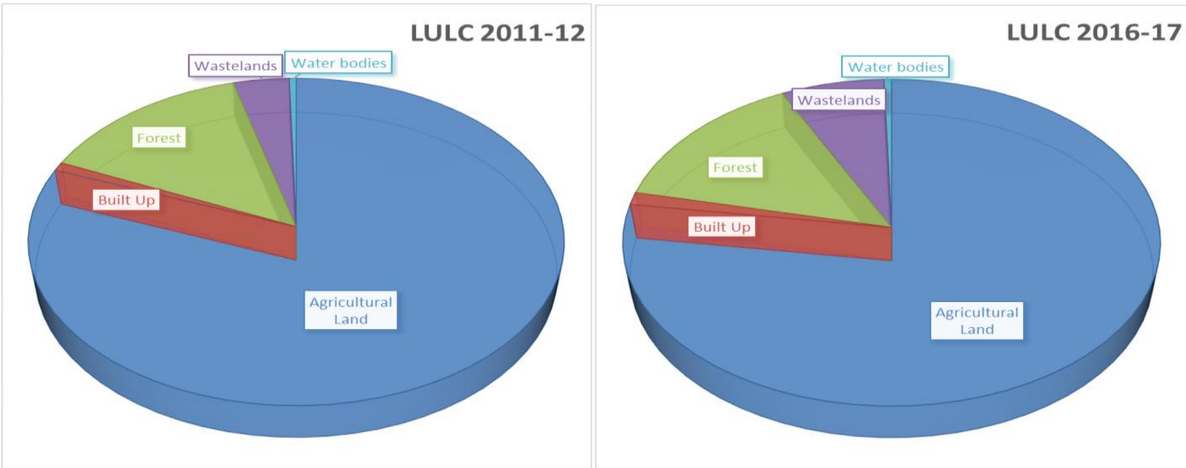


Figure 3: Graphical Representation of LULC classes of study area

S.N.	LULC Class	LULC 2011-12		LULC 2016-17		LULC Change	
		Area (Ha)	Area %	Area (Ha)	Area %	Area (Ha)	Area %
1	Agricultural Land	30317.95	80.86	28982.93	77.30	1335.03	3.56
2	Built Up	309.71	0.83	462.29	1.23	-152.58	-0.41
3	Forest	5310.85	14.16	5311.41	14.17	-0.56	0.00
4	Wastelands	1385.24	3.69	2548.65	6.80	-1163.41	-3.10
5	Water bodies	171.29	0.46	188.10	0.50	-16.81	-0.04

Table 2: Table showing LULC change statistics of study area

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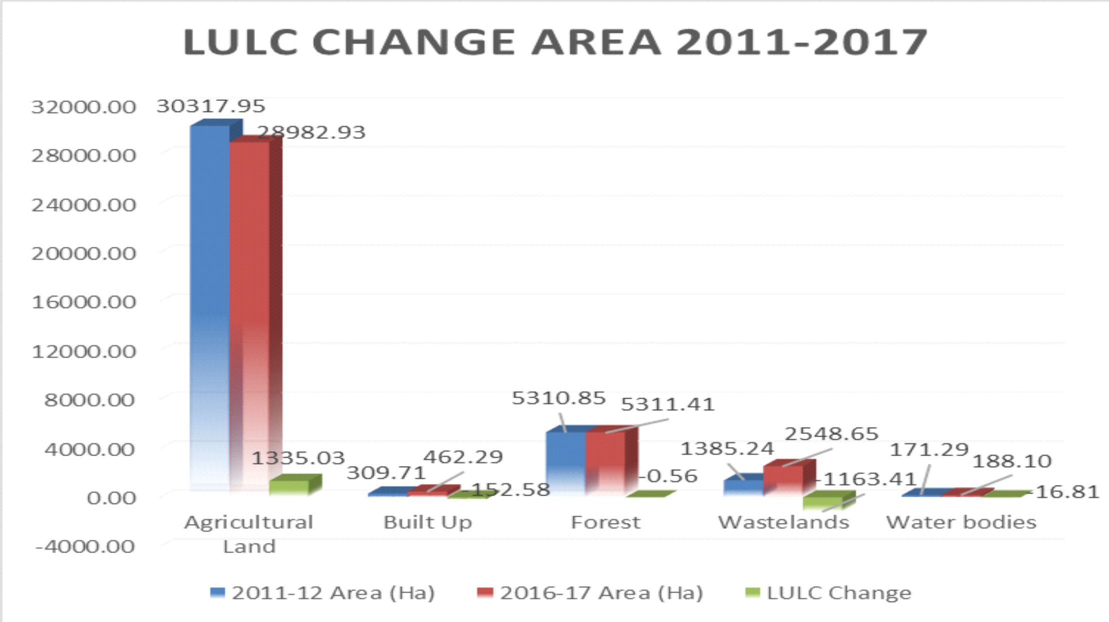

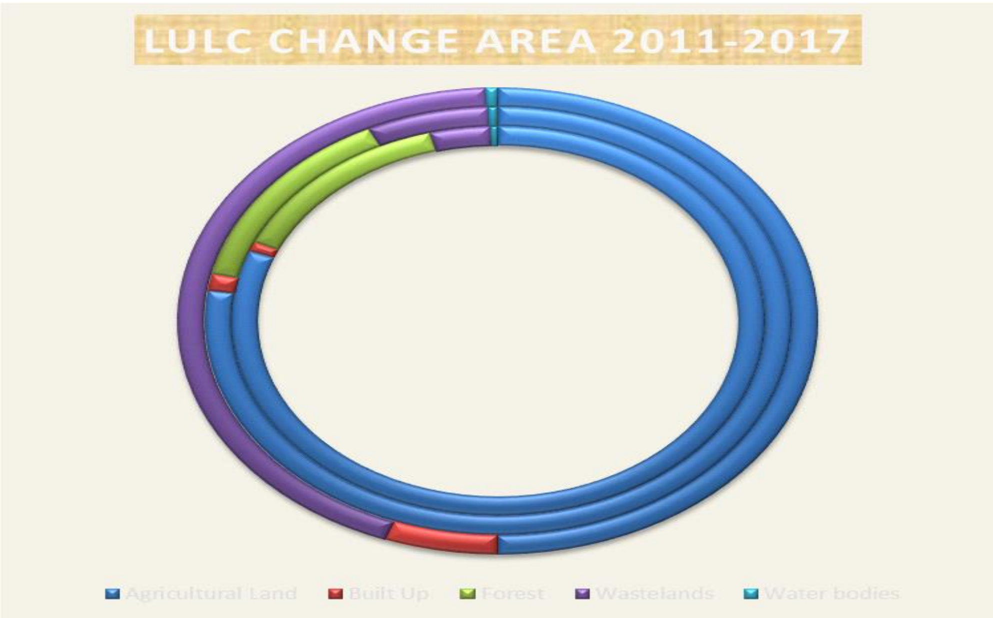

Figure 4: Graphical Representationof LULC change from 2011to 2017

The land use – land cover change matrix is provided in Table – 6, which explains total area of land transferred from one class to another within the period of four years. The matrix shows that maximum change occurs from Agriculture converted to WasteLland, Built-up, forest& Some water body converted to Agriculture and forest, some forest converted to Agricuulture, built-up, wasteland. This matrix indicates that rate of change in Majhagawan region.

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4.3 Flowchart for LULC Change Mapping using Remote Sensing and GIS

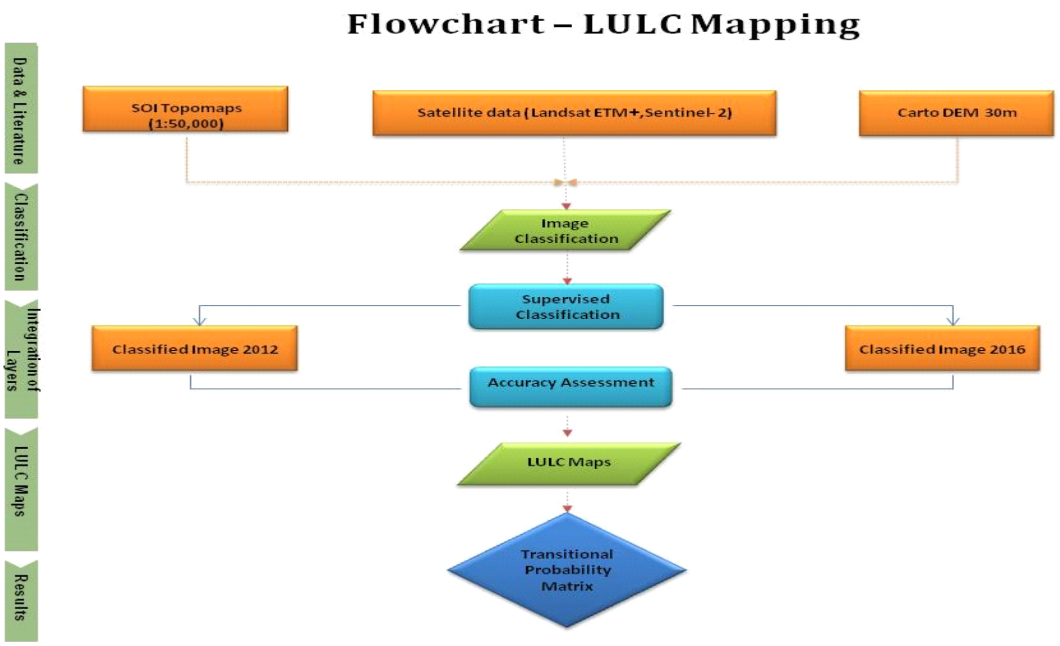

Figure 5: flow diagram showing the sequential processes of land use – land covers changes

The methodology proposed in this study to Spatiotemporal analysis of land use and land cover change in Patni Watershed Majhagawan Block, District Satna, MP Indiausing Remote sensing and GIS techniques is illustrated in Fig.5

4. CONCLUSIONS

Present study of Majhagawan land use land cover from 2011-12 to 2015-16 shows rapid change in the LULC as there is high growth in the Waste land &built up area only within four years. Waste land have occupied the Agriculture lands and forest are while forest has reduced marginally and water body is showing almost stagnant condition over time.

Ifthis trend of growth continues then most of the Agriculture areas will be occupied by Waste land and in near future which may create a threat to environment.

Satellite imageries, topographic maps and conventional data were used to prepare the thematic layers (soil, geology, drainage, lineament, slope, and land-use) then integrated in the GIS environment to prepare the comprehensive study about area of the study.

5. ACKNOWLEDGEMENT

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