LAND USE AND LAND COVER CHANGES DETECTION AND ITS IMPACT ON AGRICULTURE LAND& WASTELAND BY USING REMOTE SENSING AND GIS TECHNIQUES: A CASE STUDY IN JALANDHAR DISTRICT, PUNJAB, INDIA.

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ABSTRACT

The mapping of land use and land cover (LULC) is an important and central component in current strategies for managing and monitoring of natural resources and environmental changes. LULC change detection is very essential to understand landscape dynamic for sustainable management. The present study was carried out in Jalandhar district of Punjab state using Indian Remote Sensing (IRS)-P6 LISS-III satellite data of the year 2011-12 and 2015-16 for three crop seasons (Rabi, Kharif and Zaid). Level-III classification scheme was used to classify the study area. The results indicated that most of the study area was under agricultural land which has been found decreased from 89.12% in year 2011-12 to 88.61% during 2015-16. Most of the agriculture land has been found to be converted to built-up and it has been increased by 0.61 % of the area from the year 2011-12. Majority of the built up was constructed in the sparse formation which has also been classified in the present study. This information infers that the new habitation is developing at the fringes of the city resulting in the expansion of the city. Water body in the study area has been found to be increase, coming from the agriculture and wasteland. The agriculture land near the river was found to be converted to the water body which is mainly due to the increase in the water level in the river. This study revealed that the current remote sensing and GIS techniques are most useful for identifying, monitoring of LULC changes and planning for the development of an area.

KEYWORDS: LULC, LULC Change, Temporal satellite data, Three Crop Seasons, LISS-III.

INTRODUCTION

Land is the basic, fixed and limited natural resource. Land use refers to "human activities which are carried on land" and has been used for agricultural, industrial, residential or recreational purposes (Ramachandra and Kumar, 2012). Land cover refers to the physical and biological cover over the surface of land, including water, vegetation, bare soil and / or artificial structures (Ellis, 2007). Land cover changes refer to conversion and modification of natural land for, which may changes biodiversity, soil quality, runoff, erosion, sedimentation and land productivity (Xiubin, 1996).

Land Use and Land Cover are two different terms generally assessed in combination. Since the land cover is physical properties of surface elements and another is human use of land cover cannot be seen as independent from each other (Rawat and Kumar, 2015; Turner and Ruscher, 1998). Although land use is generally inferred based on the cover, yet both the terms land use and land cover being closely related are interchangeable. For example, settlement is cover but if we include buildings whether it is being used for residence or industrial activity, it shows the land use component (Chaudhary and Saroha, 2008). The changes of LULC associated with urbanization are important drivers of local geological, hydrological, ecological and climatic changes (Asadi and Hanumantha, 2010). LULC class of a region is an outcome of natural and socio-economic factors and their utilization by man in time and space (Rawat and Biswas, 2013). The proper information of LULC is essential for implementing numerous developments, planning, and Land use schemes to fulfil the increasing demands of basic human needs (Veeraswamy and Nagaraju, 2007).

A change in land use and land cover is increasingly rapid, and can have adverse impacts at local, regional and global environments (Brandon, 1998).LULC change analysis using remote sensing techniques gives an opportunity to obtain results with low costs, less time consumption and good accuracy, and geographical information systems allow updating results whenever new data is available (Jovanovic and Govedarica 2015; Lambin and Geist 2003). The change analysis is needed to monitor the resources on the earth's surface for sustainable planning and development.

The objective of this research is to prepare the thematic map of LULC which includes built-up land, agricultural land, waste land, water bodies and other classes. This study has been carried out in Jalandhar district of Punjab, India using IRS-P6 LISS-III remote sensing datasets. The results showed some changes in land use class like built-up land, agriculture land, wasteland and Waterbodies for the year 2011-12 and 2015-16.

STUDY AREA

Jalandhar district is located in central part of Punjab state and the geographical area is about 2629.95 km^2. The district is bounded between latitude of 30° 58′ to 31° 37′ N and longitude of 75° 04′ to 75° 58′ E (**Figure-1**). The Nawan Shehar district is located on the eastern side and the Kapurthala district is located on the western side while Ludhiana district is located on the southern side and Hoshiarpur district is located on northern side. Satluj River is the major natural drainage channel in the state, which is observed in the area.

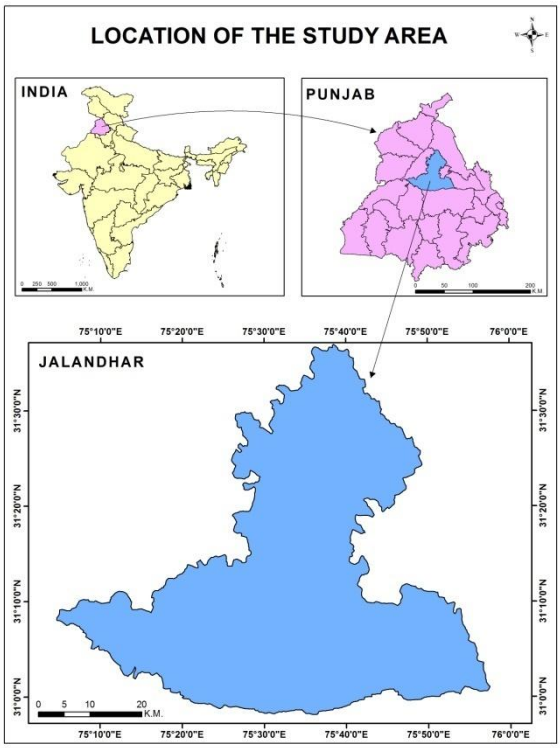

Figure 1: Location map of the study area.

MATERIALS AND METHODOLOGY

Data Used

IRS P6 LISS-III (swath is 140 km and wavelength is 0.52 to 1.70 um) satellite data for three crop seasons have been used for LULC mapping and its change analysis. This study also used field data for validation of different types of land use and land cover classifications. We have ground truth survey of LULC classes like built-up land, industries, agriculture land, scrub land and waterbodies. The details of satellite data for the study have been are given in **Table-1**.

Sensor (Resolution)	Path/ Row	Date of Pass						Data Source
		2011-2012			2015-2016			
		Kharif	Rabi	Zaid	Kharif	Rabi	Zaid	
LISS-III (23.5m)	93/49	05-10-2011	26-02-2012	08-05-2102	14-09-2015	05-02-2016	11-05-2016	NRSC, Hyderabad
	94/49	10-10-2011	02-03-2012	19-04-2012	24-12-2015	10-02-2016	16-05-2016	

Table 1: Specifications of IRS P6 LISS-III Satellite Data of Jalandhar District

Methodology

The broad methodological is represented in flow chart **Figure-2**. Acquisition and processing of satellite data was first and important step of the study. Layer stacking was done from the raw data for further classification. Layer stacked image is helpful to visualise FCC (False colour Composite) images for image enhancement and better visual interpretation. Image enhancement techniques are used to improve gray level of pixel values for visual object separation in an identified scene (Harmandeep and Prabhpreet, 2014). Spatial overlay operation has been used for image extraction using ArcMap software. LULC change analysis has been carried out for the five year time scale (2011-12 to 2015-16). Level-III classification schemes have been adopted in the study area for detailed classification. Level-I classification is broadly categorised in six major classes (Built-up, Agriculture, forest, Westland, Wetland, and Water bodies). In this study, 18 classes were analysed at level-II classification scheme for the detection of LULC changes like built-up (urban), rural, crop land, fallow land, salt affected land, scrub land, wetland, river, canal / drain etc. Level-III classification described more details about classes. We also carried out change detection LULC maps. Comparative change matrixes for the year 2011-12 and 2015-16 have been described in result section.

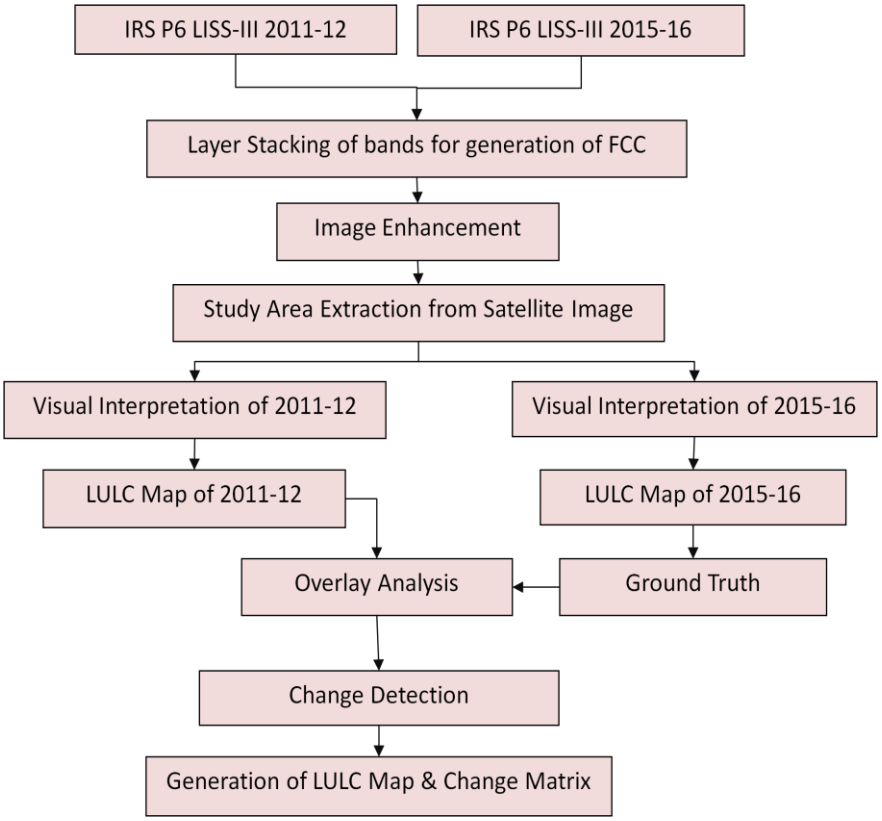

Figure-2: Flowchart of Methodology

RESULTS AND DISCUSSION:

The LULC map at level-III classification scheme was generated from the IRS P6 LISS-III satellite imagery using on screen visual image interpretation technique.

Symbolised maps of LULC are shown in **Figure-3a** (2011-12) and **Figure-3b** (2015-16). Here main built-up area is Jalandhar city which is located in the central part and some rural (village) area is located randomly in the study area. The some part of Sutlej River is present in the southern part of the study area.

The area statistics and rate of change of LULC classes of two years are given in **Table-2**. This study also included statistics of level-I classes, which are represented in Pie-Chart as shown in **Figure-4**. Level-I classification depicted the built-up area (16.12 km^2) and waterbodies (0.20 km^2) has been increased and agriculture land (13.33 km^2), wasteland (2.84 km^2) and wetland (0.15 km^2) has been decreased from previous year of 2011-12.

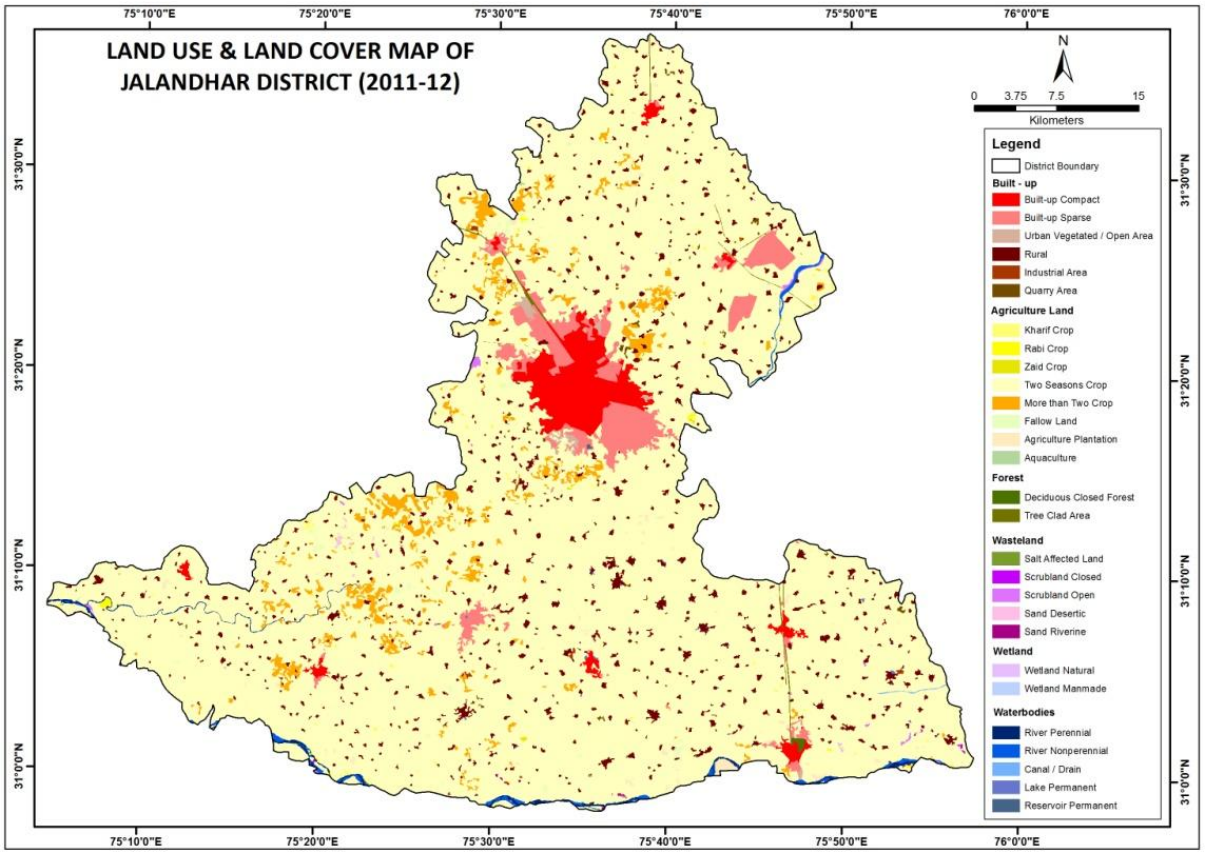

Figure-3a: LULC map of Jalandhar district (2011-12)

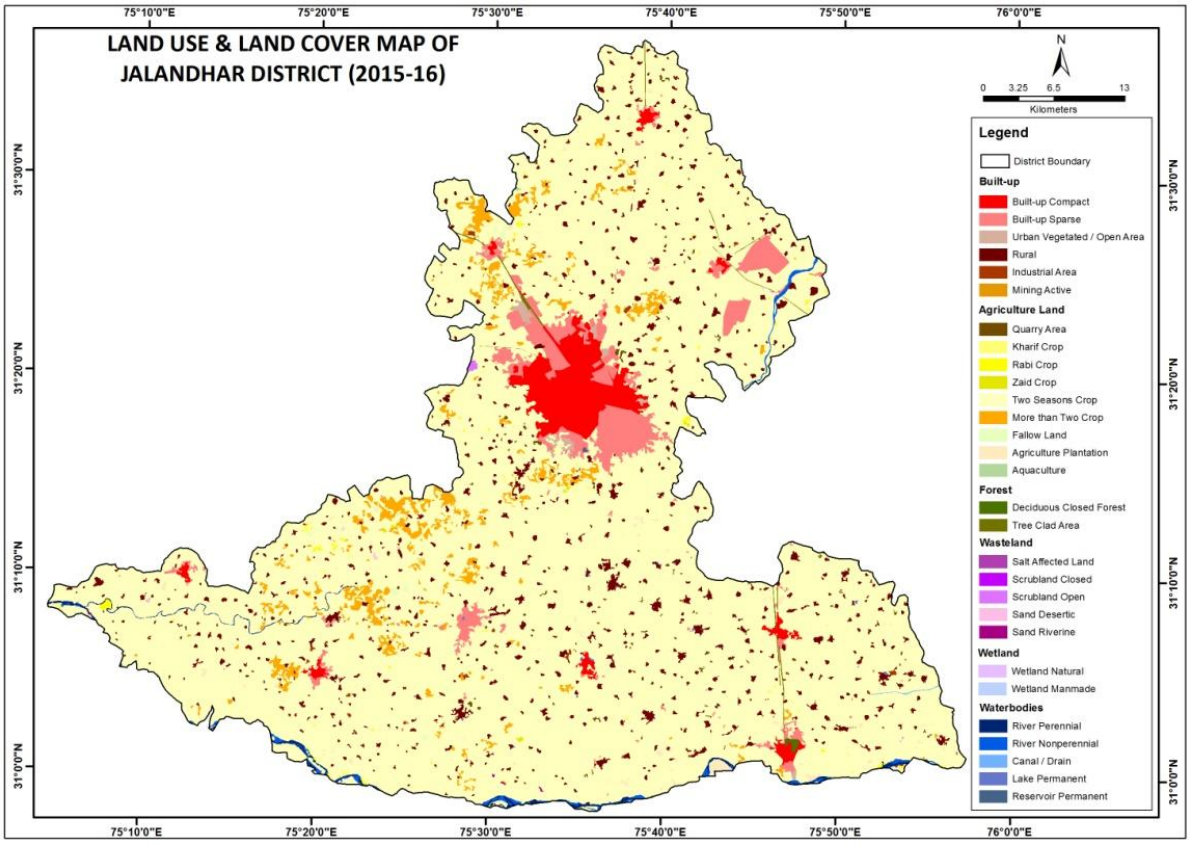

Figure-3b: LULC map of Jalandhar district (2015-16)

Level-II classification statistics are represented in Bar Graph as shown in **Figure-5** and details for one of each class are shown in **Table-3.** In this study area, crop land is the most engaged land and second engaged land is the built-up (urban) land.

Present study describes level-III classification schemes where 29 classes were analysed for change

detection in given time frame. The present study depicted the main changes in the built-up sparse is 9.39 km^2 and rural area is 4.99 km^2. This study also showed that the agriculture land has been decreased by 13.33 km^2 in the year 2015-16 (2330.50 km^2) compared to total agriculture land 2343.84 km^2 in 2011-12. It is observed that Kharif crop, two seasonal crops, more than two season crops and fallow land are decreased (0.14 km^2, 4.31 km^2, 6.77 km^2 and 3.34 km^2) while Rabi crop, Zaid crop and agriculture plantation are increased (0.58 km^2, 0.18 km^2 and 0.46 km^2) in year 2015-16.

It has also been found that there are no significant changes in forest cover whereas the wasteland area has been decreased by 2.84 km^2 (0.11%) of the total area. Total area of wasteland in year 2011-12 was observed 4.23 km^2 (0.16%) and it has been decreased to 1.39 km^2 (0.05%) in the year of 2015-16. The changes in wasteland class are positive outcomes for study area. Most of wasteland are changes in to the agriculture land (2.53 km^2) and small changes are in to built-up (0.34 km^2) and waterbodies (0.13 km^2). The scrubland were decreased by 2.04 km^2 (scrubland closed by 0.34 km^2 and scrubland open by 1.70 km^2) and sandy area were also decreased by 0.80 km^2 (Sand Desertic by 0.62 km^2 and Sand Riverine by 0.18 km^2) from the year of 2011-12.

This study interpreted the two types of wetland area. The changes in natural wetlands were decreased by 0.13 km^2 and manmade wetlands were decreased by 0.03 km^2 during the study time periods. The five types of water bodies (like river perennial, river non perennial, canal / drain, lake permanent, Reservoir Permanent) were also analysed for change analysis, and results represent the perennial water bodies were increased by 0.55 km^2, whereas, non-perennial water bodies were decreased by 0.32 km^2.**Table-2** shows in there are no significant changes in Canals and Permanent Reservoirs.

Table-2: Level-III LULC Classification and Area

Categories (Level-I)	Categories (Level-II)	Categories (Level-III)	Code	2011-12 area (km^2)	2011-12 area (%)	2015-16 area (km^2)	2015-16 area (%)	Change area (km^2)	Change area (%)
Built-up	Built-up	Built-up Compact	1	75.4	2.87	75.4	2.87	0	0
		Built-up Sparse	2	84.46	3.21	93.85	3.57	9.39	0.36
		Urban Vegetated / Open Area	3	5.51	0.21	6.01	0.23	0.5	0.02
	Rural	Rural	4	84	3.19	88.98	3.38	4.99	0.19
	Industrial	Industrial Area	5	2.99	0.11	3.81	0.14	0.81	0.03
	Mining / Quarry area	Mining Active	6	0	0	0.06	0	0.06	0
		Quarry Area	7	4.01	0.15	4.39	0.17	0.38	0.01
Agriculture land	Crop land	Kharif Crop	8	3.4	0.13	3.26	0.12	-0.14	-0.01
		Rabi Crop	9	3.57	0.14	4.15	0.16	0.58	0.02
		Zaid Crop	10	0.7	0.03	0.88	0.03	0.18	0.01
		Two Seasons Crop	11	2239.99	85.17	2235.68	85.01	-4.31	-0.16
		More than Two Crop	12	79.03	3	72.26	2.75	-6.77	-0.26
	Fallow Land	Fallow Land	13	6.62	0.25	3.28	0.12	-3.34	-0.13
	Agriculture Plantation	Agriculture Plantation	14	10.4	0.4	10.86	0.41	0.46	0.02
	Aquaculture	Aquaculture	15	0.13	0	0.13	0	0	0
Forest	Deciduous	Deciduous Closed Forest	16	0.94	0.04	0.94	0.04	0	0
	Tree Clad Area	Tree Clad Area	17	4.18	0.16	4.18	0.16	0	0
Wasteland	Salt Affected Land	Salt Affected Land	18	0.02	0	0.02	0	0	0
	Scrubland	Scrubland Closed	19	0.34	0.01	0	0	-0.34	-0.01
		Scrubland Open	20	2.47	0.09	0.77	0.03	-1.7	-0.06
	Sandy area	Sand Desertic	21	0.88	0.03	0.25	0.01	-0.62	-0.02
		Sand Riverine	22	0.53	0.02	0.35	0.01	-0.18	-0.01
Wet land	Wetland	Wetland Natural	23	0.2	0.01	0.08	0	-0.13	0
		Wetland Manmade	24	0.06	0	0.03	0	-0.03	0
Waterbodies	River	River Perennial	25	8.97	0.34	9.52	0.36	0.55	0.02
		River Non Perennial	26	9.45	0.36	9.12	0.35	-0.32	-0.01
	Canal / Drain	Canal / Drain	27	0.47	0.02	0.47	0.02	0	0
	Lake	Lake Permanent	28	1.08	0.04	1.07	0.04	-0.02	0
	Reservoir	Reservoir Permanent	29	0.15	0.01	0.15	0.01	0	0
Total				2629.95	100	2629.95	100	0	0

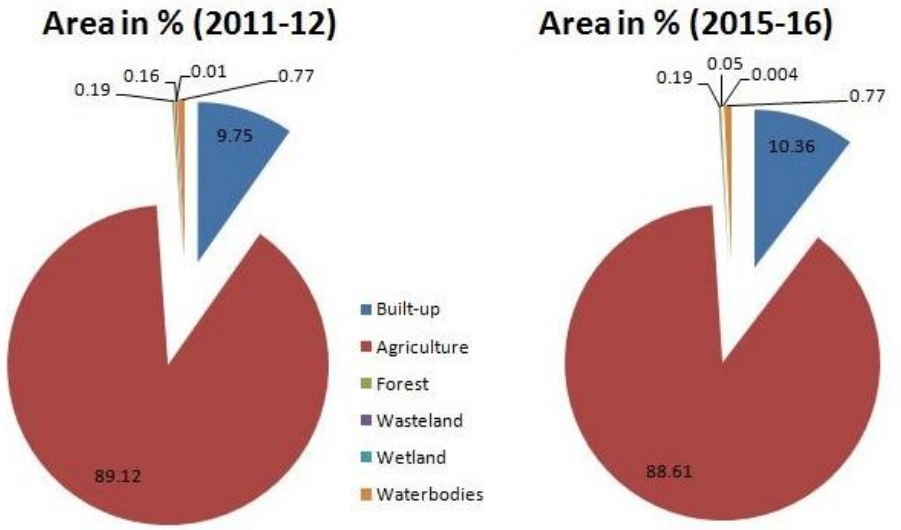

Figure-4: Percent of area occupied by various LULC classes at Level-I Classification

This study revealed that built-up land has been increased due to other categories transformed into built-up land (quarry area 0.95 km^2 transformed to two seasons crop land). As per the analysis of the study area the most of the built-up land is increased due to transformation of agriculture land while majority of waste land has been transformed into the agriculture land.**Table-4** shows how much area of level-III LULC classes has been converted into others level-III LULC classes.

This study results were similar of the study area is Rupnagar district of Punjab (Singh and Shashtri, 2010). We realized that in this paper is also built-up (settlement) lands has been increased by 33.12 km^2 (2.30%) and croplands has been decreased by 136.36 km^2 (9.47%) of the total area (1440 km^2) of the year 1989 to 2006.

Table-3: Level-II LULC Classification and Area

Categories (Level-II)	2011-12 area (sq.km)	Area in % (2011-12)	2015-16 area (sq.km)	Area in % (2015-16)
Built-Up (Urban)	165.38	6.29	175.27	6.66
Rural	84.00	3.19	88.98	3.38
Industrial	2.99	0.11	3.81	0.14
Mining / Quarry area	4.01	0.15	4.45	0.17
Crop land	2326.70	88.47	2316.23	88.07
Fallow Land	6.62	0.25	3.28	0.12
Agriculture Plantation	10.40	0.40	10.86	0.41
Aquaculture	0.13	0.00	0.13	0.00
Deciduous	0.94	0.04	0.94	0.04
Tree Clad Area	4.18	0.16	4.18	0.16
Scrubland	2.83	0.11	0.79	0.03
Sandy area	1.41	0.05	0.60	0.02
Wetland	0.26	0.01	0.11	0.00
River	18.42	0.70	18.64	0.71
Canal / Drain	0.47	0.02	0.47	0.02
Lake	1.08	0.04	1.07	0.04
Reservoir	0.15	0.01	0.15	0.01
Total	2629.95	100.00	2629.95	100.00

Table-4: LULC change matrix

Area in km^2 (2011-12)	Area in km^2 (2015-16)																													
	Code	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	Total
	1	75.40																													75.40
	2		84.46																												84.46
	3			5.51																											5.51
	4				84.00																										84.00
	5					2.99																									2.99
	7							3.06				0.95																			4.01
	8		0.02		0.21				2.91			0.19			0.08																3.40
	9		0.03		0.03					3.34		0.16																			3.57
	10										0.67	0.04																			0.70
	11		8.77	0.50	4.24	0.77	0.06	1.33		0.00		2222.87		0.20	0.43						0.03			0.08		0.64	0.05		0.02		2239.99
	12		0.11		0.37	0.05						6.16	72.17		0.16																79.03
	13		0.15		0.04				0.35	0.45	0.22	2.39	0.02	2.91									0.09								6.62
	14				0.06							0.33			10.00											0.01					10.40
	15															0.13															0.13
	16																0.94														0.94
	17																	4.18													4.18
	18																		0.02												0.02
	19											0.15		0.14	0.04					0.00											0.34
	20		0.30		0.04							1.21		0.00	0.14						0.74					0.02	0.02				2.47
	21									0.08		0.44	0.07	0.04								0.25									0.88
	22											0.23											0.21				0.09				0.53
	23											0.20																			0.20
	24											0.03													0.03						0.06
	25											0.12											0.05			8.73	0.08				8.97
	26									0.28		0.18														0.10	8.88				9.45
	27																											0.47			0.47
	28											0.04																	1.05		1.08
	29																													0.15	0.15
	Total	75.40	93.85	6.01	88.98	3.81	0.06	4.39	3.26	4.15	0.88	2235.68	72.26	3.28	10.86	0.13	0.94	4.18	0.02	0.00	0.77	0.25	0.35	0.08	0.03	9.52	9.12	0.47	1.07	0.15	2629.95

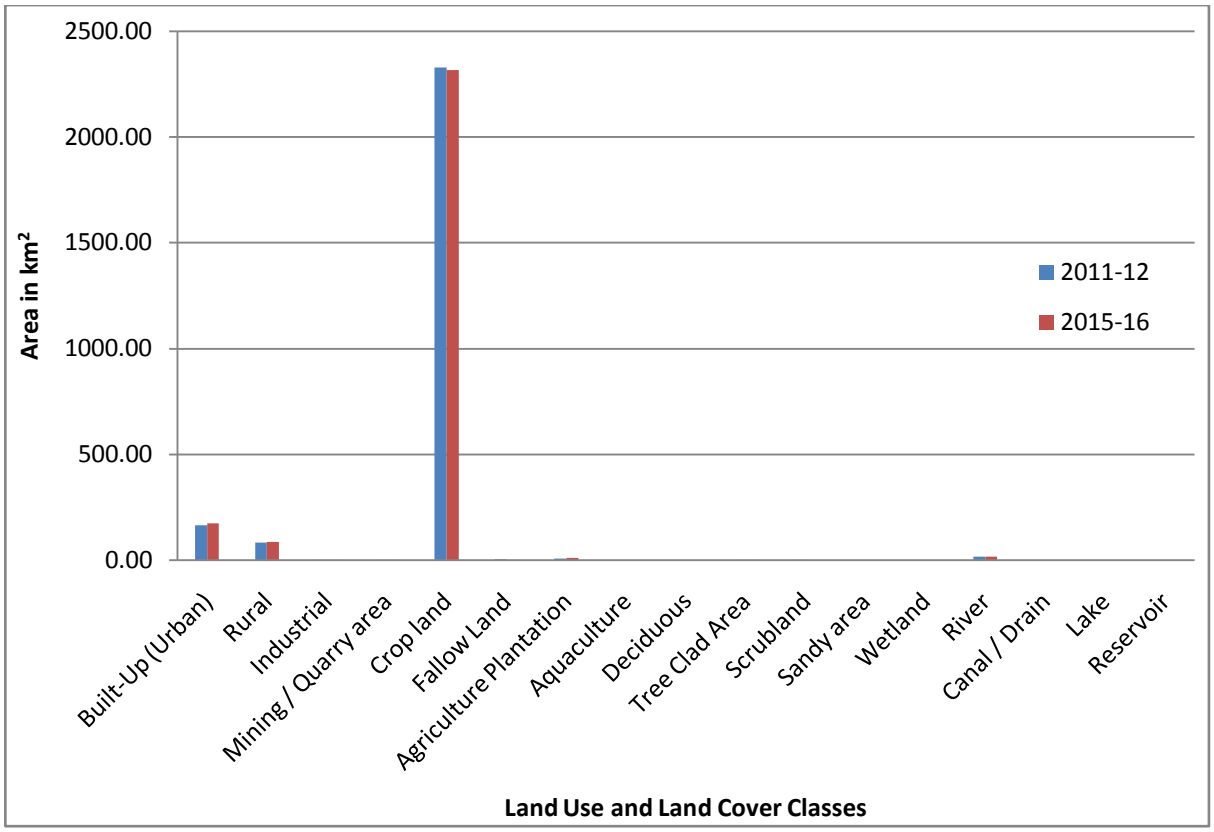

Figure-5: Area occupied by various LULC classes at Level-II Classification

CONCLUSIONS

Agriculture is the most dominant and significant class in the study area. The study reveals that, the area under agriculture land has decreased due to expansion of built-up areas. The wasteland has also decreased due to conversion in agriculture and built-up areas. The information from the study can be utilized for further wasteland management planning. The present study illustrates potential utilization of Indian Remote sensing satellite dataset for natural resource mapping and monitoring in addition to the implementation of spatial technologies like remote sensing and GIS for temporal analysis and quantification of spatial phenomena. An attempt through conventional mapping techniques have been used in the present study and in future some automatic algorithms can be used to achieve objectives. Further research using contemporary optical fine spatial resolution satellite data would help to generate information on the spatial distribution of smallest classes from land use land cover categories in the study area.

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