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Spatio-Temporal Analysis of Land Use/Land Cover Change in Ambala District, 2001-2011

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ABSTRACT: An attempt has been made to study the land use/land cover of Ambala district having a total geographic area of 1574 sq. km. The main objectives of the study were to analyze and interpret satellite data for Land Use/Land Cover mapping and to generate geo-database of the district in GIS format. The present study is the combined implementation of GIS and Remote Sensing techniques. The study has been done through remote sensing approach using LANDSAT 5 for 2001 and IRS P6 LISS III were used for 2011. Agriculture in the study is witnessing an decreasing trend as the total area under it in 2001 was 134604.0 ha and by 2011 it has decrease 132990.2 ha area. Built-up land is increasing rapidly in the study area. Rural has increased from 1775.6 ha in 2001 to 3005.1ha in 2011, thus, registering a net increase of 1129.50ha which is by means an insignificant figure. Rural has recorded an average annual increase of 112.95 ha. Rural occupied 1.13 percent of the study area in 2001 which has increased 1.91 percent showing net increased by 0.78 percent with an annual rate of increase of 11.295 ha area. Urban has increased from 4620.3 ha in 2001 to 5802.14 ha in 2011, thus, registering a net increase of 1181.89 ha. Urban occupied 2.94 percent of the study area in 2001 which has increases a total of 3.69 percent in 2011 showing net increase of 0.75 percent with an annual rate of increase of 118.189 ha area. Land use/ Land cover categories identified in this area were Agricultural crop land, Plantation, Wastelands, Built-up area & water body.

KEY WORDS: Land Use/Land Cover, Remote Sensing, GIS

I. INTRODUCTION

Land use is a primary indicator of the extent and degree to which man has modified the land resources. It is the application of human controls in a systematic manner, indicating an intimate relationship between prevailing ecological conditions and man (Vink, 1975). The regional differences in natural environmental and socio economic condition lead to significant regional variations in agricultural land use pattern. The information on the land use provided by the Statistical Abstract of Haryana is based on nine fold classification of land use by Revenue Department, Government of India. Ambala district of Haryana lies between 30°10': 31°35' north latitude and 76° 30': 77° 10' east longitude. Total geographical area of the district is 1574 sq. km. Administratively this district is controlled by Ambala division. It is divide into three tehsils namely Ambala, Barara, and Naraingarh, and sub divided into six development blocks namely Ambala 1, Ambala 2, Barara, Shahzadpur, Naraingarh,. It is bounded by the district Yamuna Nagar in south-east. To its southern lies Kurukshetra district, while in its west are situated Patiala and Roper districts of Punjab and the union territory of Chandigarh. The Shivalik Range of Solan and Sirmaur districts of Himachal Pradesh bounded the Ambala district in the north and north east. The average altitude from the sea level is 900 feet approximately. Ambala district is comprised in 1574 sq. km. As per 2011 Census Ambala tehsil cover 46.63 percentage, Barara 19.31 percentage, and Nraingarh 28.56 percentage.

II. DATA BASE AND RESEARCH METHODOLOGY

The present study has been carried out utilizing both primary as well as secondary data sets. Primary data includes Survey of India toposheets on 1:50000 scale. For the study, Landsat satellite images of Ambala district were acquired for the time period; LANDSAT TM 2001 from Global Land Cover Facility, an earth science data interface (GLCF), while IRS-P6 LISS-III, for the year 2011 was obtained from (BHUVAN).

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Vol. 6, Issue 7, July 2017

The administrative state boundary map was also brought to Universal Transverse Mercator project in zone 43 and later the satellite imageries were clipped with the administrative boundary of Ambala. The different False Colour Composite (FCC) of Ambala for different periods were prepared. Secondary data collected from government and semi-government departments, and from published and unpublished reports. The general characteristics of the satellite image that has been used for the generation of land use map of 2001 and 2011 are highlighted in the table 1.1

Table: 1.1 Characteristics of Remote Sensing data acquired for the study

Satellite	Sensor	Band	Orbit	Altitude	Swath	Spatial
IRS P6	LISS III	4	24 Days	140 km	141km	Resolution 23m
Landsat5	TM	7	16	750km	185	30m

Source: <http://earth.esa.int/web>, Source: Landsat.gsfc.nasa.gov

Construction of a Digital Data base: The first step is the transformation of the soft copy into digital form. This process is accomplished in various steps as given below:

Base Map Preparation - Base map of the study area was prepared from the Survey of India toposheets on 1:50,000 scale. The preparation of base map of the study area is the first step in the analysis of land use and land cover. Various permanent features like settlement, rivers or any other land based features were to the transferred base map. Thereafter preliminary interpretation of satellite data was carried out and a preliminary interpretation key was prepared.

Geo-referencing: - The thematic maps like Base map, Drainage map, Land use/ Land cover map were generated from SOI toposheets of 1961. These toposheets were in photographic TIFF (Tagged image file format) format and were finally registered to a Universal Geographical Coordinate system.

Digitization: - The second step involved is the on screen digitization of various themes like, drainage, land use/ land cover, etc in the form of feature data line, polygon and point. The process of digitization was done in ArcMap 9.3 a GIS software.

- Cleaning and Building Topology:** - The process of cleaning and building topology has been done by first changing the format of the data from shape file to Arc coverage and then the tools like clean vector layer and Build Vector layer topology are operated to do the required job.
- Analysis and quantification of differences in Land use Preparation of final maps:-** The land use statistics obtained from the attributes tool of raster module of the software were analyzed to draw certain inferences. The absolute change in land use of the two dates was obtained by the difference of the values of different dates of the same category while percentage change was calculated by dividing it with the total area and multiplying by hundred

$$\text{Percentage Change} = \frac{\text{Absolute change} \times 100}{\text{Total change}}$$

The ArcView 9.3 was used in preparation of final outputs in the form of maps. They were then exported to photographic formats for hard copy output.

III. RESULTS & DISCUSSION

Land Use Change in Ambala District 2001-2011

The land use land cover change that has occurred in the study area from 2001 to 2011 is shown in the table. The figures given in the table 1.2 reveal that the highest change has occurred fellow land, build up, waterlogged area, river and scrub land. Agriculture in the study is witnessing an decreasing trend as the total area under it in 2001 was 134604.0 ha

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 7, July 2017

and by 2011 it has decrease 132990.2 ha area. A total area 1617.71 ha has been decreased to the agriculture with an average annual decrease of 161.71ha area thus, registering a net decrease of -1.03 percent. Built-up land increasing rapidly in the study area. Rural has increased from 1775.6 ha in 2001 to 3005.1ha in 2011, thus, registering a net increase of 1129.50ha which is by means an insignificant figure. Rural has recorded an average annual increase of 112.95 ha. Rural occupied 1.13 percent of the study area in 2001 which has increased 1.91 percent showing net increased by 0.78 percent with an annual rate of increase of 11.295 ha area.

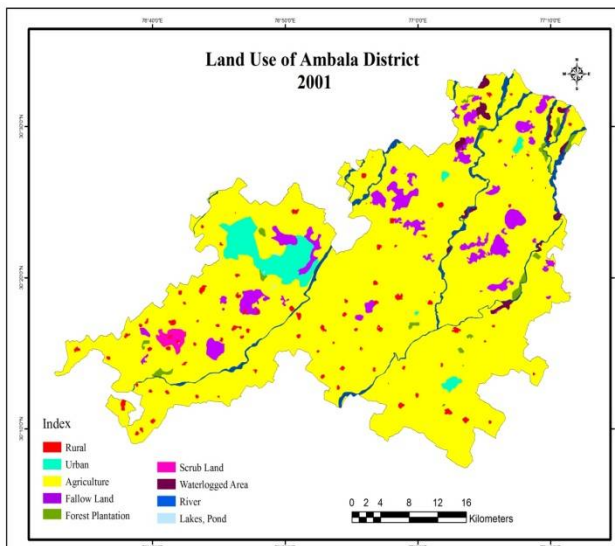


Fig. 1.1 Source: Generated from LANDSAT, TM Satellite Image, 2001

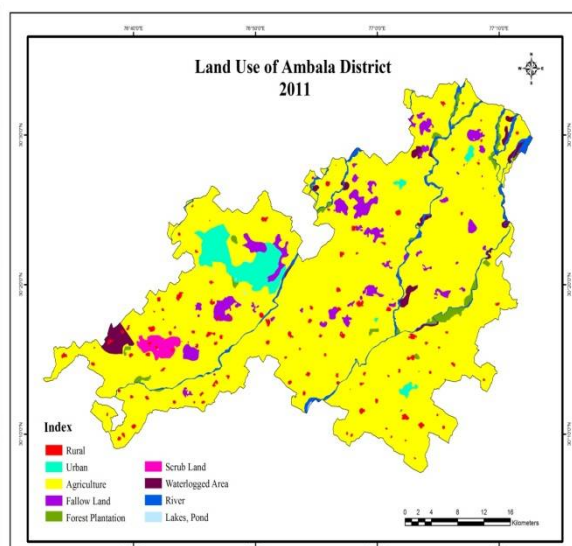


Fig.1.2 Source: Generated from IRS-P6 LISS III Satellite Image, 2011.

Urban has increased from 4620.3 ha in 2001 to 5802.14 ha in 2011, thus, registering a net increase of 1181.89 ha. Urban occupied 2.94 percent of the study area in 2001 which has increases a total of 3.69 percent in 2011 showing net increase of 0.75 percent with an annual rate of increase of 118.189 ha area.

Scrub has increased total area of 1230.62 ha in 2011 to 679 ha in 2001 thus registering a increase of 551.62 ha within a period of ten years. Scrub occupied 0.43 percent of the study area in 2001 which has increase a total of 0.78 percent in 2011 showing a net increase of 0.35 percent with an annual rate of increase of 13.79 ha area.

Forests occupied 0.63 percent of the study area in 2001 which has increase to a total of 1.00 percent in 2011 showing a net increase of 0.37 percent. Forest plantation in the study is witnessing an increasing trend as the total area under it in 2001 was 989.4 ha and by 2011 it has increased upto 1572.29 ha area.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

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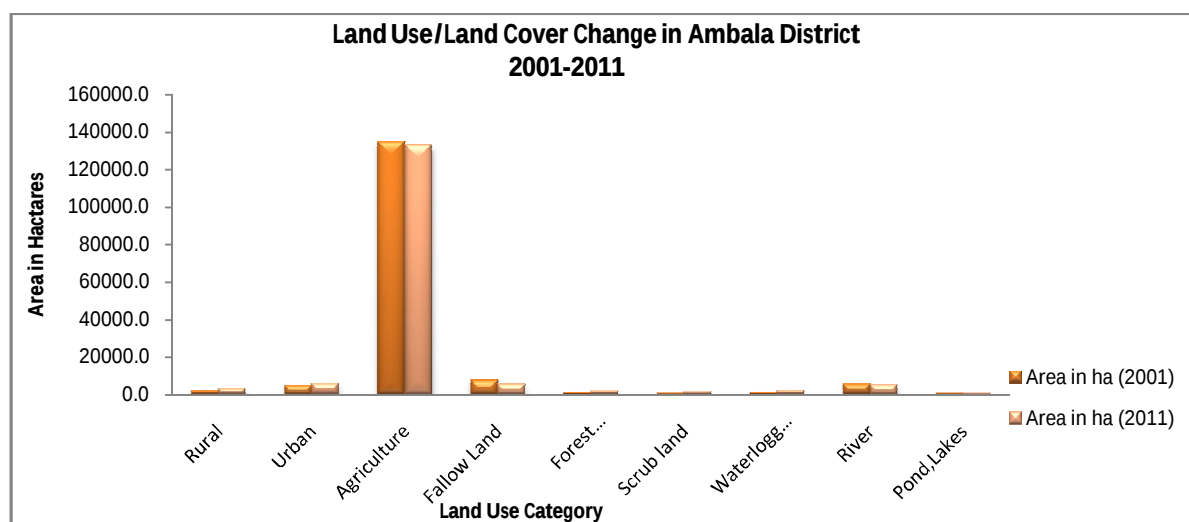
Vol. 6, Issue 7, July 2017

Table 1.2 Land Use/ Land cover Change in Ambala District 2001-2011

Land Use Class	Area in ha %age (2001)	Area in ha %age (2011)	Change in Area %age (2001-11)
Rural	1775.6 (1.13)	3005.1 (1.91)	1129.50 (0.78)
Urban	4620.3 (2.94)	5802.14(3.69)	1181.89 (0.75)
Agriculture	134604.0 (85.52)	132990.28 (84.49)	-1617.71 (-1.03)
Fallow Land	7596.1 (4.83)	5249.3 (3.34)	-2346.83 (-1.49)
Forest Plantation	989.4 (0.63)	1572.29 (1.00)	582.90 (0.37)
Scrub Land	679 (0.43)	1230.62 (0.78)	551.62 (0.35)
Waterlogged Area	1090.0 (0.69)	2016.21 (1.28)	926.20 (0.59)
River	5523.8 (3.51)	5022 (3.19)	-501.80 (-0.32)
Pond, Lakes	522.1 (0.33)	512.1 (0.33)	-10.00 (-0.01)
Total	157400.3 (100%)	157400.40 (100%)	-104.23 (-0.01)

Source: Derived from LANDSAT TM Satellite Image, 2001 & IRS-P6 LISSIII Satellite Image, 2011.

A total area of 582.90 ha has been added to the forest plantation with an average annual increase of 58.29ha thus, registering a net increase of 0.37percent.



Source: Computed from LANDSAT TM Satellite Image, 2001 & IRS-P6 LISS III Satellite Image, 2011. Fig.1.3

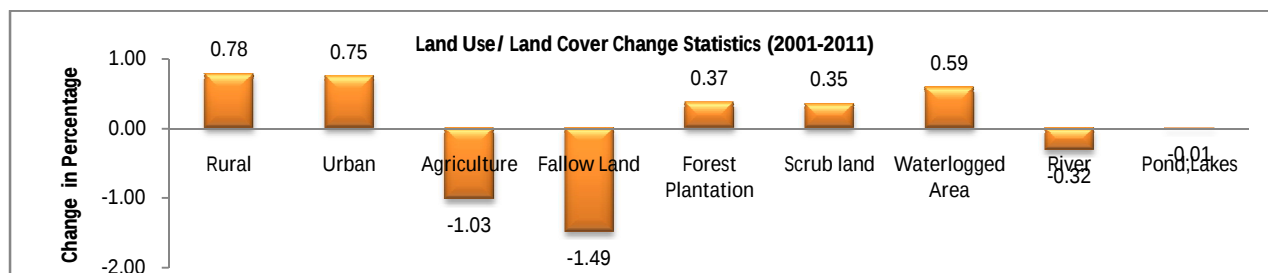
Waterlogged was spread over an area of 1090.0 ha in 2001 and this figure has gone upto 2016.21 ha in 2011. Net increase in percentage is 0.59. On an average waterlogged area increased by 92.62 ha per year. A net decrease of 501.80 ha has occurred in the rivers located in the study area.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 7, July 2017



Source: Computed from LANDSAT TM Satellite Image 2001 & IRS-P6 LISS III Satellite Image 2011. Fig. 1.4

Rivers have decreased from 5523.08 ha in 2001 to 5022 in 2011. River occupied 3.51 percent of the study area in 2001 which has decrease a total of 3.19 percent in 2011 showing a net decrease of -0.32 percent with an annual rate of decrease of 50.18 ha area. Pond and lakes in the study is witnessing an decreasing trend as the total area under it in 2001 was 522.1 ha and by 2011 it has decrease 512.1 ha area. A total area -10.00 ha has been decreased to the pond and lakes with an average annual decrease of -1 ha area thus, registering a net decrease of -0.01 percent.

Growth in Land Use Class, 2001-2011

Total percentage growth in different land use categories in the study area is very high. Some land use classes have registered a positive growth while as others have witnessed a negative growth shown in table 1.2(Fig.1.3). **Rural:** - it constituted 1.13 percent of the study area in 2001 and 1.91 percent in 2011 thus, registering a growth of 69.0 percent from 2001 to 2011. **Urban:** - It constituted 2.94 percent of the study area in 2001 and 3.69 percent in 2011 thus, registering a growth of 25.51 percent from 2001 to 2011. The built-up category is still increasing on an accelerating pace to compensate the high population growth within the study area. **Agriculture:** - Agriculture being the dominant activity in Ambala district has got maximum area under it. Agriculture has reduced from 85.52 percent in 2001 to 84.49 percent in 2011, thus registering a total growth of -1.20 percent. Agriculture is expanding towards the higher reaches of study area. The unchecked population growth in the region demands more agricultural land to satisfy the need of this increasing population. People are more dependent on agriculture than any other sector of economic activity.

Table: 1.3 Growth in Land Use Class 2001-2011

Land Use/Land cover Class	% of total area 2001	% of total area 2011	Total Growth (%)
Rural	1.13	1.91	69
Urban	2.94	3.69	25.51
Agriculture	85.52	84.49	-1.2
Fallow Land	4.83	3.34	-31
Forest Plantation	0.63	1	58
Scrub Land	0.43	0.78	81.3
Waterlogged Area	0.69	1.28	85.5
River	3.51	3.19	-9.11
Pond, Lakes	0.33	0.33	0.01
Total	100	100	361.63

Source: Computed from LANDSAT TM Satellite Image, 2001 & IRS-P6 LISS III Satellite Image, 2011.

Fallow Land: - There has been a substantial decrease in the area under fallow land from 2001 to 2011. A growth rate of -31 percent has occurred in this land use category within a period ten years. Increasing build-up land has decreased the size of fallow land. It constituted 4.83 percent of the study area in 2001 and 3.34 percent in 2011. Land reclamation

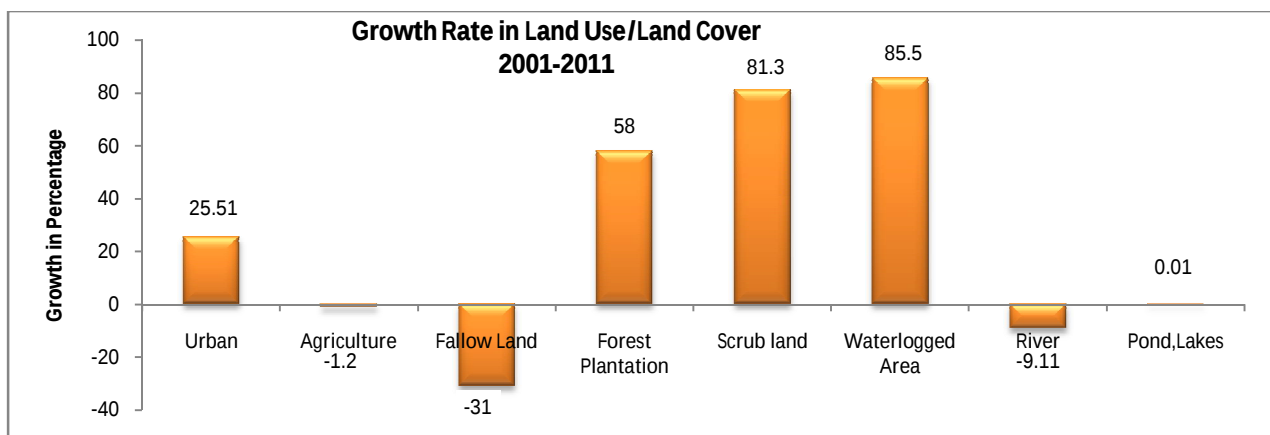
International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 7, July 2017

is one more factor that has led to the decrease the size of fallow land. **Forest Plantation:** - It occupied 0.63 percent of the study area in 2001 which has increased up to 1.00 percent in 2011 with a total growth of 59 percent. Forest plantation is more adapted to the water logged condition and has high soil accumulation capacity. It is mostly found along river banks. **Scrub Land:** - scrub is one of the major land use category in Ambala district and has registered a further growth of 81.3 percent from 2001 to 2011. The degradation of forests due to various reasons over a long period of time transforms them into scrublands. **Waterlogged Area:** - These are located in the plain region of the study area mostly around the river. At the time of floods, wetlands act as the natural absorption basins. Wetlands are now mostly covered by the willow plantation. A total of 85.50 percent has occurred in wetlands from 2001 to 2011. About 40% of wetlands have been increase during the last century. The increasing sediment load of the river channels finds their way into these wetlands which also act as flood absorption basins.



Source: Computed from LANDSAT TM Satellite Image, 2001 & IRS-P6 LISS III Satellite Image, 2011. Fig. 1.5

River: - There has been a substantial decrease in the area under rivers from 2001 to 2011. A growth rate of -9.11 percent has occurred in this land cover category within a period of one decade. Increasing upstream erosion and sediment load has decreased the channel size of streams and other water bodies. Land reclamation is one more factor that has led to the decrease in the channel size of small streams. **Pond & Lakes:** - It constituted 0.33 percent of the study area in 2001 and same percent in 2011 thus, registering a growth of 0.01 percent.

IV. CONCLUSION

Land use has drastically changed in the Ambala district since 2001. Scrub land, wetlands and river have suffered the most. Highest positive growth has been registered by the built-up and forest plantation. Forest plantation in the study is witnessing an increasing trend as the total area under it in 2001 was 989.4 ha and by 2011 it has increased upto 1572.29 ha area. A total area of 582.90 ha has been added to the forest plantation with an average annual increase of 58.29ha thus, registering a net increase of 0.37 percent.

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Vol. 6, Issue 7, July 2017

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