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Land Use/Land Cover Change Detection Using Geo-Spatial Techniques A Case Study of Bassi Tehsil, District Jaipur, Rajasthan

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Abstract

Land is a very important natural resource. During recent years, drastic changes in land use systems have taken place due to rapid extension of agricultural land. Land use refers as how land is used by human beings, whereas land cover refers to the actual vegetative, structural, or other surface cover resulting from a given land use. The present study focused on a comparative analysis of Land use/Land cover (LU/LC) changes in the agricultural area of Bassi tehsil (from 2004-05 to 2013-14) determined by using Geographical Information Systems (GIS) and Remote sensing technology. Now day's Remote-sensing data plays an increasingly important role in LU/LCC analysis. Though it simply measures the reflective response of the earth's surface and provides an index of the intensity of human lifestyles and GIS helps in management and analysis of this spatial data. The study is employed by using the Survey of India topographic map 54B/01 and the remote sensing data of LANSAT ETM+ for 2005 and IRS-P6 LISS-III for 2013-14. The study area is classified into fifteen LU/LC categories on the basis of field study, geographical conditions, and remote sensing data. The study aims at projecting a tangible picture of how the LU/LC changed during 2013-14 over 2005-06. The result showed that there is a significant change in the agricultural land use and land cover.

Keywords: Land Use, Land Cover, GIS, Remote Sensing

Introduction

Now a day's land use analysis has become an important aspect in geographical studies as it provides a sound base for sustainable management. Land-use denotes how humans use the biophysical or ecological properties of land while land cover refers to the physical characteristics of the earth's surface i.e, distribution of vegetation, water, soil, etc. In other words land cover is that which covers the surface of the earth and land use describes how the land cover is modified.

Land use refers to utilization of land resources by human beings and land cover changes often reflects the most significant impact on environment due to excessive human activities. Land use and land cover are dynamic in nature and provides a comprehensive understanding of the interaction and relationship of anthropogenic activities with the environment (Prakasam, 2010). Land use/cover changes also involve the modification, either direct or indirect, of a natural habitats and their impact on the ecology of the area. Land use/cover change has become a central component in current strategies for managing natural resource and monitoring environmental changes (Tiwari and Saxena, 2011). Land use affects land cover and Changes in land cover affect land use. A change in either however is not necessarily the product of the other. Changes in land cover by land use do not necessarily imply degradation of the land. However, many shifting land use patterns driven by a variety of social causes, result in land cover changes that affects biodiversity, water and radiation budgets, trace gas emissions and other processes that come together to affect climate and biosphere (Riebsame, Meyer, and Turner, 1994). In some instances, land use land cover change may result in environmental, social and economic impacts of greater damage than benefit to the area (Moshen A, 1999). Therefore data on land use change are of great importance to planners in monitoring the consequences of land use change on the area. Such data are of value to resources management

and agencies that plan and assess land use patterns and in modelling and predicting future changes.

Remote sensing systems are now one of the most important tools for collecting and classifying the spatial data by systematic, synoptic, rapid and repetitive coverage in different windows of electromagnetic spectrum and GIS acts as a powerful tool for management and analysis of these spatial data. Use of remote sensing and GIS helps a lot in understanding landscape dynamics. Geographical information systems (GIS) and Remote Sensing are well-established information technologies, the value of which for applications in land and natural resources management are now widely recognized. They are, however, still essentially separate technologies and practitioners still generally consider themselves primarily involved with one or the other (Qiming zhou, 1995). Current technologies such as geographical information systems (GIS) and remote sensing provide a cost effective and accurate alternative to understanding landscape dynamics. Digital change detection techniques based on multi-temporal and multi- spectral remotely sensed data have demonstrated a great potential as a means to understanding landscape dynamics- detect, identify, map, and monitor differences in land use and land cover patterns over time, irrespective of the causal factors(Jensen,J.R, 1996). Now a day's remote sensing data, along with increased resolution from satellite platforms, makes these technology appear poised to make better impact on land resource management initiatives involved in monitoring LULC mapping and change detection at varying spatial ranges (Singh et al., 2010; Thakur, 2010). Remote sensing technology offers collection and analysis of data from ground-based, space and Earth-orbiting platforms, with linkages to Global Positioning System (GPS) and geographic information system (GIS) data with promising modelling capabilities (Franklin, 2001; Thakur et al., 2010). This has made remote sensing valuable for land cover and land use information.

As such, spatial repetitive and synoptic coverage from satellites collected over a wide range of electromagnetic spectrum admirably suit the requirement of LULC mapping and monitoring. These spatial data indicates the distribution of various LULC categories in an area. Due to the availability of repetitive data, it is possible to update existing database for various land use planning and design making. Therefore, with the use of geospatial technology (remote sensing, GIS, GPS and computational techniques) it is evident that these could be used effectively to prepare LULC mapping (Tejaswini, 2005; Rao et al., 1996, Mukherjee et al., 2009; Srivastava et al., 2010). Geospatial technology guarantees the availability and quick access of real time data, geospatial information for resource mapping.

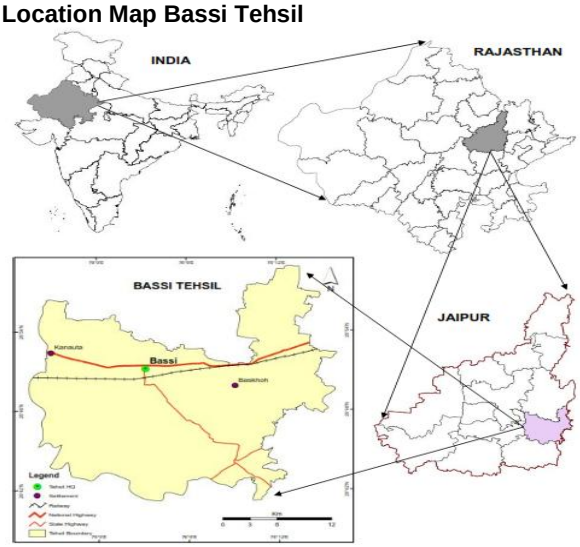
In India, spatial accounting and monitoring have been carried out at a national level on 1:250,000 scale, using multi-temporal Indian Remote Sensing (IRS) satellites to address the spatial and temporal variability in landuse patterns (NRSA, 1989).

Study Area

Bassi tehsil is a sub-division of Jaipur district in the state of Rajasthan. This is one of the major agricultural Tehsil of Jaipur district approximately 30 km from Jaipur city. Bassi tehsil is located in the East of Jaipur district between 26°4' N and 26°59` N latitude and 75°54' E to 76°20' E longitude. National Highway No. 11 passes through Bassi. It has a total area of 653 km. It is one of the densely populated tehsil of Jaipur district. The sub-district had a population of 229,639 (2011 census) spread over 215 villages of this 72237 are schedule tribes and 44013 are schedule caste people. The sex ratio of the population of Bassi is 910 females per 1000 males. The literacy rate in the city is 58.14%, 77.99% for males and 36.3% for females. It has 37 gram panchayats, 43 patwarmandal and 215 villages and 1 municipality. The study conducted in Bassi tehsil advocates that multi temporal satellite imagery plays a vital role in quantifying spatial and temporal phenomena which is otherwise not possible to attempt through conventional mapping only. Therefore an attempt is made to map out the status of land use and land cover change in Bassi tehsil. Sound and consistent monitoring and modelling has been done with the help of geospatial techniques.

Figure : 1

Location Map Bassi Tehsil



Objective of the Study

1. The aim of the study is to analyze LU/LC changes using geospatial techniques
2. To discuss spatial pattern of agricultural land use and land cover
3. To analyse the factors responsible for land use and land cover change.

Database and Methodology

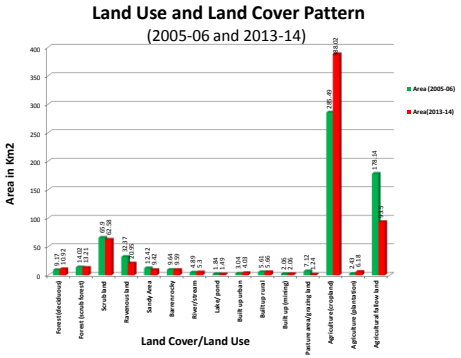
Landsat Enhanced Thematic Mapper plus (ETM+) at a resolution of 14.5 m for 2005-06 and IRS-P6 LISS-III at a resolution of 24.00m for 2013-14 were used for LU/LC classification and visual interpretation on computer screen has been performed. Select categories with certainty, were randomly selected.

Table-1
Land use/ Land cover pattern in Bassi Tehsil

		Total geographical area (acc to village sheets)	Forest area	Non-Arable Land			Non Agricultural Land (Except barren land)				Fallow land			Net sown area	Gross cropped area	Area sown more than once
				Land use other than agriculture	Wasteland and non agricultural land	total	Permanent pastures and grazing ground	Tress and gardens	Wasteland (agricultural use)	total	Other fallow land	Current fallow	total			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
2004-05	Area (Km^2)	654.69	21.17	37.51	44.80	82.31	47.18	1.43	23.05	71.66	44.83	45.34	90.17	389.38	559.08	169.70
	%	100.00	3.23	5.73	6.84	12.57	7.21	0.22	3.52	10.95	6.85	6.92	13.77	59.48	85.39	25.92
2014-15	Area (Km^2)	654.69	21.16	41.50	31.54	73.04	47.27	1.10	19.51	67.88	38.08	37.04	75.12	417.49	619.92	220.93
	%	100.00	3.23	6.33	4.83	11.16	7.22	0.17	2.98	10.37	5.81	5.66	11.47	63.77	94.69	33.74
Land use Change	Area (Km^2)	100.00	-0.01	+3.99	-13.26	-9.27	+0.09	-0.33	-3.54	-3.78	-6.75	-8.30	-15.05	+63.77	+60.84	+51.23
	%	100.00	-0.05	+10.64	-29.59	-11.26	+0.19	-23.07	-15.35	-5.27	-15.05	-18.31	-16.69	+16.37	+10.88	+30.18

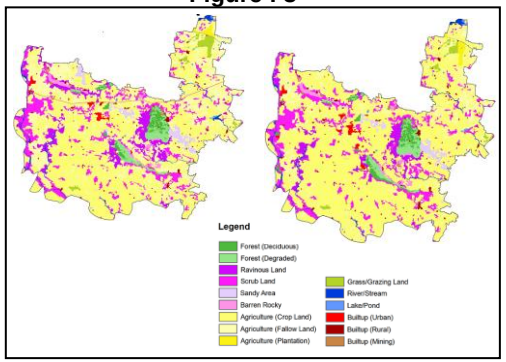
Source :District statistics profile 2016,office sub director collector economic and statistics, collectrate jaipur

Figure: 2



Source : Computed by Author

Figure : 3



Source: Landsat ETM+ and IRS-P6 LISS-III

Findings

Land use/Land Cover change detection

For performing LU/LC change detection is a post classification detection method is employed. A pixel based comparison is used to produce change information on pixel basis and thus interpret the changes more efficiently. Classified image pairs of two different years data were compared for the periods from 2005-6 and 2013-14. The results obtained through the analysis of multi-temporal satellite imageries were diagrammatically illustrates in figure 3,4,and data is depicted LU/LC change in different land use categories is in table 2

Table : 2

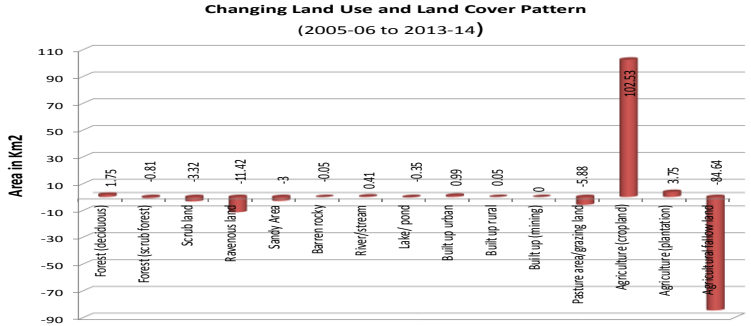
Land Use / Land Cover Change in Bassi Tehsil in Agricultural Year 20013-14 over 2004-05

		Land Use and Land Cover Types																		
		Non Arable														Arable				
		Land Cover									Land Use					Land Use				
Year		Forest deciduous 1	scrub forest 2	Scrubland 3	Ravenous land 4	Sandy land 5	Barren rocky 6	River/ Stream 7	Lake/ pond 8	Total 9	Built up (urban) 10	Built up (rural) 11	Built up (mining) 12	Pasturev and graziong land 13	Total 14	Agriculture (cropland) 15	Plantation 16	Agriculture (fallow land) 17	Total 18	Grand total (9+14+18)
2005-06	Area (Km^2)	9.17	14.02	65.90	32.37	12.42	9.64	4.89	1.84	150.29	3.04	5.61	205.79	2.06	17.83	285.49	2.43	178.14	466.07	634.20
	%	1.45	2.21	10.39	5.11	1.96	1.52	0.77	0.29	23.70	0.48	0.89	0.32	1.12	2.81	45.02	0.38	28.09	73.49	100
2014-15	Area (Km^2)	10.92	13.21	62.58	20.95	9.42	9.59	5.30	1.49	133.48	4.03	5.66	206.42	2.06	13.00	388.02	6.18	93.50	487.71	634.20
	%	1.72	2.08	9.87	3.30	1.49	1.51	0.84	0.24	21.05	0.64	0.89	0.32	0.20	2.05	61.18	0.98	14.74	76.90	100
Change	Area	+1.75	- 0.81	-3.37	-11.42	-3.00	-0.05	+0.40	--0.35	-16.80	+0.99	+0.05	0.00	-5.88	-4.82	+102.53	+3.74	-84.64	21.63	00.00
	%	+19.05	-5.77	-5.04	-35.28	-24.16	-0.57	+8.30	-19.01	-11.80	+32.60	0.99	+0.31	-82.59	-27.07	+35.91	+153.84	-47.51	+4.64	00.00

Source: Computed by Author

Table 2 shows a considerable change the pattern of land use and land cover of Bassi tehsil during 2013-14 over 2005-06. The total land use (arable + non arable) had increased to 3.47per cent.

Figure : 3



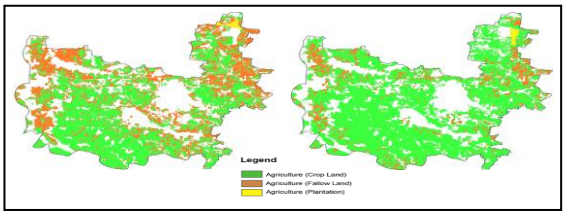
Source : Computed by Author

Findings

Figure 2 shows a considerable change the pattern of land use and land cover of Bassi tehsil during 2013-14 over 2005-06. The total land use (arable + non arable) had increased to 3.47per cent. The Arable land use category had registered an increase of 4.64per cent during 2013-14 over 2005-06. The maximum increase of 153.8 per cent had been recorded under plantation class owing to several social forestry programmes. About by 36per cent increase is registered under cropland also due to better rainfall. Figure4 shows change under plantation and cropland in the north and north eastern part of the Bassi tehsil.

Figure : 4

Change detection in agriculture land use/ land cover in 2013-14 over 2005-06

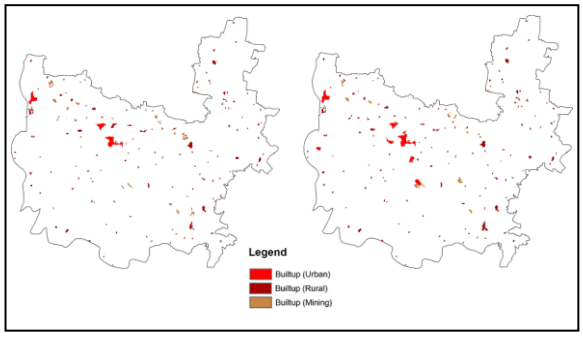


Source: Landsat ETM+ and IRS-P6 LISS-III

The total Non-arable category accounts for a decrease of -12.87per cent during 2013-14 over 2005-06. A decrease of-11.80per cent had been registered in land cover class. Forest (deciduous) had registered an increase of 19.05per cent which is due to better monsoon rains during 2010 to 2012. The ravenous land had also registered a decrease of -35.28per cent. Sandy area has also decreased to about 24 per cent due to average to above average rain in 2010-11 over 2005-06

Figure : 5

Change in built up area in 2013-14 over 2005-06



Source : Landsat ETM+ and IRS-P6 LISS-III

The land use class in non arable category accounts for a decrease of -27.07per cent. Figure5 shows an increase of built up urban in the central part of the tehsil. An Increase of 32.60per cent had been registered in built up urban class due to population growth and urbanisation.

Conclusion

Bassi tehsil (study area) is a major agricultural tehsil of jaipur district and with the help of geospatial techniques an attempt has been done to detect the changing land use and land cover pattern in the study area. A considerable change in the pattern of land use and land cover of Bassi tehsil during the agricultural calendar 2013-14 over 2005-06. There is an increase in the total land use pattern (arable + non arable category) which is around 3.47per cent. This research work demonstrates the ability of GIS and Remote Sensing in capturing spatial-temporal data. Attempt is made to capture accurate fifteen possible land use land cover classes as they change through time.

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