

Land Use / Land Cover Change Detection from 2001 to 2012 in Mahendragarh District, Haryana.

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Abstract

Understanding the man-environment interrelationship requires knowledge of land use and land cover. There are far-reaching consequences for ecosystems on local, regional, and global levels as a result of the changes in land use and cover that are driven mostly by human activities. The IRS-P6 (RESOURCESAT-1), LISS III satellite data, March 2002 and March 2012 is used for land use/cover mapping, along with the Survey of India topographical sheet and Google earth satellite image. In 2001, 72.17 percent of Mahendragarh District's land was used for agricultural purposes, 18.19 percent was for forestation, and 0.10 percent was unusable. Ninety-seven percent of the district's land is used for agricultural, forest, and hilly region purposes, while only three percent is developed (settlements, transport etc.). In 2012, just 3.80 square kilometres of the total 1938.46 square kilometres of the Mahendragarh District were under a canal network, whereas 1280.90 square kilometres were devoted to agricultural. From 2001 to 2012, agricultural land was lost at the greatest rate in the Satnali block (34.47 square kilometres), followed by the Mahendragarh block (27.94 square kilometres), the Nizampur block (27.14 square kilometres), and the Nangal Chaudhary block (27.14 square kilometres) (21.55 sq. km. area). The results show that both the amount of developed land and the amount of farmland are rapidly expanding.

Keywords: LULC, LISS III, agriculture, built up, Mahendragarh.

Introduction

Land use/ land cover is an important component to understanding the man environment relationship. It is necessary to monitor and detect the changes because land use/ land cover changes are the major concern issues of global environment change today. During the past millennium, humans have played an increasingly large role in the modification of the global environment. With increasing numbers and developing technologies, man has emerged as the major, most powerful and universal instrument of environmental change in the biosphere today (Houghton et al., 2012; Meyer & Turner, 1992) Land use/ land cover pattern is basically controlled by anthropogenic demands and interventions as well as natural phenomena.

Land use refers to man's activities and the varied uses which are carried on over land and land cover refers the assemblage of biotic components on the earth's surface. Biotic is one of the most crucial properties of the earth system (Herold et al., 2002). Land cover is that which covers the surface of the earth and land use describes how the land cover is modified.

Human activities play a dominant role in land use and cover changes and have significant effects on the ecosystems at the local, regional, and global scales. Consequently, it directly or

indirectly exerts great influence on the landscape changes. It is directly related to issues of food security, controlling factors such as water and soil quality, soil types; ground water depth and other important life support issues; environmental conditions and government policies also (Lambin et al., 2003). Land-use and land-cover change is among the most vivid manifestations of the anthropogenic impacts on our environment. An improved understanding of land-use change is considered to be a requirement for the spatial assessment of landscape dynamics, with reference to their various functions (Tiwari et al., 2010).

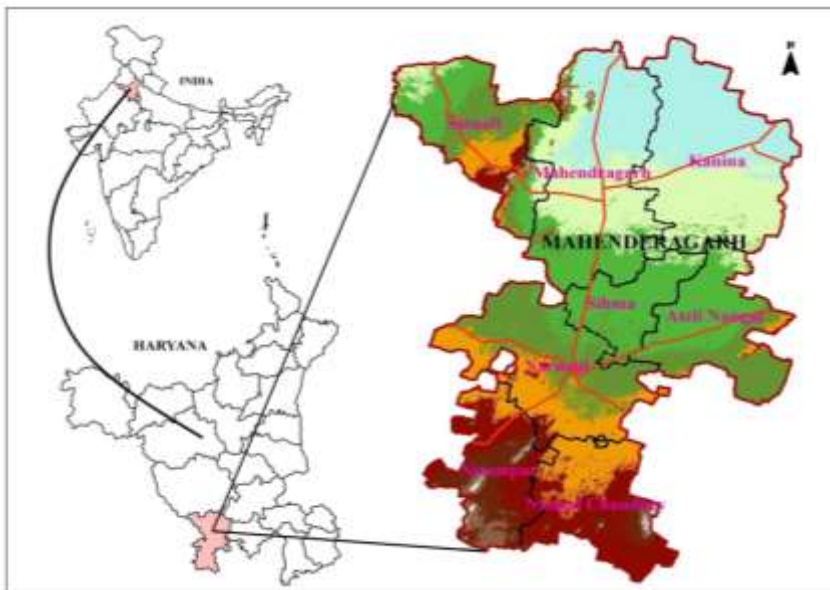
It is widely accepted that land use / land cover changes have an important effect on the functioning of the Earth's systems as a whole and the majority of ecosystems. It also affects climate change in the long term (Rodríguez Eraso et al., 2013). Land use / land cover changes are recognized as one of the most relevant rivers of biodiversity loss in ecosystems. Through the analysis of satellite images, this project work quantifies the Land use / land cover that occurred between 2002 and 2012 in the Mahendragarh district, Haryana.

Over the course of the previous few decades, numerous methods for mapping LULCs and detecting changes have been developed and implemented in countries all over the world (Dewan & Yamaguchi, 2009; Dutca & Abrudan, 2010; Falcucci et al., 2007; Jayakumar & Arockiasamy, 2003; Lu et al., 2004; Lunetta et al., 2006; Mas, 1999; Mayaux et al., 2008; Rogan & Chen, 2004).

At present, project case study is important for gaining an understanding of the complex relationship between social and natural systems that drive land resource changes. Whole study work is based on remote sensing and GIS technology. Unsupervised classification is the identification of natural groups, or structures, within multispectral data. It is also known as a posterior decision classification (Carlson & Arthur, 2000; Shalaby & Tateishi, 2007). This is a completely automated process where the image processing software separates classes by distinct spectral differences. It has no user input, so requires no knowledge of what is actually on the ground. It is a fast process hence good for classifying large areas over multiple images. Supervised classification is the process of using training samples, samples of known identity to classify pixels of unknown identity (Lambin & Geist, 2008; Myint, 2001; Rodríguez Eraso et al., 2013). It is semi-automated, prior decision-based classification method. The quality of a supervised classification depends on the quality of the training sites.

Study Area

Geographically, district Mahendragarh is located $27^{\circ} 47' 50''$ and $28^{\circ} 28' 00''$ North Latitudes and $75^{\circ} 54' 00''$ and $76^{\circ} 22' 11''$ East Longitudes. It lies in Southern part of Haryana state covering an area of 1939 km^2 sq.km according to Survey of India Topographical maps. It is bounded by Bhiwani district in the north, by Rewari district in the east and by the state of Rajasthan in the southeast, south, southwest and west (Map 1). It is constituted by eight administrative blocks as, Mahendragarh, Satnali, Kanina, Ateli, Nangal Chaudry, Shima, Narnaul and Nizampur. Total 371 villages, 347 Gram Panchyats, and 458 habitations are situated in the district. The normal annual average rainfall of the district varies from 420 mm to 480 mm during the last two decade which is unevenly distributed. From about the beginning of March, temperatures begin to increase rapidly even up to 48°C in May and June. The mean daily maximum temperature in January is about $18-21^{\circ}\text{C}$ and the mean daily minimum temperature about $4-7^{\circ}\text{C}$.



Map 1 Location Map of the Study Area.

Data Base and Methodology

The current study is based on secondary data derived from several satellite images, with primary data used for field verification. ArcGIS 10.8 is used to conduct all GIS-related procedures. The IRS-P6 (RESOURCESAT-1), LISS III satellite data, March 2002 and March 2012 is used for land use/cover mapping, along with the Survey of India topographical sheet and Google earth satellite image. The existing land use/cover map was prepared with multispectral and multi-temporal satellite imagery (2002 & 2012). Unsupervised and supervised digital image classification procedures with maximum likelihood classifiers were used to classify multispectral pixels into different land use/cover classes (Chen et al., 2006). Each cluster is awarded a class based on a

careful examination of the Google Earth pictures and toposheets of the research area. The study area is mainly separated into nine classes of LULC. LULC maps for the research region are created using the aforesaid approach for 2002 and 2012. The current study's major goal is to examine the change in LULC of the study area and its impact of society. Supervised classification is the process of using training samples, samples of known identity to classify pixels of unknown identity (<http://gers.uprm.edu>). It is semi-automated, prior decision-based classification method. The quality of a supervised classification depends on the quality of the training sites.

Spatial Data

- i. Open series Survey of India toposheets 1: 50,000 and other maps
- ii. IRS LISS – III; Multi- Spectral Satellite Image (March, 2002 & 2012)
- iii. Google Earth Image.

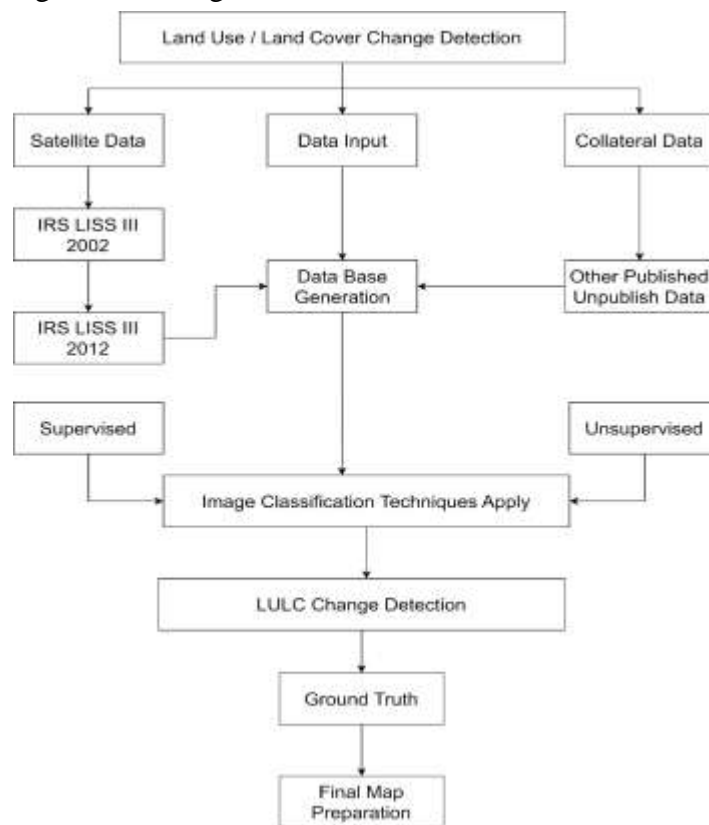


Fig 1 Methodology to find LULC Changes.

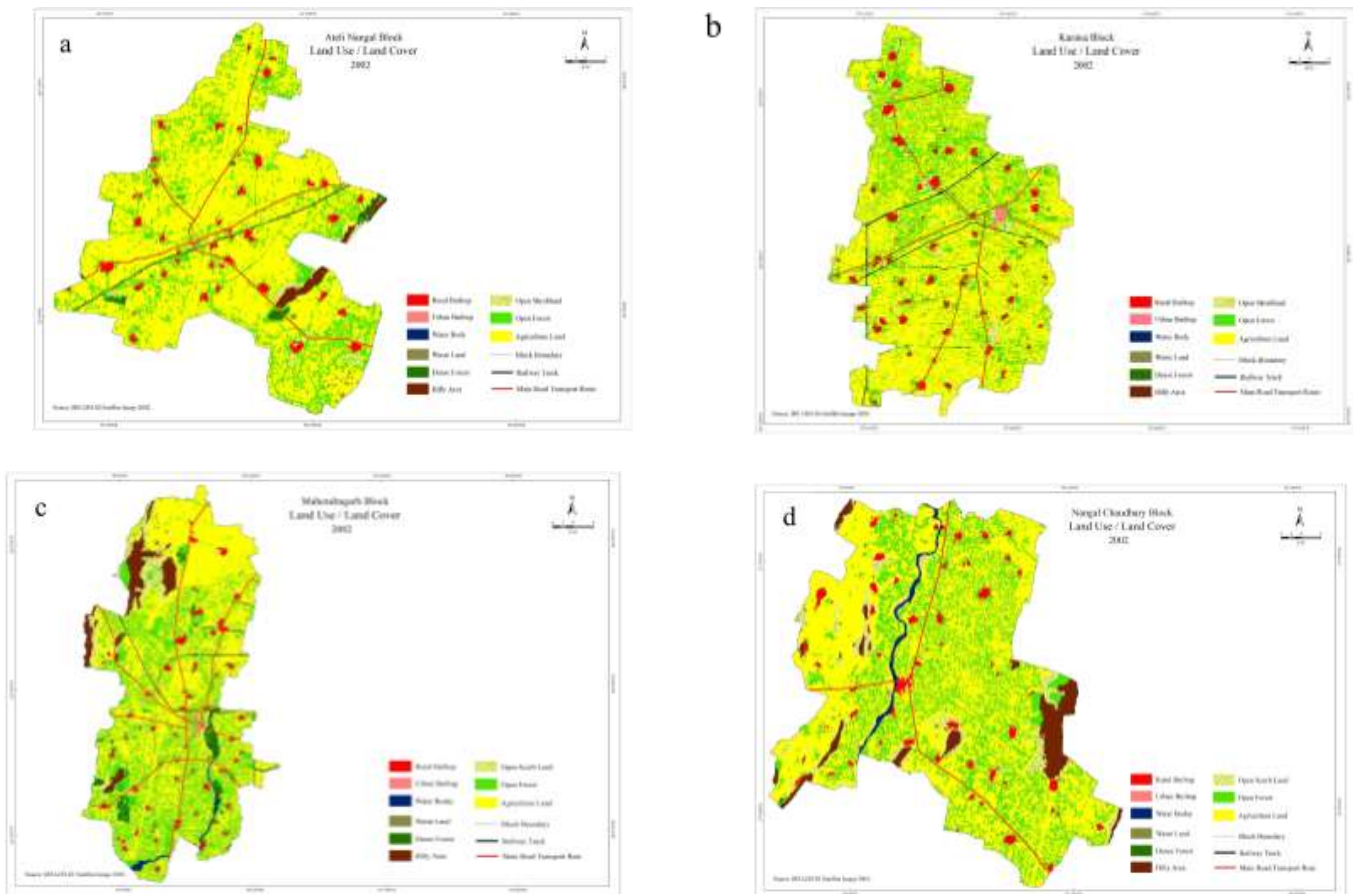
Results and Discussions

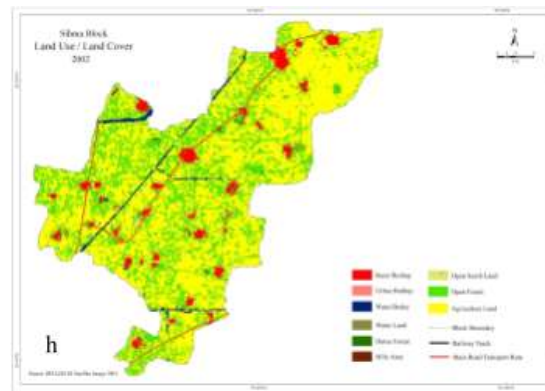
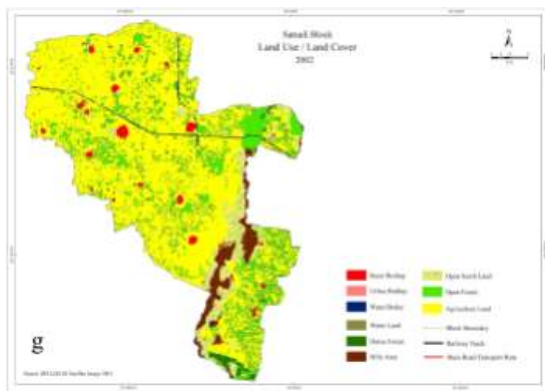
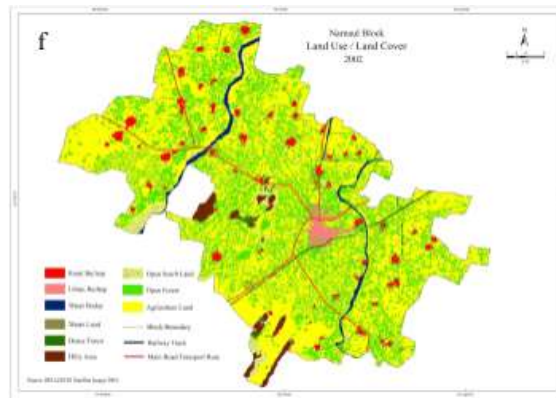
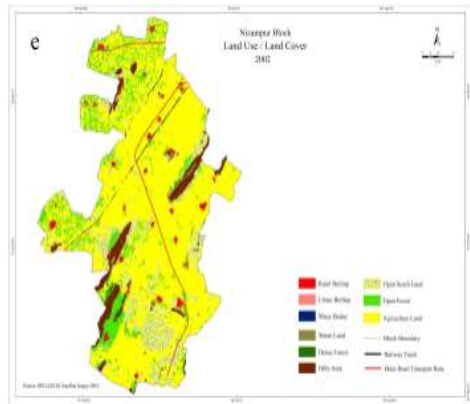
Land Use / Land Cover 2002

For the sake of better LULC analysis, Mahendragarh District is divided into eight blocks viz. Ateli, Kanina, Mahendragarh, Nangal Chaudhary, Narnaul, Nizampur, Satnali, Sihma. All the blocks are dominated with agricultural land use practices due to availability of water for irrigation and acceptable soil characteristics. Ateli Nangal block has highest proportion of their land under

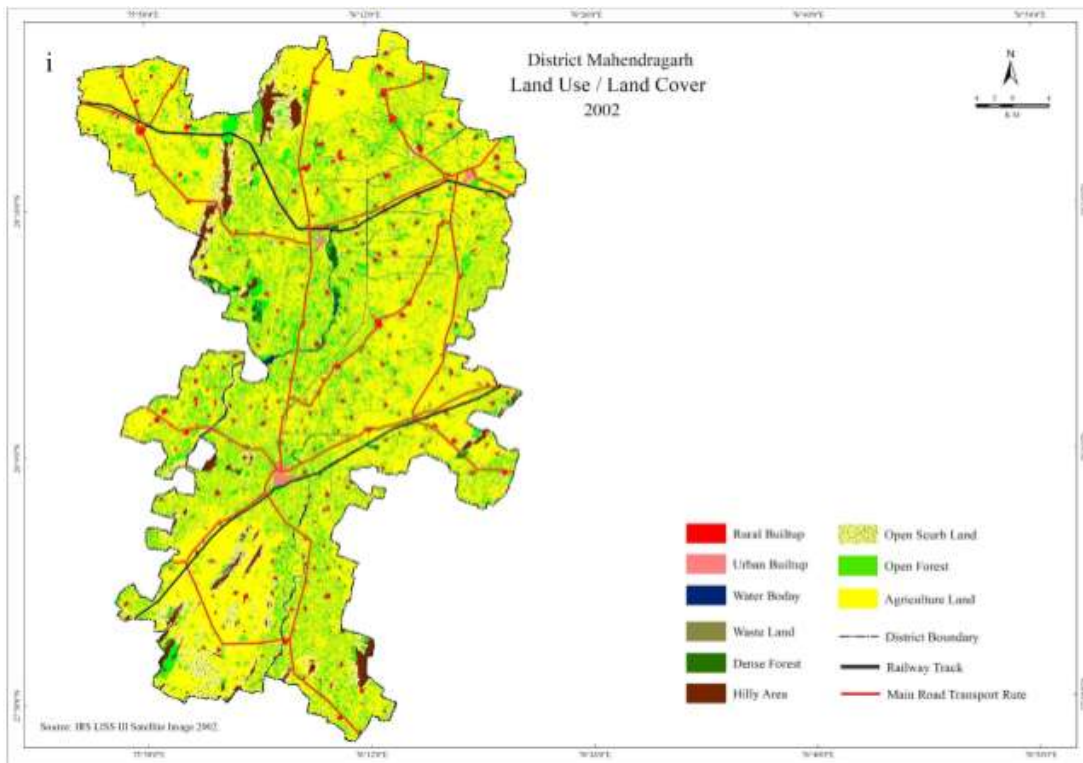
agriculture while Narnaul has smallest. Second predominate LU/LC is forest for all the eight blocks.

Ateli Nangal block is located in the eastern portion of the Mahendragarh District, with 97.21% of the land area being non-built-up and 2.79% of the land area being built-up. The eastern portion of the block contains traces of the Aravalli Range (Map. 2a). Kanina is the largest of the Mahendragarh District's blocks. 96.86% of the land area is non-built-up, with just 3.14% of the total built-up area. Well-connected settlements with a public transportation system are visible on the map (Map. 2b). With the 97.46%, 2.5% of non-built-up and built-up area respectively Mahendragarh block is situated in the northern part of the district sharing its northern boundary with the Bhiwani district. Some residuals of Aravalli covered with vegetation are also found in the block (Map. 2c). Narnaul block has agricultural land with scattered open forest in between. Two canal streams irrigated the block which have some patches of small hills (Map. 2f). Nangal Chaudhary block covers the southern part of district having only one canal to irrigate the land with majority of agricultural land situated on its eastern side. Eastern most part of the block is studded with hills which are covered with forest on limbs and open scrub land on the foothills (Map. 2d). Nizampur block has some branches of Aravalli range, extended to the middle part of block surrounded with agricultural land.





It has 98.40% non-built-up area and 1.60% of built-up area (Map. 2e). Satnali block has its place in the northwestern region of Mahendragarh District, having 98.23% of area under non-built-up category and 1.77% area under built-up category (Map. 2g). Sihma block, which comprises a small area in the middle part of Mahendragarh district, has the distinction of having the smallest proportion of non-built-up area (Map. 2h). Combination of all the blocks formed Mahendragarh District having 72.17% of land under agriculture, 18.19% forest area, 0.10% waste land etc. In aggregate 97% of land in district is under non-built-up activities (agriculture, forest, hilly Area etc) and only 3% built-up area (settlements, transport etc.) (Map 2i).



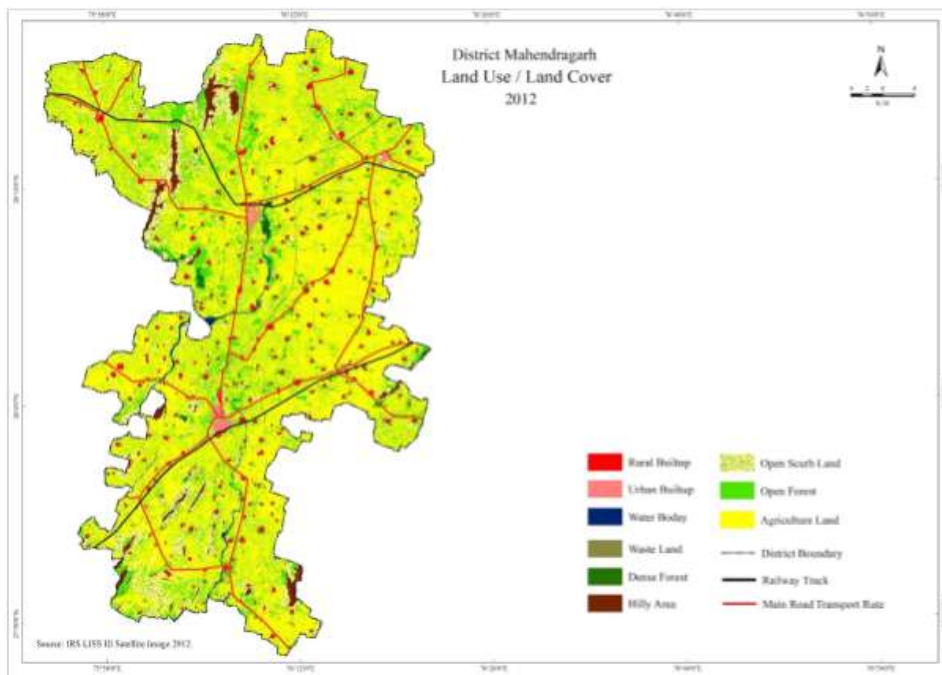
Map 2 2002 LULC Map of Ateli (a), Kanina (b), Mahendragarh (c), Nangal Chaudhary (d), Narnaul (e), Nizampur (f), Satnali (g), Sihma (h), District Mahendragarh (i).

Land Use / Land Cover 2012

Block wise land use / land cover analysis for Mahendragarh district is depicted with the help of Maps. In proportion to their respective area, Ateli block has largest portion of land under agricultural activities and Nangal Chaudhary block has minimum. Forest area is the second dominated land cover for all the blocks whereas; water bodies occupy the least land area. The total area of Mahendragarh District is 1938.46 sq. km, out of which, 1280.90 sq. km is covered by agriculture and only 3.80 sq. km of area is under canal network in 2012 (Table 1). Some patches of hills are also found in northwestern and southern part of district which occupies 2.04% or 39.51 sq. km of district's total area. Forest area secures its second position in term of total area for whole district. Detailed block wise analysis of the study area with the help of maps is depicted in the Map 3a to 3h.

Land Use/ Land Cover Changes from 2002 - 2012

In this project work, changes in the land use and land cover of Mahendragarh district of Haryana are evaluated from the differences between ten years of period (2002-2012). Historically, in India land development decisions have been taken by a landowner at the parcel



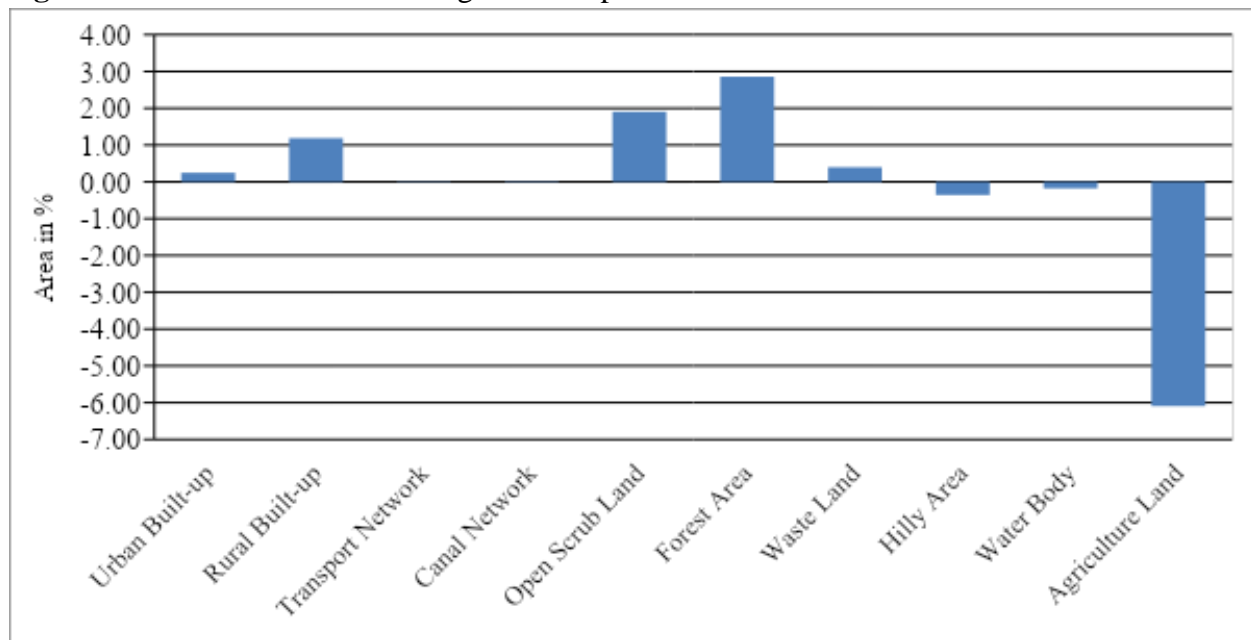
Map 3 2012 LULC Map of Ateli (a), Kanina (b), Mahendragarh (c), Nangal Chaudhary (d), Narnaul (e), Nizampur (f), Satnali (g), Sihma (h), District Mahendragarh (i).

level. During the field work, it is observed that the expansions of human activity in natural resources, exploitation, and lack of conservation planning and socio-economic factors have determined the land use and land cover changes in the district. Over the last ten years, a lot of land use / land cover changes have occurred. The direct or indirect relationship of these changes might have observed natural resources degradation in the study area. Geographical Information System technology was used to assess the land use / land cover changes of project study area. These changes have been carried out to adopt the methods of systematic comparison of a set of individual land use / land cover class for the both time satellite image. The regional differences in natural environmental and socio-economic condition lead to significant regional variations in land use / land cover patterns of the district. The findings reveal that there is a drastic and rapid increase in built up area and decrease in agricultural land. A concrete changes figure description of land use / land cover given of in table no. 1.

Table 1 Land Use / Land Cover Change from 2002- 2012

Sr.	Category	2002		2012		Change	
No.	Name	Area in Sq.Km	Area in %	Area in Sq.Km	Area in %	Sq.Km Area	% in Area
1	Urban Built-up	4.32	0.22	9.10	0.47	4.78	0.25
2	Rural Built-up	40.48	2.09	63.51	3.28	23.04	1.19
3	Transport Network	6.01	0.31	6.32	0.33	0.31	0.02
4	Canal Network	3.43	0.18	3.80	0.20	0.37	0.02
5	Open Scrub Land	67.18	3.47	104.11	5.37	36.93	1.91
6	Forest Area	352.62	18.19	407.94	21.04	55.31	2.85
7	Waste Land	1.85	0.10	9.56	0.49	7.71	0.40
8	Hilly Area	46.42	2.39	39.51	2.04	-6.90	-0.36
9	Water Body	17.13	0.88	13.69	0.71	-3.44	-0.18
10	Agriculture Land	1399.03	72.17	1280.90	66.08	-118.12	-6.09
	Total	1938.46	100.00	1938.46	100.00		

Fig 2 Land Use / Land Cover Changes for the period 2002 – 2012.

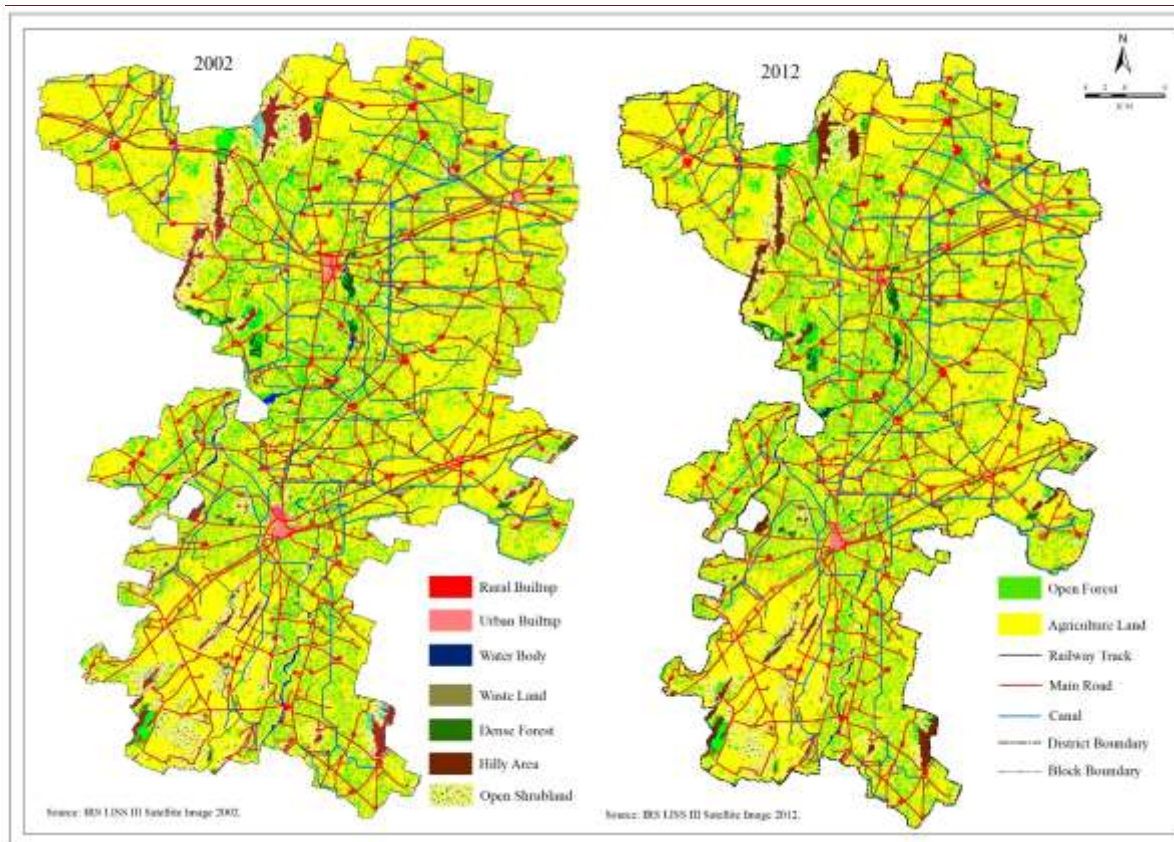


During the study period, district Mahendragarh of Haryana has lost 6.09% agricultural land (Fig. 2). Figures show that approximately 80% of the lost agricultural land has been converted into built-up area in rural area as well as urban area.

Table 2 Block Wise Land Use / Land Cover Change Area in Sq.km. from 2002- 2012

Sr. No.	Category	Ateli	Kanina	M.Garh	N. Chau.	Narnaul	Niz.	Satnali	Sihma
1	Urban Built-up	0.32	1.40	1.36	0.00	1.70	0.00	0.00	0.00
2	Rural Built-up	2.00	1.68	5.42	2.88	3.76	2.82	2.36	2.11
3	Transport Network	0.00	0.07	0.12	0.02	0.01	0.00	0.25	0.02
4	Canal Network	0.00	0.01	0.03	0.00	0.01	0.00	0.32	0.00
5	Open Scrub Land	1.44	4.99	5.42	4.68	6.09	4.79	8.35	1.18
6	Forest Area	2.37	-4.75	17.75	13.93	-12.19	14.64	25.39	-1.83
7	Bare Land	0.10	0.20	0.14	0.98	0.74	5.75	-0.48	0.29
8	Hilly Area	-0.49	-0.01	-2.03	-1.29	-0.74	-1.27	-1.13	0.05
9	Water Body	0.04	-3.08	-0.28	0.35	-0.19	0.41	-0.10	-0.58
10	Agriculture Land	-5.79	-0.37	-27.94	-21.55	0.81	-27.1	-34.47	-1.23

The study area having a large-scale land use / land cover changes heterogeneity at block level during the last decade (2002-2012). For this period of time the block Satnali has been presenting a high degree of agriculture land losses (34.47 sq. km area) followed by Mahendragarh (27.94 sq. km. area), Nizampur (27.14 sq. km. area) & Nangal Chaudhary (21.55 sq. km. area). As a result, these community development blocks have put an additional pressure on agricultural land for production, to fulfill the local livelihood requirements. For this purpose, there will be need to increase the carrying capacity of agricultural lands. Other broad change is found in forest cover area. In this category of land use / land cover the project study area represent a positive direction of development. Most of forest cover area has increased under protected forest cover category (along the road & canal network). Some pockets of land have developed under reserve forest category in the form of Herbal garden/ parks. Under this category total seven gardens have developed namely, Guggal Vatika (Salimabad), Chawan Rishi Vatika (Doshi), Faizalipur Herbal Park (Faizalipur), Kariya Herbal Park (Kariya), Kheri Herbal Park (Kheri), Mohalara Herbal Park (Mohalara) and Blaha Kalan Herbal Park (Blaha Kalan). During this period of time around 85 k. m. new link roads and 20 k. m. length of miner canal network have developed. Water body has shrunk. The built-up area has increased two-fold, especially in urban sector, it has speedily increased. Due to this, the mobility of man's force has put the pressure on natural resources.



Map 4 LULC Change in Mahendragarh District from 2001 to 2012.

Conclusion

In the study area, it was observed that the land-use dynamics at the village level ecosystems are highly interlinked to the livelihoods and anthropogenic forces as well as natural causes leading to major changes (multi-dimensional droughts). When measured in 2012, the entire area of the Mahendragarh District was 1938.46 square kilometres, although only 3.80 square kilometres were irrigated by a canal network. The remaining 1280.90 square kilometres were used for agricultural purposes. From 2001 to 2012, the block of Satnali lost the most agricultural land at a pace of 34.47 square kilometres, followed by the block of Mahendragarh (27.94 square kilometres), the block of Nizampur (27.14 square kilometres), and the block of Nangal Chaudhary (27.14 square kilometres) (21.55 sq. km. area). According to the findings, both the total amount of developed land and the total amount of farmland are growing at an alarming rate. Among the trends observed, urban influence is a major driver causing large area changes, natural causes being less significant. Other drivers included rainfall deficit, human population increase and government policies and their implementation & management decisions of local administrator.

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