Remote Sensing and GIS Enabled Mapping of Urban Outgrowth and Changing Land Use Pattern of Jhajjar City

PAWAN KUMAR & SURBHI GAUR
Centre for the Study of Regional Development (CSRD)
Jawaharlal Nehru University
Delhi (India)

Abstract:
Land is finite and fixed in a place. But land use is subject to control by people whose numbers are not fixed and who have many needs and who move easily. To increase an area of one land use, one has to encroach upon another land use. Thus, land use/land cover changes to meet the variable demands of the land by the society in its new ways and condition of life. This type of change will enhanced the superimposition of manmade feature on the natural landscape. The demand for new uses of land may be inspired by a technological change or by a change in the size, composition and requirements of a community. Some changes are short-lived whereas others represent a constant demand. In recent years, human activities have been recognized to be the major force in bringing about changes in the land use pattern. Understanding these land use changes and the forces which compels man to bring these changes is crucial in understanding, modeling, predicting and managing the local, regional as well as global land use patterns. The fast rate of urban development has made many changes in the land use patterns around cities. The urbanisation and changing land use cover in peripheral area now days become hot debatable issue among the planner, urban scientist, geographer and other social scientist. Effects of growing urbanization are being felt in both developed and developing countries.

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

1. Introduction

Remote Sensing (RS) and Geographic information system (GIS) are now providing new tools for advanced assessment of the changing land use and land cover. The collection of remotely sensed data facilitates the synoptic analysis of earth system function, patterning, and change at local, regional and global scales over time; such data also provide an important link between intensive, localized ecological research and regional, national and international conservation and management of biological diversity (Wilkie and Finn, 1996).

Land sat data provide a balance between the requirements for localized high-spatial resolution studies and global monitoring (Goward et al., 2001) and the free Land sat data policy opens a new era for utilizing the more than three million scenes stored in the U.S. Landsat archive at the United States Geological Survey (USGS) Earth Resources Observation and Science (EROS) and GLCF(Wulder et al., 2012).

However, in developing countries urbanisation has been growing at a much faster rate and consequently there is a proportionate change in land use. In 1950, the percentage of total population livingin urban areas was only 17, in 1970 it reached to 25.4% and by 2000, it rose to 41%. By 2000 and 2025, there will be doubling of urban population in developing countries (Hall & Pfeiffer, 2000). There has been a substantial growth of urban population in the Third World cities over the last decade and it is more shrinking in the poorest countries where the urban population is increasing by 5% per

annum. The built up area in developingcountries between 1980 and 2000 has increased by 118% (United Nations Centre for Human Settlements (UNCHS) 1996; World Bank, 1997).

Although India is a rural country but there is a definite urban orientation. The scale of urban development is quite alarming. The urban population of India was 25.7% of the total in 1991, which increased to 27.8% in 2001 and now in 2011 it become 31.16 percent. The overall urban population increased from 217 million in 1991 to 285 million in 2001. This figure will increase more higher in last decade as compare previous one. At present total urban population become 377 million. The numbers of towns and cities have increased from 4689 to 5161 between 1991 and 2001 (Census of India, 1991–2001). In previous decade, 2774 new town added in total, now the total urban town become 7935. This rapid growth of urbanization indicates that pressure on land for non-agricultural activities is increasing. The loss of agricultural land is far more serious in India. Between, 1955 and 1985, about 1.5 million hectare of agricultural land and in 1985–2000 about 800,000 hectare of agricultural land went to urban growth (Ramachandran, 2001). With rapid urbanization combined with continuing population growth both agricultural and social scientists have long expressed a concern as to whether India will be able to feed her teeming millions. Jhajjar is a walled city in historical time. Due to proximity to NCR (National Capital Region) and recently declared as district headquarter will make it more susceptible to change in term of land use pattern. The recently infrastructure development around the city and increasing frequency of connectivity to the mega city also accelerate the rate of city growth.

GLS (Global Land Survey) data are designed to provide a consistent set of observations to assess land-cover changes at quasi-decadal scale.GLS data set is composed of from only one to three Land sat images per land location which provides insufficient data to capture surface changes required for optimal land cover classification. Global 30 m observations have been provided by the Land sat 5Thematic Mapper (TM) and Land sat 7 Enhanced Thematic Mapper Plus (ETM+) from 1984 to present, corresponding to about 75% of the duration of the 40 year Land sat temporal data record (Loveland& Dwyer, 2012; Williams et al., 2006).

2. Review of Literature

At lot of work is done on the land use and land cover in last two decade, a lot of research scholar and institute try to attempt to identify and depict changing land use pattern all over the world. But still we are lacking in term of exact holistic and comprehensive research on land use and land cover. Thought and work of the some important and relevant theorist is discussed fallowing.

Land use and land cover are distinct yet closely linked characteristics of the Earth's surface. The use to which we put land could be grazing, agriculture, urban development, logging and mining among many others. While land cover categories could be cropland, forest, wetland, pasture, roads, urban areas among others (Meyer, 1995). 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).

Change detection is the process of identifying differences in the state of an object or phenomenon by observing it at different times (Singh, 1989). The basis of using remote sensing data for change detection is that changes in land cover result in changes in radiance values which can be remotely sensed. Techniques to perform change detection with satellite imagery have become numerous as a result of increasing versatility in manipulating digital data and increasing computer power. Many studies have been done using remote sensing and GIS in change detection.

Jusoof and Hassan (1998) suggested that the remote sensing data gives important information for land use. They also suggest that the change detection depend upon the spatial, temporal, spectral and radiometric characteristics of the sensor used in data collection. Zeng Shan (1999) used the applications of remote sensing and GIS in urban studies at present in China give more weight on the acquisition of urban land use information and the comparison on the urban sprawl spanning most recent several decades, giving an image that remote sensing and

Mertens and Lambin (2000) study with the objective to better understand the complexity of deforestation processes in southern Cameroon by testing a multivariate, spatial model of land-cover change trajectories associated with deforestation. Chen et al. (2000) studied the early applications of remote sensing to environmental monitoring and resources investigation, and outlined its achievements in China.

3. Objectives

The aim of this study is to produce a land use/Land cover map of areas in and around Jhajjar district of Haryana at different epochs in order to detect the changes that have taken place over a given period. The following specific objectives will be pursued in order to achieve the aim above.

- To create a Land use/ Land cover classification scheme of the study area.
- To determine the trend, nature and magnitude of Land use Land cover change.
- To analysis and interrelate the forces which are accelerate Land use and Land cover.

4. Methodology

The images which cover the Jhajjar were initially geo-referenced using top sheet of study area. The images with resolution 30 meter are enhanced using histogram equalization to increase the volume of visible information. Further, each image belongs to different years are following the geometric corrections, the base map is laid over each imagery and clip of image match to the Area of Interest (AOI) using Arc Gis 9.3.

Land use categories relating to agriculture, built-up area, dense forests, open scrubs, vegetation cover, water bodies, fellow land and waterlogged area present in the study area have been generated from remote sensing data. The non-spatial data relating to demographic characteristics have been obtained from Statistical Abstract of Haryana, etc. The administrative boundaries of district and reserved forest boundary have been taken from top sheets.

Geographic Information System (GIS) and Image processing software such as the Arc GIS 9.3 and ERDAS Imagine 10 have been used for image processing, geographical analysis, integration, superimposing/ overlaying and presentation of the spatial and non-spatial data for examining land cover and land use changes in the study area.

Land use and cover patterns for the year 1989, 2000 and 2011 are mapped by the use of satellite imageries. Firstly, each satellite image is classified using a supervised classification with minimum distance parameters. The classified images are verified again for its accuracy. It shows that some of the bare land is having similitude of agriculture land and it is categorized under agriculture land in supervised classification. ERDAS 10 software has been used for the land use change. Arc GIS was used for the production of final layouts and maps.

My familiarizations with the study area, availability of Google Earth's imagery for 2000 and 2006 have helped in proper identification of the land use and land cover classes during the signature editing. A set of rules was set to ensure a proper classification process.

The Normalized Difference Vegetation Index (NDVI) has used to identify a simple graphical indicator that can be used to analyse remote sensing measurement. The value of the NDVIis ranged from -1 to +1. The value of NDVI never got this figure exact but it lies between somewhere between this range. The high value of NDVI is in the equatorial forest and low in bare ground surface. This indicator gives us valuable information about the change in vegetation cover and health.

5. Data Sources

The fallowing data is used for the study

Table1: Sources of Data

Sr.	Data	Satellite	Date
1.	SOI Toposheet H43W10	-----	2007
2.	Satellite Image	Land sat (TM)	09/10/1989
3.	Satellite Image	Land sat (TM)	05/10/2000
4.	Satellite Image	Land sat (ETM)	09/10/2006
5.	Census of India		1991, 2001 & 2011

6. Study Area

Jhajjar town has rich historical heritage. The town is founded by Chhaju, in whose name; Jhajjar town has derived its name. The town is located at 76^0.40' East longitude 28^0.37' North latitude at an elevation of 214 metres from Mean Sea Level. Hot summer, cold winter, and scanty rainfall are the main climate characteristics of Jhajjar and its surrounding areas.

The town is encircled from three sides by a flood protection bundh. This bundh is a physical barrier for its horizontal expansion towards northern, western and southern sides. There is no perennial river in the district. The morphology of the town comprises of narrow lanes, temples, mosque, old dilapidated structures, linear pattern of shops and ponds etc. But being a part of National Capital Region (NCR), the town is expecting good potential for its development in future.

7. Demographic Structure

As per 1991 census the town has a population of 27,693 persons. The population growth ratehas been increased in the year 1991-2001 on becoming the District Headquarter. The decade wise population of town since 1991 is as per table given below:-

Table 2: Populations and Growth Rate of Jhajjar

Census Year	Population	Decennial growth rate % age
1991	27,693	--
2001	55,154	50.21
2011	80,000	68.94

The existing town and settlement covers a total built up area ofapproximate 284 hectares. As per censes 2001 the existing population of the town is 42305 persons. The gross population density for the town is about 90 persons per hectare whereas net residential area density is 300 persons per hectare.

8. Land Use Pattern

These anthropogenic influences on shifting patterns of land use are a primary component in the study area to create the current environmental concerns. The study of land use and land cover change is gaining recognition as a key driver of environmental change. This will give us the overall scenario to identify the changes. The patterns of the land use and land cover are change pervasive, increasingly rapid, and can have adverse impacts and implications at local, regional and global scales.

This study try to understand local level implication of the intesity of changing pattern in the landuse and land cover. In Jhajjar district in last 17 years data shows that a large scale change taking place in all area. Some of the area like Barren Land is showing the declining trend, in 1981 Barren Land is 6.11 percent of the study area, it shows the slight increasing in 2000. During 2000 it was 7.74 percent of the toatal area. But in the 2006 the barren land shows the deastically decline it remain only 4.14. The absolute change in this category was -3.60. It was such a big change with in the short span of time. The reason behind this was increasing in the demand of land, for that an atttempt to enchrochment more and more land in the southen western area mainly in Mathenal and Sasroli belt. In this area the soil are sandy in nature small type of sand dunes are found here in this area, which are not economically valuable for the farmer to cultivate them. But with time and changing saptial temporal nature of demand and supply with the advancement of the technology ehance the human capacity to grab more and more barren land into cultivable land.

Table 3: Land Use and Land Cover of Jhajjar District, Haryana

Class	1989	2000	2006
Barren Land	6.11	7.74	4.14
Open Scrubs	15.98	11.85	10.65
Build Up Area	8.60	9.15	11.69
Fellow Land	22.38	13.75	11.06
Dense Forest	3.02	5.31	6.34
Waterlogged Area	2.71	5.35	6.26
Agriculture Field	35.71	39.57	43.70
Water Bodies	2.58	4.38	4.14
Unclassified	2.91	2.91	2.03

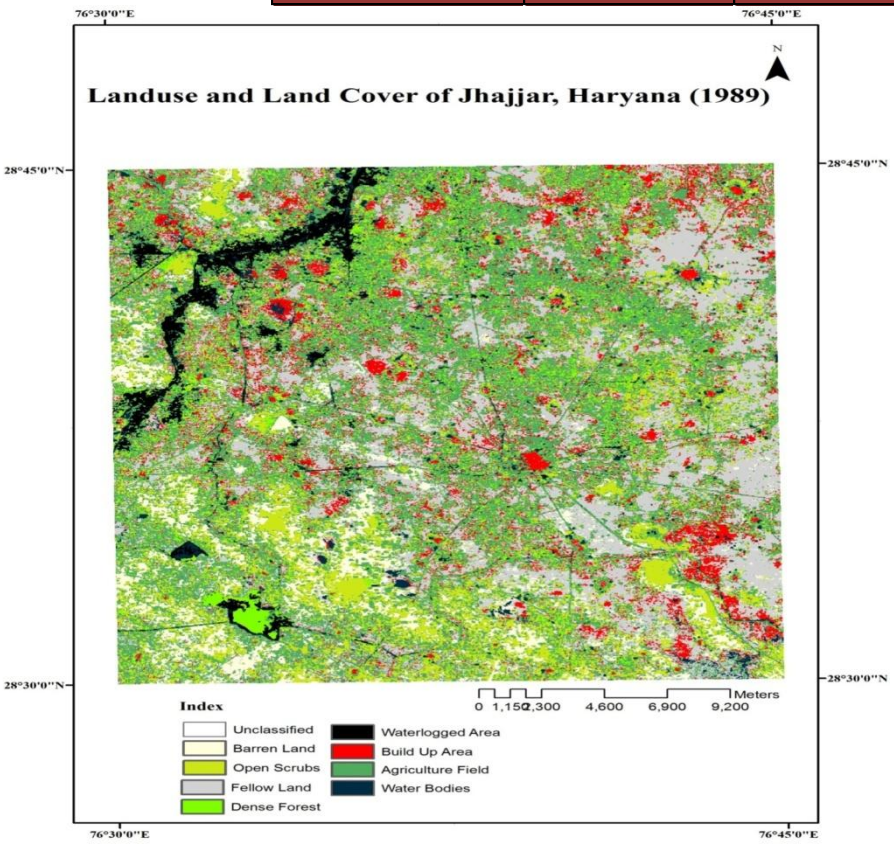

Fig. 1 Land Use and Land Cover of Jhajjar (1989)

The study area is located in the southern part of the Haryana, having the dry and semi-arid condition. The climate of the District is sub-tropical, semiarid, continental and monsoon type. The average annual rainfall from 1987 to 2005 is 580 mm. The weather during May and June is dry and hottest. The maximum temperature reaches up to 45^{o}C while in summer. This type of climatic condition provide the healty environment for the development of the scrubs, these are mainly located in the middle and southern part of study area. In the 1989 open scrubs are noted 15.98 percent of the area. These are showing the drastic decline in the remaining 11.85 having the decline more than 4 percent.

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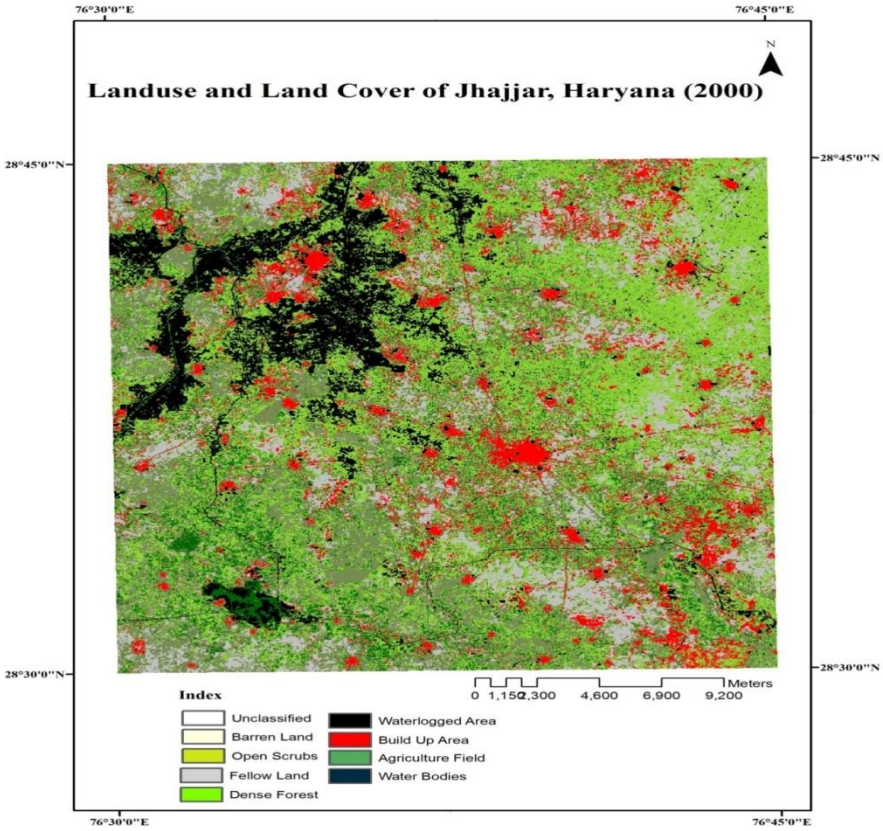

Fig. 2: Land Use and Land Cover of Jhajjar (2000)

The total area under open scrubs in 1989 was 10963.58 hectaure and it remain only 8124.4 hectaure. In the secound span of time (2000-06) this area under scrubs in degraded continously (10.65%) but the degree of degragation is gone down. The inferastrature development and agriculture advancement are the mainly responsible factor behind this change.

Table 1: Absolute Change in the Land Use and Land Cover (1989- 2006)

Class	Absolute Change in (1989-2000)	Absolute Change in (2000-06)
Barren Land	1.63	-3.60
Open Scrubs	-4.14	-1.20
Build Up Area	0.55	2.54
Fellow Land	-8.63	-2.69
Dense Forest	2.29	1.03
Waterlogged Area	2.64	0.91
Agriculture Field	3.86	4.13
Water Bodies	1.80	-0.24
Unclassified	0.00	-0.88

Build up area is increasing from the last two decades but the change are more drastic between the 2000 and 2006. During this period the absoltue share of build up area in increase 2.54 percet. The increasing share of build up area was boost up by increasing population, accumulation of wealth in the hand of farmer and changing life style of rural area. One interesting fact is that build up area in the small town like (Beri, Chwechekwas, Mathenal) and village like (Charra, Mathan, Barghena) was increasing more than as compare to district centre. The resposible factor for this will be discuss later.

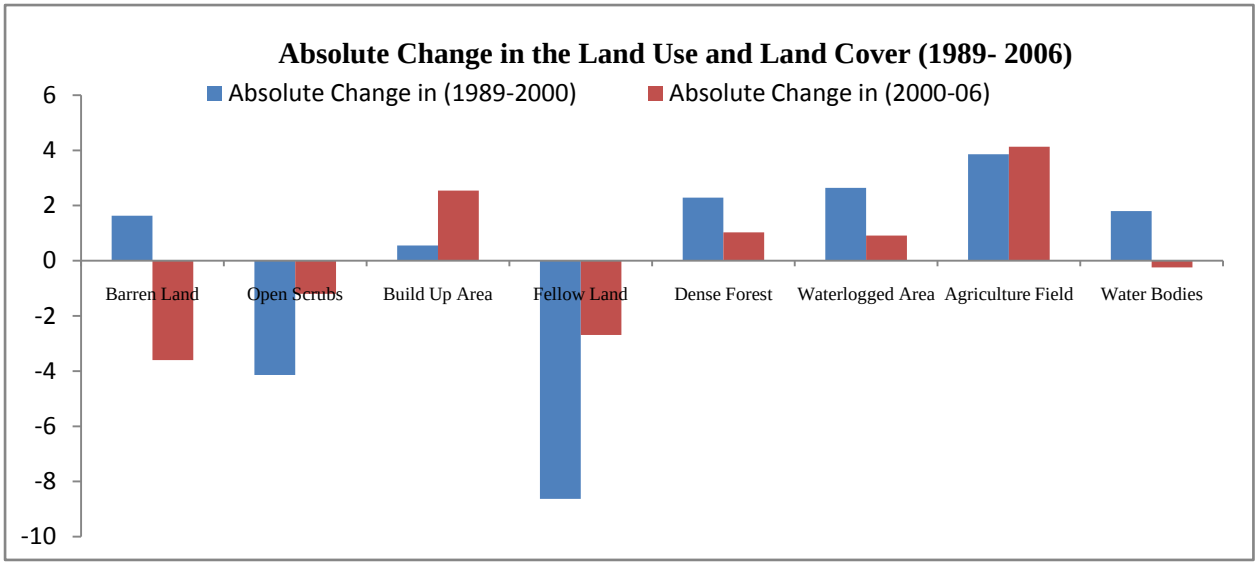

Fig. 3: Absolute Change in the Land Use and Land Cover (1989- 2006)

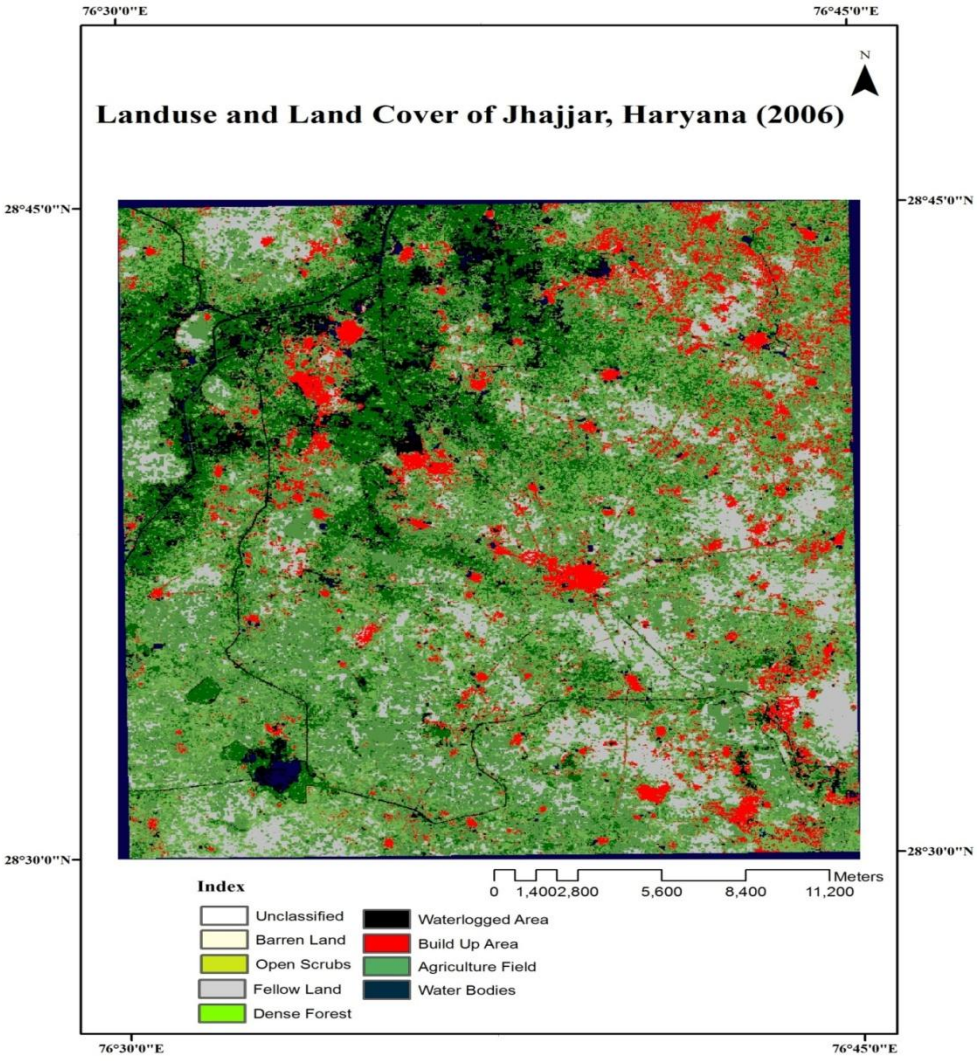

Fig. 4: Land Use and Land Cover of Jhajjar (2006)

Fellow land includes all lands which were taken up for cultivation but are temporarily out of cultivation for a period of not less than one year and not more than five years.

Impact of growing population on the landuse change is also discernible as population has experienced more increase during the study period. The study reveals that area underagricultural land and built up use has witnessed sharp increase respectively. This change in land use has largely been between these two categories. It is more evident from the fact that area under agricultural use was about 35 percent during early 1989s which increased to 39.57 percent during the next decades and further increased to 43.70 percent in 2006.

9. Normalized Difference Vegetation Index (NDVI)

The Normalized Difference Vegetation Index (NDVI) is a simple graphical indicator that can be used to observed green vegetation and its health. To determine the density of green on a patch of land, researchers must observe the distinct colours (wavelengths) of visible and near-infrared sunlight reflected by the plants. NDVI is calculated from the visible and near-infrared light reflected by vegetation. Healthy vegetation (left) absorbs most of the visible light that hits it, and reflects a large portion of the near-infrared light. Unhealthy or sparse vegetation (right) reflects more visible light and less near-infrared light. Calculations of NDVI for a given pixel always result in a number that ranges from minus one (-1) to plus

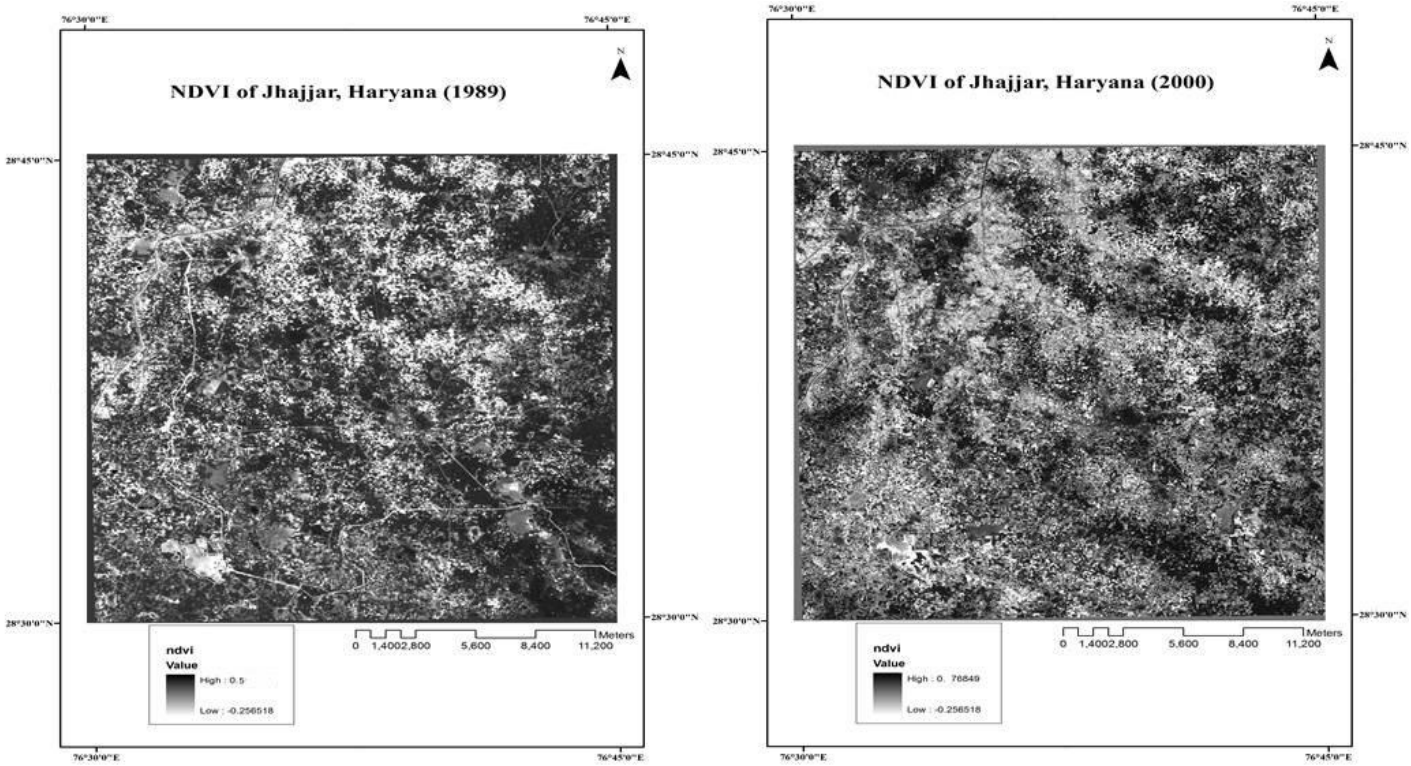

Fig. 5: NDVI of Jhajjar (1989, 2000)

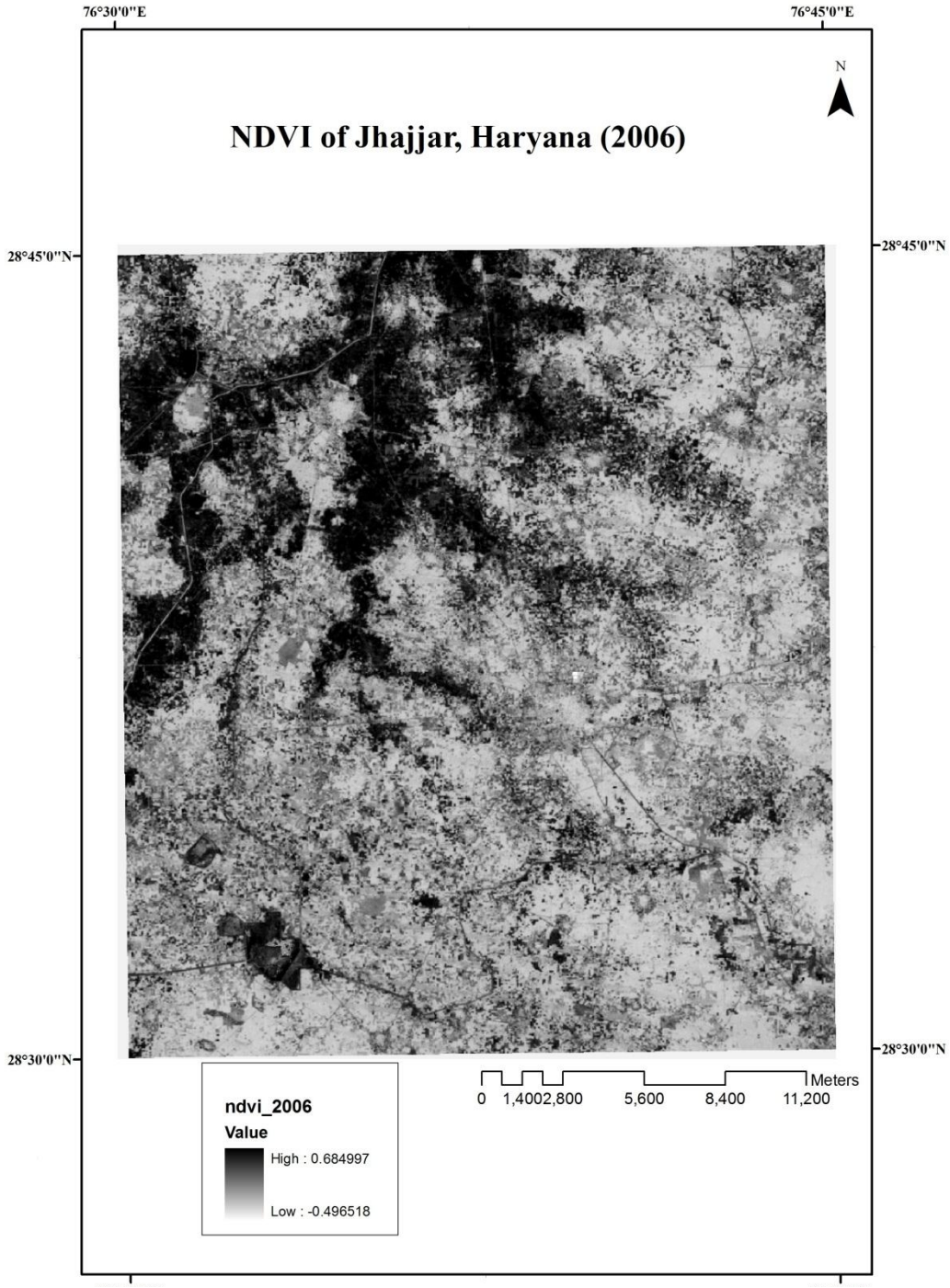

Fig. 6: NDVI; 2006

One (+1); however, no green leaves gives a value close to zero. A zero means no vegetation and close to +1 (0.8 - 0.9) indicates the highest possible density of green leaves

An attempt is made for understand the changing pattern in the vegetation and its health by using NDVI. In simple words the NDVI gives us the information about the vegetation cover of the study area; the black area is showing the dense crop area or forest cover area. If we analysis 1989 and 2006 data we find that vegetation in the North West part become very dark. This area shows the remarkable improvement in the agro forestry and micro irrigation system and increasing availability of the canal irrigation are the main responsible factor.

If we have a look to all of three images together we found that in vegetation perspective study area does not showing any large scale change. The There is a temporal change noted in NDVI of the study area. The NDVI max value around .5 but increase 0.7 in 2000; but again the value is decreasing in 2006. The value of NDVI is increasing between 2000-06 due to increasing in cropped area and crop intensity. But in between 2000-06 value of NDVI is decrease because of a large scale development project caused degradation of forest and encroachment of agriculture land.

Table 2: Normalized Difference Vegetation Index (NDVI) Value of Jhajjar District

Years	Lowest	Highest
1989	-.2647	0.5
2000	-0.2185	0.7684
2006	-0.4965	0.6849

Some of the barren lands convert into the agriculture field this will leads to increasing of vegetation cover area. The pace of change is differentduring 2000-06 as compare to change in 1989- 2000. Southern east part of the image is showing decline in the vegetation health as well as area.

10. Land Use Pattern of Jhajjar City

The land use/land cover map of 2000 shows that the built up area was only 18.44% of the total area. The major land use class in study area was agricultural land 14.78 sq. Kim. i.e. 56.09% of the total area. Vegetation, bare land and water bodies' classes cover an area of 4.61 sq. km, 1.11 sq. km. and 0.98 sq. km. respectively.

Table 3: Land Use and Land Cover of Jhajjar City

Land Use Type	2000		2006		Net Change Area	
	Area in Sq. k.m	Area in %	Area in Sq. k.m	Area in %	Area in Sq. k.m	Area in %
Build up Area	4.86	18.44	6.45	24.48	1.59	6.04
Water Bodies	0.98	3.72	0.72	2.72	-0.26	-0.99
Agriculture	14.78	56.09	13.16	49.94	-1.62	-6.15
Vegetation	4.61	17.5	4.83	18.33	0.22	0.83
Bare Land	1.11	4.21	1.18	6.9	0.07	2.69
Total	26.35	100	26.35	100		

As per the land use/ land cover assessment of 2011, it is estimated that 49.94% area was under agriculture land, 2.73% of the area under water bodies, 18.33% under vegetation category, 24.48% under built up and 6.90% under bare land. The increase population and urbanization causes huge change in the core of the town.

The analysis of Land use/land cover for different time periods, indicate substantial change. Major changes have taken place mainly in the built-up area and agricultural land. Agricultural land has decreased and built up area is increases in the time period of 2002-2006. Analysis indicates that agriculture land is reduced continuously by human activities. Loss of agriculture land can be easily accredited to the urban expansion. It shows that the town's economy is based on agriculture.

Jhajjar is a walled city in the ancient time this pattern still exists till 2006. Most of the growth of the city in the fort shape pattern. But now a day's core of the city is saturated and population is increasing at faster pace. A few encroachments are made towards the north elongated to highways and roads. This force result the city pattern in future.

Table 4: Jhajjar City Land Use Pattern, 2006

Serial Number	Land use	Area in Hectares	Percentage
1	Residential	1868.82	35.95
2	Commercial	282.19	5.43
3	Industrial	677.82	13.04
4	Transport and Communication	780.12	15
5	Public Utilities	338.84	6.52
6	Public and Semi Public Use	478.54	9.21
7	Open spaces and Green belt	771.81	14.85
	Total	**5198.14**	**100**

Source: HUDA, Jhajjar

Land use of Jhajjar city is showing different type of the city structure. More than the 35 percent of city land is used for the residential purpose. Which is commonly not found in Indian Cities?Only 5 percent is used for commercial purpose, 13 percent is used for industries. Most of industries are small scale industries and based on the agriculture or related activities. 15 percent of the city land is used for transport and communication this shows the smoothness of the city transport. After analysis the city land use pattern in future some of the area has the potential to grow at large scale like services, industry and public utilities.

11. Constraints of Urban Development in Jhajjar Town

Pattern of urbanisation in Jhajjar district is not as fast as the other NCR city, because a lot of locational and other physical- social factor constrain in the Jhajjar city. The constraints are discussed below.

(1) Flood: The South-West and North-West parts of Jhajjar town including surrounding areas in these directions are heavily prone to floods due to existence of saucer like depression, rain water accumulates in aforesaid depressions/low lying areas. Due to this problem of floods, this town had experienced outmigration to other urban centres and this factor has acted as a deterrent for establishment of new industrial or commercial activities as well as expansion of the existing town. A Bundh/barrier in the form of the western periphery road has been proposed and constructed to safeguard this area from floods.

(2) Non-availability of Potable Underground Water: Availability of good quality of surface or groundwater is essential for the expansion of agriculture, industry as well as urbanization. However, in Jhajjar town, by and large quality of ground water is brackish. The surface water is also limited to its source which lies outside the state. It is therefore, imperative to provide canal based water supply to the town.

(3) Non Accessibility though Rail Network: The accessibility through rail network is essential for the development of an urban centre. Since Jhajjar town is not connected through any rail network,therefore, this town could not become an attraction for new industrial and commercial units. Hence, the small market of Jhajjar town is catering only to the agrarian demand of its hinter land. Now, the Rohtak - Jhajjar- Rewari Railway segment has been approved which is at completion stage.

(4) Poor Infrastructure: The availability of higher order of infrastructure is essential for the healthy growth of town. Since, Jhajjar town has attained the status of District Headquarter in 1997; therefore, district level infrastructure is yet to be created in this town.

(5)Poor Economic Base: The Jhajjar town does not possess any sound economic base due to aforesaid reasons which has resulted in out-migration of population.

12. Conclusion

Foregoing discussion makes it clear that landusesin the study area have undergone significant transformations during last 17 years. In contrast, the built-up land was hardly 18.44 percent in 2000 in

controlled area, which rose further to about 24.48 percent in 2006. It is observed that such increase in built up area has taken place due to new planned residential estate known as HUDA and increasing urban sprawl due to nearness of NCR and development of good accessibility due to network of roads including NH-72 . The study therefore reveals that changes in land use particularly urban expansion has occurred due to huge population pressure in the study area. The study also reveals that the natural vegetation cover has also been depletion might pose a serious threat to ecological balance as the whole study area is environmentally sensitive region and rich in biodiversity. The study also illustrates the difference of change in land use within city and outside the city.

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