

## Urban Growth, Land Use Changes and Its Impact on Cityscape in Sonipat City Using Remote Sensing and GIS Techniques, Haryana, India

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**Abstract** Urban growth of Sonipat city within the last 42 years is observed through MC map of different time which points out the dramatic change in the cityscape. The land use change is based on satellite imagery of LISS-III 2002 and 2011. Land use/land cover classification is based on supervised classification. Supervised classification was performed for the four major land use/land cover category; built-up area, agricultural land/vegetation, open/bare land and water bodies through Eradas 9.0. Arc GIS 9.3 software is used to prepare the thematic maps. Ground truth observations were also performed to check the accuracy from Google earth. Toposheets at a scale of 1:50000 have been used for geo-referencing the MC map of study area. Census data and MC map have been used to analyse the population growth and areal extension.

**Keywords** *Urban Growth; Land Use Changes; Areal Extension and GIS*

### 1. Introduction

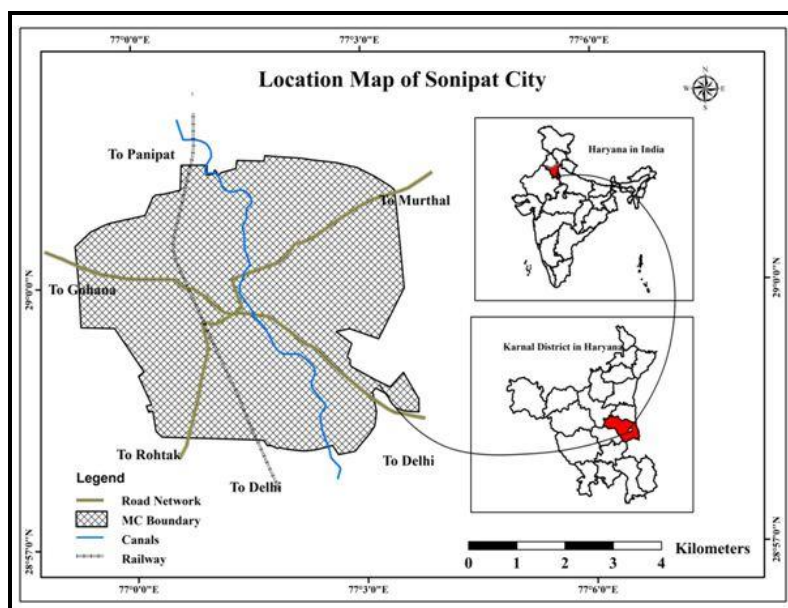
Urban growth refers to the route of growing concentration of people inside a town or city which commence from a small dot and after that it spreads in dissimilar ways with varying intensity of growth from one urban place to another. (Paul and Dasgupta, 2013). The rapid urban growth through economic development has been an issue of concern to the planners in all over the world. (Singh, A.L., 2012). The rapid urbanization has changed the Indian scenario also and the landscape has felt the consequence of land conversion. Various causes of urban expansion for example population growth, economic development, migration and infrastructural innovations are resulting in transformation of villages into towns, towns into cities and cities into metro cities (Singh, et.al, 2008).

The rapid urbanization through industrial development is responsible for unsystematic and unplanned growth of cities and the pressure of urban population in the city has a direct (positive and negative) impact on its adjoining rural area. This type of urban growth creates the tribulations like unhealthy

slums, infected environment, industrial and commercial areas resulting in traffic bottle necks and such many other problems (Sangwan et.al. 2012). The analysis of spatial and temporal changes in land use/land cover is one of the effectual ways to understand the current environmental status of an area and its ongoing changes. Urbanization makes unpredictable and long lasting changes on the landscape (Singh and Kumar, 2012). In this regard, Sonipat city is no exception because of its prime location on N.H.1 and its easy accessibility and connectivity to both National Capital of Delhi and Union Territory of Chandigarh. The new economic environment of the city demands sustainable land management and spatial information of land use and their change over the time are important for planning and management. The association between urban growth and land use changes and their impacts on cityscape has been analyzed in the present study. So, satellite data of different time periods are useful to city planners to monitoring urban growth and development of a sustainable land use plan for the future.

## 2. Study Area

Sonipat city is the head quarter of Sonipat district which lies in the national capital region. As per 2011 census, the total population of the city is 277053 persons. Its closeness to NCT Delhi and easy fast accessibility to it through N.H.1 has led to urbanization of the city. According to city development plan, the Sonipat city which is a satellite town of the National Capital Region (NCR) has been divided in 31 wards by Municipal Corporation which has grown up as residential, industrial and commercial areas.



*Figure 1: Location Map of Study Area*

## 3. Objectives

- To identify the land use changes in Sonipat city;
- To examine the areal extension and direction of Sonipat city;
- To identify the relationship between population growth and areal extension.

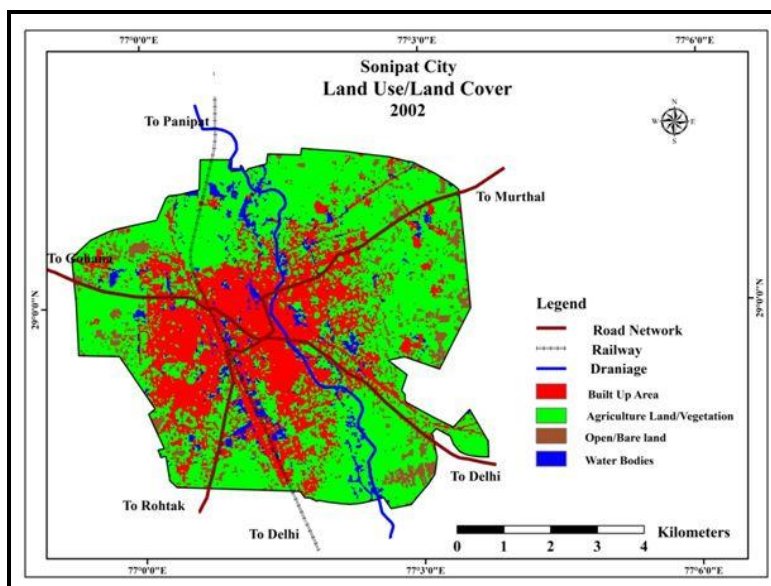
## 4. Materials and Methods

Present paper is based on the remote sensing spatial as well as the non-spatial data available from the various sources for different periods. The sources are Statistical Abstract of Haryana, Town and Country Planning, District Gazetteer of Sonipat district and Town directory of Haryana. Satellite data

of the study area for 2002 and 2011 was obtained from HARSAC (Haryana Space Application Centre), Hisar. Topographic sheet No. H43Q16, H43R4, H43W13 and H43X1 at scale of 1:50,000 are used for the geo-referencing of M.C. map of study area in different time periods. Urban growth of the study area for 2002 and 2011 has been mapped with the help of satellite data. To measure the areal extension of city different time MC map has been used. The changes in land use pattern have also been assessed and mapped with the help of Arc GIS 9.3 and Erdas 9.0 software. Field verification was performed throughout the study area using GPS and obtained correct setting for each land use class incorporated in the categorization format. The study is based on supervised classification and visual interpretation of different time satellite imageries. The 2002 land use pattern could not be checked against the ground truth but, the available historical data for the study area were used to confirm the interpretation made (Singh and Kumar, 2012). However, LISS III supervised image of 2011 was directly checked against ground truth all the way through the study area. Urban expansion through economic development has direct impact of cityscape and changes in land use of study area. The paper focuses on interpreting city's land use change pattern and growth based on spatial and non-spatial data. LISS III 2002 and 2011 satellite data are used to identify different patterns of land use changes and growth of the study area. Analysis of Sonipat growth over a period of 10 years allows a good understanding of urban development.

## 5. Sonipat City: Land Use in 2002

In 2002 agriculture land/vegetation emerged as the dominant land use class. It covers an area of 1955.64 hectares i.e. 58.15 percent of the city area followed by built up area, open/bare land and water bodies i.e. 31.70 percent, 5.40 percent and 4.75 percent respectively. In 2002 built up area had increased because the new economic reform, after 1991 giving a way of urban development of Sonipat city with industrisation on the cost of agriculture/vegetation and open/bare land. As compared to peripheral area, central part of the city, which represents the establishment of the city, is highly dense and used for the residential, commercial, public and semi-public purpose.

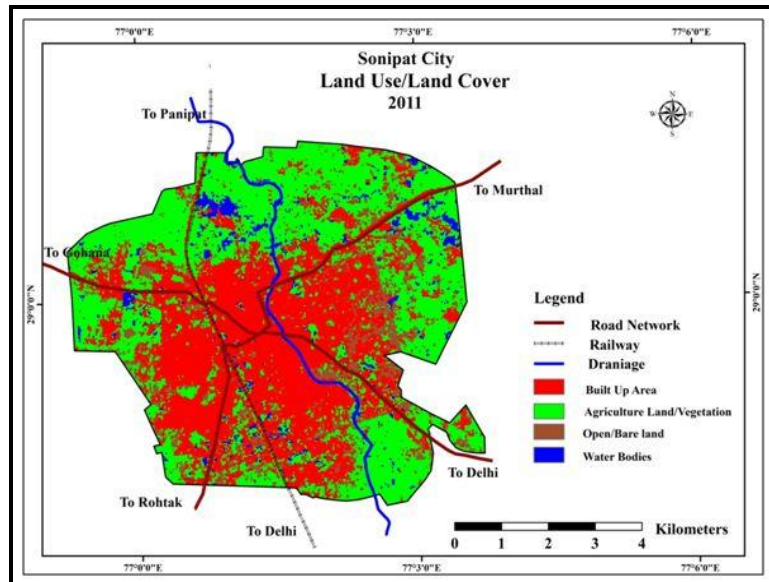


**Figure 2:** Sonipat City: Land Use/Land Cover 2002

**Source:** Based on LISS III Image (2002)

**5.1. Sonipat City: Land Use in 2011**

In 2011 the built up area has increased due to urbanization which has given a way to urban development of the city. It increased near about 30.62 percent whereas agricultural land/vegetation has been decreased 449.71 hectares i.e. 23.46 percent.



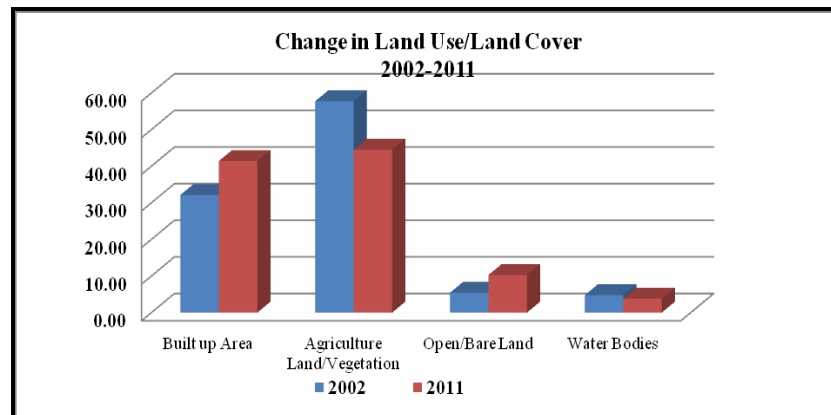
**Figure 3:** Sonipat City: Land Use/Land Cover 2011  
 Source: Based on LISS III Image (2011)

Open/bare land has been increased due to acquisition of land for residential and commercial purpose through Haryana Urban Development Authority and private builders, but there are no constructions, so it has been included in open land category. Water bodies have also been decreased 30.57 hectares i.e. 19.51 percent due to population pressure.

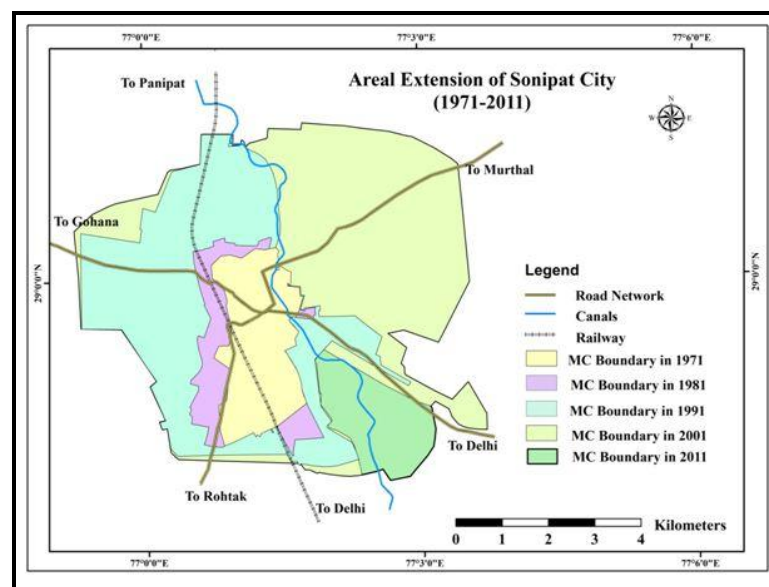
**Table 1:** Change Detection Statistics: 2002-2011

Land Use Categories	2002		2011		2002-2011	
	Area (Hect.)	Area (%)	Area (Hect.)	Area (%)	Change (Hect.)	Change (%)
Built up Area	1010.31	31.70	1371.46	41.40	320.45	30.62
Agriculture Land/Vegetation	1955.64	58.15	1465.23	44.51	-449.71	-23.43
Open/Bare Land	178.40	5.40	339.09	10.27	160.70	90.08
Water Bodies	156.72	4.75	126.14	3.82	-30.57	-19.51
<b>Total</b>	<b>3301.06</b>	<b>100.0</b>	<b>3301.06</b>	<b>100.00</b>		

Source: Based on LISS III (2002) LISS III (2011) Images



**Figure 4:** Change in Land Use/Land Cover 2002-2011  
Source: Based on Table 1



**Figure 5:** Areal Extension of Sonipat City (1971-2011)  
Source: Municipal Office, Sonipat City

## 6. Analysis of Land Use/Land Cover 2002 and 2011

Change detection statistics calculated from the processed image of year 2002 and 2011 which covers a period of 10 years. Table 1 reveals that there is a remarkable change in built up area and agricultural land use categories. The built up area has increased from 31.70 percent in 2002 to 41.40 percent in 2011 whereas area under agriculture land/vegetation category decreased from 58.15 percent (in 2002) to 44.51 percent (in 2011).

After 1991 new economic reform liberalization, privatization and globalization policies of the Government of India and opening up of FDI in real estate sector have brought a big boom in the development of large scale private industries and townships and its location, and active role of Haryana Urban Development Authority (HUDA) in well-organized sectors of industrial/commercial/residential purposes. So built up area has rapidly increased. It is observed that the low concentration of population in the central part was also converting in higher concentration. The land use statistics analysis that built up and agricultural land/vegetation is matter of concern.

The natural growth and attraction of people from surrounding rural areas due to availability of better facilities have resulted in diminution of agricultural/vegetation area and on this cost built up area has got increase.

The conversion of agricultural land/vegetation for residential and commercial purposes along with major roads and in south eastern part of the city outside the MC boundary is mainly because value of land is lowest as compared to central part.

### 6.1. Accuracy Assessment

Accuracy assessment basically three types that are over all accuracy, user accuracy and producer accuracy in four categories namely built up area, agricultural /vegetation, water bodies and open/bare land have been analyzed which is based on error matrix. The error matrix was used to assess the mapping accuracy. The overall accuracy only considers the correction of diagonal elements in the matrix. The overall accuracy calculated from 2002 and 2011 is 85.66 percent and 90.64 percent respectively which is acceptable for such change analysis (Table 2).

**Table 2:** Accuracy Assessment in 2002 and 2011

Land Use Categories	Producer' s Accuracy in Percent		User Accuracy in Percent	
	2002	2011	2002	2011
Built up	95.35	93.08	93.68	97.45
Agricultural/Vegetation	73.22	84.74	93.03	91.3
Water Bodies	93.18	93.33	49.79	35.9
Open/bare	93.13	96.57	33.59	29.6
<b>Overall Accuracy (2002)= 85.66% and (2011)= 90.64%</b>				

**Source:** Based on Error Matrix on LISS III (2002) LISS III (2011) Images

### 6.2. Population Growth and Areal Extension

The population growth is a main factor for the areal extension and sprawl because administration of the city has extended the city boundary to manage the population pressure. Population pressure creates several problems like unhealthy slums, infected environment, less development of residential area, industrial and commercial areas resulting in traffic bottle necks and many other problems. There is significant positive relationship between population growth and areal extension. There is increase of 81529 people in the population from 1971 to 1991 whereas the area has increased 12.97 hectares during the same period. In 2001 the population has been recorded 225074 which have increased up to 278149 into 2011 (Table 3). There is not any significant increase in area within MC boundary. It has increased only 2.78 hectares from 2001 to 2011. The reason behind this little extension of the area is that National Highway 1 is far from the city at a distance of 6 km.

**Table 3:** Population Growth and Areal Extension 1971-2011

Census year	Population ( Within MC)	Variation in Population	Growth Rate in Percentage	Area in Hectares (MC Boundary)
1971	62393	16511	-----	4.03
1981	109369	46973	75.29	6.02
1991	143922	34553	31.59	17.01
2001	225074	81152	56.39	30.24
2011	278149	53075	23.58	33.03

**Source:** Primary Census Abstract 1991, 2001 and 2011  
MC Office, Sonipat City, Haryana

## 7. Conclusion

Present study reveals the urban growth and its Impact on Cityscape in Sonipat city. Urban growth is a worldwide fact that comes with the land use change, population growth and economic development. Urbanization is a main cause for the Sonipat city where rate of urban expansion has occurred very fast in the recent time. The city landscape is likely to expand at a very rapid rate. After 1991 new economic reform liberalization, privatization and globalization policies of the government of India and opening up of FDI in real estate sector have brought a big boom in the development of large scale private industries and townships in study area. Present time development of industries, education institutions, tourism, hospitals, private residential builders and good road system has contributed the quick urban expansion and land use transformation in Sonipat city which influence sustainable use of land. The study also find out that productive agricultural land has been occupied by residential, commercial and industrial sectors which can be credited to the human interventions with the environment. The extent and pace of urban transformation has made an alarm about the city sustainability. As a result, the valuable urban planning and administration with a target of long term sustainability is required for the monitoring and management of the growing city.

## Acknowledgment

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