Urban Sprawl and Land Use / Land Cover Analysis of Sonipat City Using Remote Sensing Technology

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Abstract: *Urban sprawl refers to the outgrowth of urban areas caused by uncontrolled, uncoordinated and unplanned growth. This outgrowth seen along the periphery of cities, along highways, and along roads connecting a city, lacks basic amenities like sanitation, treated water supply, primary health centre, etc. Sprawl generally infers to some type of uncoordinated development with impacts such as loss of agricultural land, open space and ecologically sensitive habitats in and around urban areas due to lack of integrated and holistic approaches in regional planning. Land is becoming a scarce resource due to population growth and industrialization. Land use and land cover is an important component in understanding the interactions of the human activities with the environment and thus it is necessary to be able to simulate changes. Remote sensing and Geographic Information System (GIS) have been used in order to study urban sprawl and land use / land cover. The aim of this study is to detect urban sprawl between 1991 to 2011 and present land use / land cover of Sonipat city using satellite images of Landsat TM (1991), Landsat ETM+(2001), Google earth pro (2011) and digital SOI (survey of India) topographic maps.*

Keywords: Urban Sprawl, Land use / Land cover, Remote sensing and GIS, Landsat data and Google earth

1. Introduction

Information of land use/land cover is an important element in forming policies regarding economic, demographic and environmental issues at national, regional and local levels. Many towns and cities in India are undergoing rapid expansion and sprawling. The rural and urban fringe is most rapidly changing element in the urban landscape mapping; land use/land cover of the rural urban fringe in a timely and accurate manner is thus of great importance for urban land use planning and sustainable management of land resource (Sudhira, 2004).

The land use/land cover pattern of a region is an outcome of natural and socio- economic factors and their utilization by man in time and space. Information on land use / land cover is essential for the selection, planning and implementation of land use and can be used to meet the increasing demands for basic human needs and welfare. This information also assists in monitoring the dynamics of land use resulting out of changing demands of increasing population (Zubair, 2006).

Objectives

The main objective of the present study remains to:
To identify the urban sprawl and land use / land cover analysis of Sonipat city.

Hypotheses:
The present study has tested the following hypotheses:
- The growth and present landscape of Sonipat city is directly linked with its favorable geographical environment. Its location near national highway (N.H.) - 1 may speed up its growth.
- Sonipat is surrounded by agriculturally rich area therefore, it is expected that agro-based industrial development may increase the area under industrial land.

2. Study Area

Sonipat came under hot and semi-aridsouth eastern agro climatic zone. Sonipat is located between $28^0 57`56''$ N to $29^0 01`57''$ N latitude and $76^0 59`40''$ E to $77^0 03`01''$ E longitude. It is the administrative headquarters of the division, district and tehsil of the same name.

Map - 1
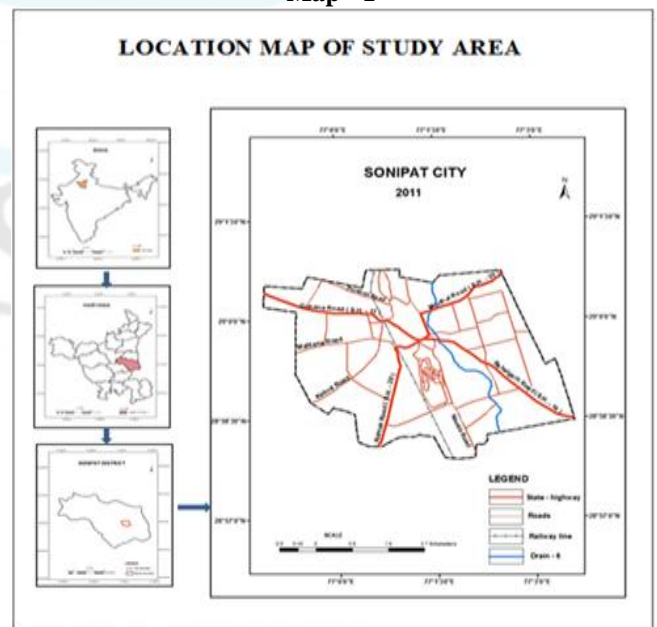
Source: Based on India, Haryana, Sonipat district and Sonipat city map.
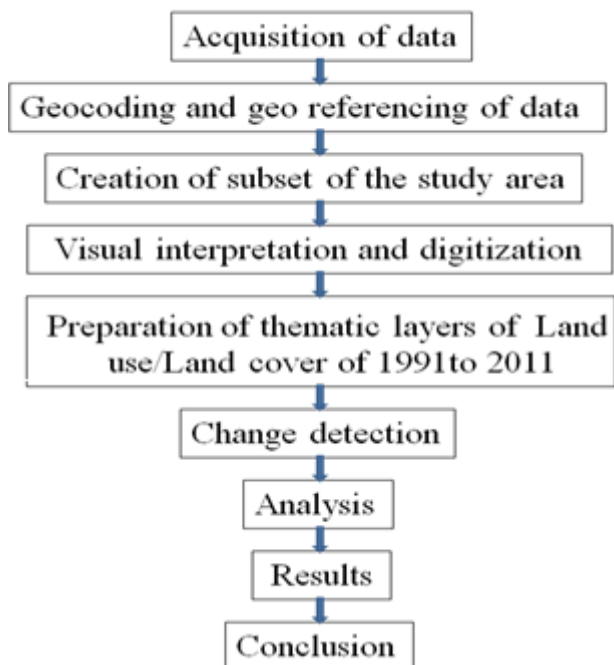
Data source and software used
The data for the present study have been taken from both primary and secondary sources. The main data of this study are municipal committee boundary map of Sonipat city, LANDSAT Images (1991, 2001, resolution 30 m), Google earth pro (2011, resolution less than 1 m) and GPS survey.

ARC GIS 9.3, ERDAS imagine 9.0 and MS office 2007 softwares are used for demarcation of land use and land cover for different years and for preparation of maps.

3. Methodology

The methodology adopted for study is given in the following flowchart.

METHODOLOGY

Acquisition of data

Geocoding and geo referencing of data

Creation of subset of the study area

Visual interpretation and digitization

Preparation of thematic layers of Land use/Land cover of 1991to 2011

Change detection

Analysis

Results

Conclusion

Land use / Land cover classification system:

Anderson classification schemes have been adopted in this study. The land use and land cover classification system presented in this project includes only the more generalized first and second levels.

Study is based on qualitative data which has been analyses with simple statistical technique and displayed with help of dot, coroplath, chorchrometic maps and diagrams prepared in ArcGIS 9.3.

4. Results and Discussion

The study demonstrates the importance and potentiality of satellite remote sensing technique for preparation of more consistent, accurate and up-to-date baseline information on urban land use/land cover for future planning, management and development of any area. Present study is based on interpretation of LANDSAT Images (1991, 2001, resolution 30 m), Google earth pro (2011, resolution less than 1 m) and GPS survey.
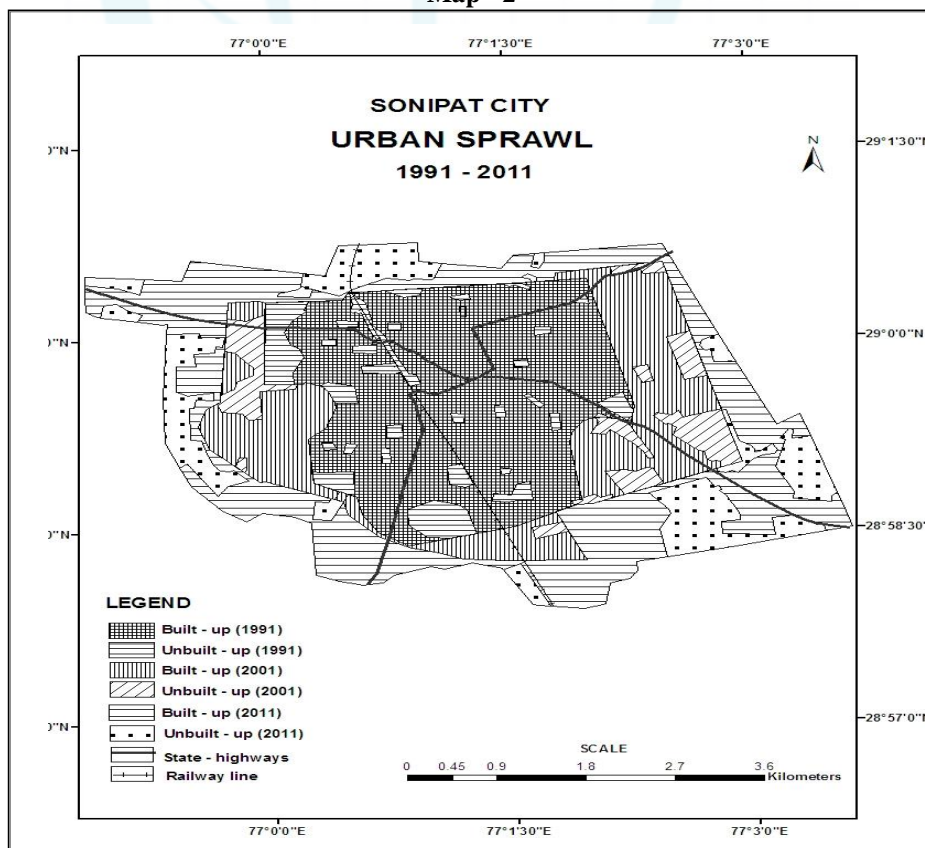
Table 1: Urban land use statistics of Sonipat city, 1991 to 2011

Year	Unbuilt-up area in hectare	Built-up area in hectare	Total area in hectare
1991	160.53	860.54	1021.07
2001	255.51	1400.51	1656.02
2011	495.86	2168.32	2663.42

Source: Estimates derived from LANDSAT 5/TM (1991), LANDSAT 7/ETM+(2001) and Google earth Pro image (2011).

Map - 2

Source: Based on Landsat5 /TM, Landsat 7/ETM+ and Google Earth Pro images (1991 to 2001).

Urban growth of Sonipat city:

Table 2: Urban growth of Sonipat city from 1991 to 2011

Sr. No.	Year	Database	Built-up area in hectare	Urban growth in hectare	% Growth
1	1991	Landsat5 /TM	860.54	-	-
2	2001	Landsat7 /ETM+	1400.51	539.97	62.74
3	2011	Earth Pro	2168.32	767.81	54.82

Source: Estimates derived from Landsat5 /TM, Landsat 7/ETM+ and Google Earth Pro images (1991 to 2001).

The total built-up land is found to be about 860.54 hectares in 1991. The growth had taken place in eastern part of city and spread uniformly throughout the city and more along major roads. The city has grown at a faster rate after 2001. Till that year, the growth has been mainly in concentric manner, while after 2001, the city had grown mainly in south-east, west and marginally towards south and north. The growth towards east is fast along the state highway-14(Delhi road). The urban growth in different directions has been governed by following factors:

- City growth towards the eastern part has been influence by National highway - 1.
- The south-east part of the city along the Delhi road, rapid urban expansion had taken place. This urban growth had transformed most of the agricultural land into residential uses.
- The growth towards the west has been attracted by administrative part (court, police line and D.C. residence) of Sonipat city.
- The urban expansion has extended along the side of railway track in the southern part of city.

Table 3: Land transformation / Conversion due to urban sprawl

| Categories	From 1991 to 2001		From 2001 to 2011	
	Area in ha.	%	Area in ha.	%
Built – up land	539.97	85.04%	767.81	76.15%
Un built – up land	94.98	14.95%	240.35	23.84%

Source: Estimates derived from Landsat5 /TM, Landsat 7/ETM+ and Google Earth Pro images (1991 to 2011).

About 539.97 hectares of agricultural land in 1991 had been converted to urban built-up land during 1991 - 2001. Further, it is observed from the table (3) that from 2001 onwards most of the agricultural or fallow land got converted to built-up land. About 767.81 hectares land in 2001 got converted to urban built-up during 2001-2011.

Urban growth versus population growth:

Table 4: Urban growth and population growth of Sonipat city from 1991 to 2011

Year	Urban Population	Decadal change in absolute population	%Urban population growth	Urban built-up area in hect.	%Urban built-up growth	Population density people/hect.
1991	143922	-	-	860.54	-	167
2001	214974	71052	49.36%	1400.51	62.74%	153
2011	277053	62079	28.87%	2168.32	54.82%	128

Source: (1991) Rand McNally International Atlas 1994, School of planning and Architecture (web). (2001) Office of the Registrar General and Census Commissioner (web), Delimitation Commission of India (web) and concerned imageries (1991-2011) Statistical abstract of Haryana.

Population density of Sonipat city
Ward no 3 (419), 4 (387), 5 (330), 7 (504), 14 (555), 16 (222), 18 (393), 24 (345) and 25 (214) are situated in the heart of the city and old Rohtak road which is the oldest part of the city so this area is densely populated initiated by early occupancy. Ward no 1 (197), 6 (187), 8 (108), 15 (152), 27 (166) and 28 (172) are having high density (150 to 200) of population per hectare because these wards are situated near C.B.D, Railway station and Murthal road (S. H. -20). Ward no 2 (142), 9 (148), 11 (101), 19 (140) and 20 (128) are moderately populated (100 to 150) areas which are scattered between Purkhas and Murthal road. Ward no 10 (82), 12 (88), 17 (65), 21 (97), 23 (86), 26 (53), 30 (90), and 31 (66) are having low density (50 to 100) and less facilities. Ward no 13 (23), 22 (47) and 29 (166) are very low density (less than 50) these wards are situated in those outer parts of the city which are lack of facilities.

Map - 3
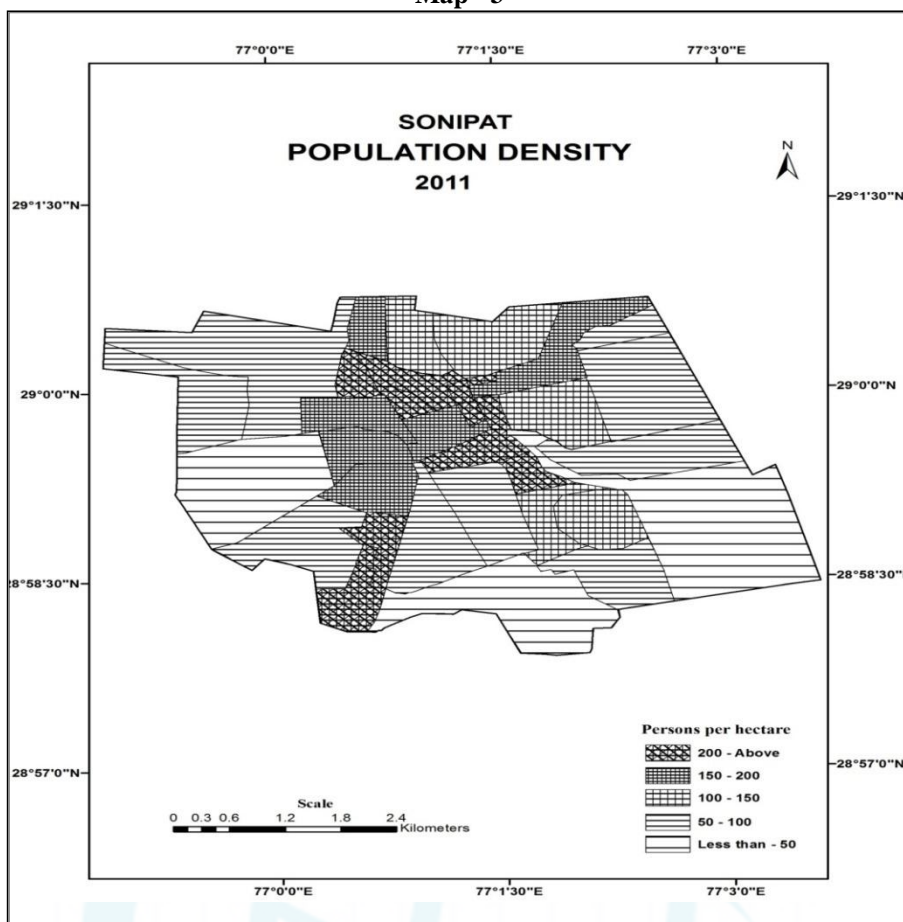
Source: Census of India, 2011 (primary census abstract)

Urban Land Use/Land Cover (2011):

Table 5: Land use/land cover statistics of Sonipat city, 2011

Sr. No.	Category	Area in hectare	Area in Per Cent
1	Urban Built-up	2168.32	81.41
2	Vacant Land	264.45	9.92
3	Water Body	29.21	1.09
4	Fallow land	201.42	7.56
5	Total Area	2663.42	100

Source: Estimates derived from Google Earth Pro image (2011).

Study found four major land use/land cover categories in the study area which are built-up, water body, fallow land and vacant land. Out of the total study area 81.41 percent is urban built-up whereas 18.59 percent is used for other purposes. Residential is the major activity in the study area which occupied 79.14 and 64.43 percent of urban built up and total area respectively. Majority of residential area (79.48 percent) is under unplanned category and 20.51 percent is under the planned category.

However, in recent times some planned residential area is increasing on the outside of city, particularly towards Delhi road. Some other categories in the study area are like public and semi-public facility, industrial land, commercial land, recreational area, vacant land, water body and fallow land which occupied 10.10, 2.96, 2.80, 1.09, 9.92, 1.09 and 7.56 percent of the study area respectively.

Urban Built-up area

Table 6: Urban built-up area of Sonipat city, 2011

Sr. No.	Category	Area in hectare	Area in Per cent of built-up urban area	Area in Per cent of total area
1	Residential land	1716.18	79.14	64.43
2	Industrial land	79.00	3.64	2.96
3	Recreational Area	29.16	1.34	1.09
4	Commercial land	74.76	3.44	2.80
5	Public and semi public	269.20	12.41	10.10
6	Total	2168.32	100	100

Source: Estimates derived from Google Earth Pro image (2011).

Map - 4
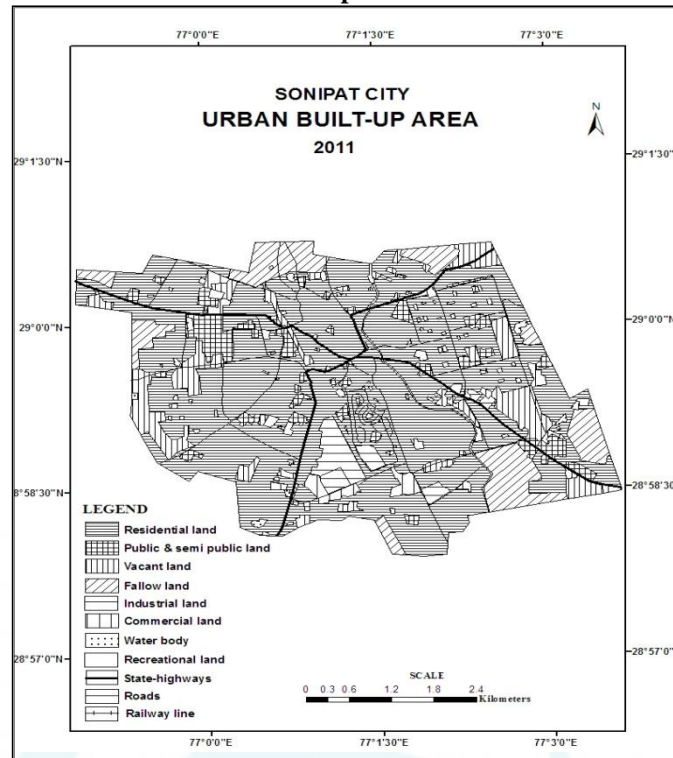
Source: Based on Google Earth Pro images 2011

Public Utilities and Facility:

Location of the following public utilities have been observed with the help of GPS and marked on the map no. 5, 6 and 7.

- Educational facilities
- Health facilities
- Police station

According to 2011 census, average literacy rate of Sonipat city is 87.56 percent of which male and female literacy was 93.21 and 81.17 percent respectively. Apart from number of schools and colleges, the district has three universities.

These are Deenbandhu Chhotu Ram University of Science and Technology (DCRUST), Bhagat Phool Singh Mahila Vishwavidyalaya (BPSMV) and O.P. Jindal Global University (JGU). There are six government, eight government added and 96 private schools in the city. There are large numbers of colleges in the city which are affiliated to Maharshi Dayanand University. The city does not have any government college.
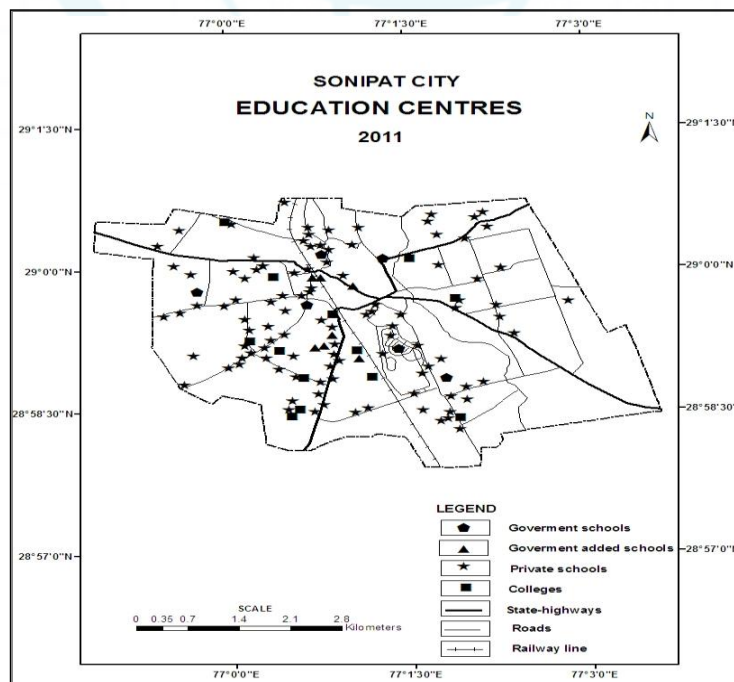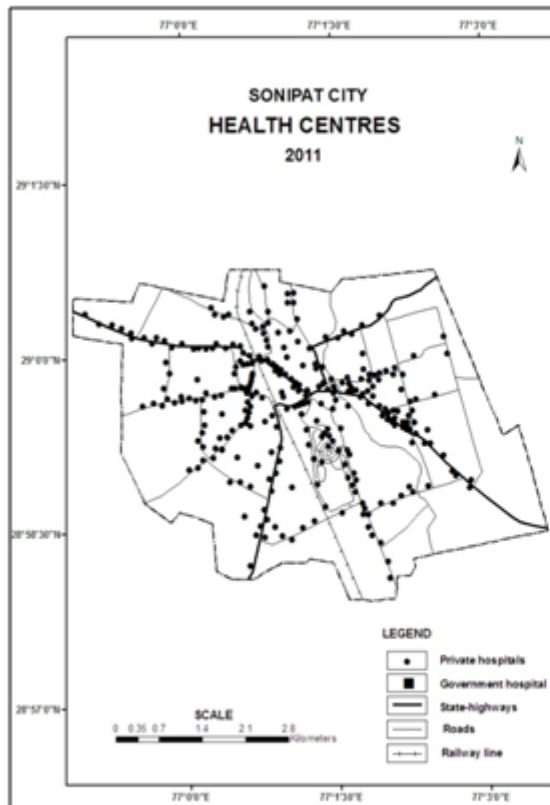

Map 5
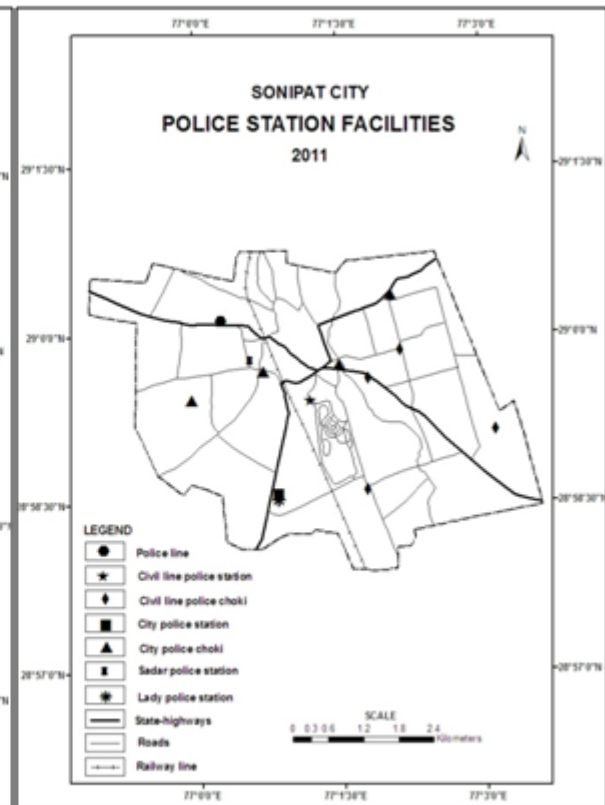Source: Based on G.P.S. survey, Dec., 2012.

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Map -6
Source: Based on G.P.S. survey, Dec., 2012.

Map -7
Source: Based on G.P.S. survey, Dec., 2012.

There is one government hospital in the city i.e. civil hospital, 242 private hospitals and clinics which are also providing health services to the city populace such as maternity and nursing home, eye hospital, dental clinics etc. These government and private hospitals are spread all over the city

Sonipat city has one CIA staff, one police line and 4 police stations. Each police station has some chokies. All chokies of two police stations come under the municipal council area of Sonipat city. Sadar police station chowki covers not only municipal council area of Sonipat city but also nearby villages. During festivals and other such mass gathering or public celebrations to check the incidents of criminal cases, the police authority opens additional police chowkis in the Sonipat city. These are largely temporary in nature.

5. Conclusion

The present study has shown that there is significant decrease of agriculture area largely at the cost of increase in settlement area from year1991 to year 2011. The rapid urban growth has transformed most of the agricultural land into built-up area. About 634.95 and 1007.4 hectares of agricultural land are transformed to other land use features during 1991 to 2001 and 2001 to 2011 respectively. New urban expansions are taking place largely towards east, south-east, west and south-west directions along the main transportation route of the city. New urban development occurs mainly on agricultural land. The above study provides a methodology for better estimation of urban growth and population using various land uses with time.

Identification and analysis of the sprawl patterns of Sonipat city would help in effective land use planning in urban area.

References

[1] Anderson, J., Hardy, E., Roach, J., Witmer, R., (1976), "A Land Use and Land Cover Classification Scheme System for use with Remote Sensor Data. US Geological Survey". http://landcover.usgs.gov/pdf/anderson.pdf [Accessed 03/09/2010]

[2] Sundarakumar, K., M. Harika, M., Yamini, S., Balakrishna, K., (2012), Land Use And Land Cover Change Detection And Urban Sprawl Analysis Of Vijayawada City Using Multi-temporal Landsat Data. International Journal of Engineering and Sciences, Vol: 4 NO.1 ISSN: 0975-5462.

[3] Tamilenthi1,S., Punithavathi1,J., Baskaran1,R., Chandra Mohan, K.,(2011), Dynamics of urban sprawl, changing direction and mapping: A case study of Salem city, Tamilnadu, India, Achieves of Applied Science Research, 3(1): 277-286.

[4] Sudhira, H. S., Ramachandra, T. V., Jagadeesh, K.S., (2004), Urban sprawl: metrics, dynamics and modeling using GIS, International Journal of Applied Earth Observation and Geoinformation,5, pp. 29-39.

[5] Zubair, A., (2006); Change Detection in Land Use and Land Cover using Remote Sensing Data and GIS: A Case Study of Ilorin and its Environs in Kwara State: GIS Development Journal: Available from http://www.gisdevelopment.net/thesis/OpeyemiZubair_ThesisPDF.pdf

Government Offices:
[6] District Gazetteer, October 1990.
[7] District Statistical Office
[8] Town and Country Planning
[9] Municipal Committee

Websites:
[10] http://gisdevelopment.net/application/urban/sprawl/ma0
5245.htm
[11] http://www.infibeam.com/Books/info/asha-
bhende/principles-population-studies/8174936165.html
[12] http://www.realestateindia.com/haryana/
[13] http://en.wikipedia.org/wiki/Urban