

Urban Sprawls and Land Use Change analysis of Karnal City: Using Remote Sensing and GIS Techniques

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Abstract

Urban sprawls are transition zones with indefinite borders between rural and urban areas. Many factors cause urban sprawl such as population increase, socio-economic factors, technological development and development policies. This surface has been recording changes throughout geological times but with recent rapid urban expansion this change has been occurring at a much faster rate. This change needs to be detected, mapped and measured at frequent intervals so that we can have real time information on it. The study area Karnal is an agricultural-industrial district in the north-central part of Haryana. It has become synonymous with the National Highway 44 (NH-44), which is popularly known as GT Karnal Road (Grand Trunk Karnal Road). Present paper has tried to find out the changes which have taken place in landscape of Karnal City in Haryana from 2000-2021. Study has used open-source satellite images of Landsat data downloaded from www.glovis.usgs.gov/. Besides satellite images Toposheet No 53 C/14 (Survey of India) and guide map of Karnal city has been used for ancillary information. The objective of study has been to find out the pattern of sprawl of Karnal city and changes in land use from 1990-2020. Supervised classification using ISODATA algorithm has been carried out for land use classification. Further the change in these categories from 2000-2021 has been measured and mapped Software's like ERDAS IMAGINE 9.0, ARC GIS 10.1 and MS OFFICE 2007 have been used. Sprawl of the city has taken place in two main areas. One is area between Delhi-Ambala main railway track and National Highway No.44. Secondly it has spread along National Highway No.44 in the eastern part of the city. The study has found that major change in land use has taken place in urban built and crop/vegetation land.

Keywords- Land-use Change, Urban Sprawl, Remote sensing and GIS, supervised classification, Urban Expansion.

Introduction

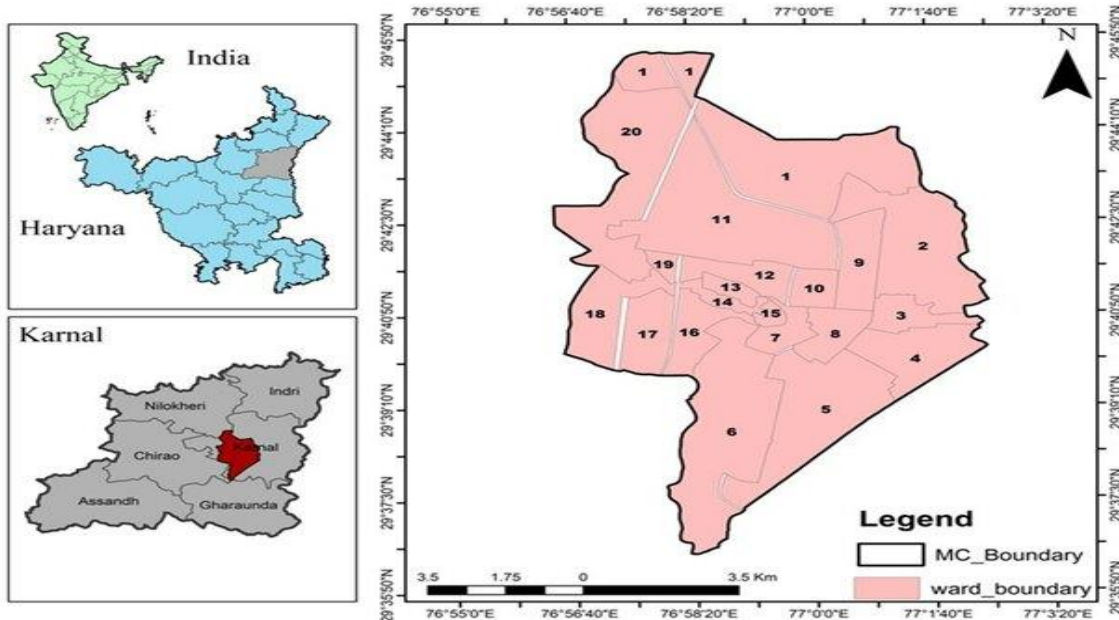
The land surface has always been an area of interest for geographers and other scholars interested in analysis of spatial phenomena. Change in use of land has been a continuous process but with recent rapid urban expansion this change has been occurring at a much faster rate. In rural and remote areas, the land use / land cover remains constant over longer periods, revealing equilibrium between various human activities, agricultural activities and climate. However, in an urbanizing area, land use and cover undergo progressive to drastic changes over the longer period of times due to population and economic growth. (Ehlers et al. 1990; Treitz et al. 1992; Harris and Ventura 1995; Yeh and Li 1996, 1997). This

change needs to be detected, mapped and measured at frequent intervals so that we can have real time information on it. This information will not only be helpful for understanding the dynamics of the change, but it is equally essential for further planning and management of land resources. Urban expansion is a great concern for the local government because the rapid growth of urban population has created environmental problems of various types (Mandal, 2000). Spatial information of land use over time is an important means for city planning and undertaking development activities. Analyzing the spatial and temporal changes in land use is one of the effective ways to understand the current environmental status of an area and ongoing change. Urban expansion is a major cause of land use changes (Singh and Kumar, 2012). During last some decades India has witnessed rapid and uncontrolled urban expansion due to progress in industries, trade and population increase. The anticipation of services and opportunities in cities fuels this growth. When the population increases due to migration, in the outer part of the city, urban sprawl is taking its toll on the natural resources at an alarming place. Land development has been out of control and the construction on land has kept expanding blindly, especially in the marginal areas of these cities. Recent research has identified a few approaches for data acquisition, land use characterization and analysis that utilize remotely sensed imagery as source data for the derivation of spatial sets (Yuan et al., 2005). To assess urban growth and to detect the changes in land use, conventional practice of field surveys and aerial photointerpretation have been in use. Now satellite images are acquired frequently and hence the same area can be observed for a change in land use over frequent intervals of time. Furthermore, the satellite images' digital format can be directly studied with image processing software. The spatial patterns of urban expansion over different time periods can be accurately assessed, mapped and monitored from satellite data (remotely sensed data) along with conventional ground data. These recent technologies help in identifying the pattern and rate of growth. Mapping urban expansion provides a "picture" of where this type of growth is occurring and to suggest the likely future directions and patterns of sprawling growth. Traditionally, the methods of monitoring changes in the land use were field methods. These methods were time-consuming and expensive. Current technologies such as geographical information systems and remote sensing provide a cost effective and accurate alternative to understanding landscape dynamics. Digital change detection techniques based on multi-temporal and multispectral remotely sensed data have demonstrated great potential to understand landscape dynamics. The present paper has tried to find out the Urban Sprawls and Land Use Change of Karnal City in Haryana based on Remote Sensing and GIS Techniques (1900-2020) and land use changes taking place there in using open-source satellite data.

The Study Area

The Karnal city is in Haryana state of India having latitudinal extent 29°37'50"-29°44'40"N and longitudinal extent 76°56'20"-77°02'50" E. Karnal is one of the 22 districts of state. Karnal city is the district headquarters of Karnal district as well. The population of Karnal in 2011 is 286,974 (2011). Karnal city has been selected as a smart city in hundred cities of India under Smart Cities Mission. Geographically, it is in the NCR region of Haryana on National Highway No. 1 and the headquarters of Karnal District in the Indian state of Haryana. It is 123 Kilometer from Delhi and 130 Kilometer from Chandigarh. It was also known as Karnaal, Kurnaul or Karnaul during the British Raj. The city is said to have been founded by Karna, a key figure in the epic Mahabharata, who died at the hands of his brother and archrival, Arjuna. It is believed that Kaurav prince Duryodhan was awarded "Ang Raaj" as a reward to Karna, so he became eligible to fight the Pandav Prince. This "Ang Raaj" was later developed by

Karna which is Karnal today. It is an important city on Delhi Ambala Railway line & Sher Shah Suri Marg (G.T. Road), connected with all important places in the country.



Objective & Data Sources

The study attempts to measure urban sprawl and land use change of Karnal city between 1990 to 2020.

- Topsheet No 53C/14 on scale 1:50000 (Survey of India, Dehradun).
- Guide map on scale 1:10000 (Survey of India, Dehradun).
- Landsat ETM+ satellite image dated having path/row 147/39 with 0% cloud cover bearing scene id LE and Landsat TM satellite image dated having path /row 147/39 with 0% cloud cover bearing scene id LT were downloaded from www.glovis.usgs.gov/. Both these data are open-source satellite images.

Methodology

All spatial data was geo-referenced with each other. A subset of study area of Karnal city was created. Supervised classification using ISODATA logarithm has been performed for land use classification for 1990 and 2020. While selecting training sites for supervised classification help has been taken from toposheet and guide map. Present work has been carried out with the help of image processing software ERDAS Imagine 9.0. All major operations like import-export of satellite data, layer stacking, subset creation, supervised image classification in this software. Arc Map 10.3 has been used for map construction and Production.

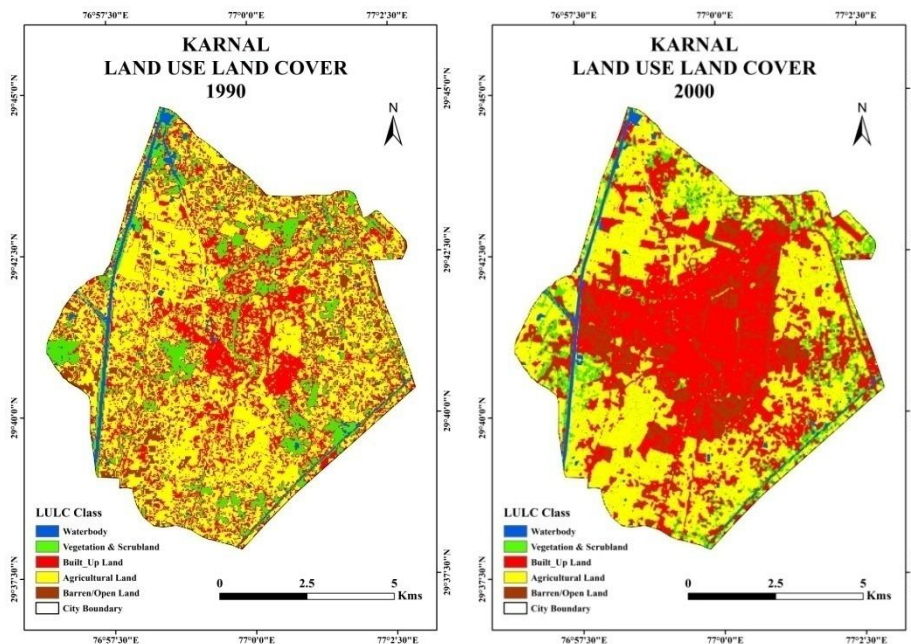
Results and Discussion

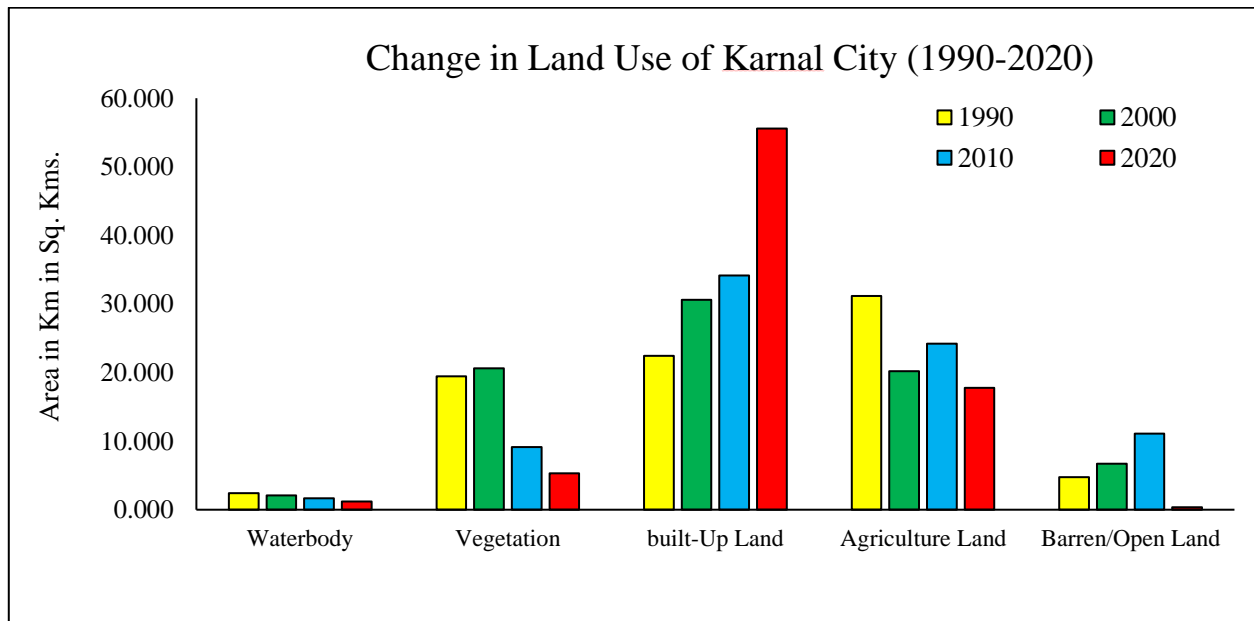
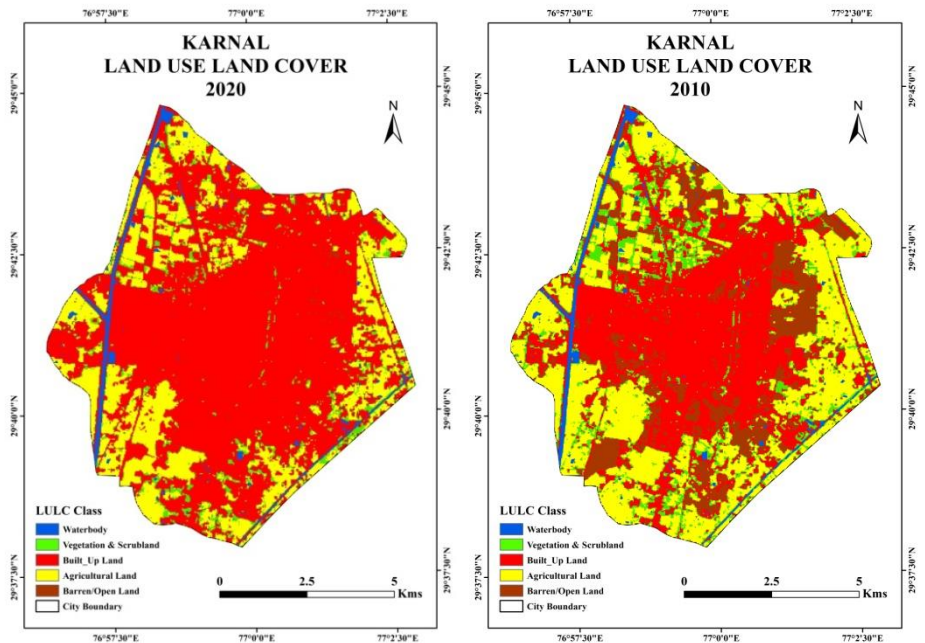
In 1990 the total built up area in Karnal city was 20.76 square kms. It increased to 32.70 square kms in 2000, thus recording a growth of 57.51 %. During this period however, the growth of population has been 23.47 % which indicates a mismatch between population growth and growth of urban sprawl. During the period of 2000 to 2011, there was an addition of 97889 people in population while the increase in built up area was 43.89 sq. km at the same time. The estimated expansion of the city in 2020

was in 104.84 sq. km. area as compared to 76.59 sq. km. in 2010. The highest growth rate in terms of built-up area and population has been observed during 2000 to 2010 but population has grown fast instead of physical expansion of the city. It indicates speculative construction in urban areas. Sprawl has taken place mainly in a linear pattern along National Highway 44. The second important pattern of sprawl is found in the area lying between NH 44 and Delhi-Ambala main railway track. Whereas sprawl has taken place by densification of built up in the area lying between NH No 44 and Delhi-Ambala main railway track it has occurred afresh along and eastern part of NH 44.

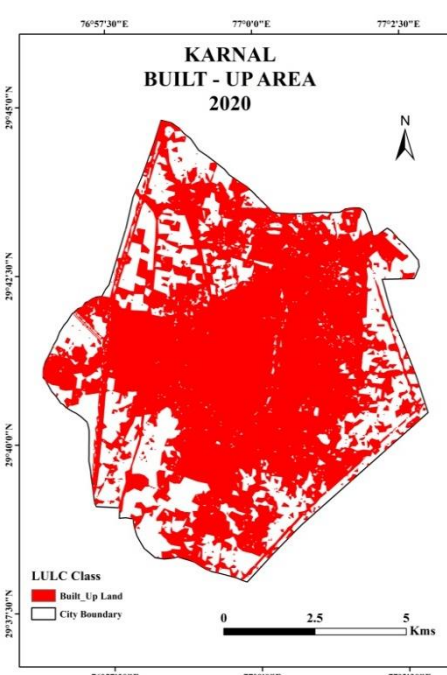
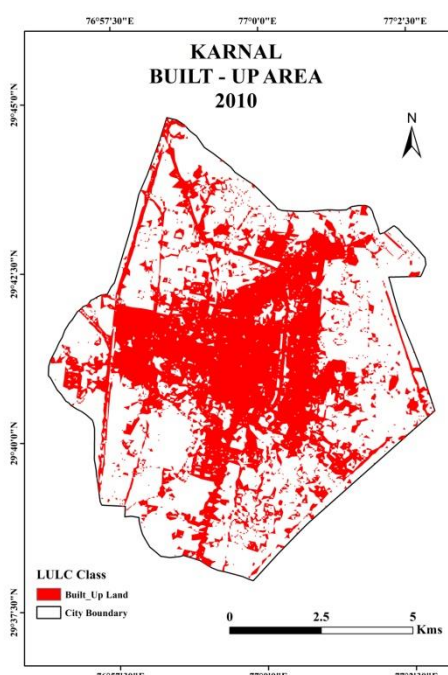
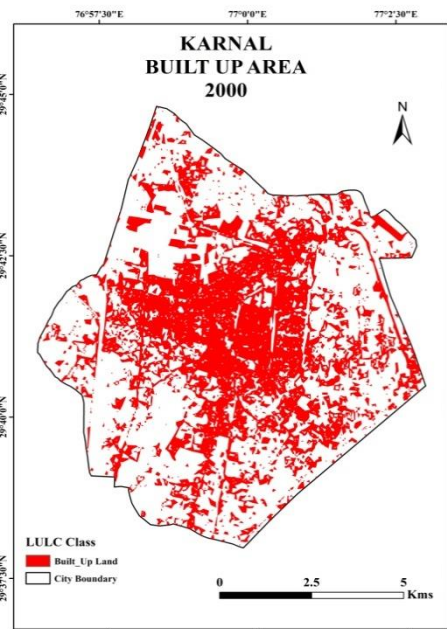
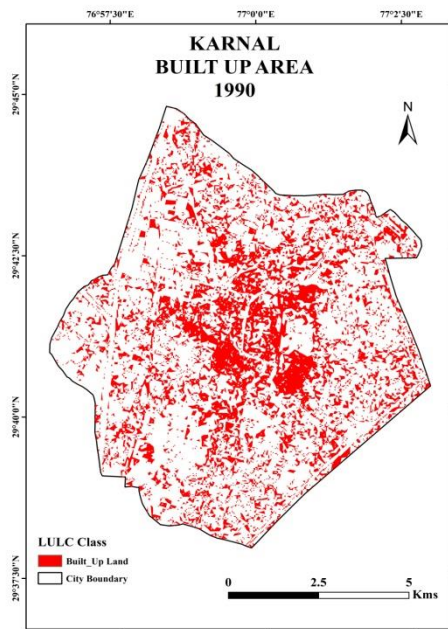
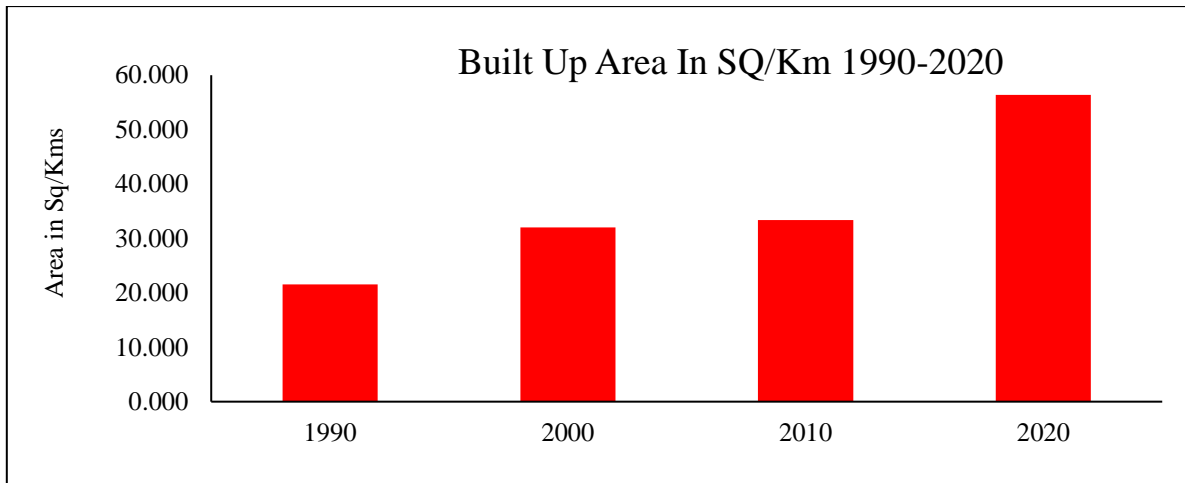
Year	Built up Area SQ. Kms	Variation in Area	Growth rate in percentage	Population	Variation in population	Growth rate in Percent
1990	20.76	9.94	91.87	165422	24986	17.79
2000	32.70	11.94	57.51	204251	38829	23.47
2010	76.59	43.89	134.22	302140	97889	47.93
2020	104.84	28.25	36.88	349390	47250	15.64

Source- Census of India and LANDSAT Satellite data.





As far as the change in land use is concerned, the study found that two categories, i.e. built up and water bodies, recorded an increase in the area while, as other categories, i.e. crop land/vegetation and open/bare land recorded a decline in their respective areas. Major impact has been found in built up areas as it has increased by 57.51% (2000-2010). Water bodies have also shown an increase of 18.28% (2000-2011). Though built up has grown in all directions but major changes have taken place in the eastern part of the city particularly along NH No. 44. The change in water bodies does not show any regular pattern. It has decreased in the north-eastern part and increased in the south-west part particularly along State Highway No. 82 leading to Shamli (Uttar Pradesh). The decline in crop land/vegetation and increase in built up has taken place due to expansion of built up at the cost of crop land/vegetation.



Conclusion

The whole study states that the rambling character of the city makes both affirmative and pessimistic impacts on the city's societal and natural milieu. The establishment of various industries, commercial and didactic institutions as well as study centers has proved the key point for rapid urbanization in the city. On another side, large areas in the surrounding part of the city have been developed as planned residential sectors by the government as well as private corporations which have significantly contributed to city growth and expansion. The satellite images offer an up to date and correct substitute to understanding the dynamics of land and prediction of sprawling temperament of cities and towns. It has been revealed that a large area has been occupied by private residential builders in the peripheral part of the city. The maximum sprawling has occurred in the northern and southern part of the city in terms of new inhabited and commercial sectors. The western part of the city has observed a lesser amount of expansion due to the obstacle of Railway line and Western Yamuna canal. The establishment of the National Dairy Research Institute have created a barrier to the expansion of the city in North-western part. The study also shows that physical expansion of the city has taken place on contiguous productive farming land which is concerned for agriculture in terms of productivity. The growth of city in terms of population and physical extension was growing at a faster rate due to strategic location on National Highway-44, availability of good underground water in abundance, effects of green and white revolution in and around the city in the field of agricultural implements.

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