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A GIS BASED STUDY OF CHANGE DETECTION OF URBAN SPRAWLS OF JAMMU, J&K, INDIA

Vishakha Sharma*[1] & Vishesh Magotra[2]
*[1]GIS Analyst, M.sc Remote Sensing and GIS, University of Jammu, India
[2]Student, Department of Computer Science, Chandigarh Group of College Jhanjeri, India

ABSTRACT

Urban growth is a worldwide phenomenon but the rate of urbanization is very fast in developing country like India. The rapid urbanization has resulted to plan and develop urban areas in a logical manner as the increasing population is demanding rapid increase of urban centre. It is prerequisite for any urban area to have a GIS based map. This research paper seeks to detect, analyse and mapping of the urban built-up changes/growth using maps generated through remote sensing and geospatial techniques. Jammu as one of the capital city of state Jammu and Kashmir has experienced rapid expansion of urban area during last three decades. Therefore, an attempt has been made to project the urban built-up changes between (1997-2017) using maps generated in GIS environment, to assist the state government, policy makers and urban planners to have effective and efficient planning of the urban areas to formulate better future plans of urban growth of the city.

Keywords: GIS, Urban built-up, Change detection, Mapping.

I.   INTRODUCTION

Urban sprawl describes the expansion of human populations away from central urban areas into low-density, non-functional and usually car-dependent communities, in a process called suburbanization. In addition to describing a particular form of urbanization, the term also relates to the social and environmental consequences associated with this development. In India, urban sprawl coupled with unplanned developmental activities has led to urbanization, which lacks infrastructure facilities. This is particularly true for developing cities like Jammu. This also has posed serious implications on the resource base of the region. As per Census 2011, Jammu had a total population of 951,373 and a density of 5697 persons per square kilometre. With the pace of urbanization witnessed in the last five years, Jammu City too has attained the metropolitan status as of now (Master Plan2021 projections). The outcome of the projections and calculations can be used as a basis for suggesting alternative sustainable urban development plans for the cities. It is highly imperative to study the causes and dynamics of urban growth and provide better idea of urban growth to the planning bodies so as to be able to predict and forecast urban growth patterns and structure the policies both short and long term for urban growth plans. Geographic Information System (GIS) and Remote Sensing (RS) along with collateral data (such as Survey of India maps, etc.) together can help perform various types of analysis. Some of them concerning us include the patterns of city growth, spatial distribution, and identifying the temporal changes. Mapping the urban growth provides a pictorial representation of where the growth is occurring, it also helps identify the environmental and natural problems caused by this unprecedented growth, and also suggests the likely future directions and patterns of expected sprawling growth (Michael and Gabriela, 1996). The availability of up to centimetre level of high-resolution satellite imageries and the ever-growing advancements in computer hardware and software has opened doors for greater GIS analysing capabilities than ever before. The highly specialized image processing software is quite effective in capturing the features on ground. The spatio-temporal information of different time-periods obtained from the various satellites can be easily utilized to find out the pattern of development in the cities over the years. Change analysis helps in the formulation of better future plans.

II.   STUDY AREA

The study area consists of Jammu planning area as per Jammu Master Plan 2021. The city of Jammu is located at 74 degree 24' and 75 degree 18'East longitude and 32 degree 50' and 33 degree 30' North latitude. It falls in

the sub-mountainous foothills of Himalayas and is situated on the banks of river Tawi. Jammu city is at an elevation of 1030 feet (327 m) above the sea level. It is located on the National Highway–1A. Because of its locational advantage, Jammu assumes importance as a linkage corridor to Rajouri, Poonch, Kishtwar, Doda and serves as the gateway to Kashmir Valley. The city has faced lateral expansion along the National Highway NH-1A towards south and along Akhnoor road towards north. The city actually took shape in 1962 when its extent was limited to just16.87 sq.km. By 1994, the urban agglomeration had expanded much beyond its municipal limits to engulf a total area of around 143.52 sq. due to the mass exodus of Kashmiri Pundits and some families belonging to Sikh and Muslim communities since the 90's owing to the disturbed conditions existing in the Kashmir Valley. The present extent of the Jammu city is 167.38sq.km while the planning area is 287.92sq.km (Jammu Master Plan, 2021).
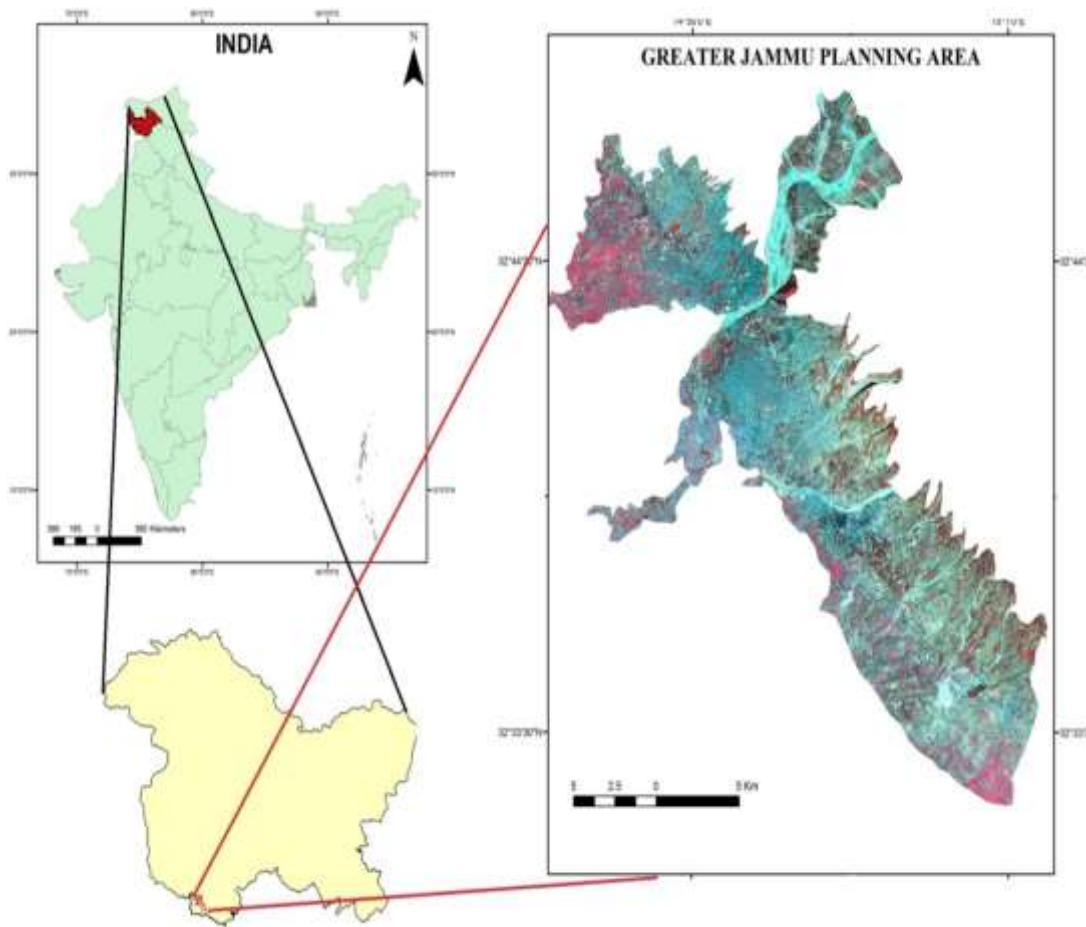
Figure 1 location map of study area

III. OBJECTIVES
- To analyse the types of urban spatial growth in the study area.
- To detect the changes of urban built-up area for the time period (1997-2017).
- To prepare the GIS based urban sprawl map.

IV. DATASETS AND METHODOLOGY
In this study spatial data regarding the chronological nature were used to study the spatial and time-based patterns of urbanization. To accomplish the desired objective of the study, datasets of LANDSAT for the three time periods (1997, 2007 and 2017) were used, which were are made available by the website USGS Earth Explorer. Data coordinates 33.177050 N and 74.42666 0 E were utilized as the data input sources. The task of image correction, pre-processing and classification was done in ERDAS Imagine 14 software. Preparation of

various data layers and their analyses were carried out in GIS software ArcMap 10.1. The images were geo-referenced with spatial reference WGS_1984_UTM_Zone_43N. Further for assistance in the process of interpretation Survey of India toposheet (1972) was also geo-referenced and was given similar projection and datum. Satellite imagery was stacked into different bands to produce a false color composite (FCC), the area of interest was extracted by sub-setting of the image. These images were digitized in GIS environment using ArcMap 10 software in the form of polygons representing different land use land cover categories. The trend and pattern of urban expansion was calculated and every polygon representing the particular class was quantified and displayed in respective maps. The aims of the this study is to produce a land use/ land cover map of Jammu in order to detect changes that have taken place particularly in the built-up land and to analyze the urban sprawl of the different time period (1997-2017).
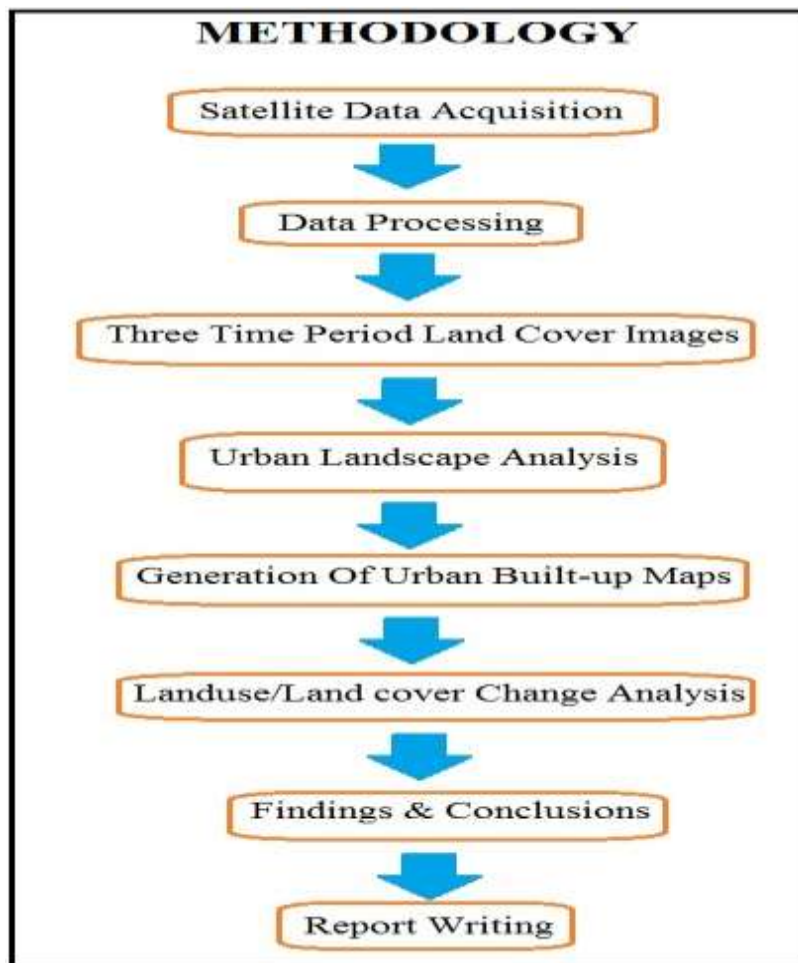

Figure 2 methodology flow chart

V.   RESULTS AND DISSCUSSION

The present study for Jammu city is focused to analyze spatial and temporal information of land cover and land use patterns. A detailed classification system is being developed for mapping Jammu city using high resolution satellite data. Jammu is one of the fast developing cities in North India. The land use of the city over a period from 1997-2017 has showed tremendous rises in the built-Up.
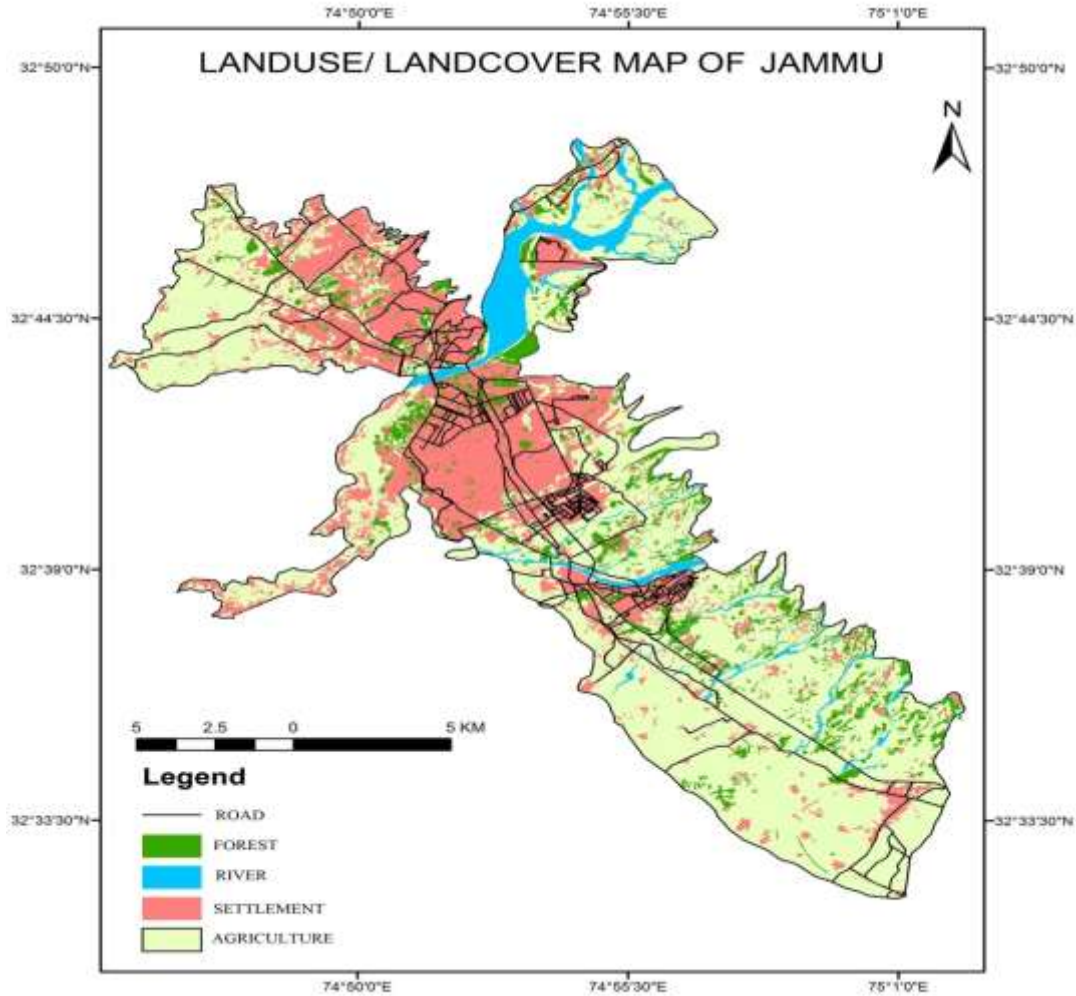
Figure 3 land use/land cover map of jammu

From the year 1997 to 2017 we can witness an increase in the settlement from 38.85 sq.km in 1997 to 50.92sq.km in 2007 and finally 81.21sq.km in 2017. Various factors like increase in population, better road connectivity, mobility services, and social infrastructure have resulted in such a tremendous increase in built-up area of Jammu. On the other hand there is a gradual reduction in forest land and vegetation from 1997 to 2017. The area under water bodies has also shown a decline.

Table: 1 landuse from 1997 to 2017

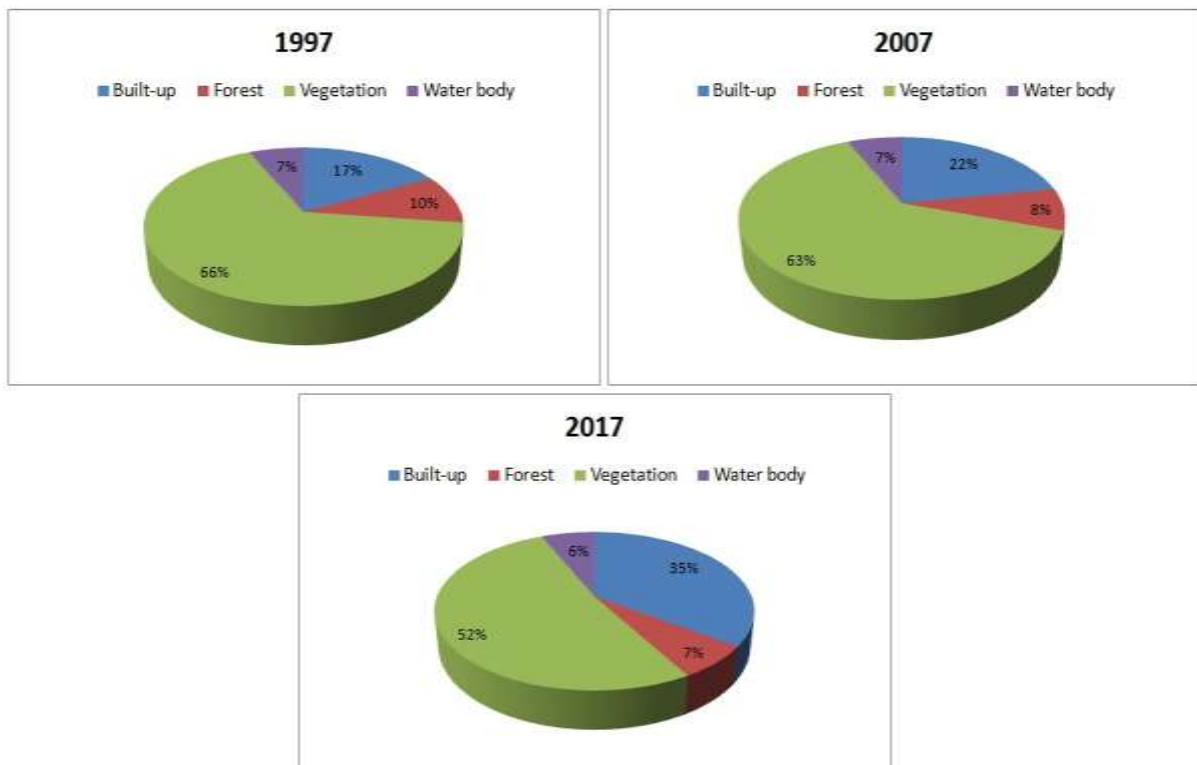| Categories	Area in year 1997 (sq.km)	Area in year 2007 (sq.km)	Area in year 2017 (sq.km)
Built-up	38.85	50.92	81.21
Forest	22.8	19.15	15.8
Vegetation	150.23	145.98	120.59
Water body	15.1	14.96	14.91

Figure 4 pie charts of landuse from 1997-2017

As can be seen from the pie-chart above, in the year 1997, out of the total area of 27600 hectares, 3885.2 hectares which is 17% of the total area is the Built-Up area whereas a major share of the total area, 66% which is 15023 hectares is covered by vegetation and land area of 228 and 1510 hectares belongs to forest and water body categories. In year 2007, built-up area is about 5092 hectares which is an increase of 12%. Further we can see an increase of 30.28% in built-up area in the year 2017. A substantial area of 1510, 1496 and 1491 hectares belonged to water body class in year 1997.2007 and 2017, does not show much change. Whereas there is an overall decrease in 7% in the forest cover of the study area. Vegetation has undergone major change from 1997 to 2017. There is a decrease of about 5% and 25% in year 2007 and 2017 respectively.
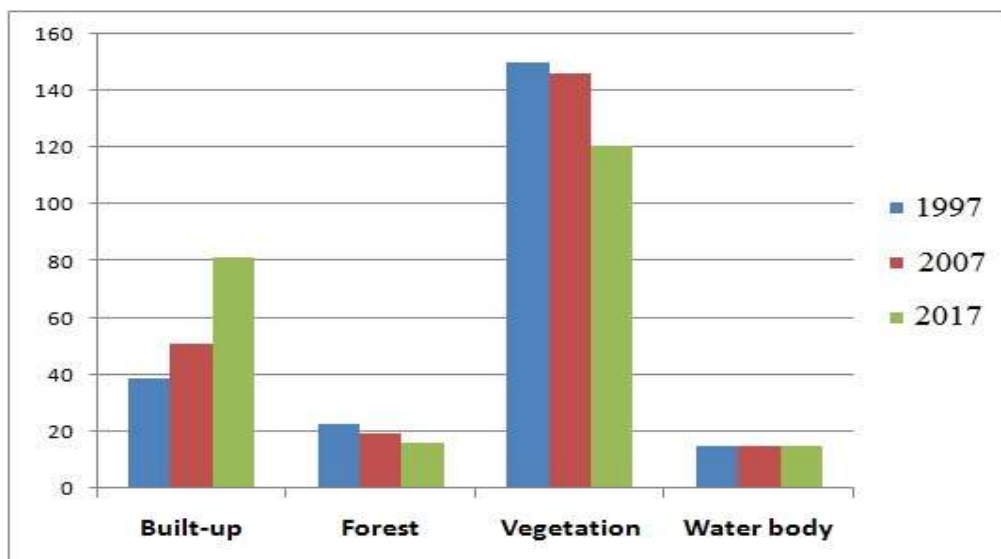

*Figure 5 temporal comparison of land use types from 1997-2017*

Figure 5 shows the comparison between the various land-use classes for the three time periods of 1997 to 2017 where one can visually find out the changes in each land cover categories between three time periods. The horizontal axis represents the land cover classes and the vertical axis defines the proportion of each land cover class (in sq.km) with respect to the total area under consideration and how it varies between the two time periods of 1997 to 2017.

 Urban sprawl and population trends in the city refer to the area expansion of urban concentration beyond what they have been. Urban sprawl can be continuous, ribbons or check broad type. The increase in population and rapid urbanization causes great change in the centre of the city and the problem of the expansion of the city centre is complicated by the fact that, it must take place within the built-up area which is not possible. Thus the pressures of the continuous growing city centre gradually change the surrounding environment and neighbourhoods. Sprawl generally refers to some type of development with impacts such as loss of agricultural land, open space, and ecologically sensitive habitats. In simpler words, as population increases in an area or a city expands to accommodate the growth; this expansion is considered as sprawl. Usually sprawls take place on the urban fringe, at the edge of an urban area or along the highways. It is always easy to find out the growth in the urban area taking place over different time periods but to categorise the urban growth type in the form of Infill Growth, Extension Growth is some great added advantage of using this tool. We could not only know about the spatial distribution of growth but also the type of growth. Infill growth refers to the new development occurring within the spaces inside the city core i.e. when the urbanized open spaces get converted to built-up. It increases the contiguity of the built-up area by filling in the urbanized space. Extension growth on the other hand extends directly from the previous development. The new growth is thus contiguous to the already existing built-up area and could be extended linearly or in patches from the previous development.
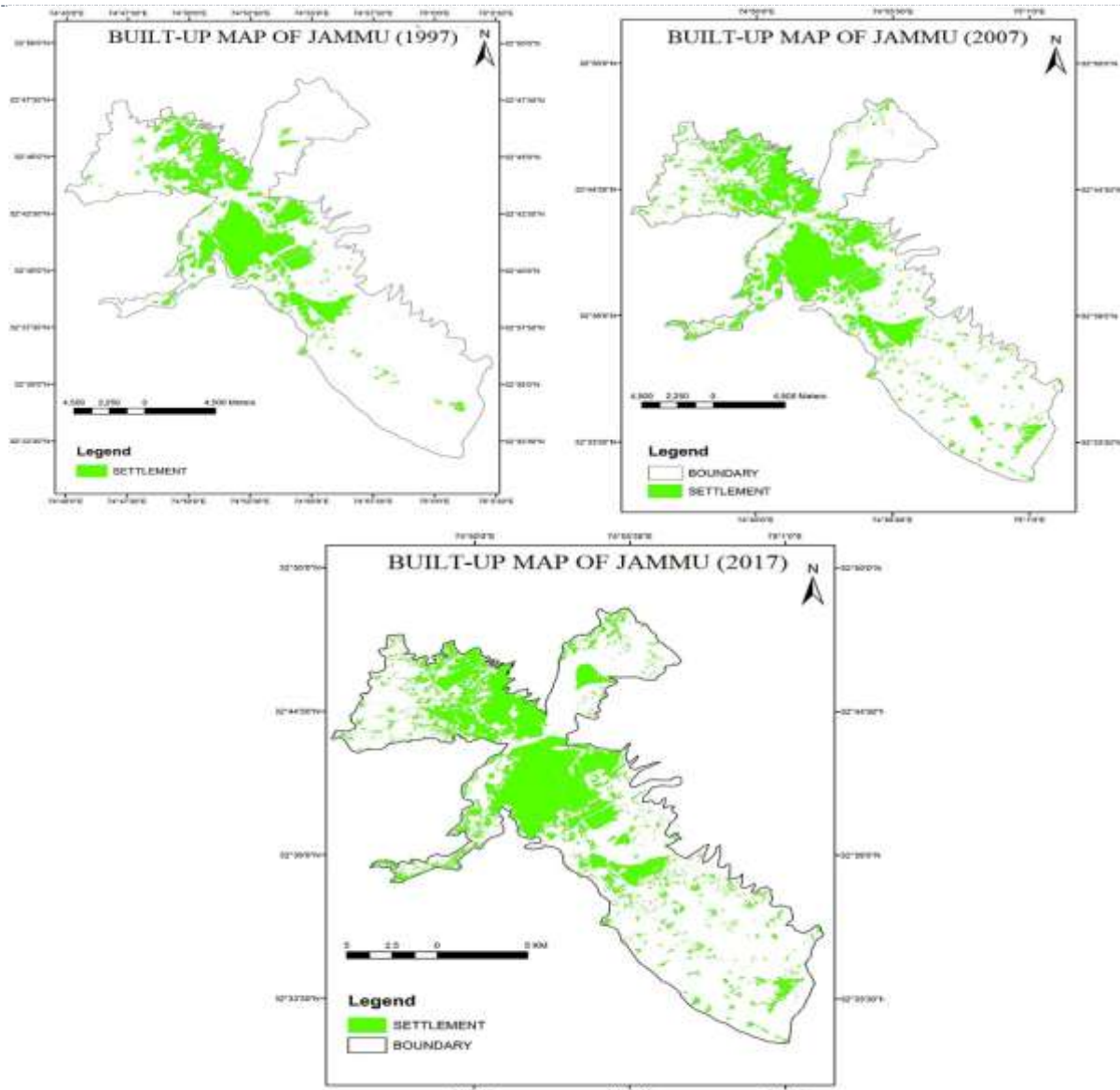
Figure 6 urban sprawl from 1997-2017

We can see much dispersed form of urban growth occurring within the time-periods, mostly scattered around the national highways and close to the already existent built up. The city has expanded towards south-east and north-west predominantly and also in small patches around the NH-1A national highway. Figure 6 shows that infill growth within the city core is much lesser in comparison to the lateral city expansion in all the temporal data images. Most the forest area in north-east (sidhra) has being converted into residential area, due to National highway. The city area extended up to Bhalol Nallah in the South, Narwal Bala and Channi Himmat in the East, Patoli Brahamana and Bantalab in the North and village Muthi and Aquilpur in the West. Urbanization is engulfing more and more area under agriculture, forests and wastelands to accommodate the fast growing population of the city.
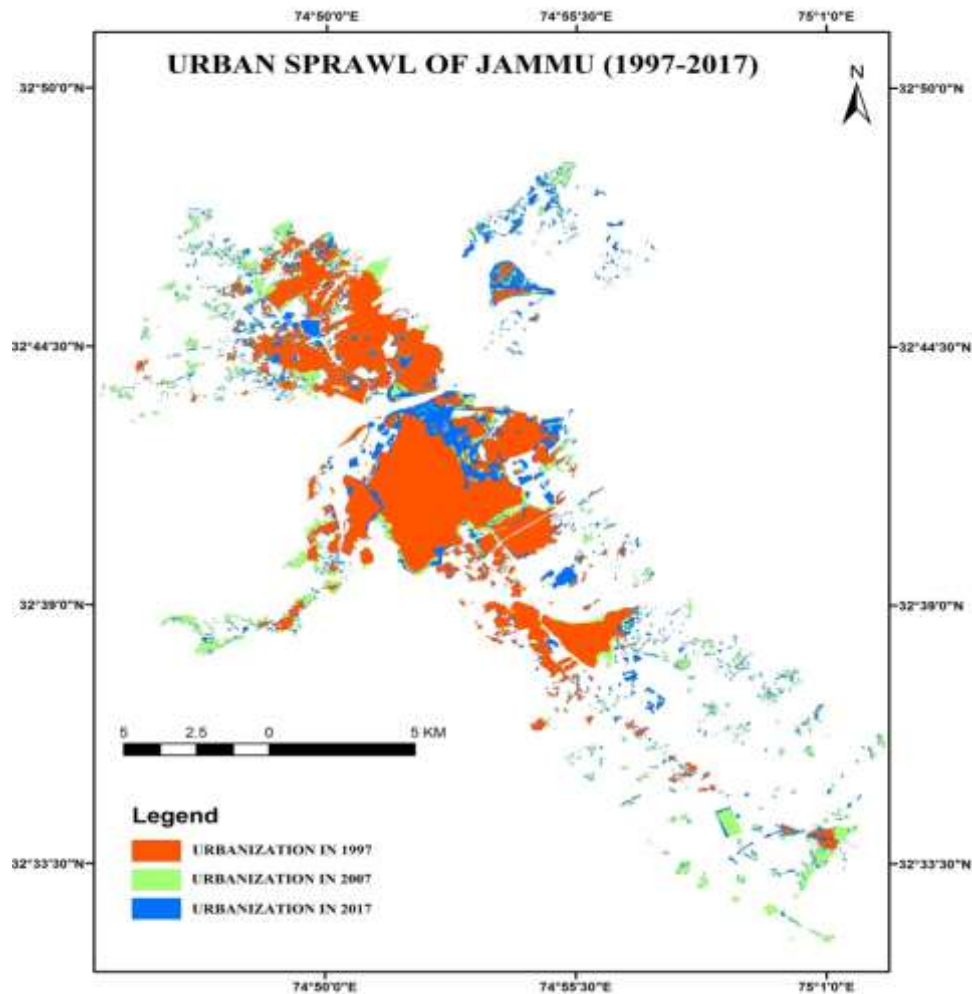
Figure 7 urban sprawl of jammu from 1997-2017

Urban Growth Trend for the study area was performed using image overlay techniques to see the actual amount of change from Non-Built Up to Built-Up categories respectively from the years 1997-2017.This gave an overview of the growth trend in the study area.

VI.   CONCLUSION

The developing world is associated with many problems if its growth is unchecked and uncontrolled. For this reason, determining the current spatial use and urban growth dynamics of cities and knowing the factors that fuel this growth are among the top-marked issues in modern urban research. The city of Jammu has experienced rapid urbanization in the recent years. As a result of this rapid urbanization, Jammu is faced with several problems like destruction of natural resources, population expansion, ineffective utilization of space and resources, haphazard growth which have severe consequences not only for the city from the stand-point of its economic condition but also for the state and the country as a whole. When large numbers of cities are growing this way, unchecked and improper haphazard development could take tolls and bring barriers to the overall nation.

The present research focused on using geospatial techniques for combining geospatial themes to analyze the urban sprawl mapping and detect changes of urban land use/ land cover through different years in the environs of Jammu city. Satellite data are found to be useful in mapping and quantifying the extent of urban area in different time periods. The above study provides a methodology for better estimation of urban growth and population

using various land uses with time. Geographical information system (GIS) and satellite images have been used in this study to provide spatial inputs and test the statistical model describing growth. The main change observed for the time period of 1997-2017 was that the built-up area. New urban region developments are growing largely all directions of city. While in the Lu/Lc mapping agriculture and forest land has been witnessed as the prime victim of this land transformation during the study period. Vegetation land is reduced to 120.59sq.km in 2017 from 150.23sq.km in 1997 and forest land has reduced to 15.80sq.km in 2017 from 22.80sq.km in 1997.

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