Changing Land Use / Land Cover Pattern Of Srinagar City During Last Three Decades

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ABSTRACT

Rapid urban development and increasing land use changes due to population and economic growth in selected landscapes is being witnessed of late in India and other developing countries. The cities are expanding in all directions resulting in large-scale urban sprawl and changes in urban land-use. The spatial pattern of such changes is clearly noticed on the urban fringes or city peripheral rural areas, than in the city centre. In fact, this is reflected in changing urban land-use patterns. Land-use change is one of the major factors affecting global environmental conditions.

There is an urgent need to accurately describe land use changes for planning and sustainable management. In the recent times, Remote Sensing and GIS is gaining importance as vital tool in the analysis and integration of spatio-temporal data. The present study highlights a coordinated significance of Remote Sensing and GIS techniques in detecting land use changes that have been experienced in last thirty years in Srinagar city. The study area lies between 33°59'14'' N and 34°12'37'' N latitude and 74°41'06'' E and 74°57'27'' E longitude. The city is located on both sides of the River Jhelum, locally called Vyeth in Kashmir, spreads between the plains of vale of Kashmir. It represents one of the, ecologically fragile, economically developing, tectonically unstable and one of the densely populated mountain ecosystem.

Keywords: Remote Sensing, GIS, Land-use, Urban Sprawl, spatio-temporal

I INTRODUCTION

Changing Land use of Srinagar

Land is most important and basic resource concerning the urban development. Population growth, unplanned industrialization, urbanization and its consequences adversely affect the regional environment. Improper land use practice results in an adverse impact on ecosystem. So the two words “Land cover” and “Land use” have important significance in regard to land.

The Human use of land resources gives rise to “land use” which varies with the purpose it serves, whether it be food production, provision of shelter, recreation, extraction and processing of materials, and the biophysical characteristics of the land itself. In the developing countries, due to population pressure and in a bid to extract the maximum output from the available sources, the impact of degradation can be worse than in other countries and adversely affect the land cover of the region.

Land use is the human use of land. It involves the management and modification of natural environment or wilderness into built environment such as fields, pastures, and settlements. Land use is a product of interaction between a society's cultural background, state and its physical needs on the one hand and the natural potential of land on the other hand [1]. Land cover refers to the physical and biological cover over the surface of land, including water, vegetation, bare soil and/or artificial structures [2]. Two methods are primarily used for capturing information on land cover: field survey and analysis of remotely sensed imagery. Land cover is distinct from land use despite the two terms often being used interchangeably. Changes in land use and land cover can have significant ecosystem consequences such as impacts on global and regional climate and biogeochemical cycles.

Nowadays Urban sprawl, loss of natural vegetation and open space, and a general decline in the extent and connectivity of wetlands and wildlife habitat have become the growing problems for most of the major metropolitan areas. The public notices these problems when they see residential and commercial development replacing undeveloped land around them. Urban growth rates show no signs of slowing, especially when viewed at the global scale, since these problems can be generally attributed to increasing population. Cities have changed from small, isolated population centers to large, interconnected economic, physical, and environmental features. Since urban growth and development cannot be stopped, the available land has to be used in the most rational manner in order to have a planned growth and development without further deteriorating the bio-environment. This requires the details of the present and past land use and land cover data of the area and its changing pattern. Detection of changes in land use/land cover over a period of time has become possible in less time, at lower cost and with better accuracy through remote sensing and GIS technique

II STUDY AREA

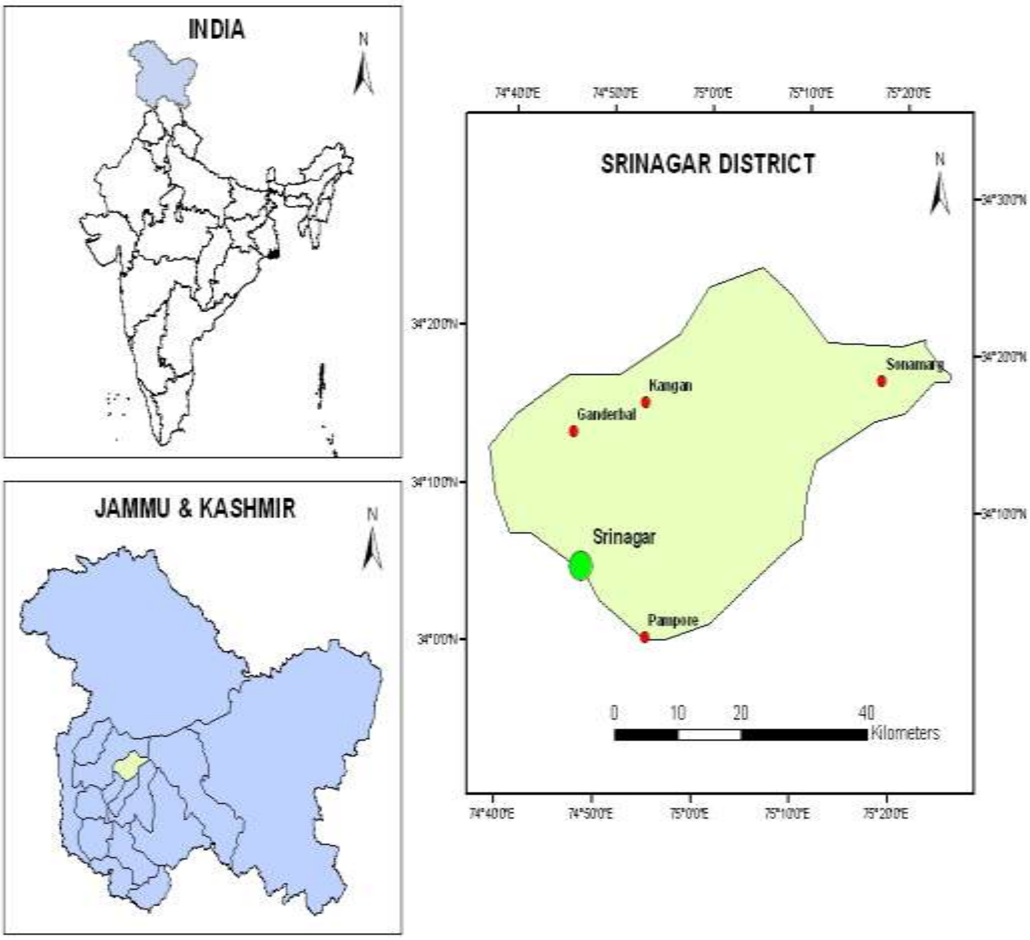
Geographical coordinates: 34° 5' 0" North, 74° 49' 0" East Situated at the centre of the Kashmir valley, **Srinagar** is the most populous district in the state of Jammu and Kashmir, India and is home to the summer capital (Srinagar) of Jammu and Kashmir (The capital moves to Jammu city in the winter). The largest city is Srinagar. It is also home to the scenic Dal Lake, a popular tourist destination.

The Srinagar city is located on both the sides of the Jhelum River, which is called *Vyath* in Kashmir. The river passes through the city and meanders through the valley, moving onward and deepening in the Wular Lake. The city is famous for its nine old bridges, connecting the two parts of the city.

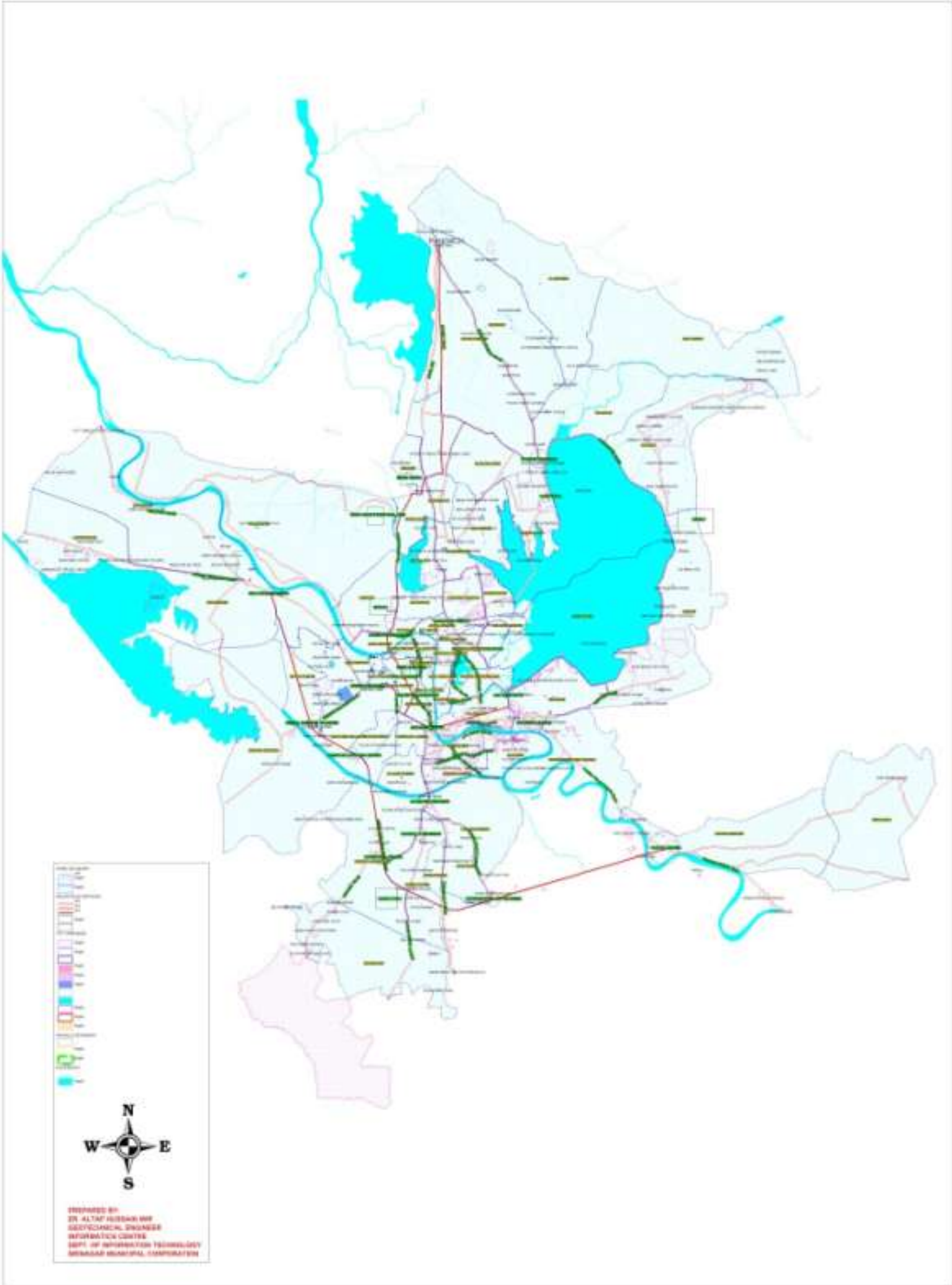
The climate of Srinagar may be generally described as warm temperate. The city has warm summers from June through August, and winters from December-February. The city generally gets some snowfall from December to February but seldom accumulates for longer periods. The average temperatures are 24 °C (75 °F) in July (ranging between 18 to 29°C or 65 to 84°F) and 4 °C (39 °F) in January (between -2/7°C or 28/45°F (night/day), -2/0°C or 28/32°F and 7/11°C or 45/52°F some of local extremes.

Srinagar district is situated in the centre of Kashmir Valley, is surrounded by five districts. In the north it is flanked by Kargil, in the South by Pulwama, in the north-west by Budgam. The capital city of Srinagar is located 1730 meters above sea level. The district with a population of around 9, 00,000 souls (1991- census), is spread over an area of 2228 Sq.Kms. It comprises three tehsils/ towns viz Srinagar, Ganderbal and Kangan, four blocks (Srinagar, Ganderbal, Kangan and Leh), besides 175 villages. The population density in the district Srinagar is 401 per Square Kilometer which is highest in the state. The literacy rate of the district was 33.80%in 1981.

LOCATION MAP



WARD MAP OF SRINAGAR MUNICIPAL CORPORATION



Source: Srinagar Municipal Corporation

III MATERIALS AND METHODS

In the present study we have used mainly two types of data, topographic maps and remote sensing data. The remote sensing data in the digital mode was procured from the National Remote Sensing Agency (NRSA), Government of India, Hyderabad, and used. The topographic map 43 j/16 (1:50,000 scale) is obtained from the Survey of India, Hyderabad, which was surveyed and prepared in 1975; it is converted to digital mode using scanning. The topographic map is georeferenced with longitude and latitudes using the ArcGIS software and spatial analyst tools and demarcated the boundary of study area.

Land use change detection was carried out by using toposheets, Landsat MSS 1980, Landsat MS 1990, Landsat TM 2000, Landsat ETM+ 2010 satellite data.

The images were geo-corrected and geo-referenced in ERDAS (Earth Resource Data Analysis System) imagine 9.0 software. Satellite imageries were stacked in different bands to produce a false colour for the extracted of the study area by sub-setting of the image. The images were digitized in GIS environment using Arc View 3.2a software in the form of polygons representing different land use and land cover categories.

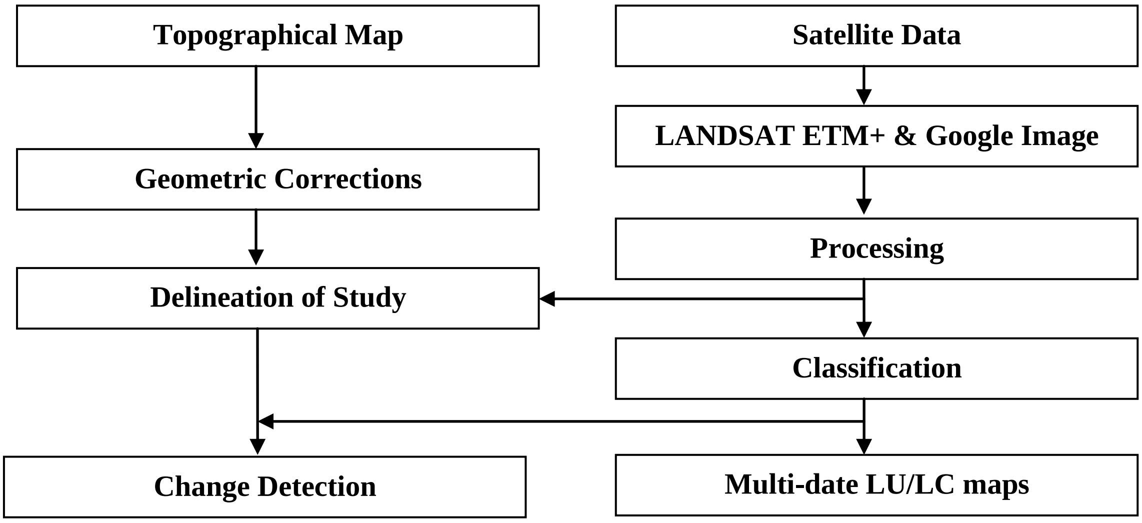


Figure 1

Figure 1 shows the Flow chart of methodology for land use/land cover and change detection.

GIS in Land Use Change Detection

Many urban land use studies have assessed the use of remote sensing images through diverse methods of classification to generate accurate urban land use maps and also to detect changes in urban land use/land cover [3], [4], [5], [6], [7]. Monitoring and mapping the trend of changes in urban land use with time were the main objectives of many remote sensing studies [8], [9], [10], [11].

Remote sensing technology provides a means to measure changes in landscape pattern as well as changes in its condition over time [12], [13], [11]. Since landscape types are constantly changing, studies of landscape dynamics at large spatial extent would have been difficult without the development of Remote Sensing techniques during the last two decades. Such developments, in combination with the increasing availability of remotely sensed data and new methods in spatial modeling and GIS, have increased the extent and accuracy of assessing rates, patterns, and direction of regional change.

Remote sensing with multi-temporal high resolution satellite data has become a strong tool for monitoring aspects such as vegetation cover soil degradation, urban expansion and more generally for most types of LU/LC changes [10].

Remote sensing and GIS are important tools for studying land use patterns and their dynamics. Change detection using satellite data can allow for timely and consistent estimates of changes in land use trends over larger areas and has the additional advantage of ease of data capture in to a GIS [14].

Satellite remote sensing collects multispectral, multi-resolution and multi-temporal data, and turns them into valuable information for understanding and monitoring urban land processes and for building urban land cover datasets. GIS technology provides a flexible environment for retrieving, analyzing and displaying digital data from various sources that are essential for urban feature identification, change detection and database development. The launching of Landsat in 1972 began an era of major advancement in the inventory of resources and the monitoring of the environment from space.

Since then, techniques have been developed in using satellite images to detect land use change to find out the type, amount, and location of land use change that has taken place. Data from the Landsat Multi Spectral Scanner (MSS), Thematic Mapper TM, and Enhanced Thematic Mapper (ETM+) sensors, with its synoptic and regular (18- day for WRS1, 16-day for WRS2) coverage, have the potential for detection and inventory of all changes in cover type, cover condition, and therefore land use, in areas of research interest.

Changing landscape of Srinagar

It is not sufficient if a researcher examines only the general structure of the cities for any kind of comprehensive study of the growth of cities over time and space. Rather, it is essential to understand the land use arrangement and the population patterns existing within them.

In western countries the land use structure converges on a Central Business District (CBD) while in case of Indian cities with mixed functions this tends to get hazy. The city core in the western cities is always characterized by intensive land development, high-rise buildings, government offices, communications centers such as post and telegraph offices, commercial establishments, shopping complexes etc. [15]. Usually, residential land use is found beyond the CBD whereas in case of Indian cities, even within the city core has substantial residential population. For Srinagar also, one finds considerable residential use in the core area and the absence of a well defined CBD.

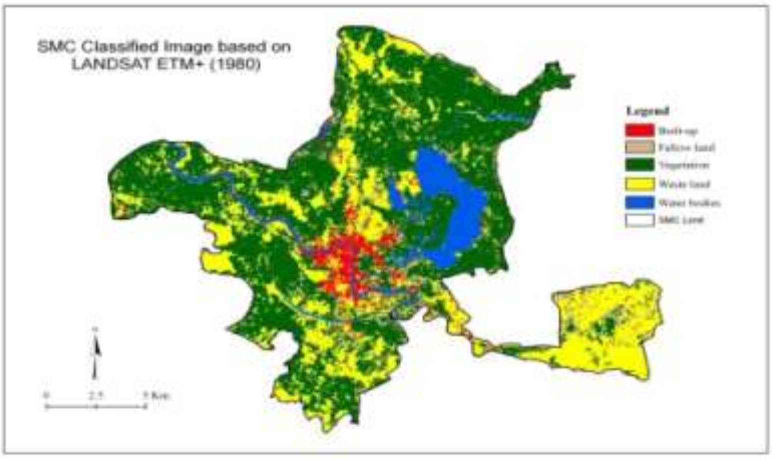
In order to understand the existing land use pattern of Srinagar, it is necessary to have knowledge of the past pattern and the land use pattern of Srinagar was studied from the year 1980 to 2010 with the help of toposheets, town planning maps and the satellite images classified into different land use/land cover classes based on National Remote Sensing Agency (NRSA) classification. The term classification generally refers to putting the similar things together, which means grouping of subjects into categories on the basis of their common properties or characteristics. The general land use/land cover classification scheme has three different levels. Level-I, level-II and level-III based on the spatial resolution of the satellite data used. Level-I classification includes broad categories such as built up land, agricultural land, water bodies etc. Whereas under level-II classification, sub categories within each category have been identifies. For example, the built up land is sub divided into residential areas, industrial areas etc. Under level-III classification, each sub category of level-II is further classified. For example, category-residential area in level-II has been further classified into densely built-up, medium built-up and low built-up areas. Similarly the recreational areas have been further classified into play grounds, race courses, parks etc.

IV RESULTS AND DISCUSSION

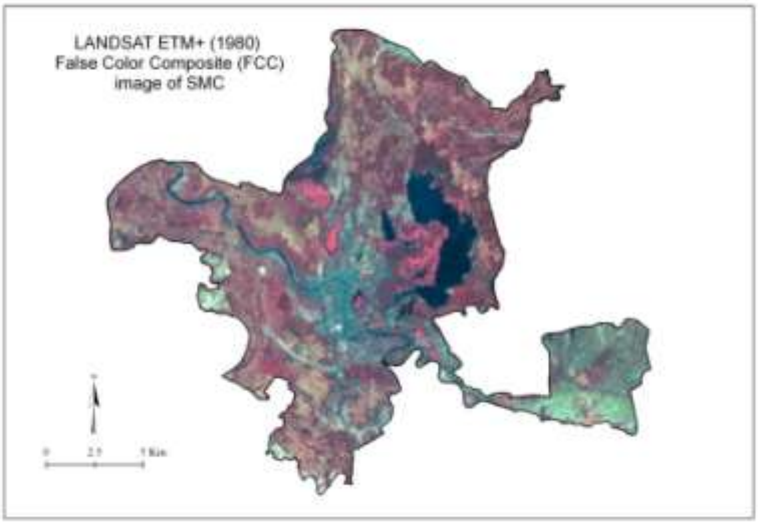
Land use Analysis -1980

During last 100 years, the city of Srinagar has grown 140 percent in terms of population size and 240 percent in terms of its spatial extent, which has resulted in low density sprawl towards its rural-urban fringe mainly in the form of leap frog and ribbon development [16]. The total area of Srinagar city is 240.77 km^2. The land use analysis of the study area in the year 1980 was dominated by natural green categories with an area of 130.76 square kilometers constituting about 54.30 percent of the total area followed by the waste land about 67.77 square kilometers (28.15 percent) . The fallow land occupied an area of 18.78 square kilometers constituting 7.80 percent of the total area. The area occupied by water bodies was 14.57 square kilometers (6.06 percent) and the least area was occupied by the built up which was found to be 8.89 square kilometers constituting about 3.70 percent of the total area of the city.

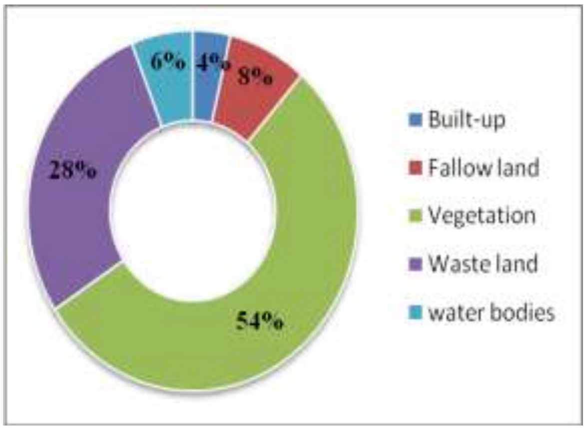
Land use/Land cover Area (1980)



Land Use Analysis of the year 1990



1980		
Class	**Area in Sq km**	**Percentage**
Built-up	8.89	3.7
Fallow land	18.78	7.8
Vegetation	130.76	54.3
Waste land	67.77	28.1
water bodies	14.57	6.1
Total	**240.77**	**100.0**



In the year 1990, the built up showed an increase from 8.89 square kilometres in 1980 to 51.37 square kilometres constituting about 21.34 percent of the total area. Not much change was observed in the vegetation cover of the city. However the waste lands showed a significant decrease from 67.77 square kilometres in 1980 to 40.75 km2 in 1990 comprising about 16.92 percent of the total area. The water bodies also showed a decrease in the area from 14.57 km2 in the year 1980 to 11.6 km2 in 1990 constituting about 4.82 percent of the total area.

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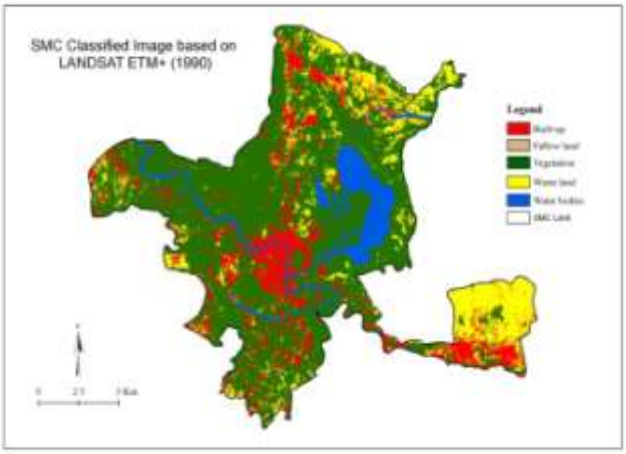
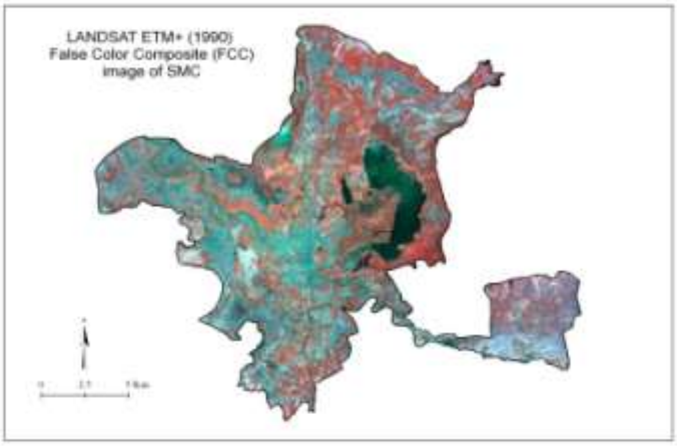
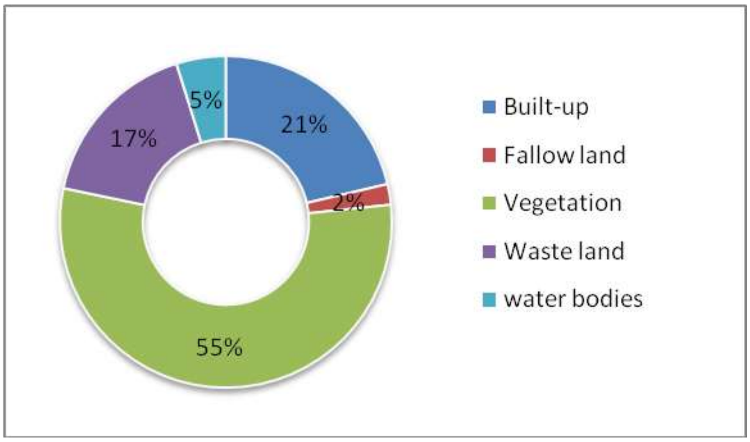
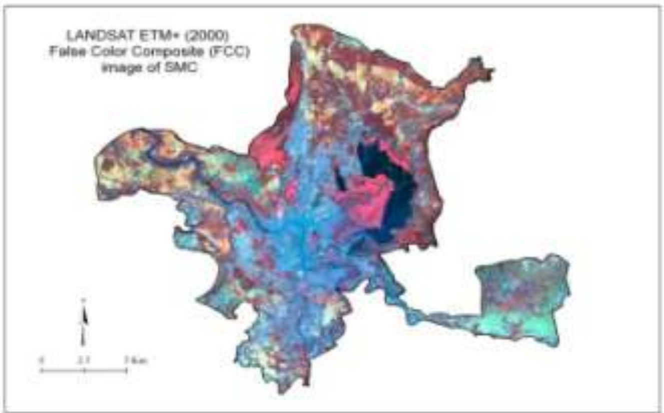




1990		
Class	**Area in Sq km**	**Percentage**
Built-up	51.37	21.34
Fallow land	4.85	2.01
Vegetation	132.2	54.91
Waste land	40.75	16.92
water bodies	11.6	4.82
Total	**240.77**	**100.00**



Land Use Analysis of the year 2000



In the year 2000, the built up was found to be 91.35 km2 constituting about 37.94 percent of the total area of the city. The fallow land was 26.56 km2 that consisted of 11.03 percent of the total area. Vegetation cover of the city showed a drastic decrease from 132.2 km2 in 1990 to 74.82 km2 in the year 2000 constituting about 31.08

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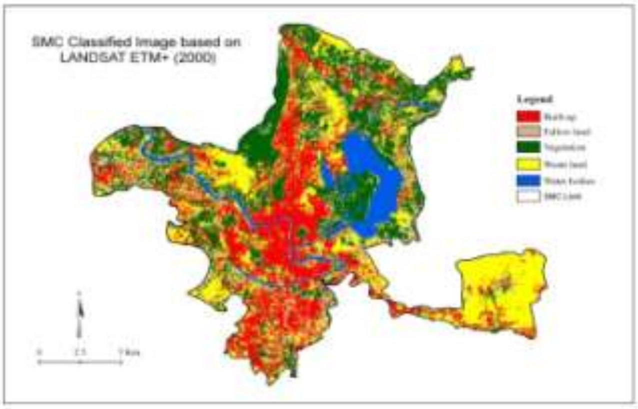
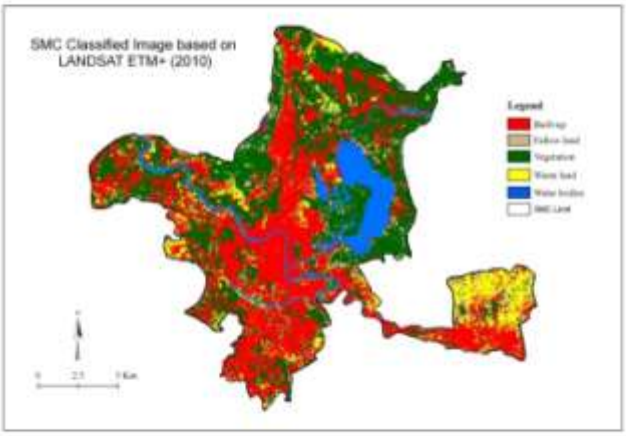
percent of the total area. The area under waste land was 38.43 km2 that constituted about 15.96 percent of the area and the area under water bodies was found to be 9.61 km2 constituting about 3.99 percent of the total area of the city.

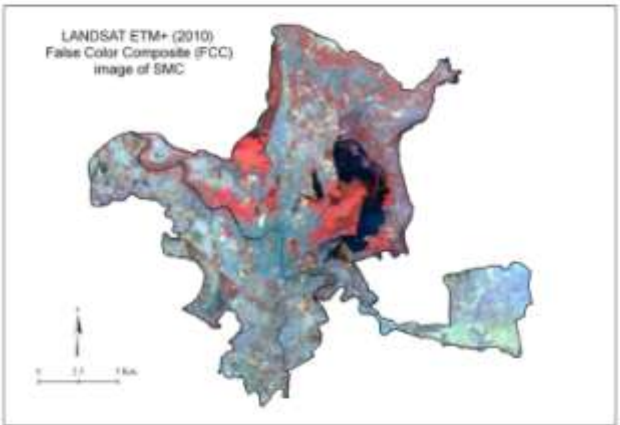
2000		
Class	**Area in Sq km**	**percentage**
Built-up	91.35	37.94
Fallow land	26.56	11.03
Vegetation	74.82	31.08
Waste land	38.43	15.96
water bodies	9.61	3.99
Total	240.77	100.00



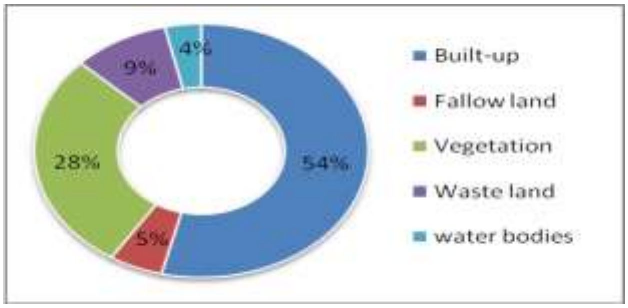
Land Use Analysis of the year 2010

The land under built up was 129.64 km^2 that constituted about 53.84 percent of the total area. Total fallow land was found to be 12.56 km^2 comprising about 5.22 percent of the total land area of the city. Vegetation cover was 67.69 km^2 (28.11 percent). Land under waste land category was found to be 22.43 km^2 (9.32 percent). Total land under water bodies was 8.45 km^2 that constituted about 3.51 percent of the total area of the city.





2010		
Class	**Area in Sq km**	**Percentage**
Built-up	129.64	53.84
Fallow land	12.56	5.22
Vegetation	67.69	28.11
Waste land	22.43	9.32
water bodies	8.45	3.51
Total	**240.77**	**100.00**



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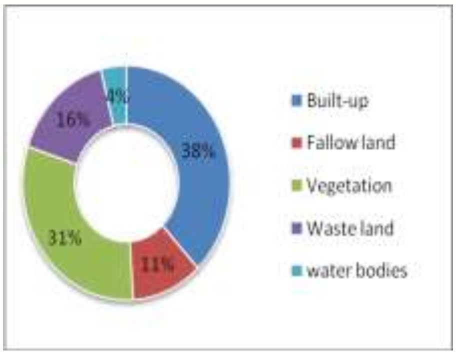
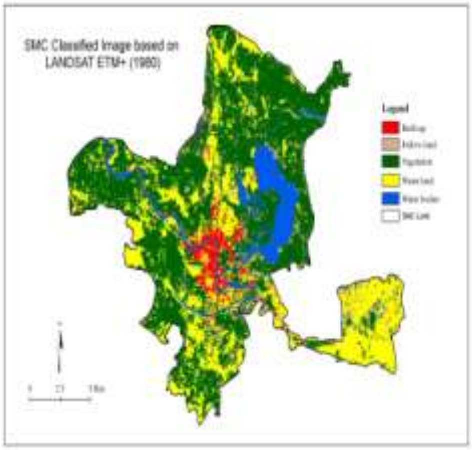
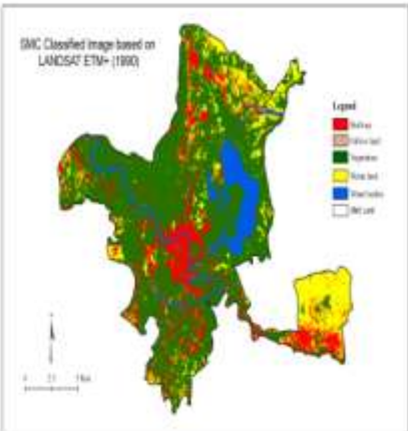
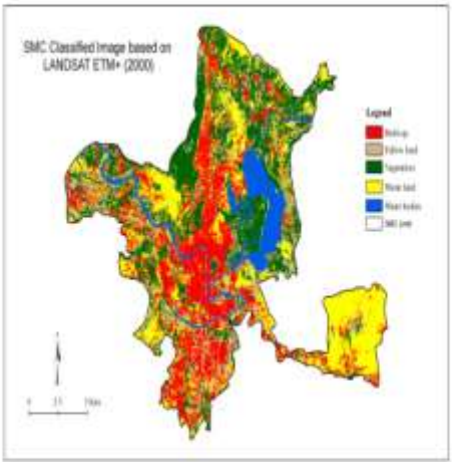
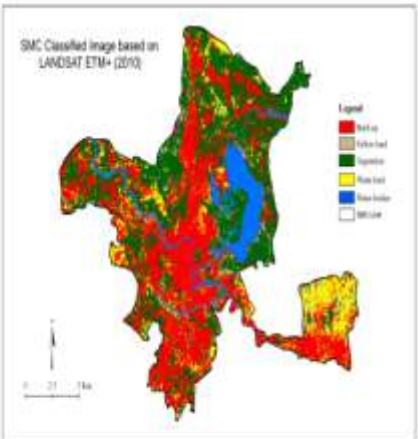


The enormous growth in respect of various socio-economic and cultural attributes has resulted not only in land use conversions within the city limits but has affected vast expanse of agricultural land in the fringe area. The ever increasing population pressure coupled with limited land available in the city lead to the urban sprawl and resultant encroachment in green spaces within the city and in the fringe areas too. The land use analysis of Srinagar city has exhibited fast and undesirable changes which are discussed below.









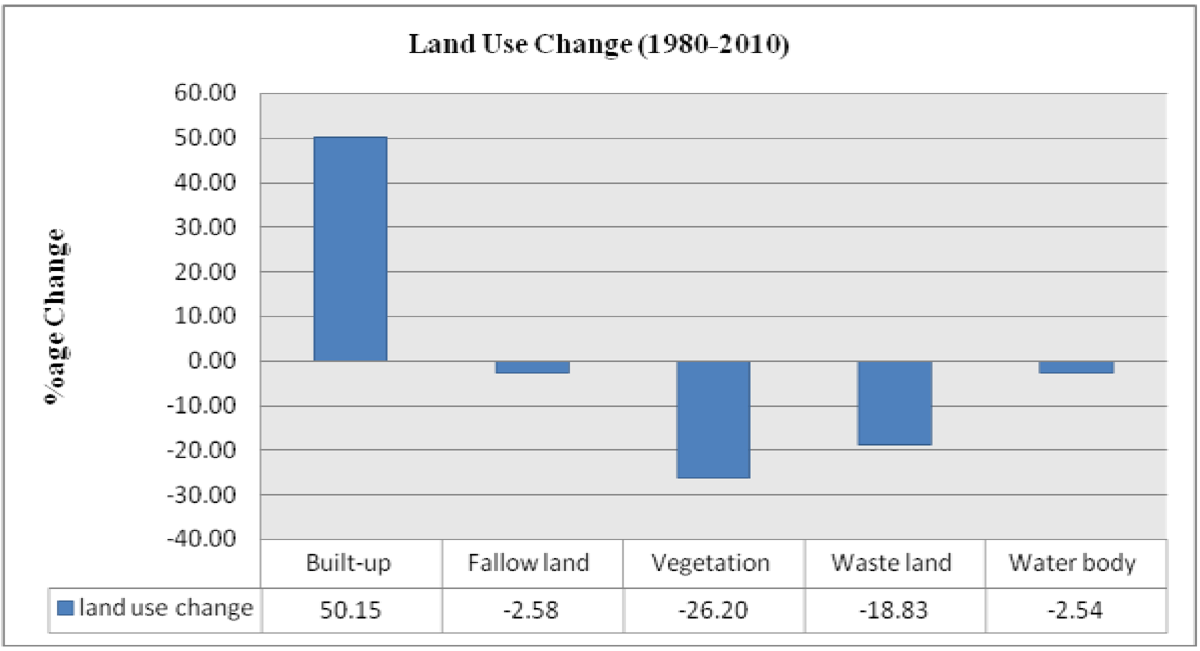
Classes	LANDSAT	LANDSAT	LANDSAT	LANDSAT
Built-up	8.89	51.37	91.35	129.64
Fallow land	18.78	4.85	26.56	12.56
Vegetation	130.76	132.20	74.82	67.69
Waste land	67.77	40.75	38.43	22.43
Water body	14.57	11.60	9.61	8.45
Total	**240.77**	**240.77**	**240.77**	**240.77**

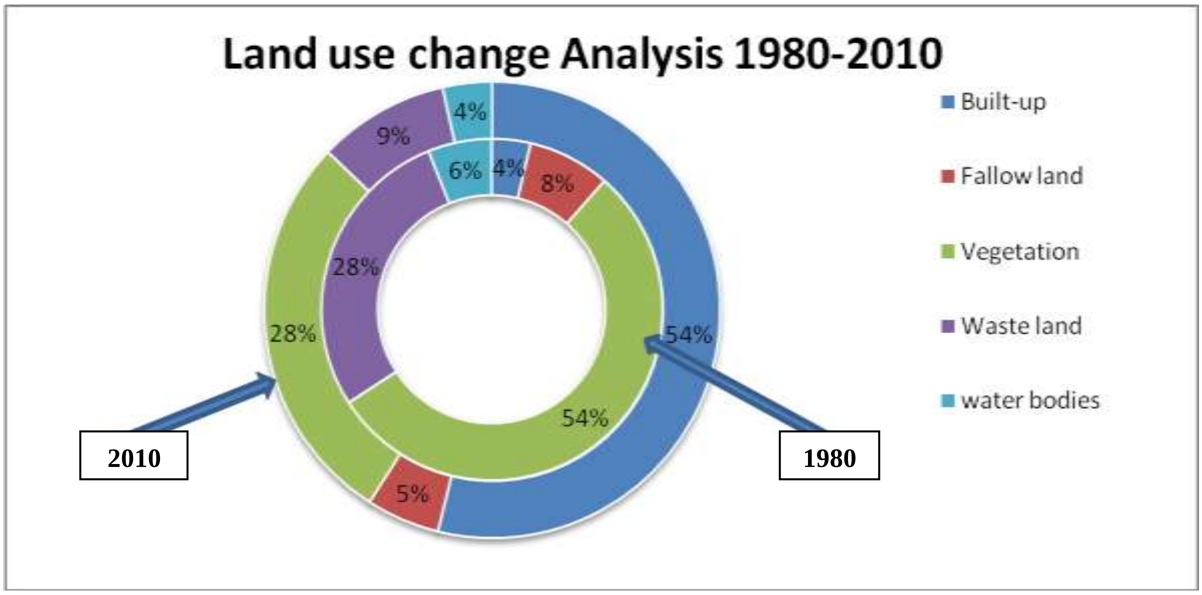
Land Use Change Analysis 1980-2010

The change detection analysis carried out in present study reveals that the land transformation has primarily been on account of increasing demands of the city. The table 1 shows that the total vegetation cover of the city has registered a significant decrease from 54.31 percent (130.76 kms2) in 1980 to 28.11 percent (67.69 km^2) in 2010, therefore, showing an absolute change of 63.07 km^2.

The water bodies of the study area in 1980 were 14.57 km^2 comprising 6.05 percent and has reduced to 8.45 km^2 in 2010 constituting 3.51 percent of the total area, thus registering a net change of -6.12km^2.

Land Use	Area (Km^2)	Percent	Area (Km^2)	Percent	Absolute	%
Built-up	8.89	3.69	129.64	53.84	120.75	50.15
Fallow land	18.78	7.80	12.56	5.22	-6.22	-2.58
Vegetation	130.76	54.31	67.69	28.11	-63.07	-26.20
Waste land	67.77	28.15	22.43	9.32	-45.34	-18.83
Water body	14.57	6.05	8.45	3.51	-6.12	-2.54
Total	240.77	100.00	240.77	100.00		





The fallow land covered an area of 7.80 percent (18.78 km^2) in 1980 and has reduced to 5.22 percent (12.56 km^2) in 2010, thus showing an absolute change of -6.22 km^2.

The analysis of built-up category reveals that it constituted 8.89 km^2 (3.69 percent) 1980 and has increased to 129.64 km^2 (53.84 percent) in 2010, thus registering an absolute change of 120.75 km^2.

The area under waste land in 1980 was 67.77 km^2 amounting about 28.15 percent of the area and it was considerably decreased to 22.43 km^2 (9.32 percent) in the year 2010, thus registering an absolute change of -45.34 km^2.

CONCLUSION

The paper focuses on land use land cover changes in an urban area, Srinagar India using Remote sensing data and GIS technology. Our results explicitly reveal that there are significant changes witnessed during the period from 1980 to 2010. The land use/cover changes have been extensive in the past three decades in Srinagar which has caused a widespread environmental degradation

Built up of the city clearly shows a considerable increase while on the other vegetation cover, water bodies shows a considerable decline during the study period. Located in the heart of the bowl of Kashmir valley, Srinagar city is its capital city, ever since its creation. The analysis reveals that besides the physiographic limitations, there has been widespread urban expansion in Srinagar city during the study period of 30 years (1980-2010). Built-up area has increased by 120.7 square kilometres, which is the combination of anthropogenic activities and it is the one that affects the other land use/cover classes.

There is a need to balance present requirements of land against future needs. Agricultural land needs to be preserved in the fringe areas of the expanding city in order to maintain and sustain the open spaces and therefore the quality of the environment. This study also proves that the integration of Remote Sensing and GIS can be used as an effective tool for urban planning and management.

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