Trans. Inst. Indian
Geographers

"Analysis and Simulation of urban expansion of Srinagar City"

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Abstract

The process of urban expansion is a dominant phenomenon in the Himalayan regions which has been accelerated by increasing levels of urbanization facilitated by marked developments in transportation, tourism and industrialization. The other determinants of sprawl include high population growth on account of migration and the establishment of growing network of public utilities. Unlike plains the vertical expansion of cities in these areas is constrained due to geo-structural sensitivity of the region, the cities in such areas mainly grow outwards along their peripheries and major transport corridors encroaching into productive agricultural land, wetlands and forest areas which in turn negatively influence the food security and environmental status of these regions. Srinagar city is the largest urban centre across whole Himalayan region and is experiencing considerably high rates of population growth and areal expansion. The city has recently been ranked as one among the first hundred fastest growing urban centers throughout the world. Therefore in present study an attempt has been made to analyse and simulate the trends and patterns of population growth and spatial expansion of this fast growing Himalayan urban centre

Keywords: *Urban sprawl, mountainous, Himalayan, wetlands, agriculture, transport corridors.*

Introduction

In the present day scenario, cities are becoming hub of almost all human activities. This has resulted in ever-growing size of cities, squeezing open spaces available within the city and has started exerting pressure on civic amenities. This extraordinary growth of population resultant areal expansion and pressure on amenities are the most dramatic phenomenon associated with urbanization. This is also a fact that the pressure of the continuously growing city centre gradually changes the structure of surrounding neighbourhoods. Further, extension of urban areas and merging of fringe areas into main city seems to be a continuous process, a phenomenon called urban sprawl. Generally speaking, growth of population is the fundamental factor in human ecological system and its relationship to the natural resources, environment and technology (Rajeshwari, 2006).

In India, unprecedented population growth coupled with unplanned developmental activities has resulted in rapid but skewed urbanization. This has

posed serious implications on the resource base, access to infrastructure and the development of the region. The urbanization takes place either in radial direction around a well-established city or linearly along the highways (Jain, 2007). Some of the causes of the sprawl include- population growth, economy and proximity to resources and basic amenities. In the course of urban spread, valuable land is being converted for building, industry, transport facilities etc.

The direct implication of such urban sprawl is the change in land use and land cover of the region. The ability to serve and develop land heavily influences the economic and environmental quality of life in towns (Turkstra, 1996; Xiao et al, 2006). Haphazard and unplanned expansion of urban centers is a typical character of the Himalayan region, the urban scene in most of the mountain valleys is dominated by urban primacy of a single central urban center.

An absence of any land use planning may lead to land degradation. Un-planned decisions may result into misery for large segment of the local population and destruction of valuable eco-system. Techniques for the planning and management of land resources specifically integrated and holistic will check long term quality of the land for human use, their prevention or resolution of social conflicts related to land use and the conversion of ecosystem (Bhatt et al., 2007). Identification and analyses of the patterns of sprawl in advance would help in effective infrastructure planning in urban area. The spatial patterns of urban sprawl over different time periods can be systematically mapped, monitored and accurately assessed from satellite data along with conventional ground data (Lata, et al., 2001).

Sprawl has a considerable impact on ecosystems and other environmental resources which provide societal and environmental benefits simply by existing and functioning. These essential biological and physical systems include wetlands that provide flood control and waste water renovation; atmosphere, forests, and grasslands that provide climate regulation; biodiversity factors that contribute to healthy, well-functioning ecosystems (Barnes, 2003; He et al, 2011). Moreover, urbanization is radically transforming rural landscapes, shifting the economic base away from agriculture towards other uses and changing the aesthetic characters of these landscapes.

Study Area

Srinagar city is not only the largest urban centre in the state of Jammu & Kashmir but in the whole Himalayan region. The city has been growing at an alarming pace therefore indicating considerable changes. The city lies 74º 43´ - 74º 52´ E longitude & 34º 0´ - 34º 14´ N latitude. It is about 5200 feet above mean sea level. The location map of the study area is shown in fig.1. (see page 119 for fig.1) The city has a unique physiographic setup with steep hills in the East and North East, low lying paddy fields falling in the flood plain of Jhelum in the South and West, the karewas of Budgam in the extreme South and towards the North are located the uplands with

moderate slopes. The famous Dal Lake is situated in the heart of the city. There are two conspicuous physical features in the shape of *Kohimaran* and *Kohisuleiman* hillocks. The city of Srinagar experiences a Mediterranean type of climate and receives most of its precipitation during the winter season in the form of rain and snow.

Location Map of Study Area

The city has a rich heritage of flora and fauna and is unique in the sense that the forests are very close to it. These forest areas are home to varied mammalian species like black bear, leopard and world famous Hangul– the only red dear found in India. The main floral species of the city are Chinar, Popolar, Willow, Kikar, Han, Bren etc.

Objectives

The study has been carried out with a focus to achieve the following objectives;

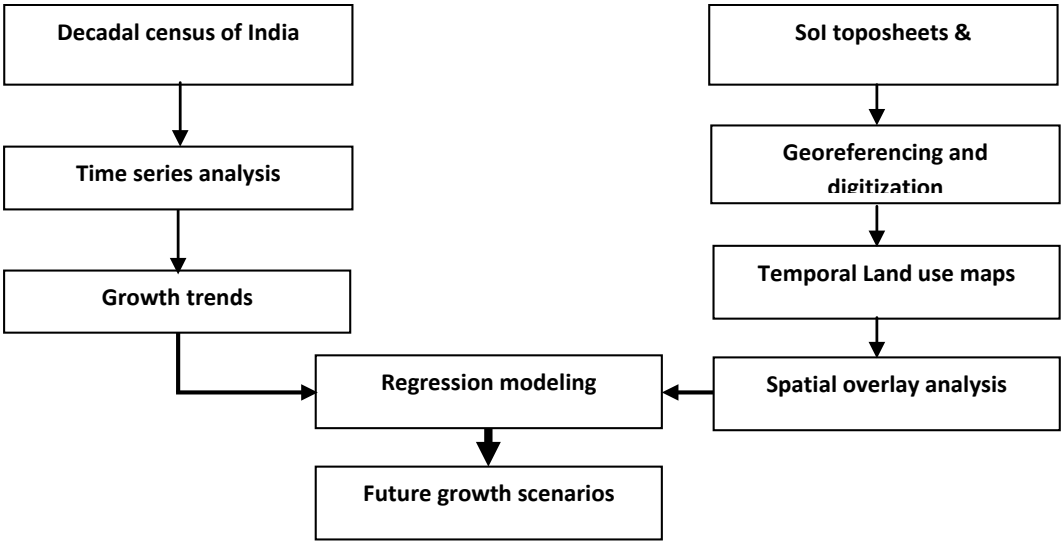
I. To analyze the population growth and urban expansion (spatio-temporal growth) from 1901 to 2011

II. To identify and analyze the forms of urban sprawl from 1901 to 2011

III. To project the future scenario of population growth and areal expansion of Srinagar city.

Materials and Methods

Flow Chart of Methodology



The projected rates of population growth were simulated through the following equation;

$$Y = A.B^{x}$$

The log form of the above equation is as;

$$\log Y = \log A + x \log B$$

Results and Discussions

Srinagar city is experiencing the phenomenon of accelerated urbanization induced by large scale development in transport and tourism, growing network of urban amenities and infrastructure developmental. All these factors have resulted in burgeoning population growth especially during the last fifty years or so. Srinagar- the primate city of the region has enjoyed its primacy throughout the ages. The city was found by king Ashoka in 272B.C and is one of the oldest urban centers of the region. The city has achieved the status of metropolitan urban centre in the year 2008 and is currently experiencing higher rates of urban growth as compared to other cities of the country. The city has experienced almost no vertical expansion due to fragile geophysical setup of the region which in turn has resulted in accelerated horizontal sprawl of the city.

Population Growth

High population growth rate is a common problem of most of the urban centers throughout the developing world. The figures regarding population of Srinagar city are relatively reliable only since enumeration of 1901 A.D. Therefore it may be taken as a base for analysis of growth trends and decadal variations in the population of the city. The Table I.I presents the pattern of population growth and percentage of variation during different decades. From perusal of the Table I.I, it is evident that the population of Srinagar city during the last century (1901-2011) has grown phenomenally. It increased from 122,618 persons in 1901 A.D. to 122,5837 persons in 2011 A.D. indicating nearly tenfold increase amounting to 900 percent growth with a net increase of 110,3219 persons. The pattern of decadal growth however, has not been uniform. In the early decades from 1901-1961A.D, the growth has been slow due to the low growth rates which has declined from 22.46 percent in 1931 A.D. to 15.71 percent in 1961 A.D. This decline in the growth rate could be attributed to the political unrest and partition of the subcontinent in 1947 A.D. which led to a large scale migration of people. It was after 1961 A.D. that a new phase of growth of population commenced. The population of the city increased from 285,257 persons in 1961 A.D. to 606,002 persons in 1981 A.D. recording a net addition of 320,745 persons with alarming growth rates of 34.31 and 40.13 percent respectively. The main factors responsible for this accelerated population growth during this period have been in migration, increase in birth rates and fall in death rates. Besides this, the merger of 62 villages in municipal limit in 1971 A.D. and the introduction of urban agglomeration concept which brought a number of rural areas under the jurisdiction of Srinagar city are indeed the other factors contributing to the rapid growth of the city population. Subsequently from 1981 to 2011 A.D. the population increased to 971,357 persons in 2001, registering a net growth of 365,355 persons in two decades with a decadal growth rate of 30.14 percent and 122,5837 persons in 2011 recording a net addition of 254,480 persons during the last ten years.

The dynamic trend in the population growth of Srinagar city suggests an

accelerated rate of growth in city's population in future which is revealed from the fact that the city has achieved the metropolitan status in the year 2008. This anticipated rapid change in the demographic dimension of the city is bound to create an impact on the socio-economic structure of the city and may accentuate the problems of housing scarcity, land speculations and urban blight and slums.

Table I.I: Srinagar City- Population Growth and Areal Expansion (1901-2011)

Year	Population	Absolute Variation	Decadal Growth Rate	Area (Km^2)	Absolute Variation Km^2	Decadal Growth Rate Km^2	Density Per Km^2
1901	122618	---	---	12.8	---	---	9579
1911	126344	3726	3.04	12.85	0.5	0.39	9832
1921	141735	15391	12.18	14.48	1.63	12.68	9788
1931	173573	31831	22.46	17.6	3.12	21.54	9862
1941	207787	34212	19.71	17.6	0.00	0.00	11806
1951	246522	38735	18.64	29.52	11.92	67.72	8351
1961	285257	38735	15.71	41.44	11.92	40.37	6884
1971	403413	118156	34.31	82.88	41.44	100	4867
1981	606002	202589	40.13	208.9	125.12	150.96	2912
1991	194902	N.A	N.A	N.A	N.A	N.A	N.A
2001	995806	389804	64.32	278.1	69.20	33.12	3581
2011	1225837	230031	23.13	416.3	138.2	49.72	4407

Source: Census of India, 1901-2011, Srinagar Municipal Corporation. NA (Not Available) No Census was conducted in 1991.

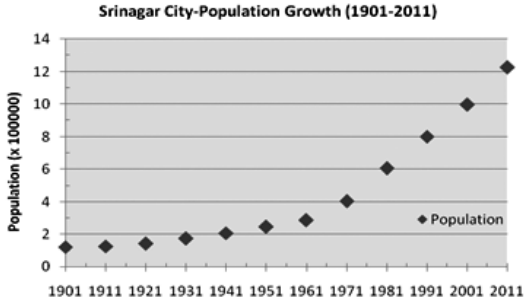


Fig. 2a

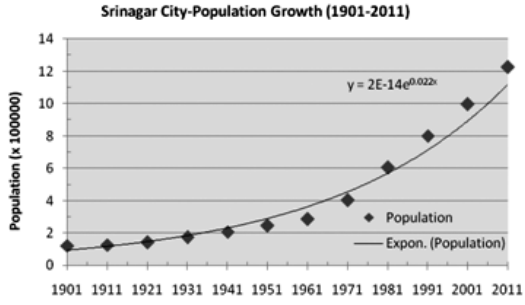


Fig. 2b

5.2 Areal Expansion

During past century (1901-2011) increasing population due to high natural growth rate and in migration for better livelihood opportunities have paved way for rapid expansion of this urban centre. The Table I.I shows the pattern of increase in the area of the city during last hundred years. It is clear from these figures that there has been a slow expansion of the city during first fifty years and a very fast expansion after 1970's as the total area of the city has increased from 12 Km^2 in 1911A.D. to 82 Km^2 in 1971A.D., 278.1 Km^2 in 2001A.D. and 416 Km^2 in 2011A.D. The analysis of the spatial expansion of the city reveals that growth of the city has been an exponential one as reflected in Fig. 3b. The sprawl of the city between 1901 and 2011 has been reflected in Fig.4. (see page 120 fig. 4)

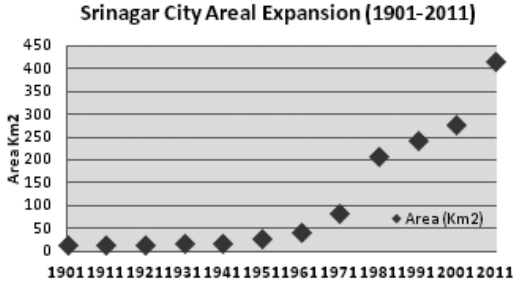


Fig. 3a

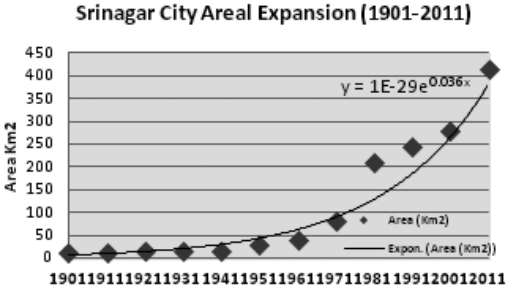


Fig. 3b

5.3 Spatial Forms of Sprawl

Sprawl development consists of three basic spatial forms: low-density continuous sprawl, ribbon sprawl, and leapfrog development sprawl. *Low density* sprawl is the highly consumptive use of land for urban purposes along the margins of existing metropolitan areas. This type of sprawl is supported by piecemeal extensions of basic urban infrastructures such as water, sewer, power, and roads. *Ribbon* sprawl is development that follows major transportation arteries outward from urban cores. Lands adjacent to corridors are developed, but those without direct access remain in rural uses/ covers (Muller et al, 2010). Over time, these nearby "raw" lands may be converted to urban uses as land values increase and infrastructure is extended perpendicularly from the major roads and lines. *Leapfrog development* sprawl is a discontinuous pattern of urbanization with patches of developed lands that are widely separated from each other and from the boundaries, albeit blurred in some cases, of recognized urbanized areas (Harvey and Clark, 1971).

The interpretation of Fig.4 highlights the changing spatial form of Srinagar city. The areal sprawl during the period prior to 1971A.D. indicates that the city has grown roughly in a circular form. However after 1971A.D. the city has experienced tremendous sprawl and has been transformed from a circular to a star shaped urban centre. This change in the spatial form of the city during last forty

years could mainly be attributed to its fragile and challenging geo-ecological setup. As visualized in the Fig.4, there has been practically no spatial expansion of city limits in the east and the north west of the city due to the presence of *Zabarwan* hills and *Anchar* wetland respectively. This shows the control of natural environment in shaping the spatial form of the city. The urbanization in Srinagar city has taken place either in the form of ribbon sprawl, in a linear direction along the highway and other major transport corridors (district roads) of the city or in the form of leapfrog, occupying certain suitable patches as per the accessibility and proximity. This has in turn resulted in large scale fragmentation and encroachment of productive agricultural and horticulture land. The wetlands and lakes of the city that have been at service both economically as well as ecologically, since times immemorial have not been spared. The presence of these physical and ecological features has played a leading role in shaping the overall form of the city.

5.4 Impacts of Sprawl

The problems created by the haphazard and unrestricted growth of Srinagar city have aggravated irregular and chaotic development of residential, industrial and commercial areas resulting in fragmentation and loss of productive agriculture and horticulture land, spatial and ecological destruction of life supporting wetlands, world famous lakes, traffic bottle necks, slums, polluted environment and others all known and felt by the residents of the city.

Suburbs of the city have attracted people from both sides i.e. migrants from rural areas in search of better jobs and access to urban amenities and from the core city in search of better environmental conditions and living quality. This has led to redistribution of land by the complementary tendencies of concentration and dispersion of population.

The environmental impact of sprawl spans local, regional, and global geographical scales. At a more regional scale the sprawl of Srinagar city has been mainly at the cost of agriculture and horticulture land. The expansion of the city in the north and the east has mainly been at the cost of precious horticulture land while in the south and the west it has been at the cost of productive agriculture and wetland area.

The fast sprawl of the city has heavily encroached on the wetlands like Littorals of Dal, Anchar, Hokrasar, and Narkara. All these wetlands have suffered a substantial loss in their spatial extant (Bhat, 2008). The ecological studies carried out during the last thirty years have shown increasing pollution levels in the water bodies of the city especially the Dal lake and the Jhelum river. These changes in the spatial and ecological status of water bodies are mainly the response to the unplanned and unregulated urban activities especially after 1970's.

Another important observation in response to the sprawl of Srinagar city is human-wildlife conflicts As the residential land uses intrude into more agricultural and wildlife habitats areas, human-wildlife conflicts are on the rise. The expansion of the city towards the upper areas of Zabarwan hills, especially in Dachigam catchment has results in an alarming increase in human-wildlife conflicts.

Despite traffic congestion and long hours to commutes the work places, the suburbs continue to remain a preferred residential location with better quality of life for many city residents. On the other hand migrants from rural areas also prefer to settle in suburbs due to the availability of affordable land and connectivity to their native rural areas. Society faces the challenge of striking a balance between curtailing urban growth beyond developed areas and providing housing opportunities for inner-city residents who struggle to improve their quality of life.

5.5 Future Growth of Srinagar City (Fig.6)

The analysis of population growth and areal expansion of Srinagar city during past hundred years show an exponential growth pattern as reflected in Fig. 2b and 3b respectively. This phenomenon of burgeoning population growth and fast areal expansion together with current growth rates being very high, suggest an unmanageable growth of the urban centre in near future.

The analysis of the past patterns (during last hundred years) of growth and

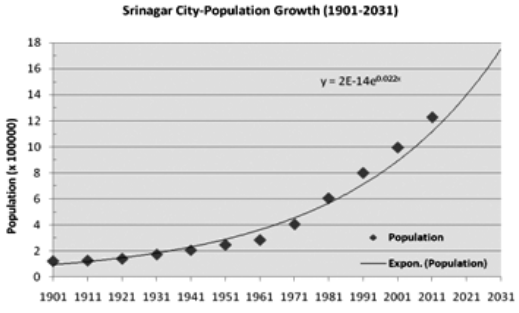


Fig. 5a

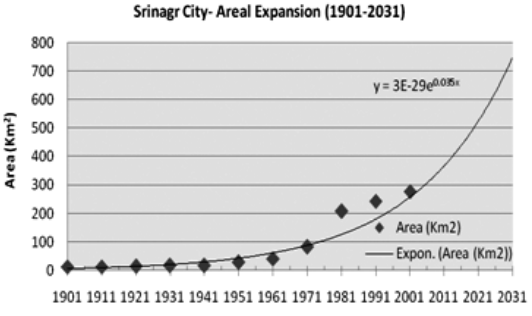


Fig. 5b

future trends through regression analysis (exponential), the city is projected to cross 1.7 million persons in terms of its population size and sprawl over more than 750 Km^2 in terms of its spatial extant by the year 2031 as reflected in Fig. 5a and 5b respectively. The immediate areas of development would be the areas in the vicinity of major transport corridors. Presently this land forms a part of productive agriculture land of the city and most of the perishable items to the city come from these areas. This phenomenon of unregulated expansion of the city in turn will put enormous pressure on the already stressed and strained urban amenity structure of the city resulting in backlogs in vital sectors and may lead to a scenario of unmanageable urban system.

Conclusion

The city of Srinagar being the largest urban centre among all Himalayan urban centers is facing the phenomenon of accelerated urbanization and resultant environmental degradation It has a very complex geo-ecological setup with precipitous hills standing guard in the East to prevent city's further expansion on this side, besides

there are a number of urban lakes like Dal, Anchar, Nigeen, Babdemb and khushalsar that have played a dominant role in shaping the spatial form of the city. These physical and ecological features have played a determining role in shaping the overall spatial form of the city. The city has grown in a circular form during the first half of 20th century and has been now transformed into a star shaped urban centre growing mainly along the major transport corridors in the form of ribbon development. The land along the roads with easy accessibility has been developed leaving behind fragmented interiors. Another form of sprawl found in Srinagar city is Leapfrog sprawl caused by rugged terrain, wetlands and water bodies. All these factors have precluded the continuous development or made it prohibitively expensive.

During the latter half of past century the magnitude of population growth and resultant spatial expansion and land use change in Srinagar city has increasingly assumed from significant to threatening proportions. The city has grown tenfold in terms of population and more than twentyfold in terms of area between 1901 and 2011AD. This escalating urban growth, in a sensitive geo-ecological setup has resulted in large scale encroachment and degradation of productive agriculture/ horticulture land, life supporting wetlands, green spaces and forest areas.

Past patterns of urban expansion of the city both in terms of population size and spatial dimensions coupled with current high rates of sprawl, suggest higher growth rates and fast urban expansion of the city in near future as well. (see page 121 for Fig. 6) The population size of the city is projected to cross 1.7 million mark and the area of the urban centre is projected to reach 750 km^2 by the year 2031. The analysis brings to light the process and pattern of rapid urbanization in this mountainous area and calls for an immediate attention of planners to devise comprehensive a land use plan for the sustainable and balanced urban development in the region. Otherwise the city may turn into an unmanageable metropolitan complex with serious ecological and social consequences.

Acknowledgement

The authors are highly thankful to the University of Kashmir for providing the space and support to conduct this research work. Thanks are also due to the University Grants Commission for providing satellite data through a sponsored research project.

References

Almas, A., Amjed S., Rahim, A., Butt, B., Tayyab, I. and Shah, C. (2007): Metropolitan growth monitoring and land use classification using geospatial techniques, *ISPRS Workshop on Service and Application of Spatial Data Infrastructure*, XXXVI(4/W6), Hangzhou, China. 14-16

Barnes, J. (2003), "Natural History of the Albany Pine Bush": Albany and Schenectady Counties. *NYS Museum Bulletin*, New York, NY, 502.

Bella, K. P. and Irwin, E. G. (2002): Spatially explicit micro level modeling of land use change at the rural-urban interface, *Agricultural Economics,* 27:217-232.

Berling, W. and Wu, J. (2004): Modeling urban landscape dynamics: a case study in Phoenix, USA" *Urban ecosystems,* 7:215-240.

Bhat, M. S. (2008) *Urban System in Himalayas-A study of Srinagar City Region*, Dilpreet Publishing Co. New Delhi.

Bhatt, B., Gupta, A. K., Gunin, G. (2007): Application of Remote Sensing and GIS for Detecting Land Use Changes: A Case Study of Vadodara http://www.gisdevelopment.net/application/urban/sprawl/remotesensing_ab.htm

Harvey, R. O. and Clark, W. A. V. (1971): The nature and economics of urban sprawl, In Bourne L. S. (eds.) "*Internal Structure of the City*" Oxford University Press 475–482.

He, C., Tian, J., Shi, P. and Hu, D. (2011): Simulation of the spatial stress due to urban expansion on the wetlands in Beijing, China using a GIS-based assessment model, *Landscape and Urban Planning,* 101:269-277.

Lata, K. M., Sankar Rao, C. H., Krishna, P. V., Badrinath, K. V. and Raghavaswamy. S. (2001): *Measuring urban sprawl: a case study of Hyderabad*, GIS Development, **5,** 12: 26-29.

Muller, K., Steinmeier, C. and Kuchler, M. (2010): Urban growth along motorways in Switzerland, *Landscape and Urban Planning*, 98:3-12

Mundia, C. N. and Aniya, M. (2005): Analysis of land use/cover changes and urban expansion of Nairobi city using remote sensing and GIS, *International Journal of Remote Sensing*, 26: 2831–2849.

Rajeshwari, (2006): Management *of the Urban Environment Using Remote Sensing and Geographical Information Systems,* J. Hum. Ecol., **20,** 4: 269-277

Sanat, K. G. and Abhik, D. (2009): Spatiality and zoning of urban functions in the North-Eastern parts of Kolkata Metropolitan Area, *Transections institute of Indian geographers,* **31**, 2.

Taubenbock, H., Wegmann, M., Roth, A., Mehl, H. and Dech, S. (2009): Urbanization in India: spatiotemporal analysis using remote sensing data, *Computers, Environment and Urban Systems,* **33**, 3: 179-188.

Turkstra, J. (1996): *Urban Growth and Land Use Options for Lower-Income Groups A Case Study of Villavicencio, Columbia*, ITC Journal 1: 57 – 63

UN Habitat, (2009): *Global Report on Human Settlements 2009—Planing Sustainable Cities: Policy Direction*, United nations human Settlements Programmee/ Earthscan, London, UK.

Wu, Q., Li, H., Wang, R., Paulussen, J., He, Y., Wang, M., Wang. B. and Wang, Z. (2006): Monitoring and predicting land use change in Beijing using remote sensing and GIS, *Landscape and Urban Planning*, 78: 322-333.

Xiao, J., Shen, Y., Ge, J., Tateishi, R., Tang,C., Liang, Y. and Huang, Z. (2006): Evaluating urban expansion and land use change in Shijiazhuang, China, by using GIS and remote sensing, *Landscape and Urban Planning,* 75: 69-80.

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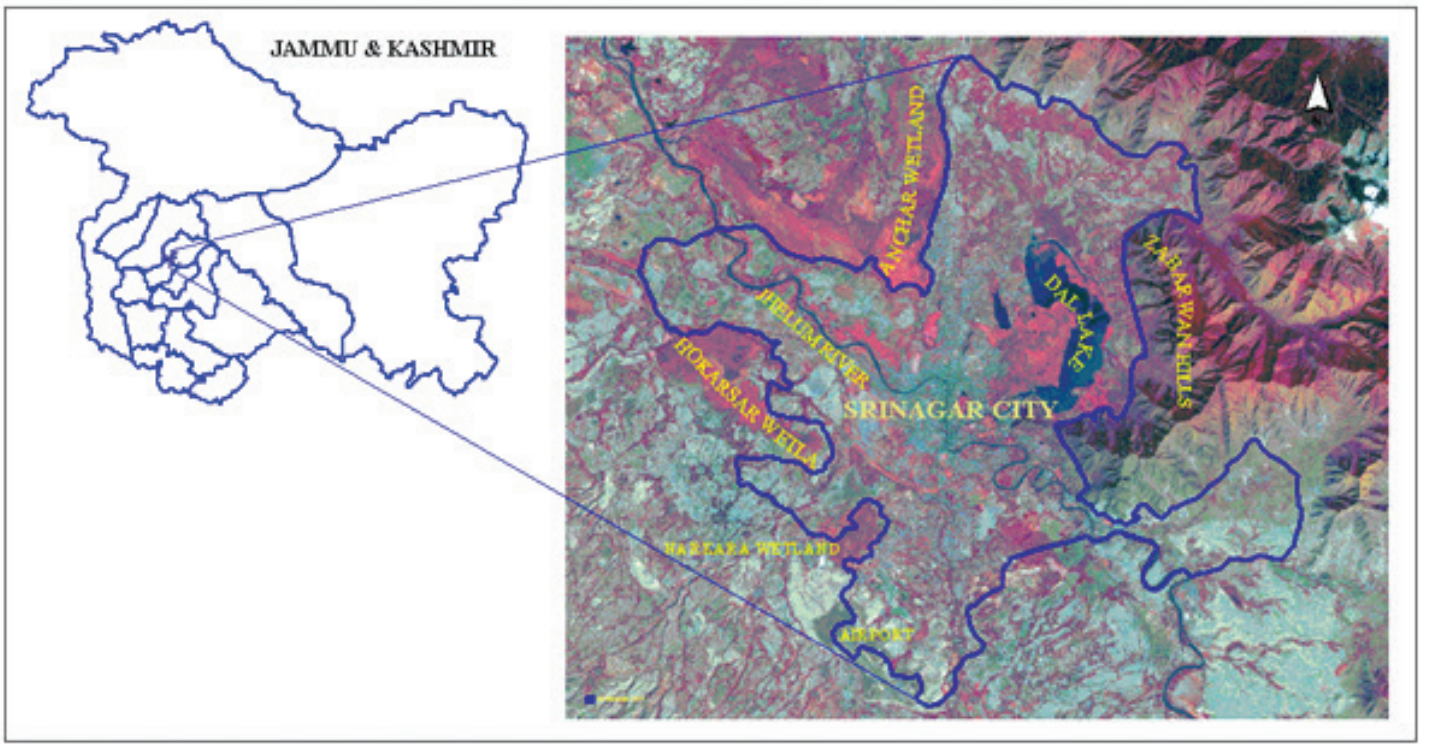
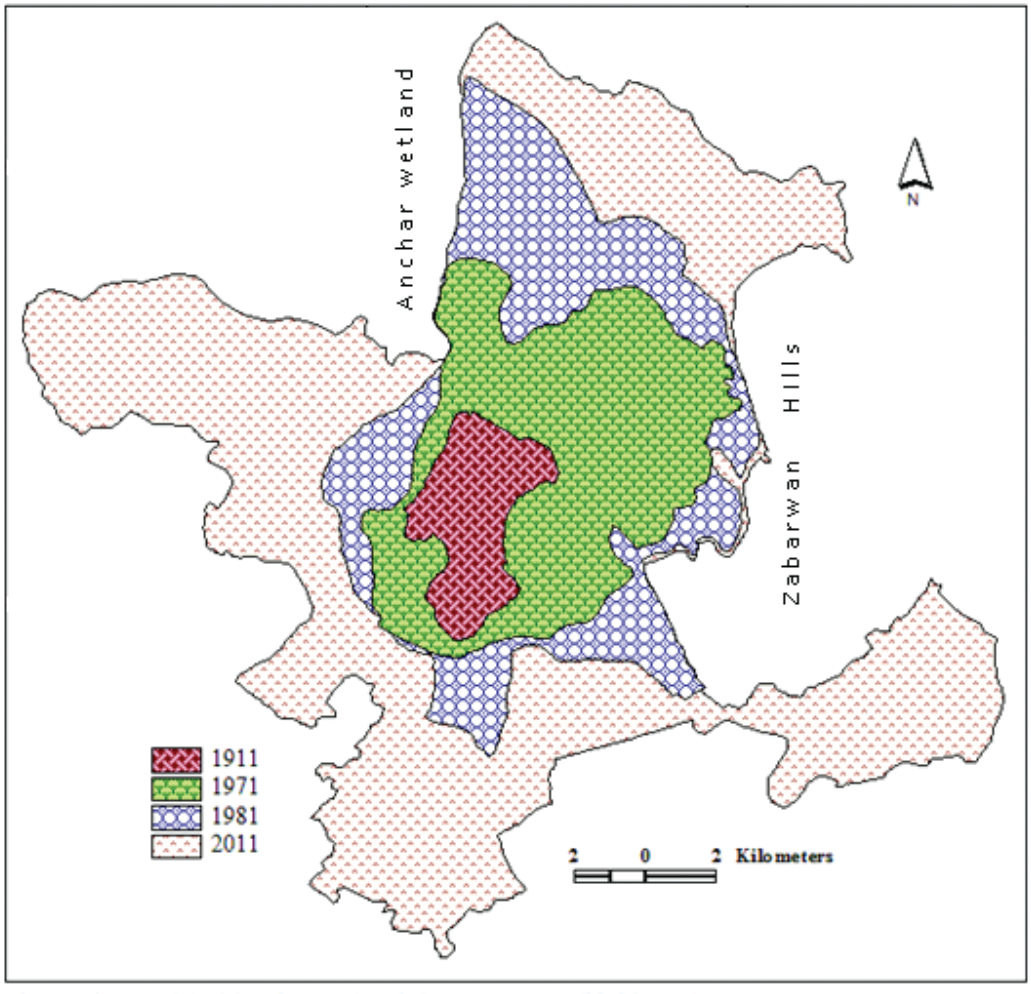


Fig. 1 Locatoion map of study area

See page 110 for text



Source: Srinagar Municipal Carporation; SoI toposheets and P5, P6 satellite data.

Fig. 4

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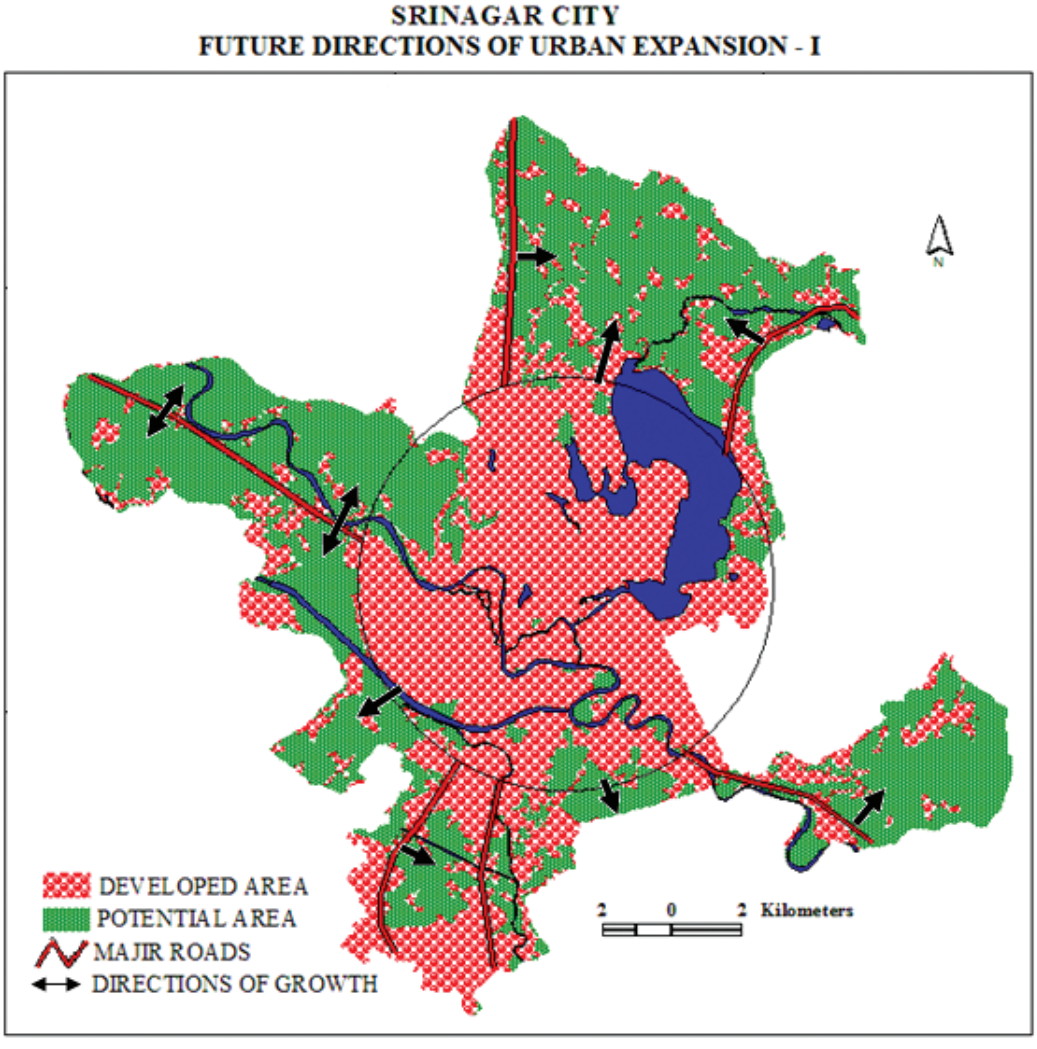

Fig. 6

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