

Nengroo, Zahoor A.; Bhat, M. Sultan; Kuchay, Nissar A.

Article

Measuring urban sprawl of Srinagar city, Jammu and Kashmir, India

Journal of Urban Management

Provided in Cooperation with:

Chinese Association of Urban Management (CAUM), Taipei

Suggested Citation: Nengroo, Zahoor A.; Bhat, M. Sultan; Kuchay, Nissar A. (2017) : Measuring urban sprawl of Srinagar city, Jammu and Kashmir, India, Journal of Urban Management, ISSN 2226-5856, Elsevier, Amsterdam, Vol. 6, Iss. 2, pp. 45-55, <https://doi.org/10.1016/j.jum.2017.08.001>

This Version is available at:

<https://hdl.handle.net/10419/194430>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

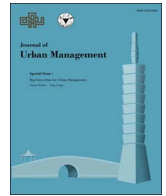


<https://creativecommons.org/licenses/by-nc-nd/4.0/>



Contents lists available at ScienceDirect

Journal of Urban Management

journal homepage: www.elsevier.com/locate/jum

Research Article

Measuring urban sprawl of Srinagar city, Jammu and Kashmir, India



Zahoor A. Nengroo*, M. Sultan Bhat, Nissar A. Kuchay

Department of Geography and Regional Development, University of Kashmir, 190006, India

ARTICLE INFO

Keywords:

Urbanization
Urban growth
Sprawl
Amenities
Ecology
Sustainable development

ABSTRACT

Urbanization, as such, is not perceived as a threat to the environment and development but it is unplanned urban sprawl that affects the accessibility to amenities and land-use of any region. It is thus imperative to study and bring out the intricacies and implications associated with the problem of unplanned urban growth ensuing into sprawl. The methods used to measure the sprawl of Srinagar City are modified versions of SCATTER (The *Sprawling Cities And Transport: from Evaluation to Recommendations*) and Cost of Sprawl: 2000 TRB (Transport Research Bureau, US). The analysis reveals that the largest urban center in the fragile ecology of Himalayas has haphazardly grown during the last forty years which has resulted in disproportionate distribution of various civic amenities, socio economic and environmental variables. This phenomenon of urban sprawl in Srinagar City has been observed as a threat to achieving sustainable urbanization.

Introduction

The study of urbanisation has evinced interest from a wide range of experts. The multidisciplinary gamut of the subject invokes the interest from ecologists to urban planners and civil engineers to sociologists to geographers to administrators and policy makers and finally the common man. This is because of the multitude of activities and processes that take place in the urban ecosystems every day. Urban ecosystems are the consequence of the intrinsic nature of humans as social beings to live together (Torrens and Alberti, 2000).

The unprecedented population growth and migration, an increased urban population and urbanisation is inadvertent in developing countries (Reddy, 2004). More and more towns and cities are blooming with a change in the land use along the highways and in the immediate vicinity of the city. This dispersed development outside of the compact urban and village centres along highways and in rural countryside is defined as sprawl (Theobald, 2001). Urbanisation is a form of metropolitan growth that is a response to often bewildering sets of economic, social, and political forces and to the physical geography of an area (Sudhira, Ramachandra & Jagadish, 2003; Ramachandra & Kumar 2009). Some of the causes of the sprawl include - population growth, economy, patterns of infrastructure initiatives like the construction of roads and the provision of infrastructure using public money encouraging development (Kulkarni & Ramachandra, 2009). The direct implication of such urban sprawl is the change in land use and land cover of the region.

Urbanisation, as such, is not seen as a threat to the environment and development but it is the urban sprawl that affects the land-use of any region that becomes a matter of concern through its affectation in the loss of prime agricultural lands (World commission on development, 1987). It is thus imperative to study and bring out the intricacies and implications associated with the problem of

* Corresponding author.

E-mail address: zanengroo@gmail.com (Z.A. Nengroo).<http://dx.doi.org/10.1016/j.jum.2017.08.001>

Received 18 January 2017; Received in revised form 4 August 2017; Accepted 25 August 2017

Available online 12 September 2017

2226-5856/ © 2018 Zhejiang University and Chinese Association of Urban Management. Production and hosting by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

unplanned urban growth ensuing into sprawl. Also, sometimes sprawl is equated with growth of town or city (radial spread) (Barnes, Morgan, Roberge & Lowe, 2001; Sudhira, Ramachandra & Bala Subramanya, 2004). In simpler words, as urban population increases, the boundary of the 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 results in the engulfing of villages into peri-urban areas, peri-urban areas into towns and towns into cities. However, in such a phenomenon of urban development, regional planning requires an understanding of the sprawl dynamics in order to provide basic infrastructure. Nevertheless, in a majority of the cases there are inadequacies to ascertain the nature of uncontrolled growth (UN-Habitat, 2002). Due to lack of prior planning, coordinated decision-making and visualization of the outgrowths, the regions remain devoid of basic amenities like water, electricity, sanitation, etc. and result in inefficient and drastic changes in land-use, affecting the ecosystem and thus threatening the sustainable development of the region.

Urban Sprawl coupled with economic development has transformed societies and cultures apart from the landscapes, and the natural environment. In the recent years, 'development' and 'urbanisation' have almost become synonymous especially in developing countries. Further 'development' *per se* is mostly associated with economic development, which most nation states promise to deliver to its citizens. A key challenge faced by most of the nations today is to 'sustain' the economic growth rate along with minimal impact on the environment. Urbanisation is also a common phenomenon, which most of the developing nations are experiencing that has led to the rise of large metros along with its slums and squatters. At the same time, an alarming concern is also about the depleting natural resources (Mitsova, et al., 2010) increasing pollution levels and associated environmental hazards (Kamat and Mahasur, 1997), apart from the rising urban-rural and rich-poor divisions; a host of environmental and socio-economic factors that have become important challenges of the recent times. In this regard, it is essential for concerned authorities to adopt integrated approaches in regional planning while addressing the needs of its stakeholders and managing the resources sustainably. This also necessitates proper planning along with effective governance to manage the urban growth and to mitigate the pressures on natural resources and environment while catering to the needs of the economy that sustains these urban areas. It is this philosophy that drives sustainable development essentially to balance both economic development and environment, not only for the present but also for the future generations.

Urban growth patterns resulting in sprawl are 'unsustainable', with the current consumption surging ahead of regions' carrying capacity and leading to depletion of natural resources for future generations (Asian Development Bank, 2003). The need for managing urban sprawl also arises out of the global concerns of achieving sustainable urbanisation. Sustainable urbanisation is a dynamic, multi-dimensional process covering environmental as well as social, economic and political institutional sustainability (United Nations, 2004). Besides this, the adoption of the Millennium Declaration and the Millennium Development Goals by all the member states of the United Nations to promote equitable and sustainable development across nations, in pursuit of shared future for all, poses significant challenges. This has also set a universal framework for development by targeting the achievement of eight significant goals. Specifically, the seventh goal on ensuring environmental sustainability addresses the concern of improving the lives of millions of slum dwellers living in rapidly expanding cities (United Nations, 2007).

Urban sprawl was initially investigated in relation to demographic and the spatial extent of urban areas. Subsequent studies dealt the problem of sprawl in relation to economics, energy, land use, vehicular emissions, transportation, demography, climate and safety. The problem of sprawl needs to be addressed considering all disciplines with an integrative approach (TRB, 1998 and 2002; Gayda et al., 2003 and 2005). The problem has been acknowledged for nearly sixty years and sprawl was ascribed as low-density development beyond the edge of service and employment (Sierra Club, 1998; Batty, Chin & Besussi, 2002; Batty, Besussi & Chin, 2004; Bensen & Torrens, 2004; and TRB, 2002). Urban sprawl has been accompanied with three interrelated problems of spatial dynamics: densification of central or core cities which usually mark the historical origins of growth; the emergence of edge cities which compete with and complement the functions of the core; and the rapid suburbanization of the periphery of cities - core and edge - which represent the spatially most extensive indicator of such growth. This uncoordinated and unplanned incremental urban growth along the fringes of the metropolitan areas invading prime agricultural and resource land is unsustainable as such areas are over reliant on the automobile for access to resource and community facilities. There have been number of studies done on urban sprawl in India but this is the first such attempt to study to analyze the underlying causes for the measurement of urban sprawl in a highly fragile Himalayan city of Srinagar. This study will serve as a reference work for any future study in Himalayan cities'.

Materials and methods

Sprawl indicators for Srinagar

The sprawl indicators used for the present study are taken from; Costs of Sprawl:2000 Transport Research Bureau (TRB) and SCATTER (EU). The set of indicators used were modified as per the suitability of the area. It is with this motivation that the sprawl indicators for the Srinagar city are grouped under four themes:

1. **Demography and Economy;**
2. **Environment and Resources;**
3. **Mobility;**
4. **Planning and Governance.**

Among the first set of indicators that were enumerated based on the samples was the nativity of respondents in different areas of

Srinagar city. The presence of migrants in a particular zone is a relative measure of suitability for determining the location for residence. The criteria for choosing the new residence were ranked on a scale of 1 to 5, where 1 was the most preferred and 5 the less preferred. Among the choices provided were: access to services, access to education, access to workplace, land prices or rent value and proximity to city centre or main roads.

The important set of indicators about mobility is mode of transport, modal share of public transport, mobility patterns, road traffic, and average road traffic speed and travel times. The modal share of public transport, passenger-km by public modes, mobility pattern considering the average home to work travel distance and average travel time (for all modes) are part of the metrics under mobility. One of the key city functions, which is regarded as a metric, is mobility, which determines why and how citizens are commuting within the city. This throws some light on the composition of people commuting for different purposes and modes employed for their commuting.

The level of accessibilities to different amenities, services and healthcare were estimated based on the sample survey in all the zones. Ranking method was applied for determining the level of access to amenities, services and healthcare. The availability of amenities (cooking gas, kerosene, fuel wood, grocery, vegetables, milk, etc.) were ranked from one (< 500 m) to five (> 5 km) distance. Similarly, the level of access to various services (water supply, electricity, roads, street lightening, and public parks etc.) were also ranked from one (< 500 m) to five (> 5 km). The level of access of services is meant as a proxy to assess the effectiveness of governance in different zones. The respondents were asked to rate according to the distances for accessing the different amenities. Various healthcare facilities (primary hospitals, Government hospitals, local clinics, nursing homes, private hospitals, special hospitals, maternity homes, etc.) were also assessed in a similar pattern determining their availability at least possible distance.

Results and discussions

Demography and economy

The first set of indicators reflects the demographic and socio-economic characteristics of the city across different zones (core to agglomeration) and can be analyzed under following headings.

Population and spatial changes

Since the beginning of 1900 AD Srinagar city has recorded a slow but consistent increase in its population and has shown marked variation from decade to decade. During first three decades of the last century (1901–31) it recorded a steady increase in population which grew 2.9 per cent in 1911 and 11.4 per cent in 1921 and 20.16 per cent in 1931. During the same period, Srinagar experienced a moderate spatial growth, its size increased from 12.80 sq. kms to 14.48 sq. kms. Since 1931, population growth of the city has been subjected to the stresses and strains of slow increase and a haunting experience of stupendous growth. During 1941–61, the growth of population slowed down (Table 1) mainly because of the widespread epidemics (in the year 1921), political unrest and partition of sub-continent in 1947 which led to the large scale migration of people.

Srinagar witnessed an accelerated growth in its population. It increased from 2.85 lakhs in 1961 to 4.57 lakhs in 1971, 6.06 lakhs in 1981, 11.10 lakhs in 2001 to 20.84 lakhs (Srinagar Metropolitan Region) in 2011. The main factors which could be attributed to accelerated population growth during these two decades have been immigration, territorial annexation, auto-urbanization and definitional changes. The increase in growth rate of population has also brought in its old excessive concentration of economic activities which provided great impetus for the growth of subsidiary urban activities.

Besides this, increase in population was too sudden for the city either to accommodate growing population or to provide urban services like proper sanitation, water supply, transportation, education, recreational and health. During this rapid increase in

Table 1
Population growth of Srinagar City, 1901–2011.

Census year	Population	Absolute Growth	Decadal Growth Rate
1901	1,22,618		–
1911	1,26,344	3726	+ 3.03
1921	1,41,735	15,391	+ 12.18
1931	1,73,873	32,138	+ 22.67
1941	2,03,787	29,914	+ 17.20
1951	2,46,522	42,735	+ 20.97
1961	2,85,257	38,735	+ 15.71
1971*	4,57,511	172,254	+ 60.38
1981	6,06,002	148,491	+ 32.45
1991	N.A	N.A	N.A
2001**	11,10,467	504,465	+ 83.62
2011***	20,84,119	973,652	+87.67

* Also includes population of village settlements annexed into city limits during 1971 census.

** Population of Srinagar Municipality.

*** Population of Srinagar Metropolitan Region.

Table 2

Components of population growth.

Source: Birth and Death Files (1954–81) Registrar, Birth and Deaths, Srinagar Municipality.

Year	Total Growth	Auto-Urbanization		Net Migration		Territorial Annexation	
		Persons	Percent	Persons	Percent	Persons	Percent
1921–1931	32138	6050	19	19,864	62.39	5927	18.60
1951–1961	38,735	18,889	48.76	17,700	45.69	1044	2.70
1961–1971	1,72,254	47,295	38.36	19,438	15.98	54,862	45.11
1971–1981	1,48,491	79,720	43.62	37,378	20.45	65,615	35.90
1981–2001	4,04,465	158,982	39.30	48,567	12.01	196,916	48.68
2001–2011	9,73,652	108,670	11.16	108,690	11.16	756,292	77.67

Economic Digest 1983–84 (Vital Statistics)

Census of India, 1921–2011

population, mushroom growth of unauthorized colonies sprang up, environmental conditions deteriorated; encroachment of water bodies and hill slopes has been going on in an unabated manner.

Srinagar City has not yet recovered from these ill-effects because the city is still growing at an accelerated pace which is highest among major urban centres of the State. The dynamic trend in population growth of Srinagar suggest accelerated rate of growth of city in future. The anticipated increase in population and changes in demographic dimensions of the city is bound to create an impact on the socio-economic structure of the city and may accelerate the urban problems.

Components of population growth

Generally, phenomenon of population growth is measured with respect to natural increase (excess of births over deaths) and net migration. But in case of fast expanding cities like Srinagar, territorial annexation also contributes to its urban growth. Looking back into urbanization pattern of Srinagar city, its agglomeration has been the outcome of the processes of auto-urbanization, immigration and territorial annexation (Table 2).

The process of auto-urbanisation which involves the natural growth of urban population has significantly contributed towards the population growth of the city. However, there has been remarkable increase in the share of urban population due to merging of rural areas within municipal limits in 1971 delimitation. Furthermore, the urban growth of the city expanded at radical pace and exceptionally high during 2001–2011 due to the amalgamation of vast areas into Srinagar Metropolitan Region.

Migration has also consistently contributed for the population growth of the city, mainly because of excessive concentration of economic, political, administrative and socio-cultural activities in the city which pull people from various parts of the State. The socio-economic survey depicts that out of the total migrants to the city about 81.86 per cent are from within the Valley, 10.21 per cent outside the Valley but within the State of Jammu and Kashmir and 7.94 per cent are from outside the State. The causes of migration as ascertained by sample survey have been business and employment opportunities (44.35 per cent) followed by education facilities (30.82 per cent), ecological reasons (24.00 percent) and political reasons (0.9 percent).

As in-migration is predominantly comprised of people from rural and small sized urban centres, it has lent Srinagar a pseudo-urban character in some concentrated pockets. It has also strengthened the economic, socio-cultural integration of the city with other parts of the Valley. The residential status of population of the city also gives some idea about the magnitude of migration during last 7 years. The findings of the primary survey reveal that about 6.81 per cent people consist of in-migrants. The spatial distribution of recent in-migration also revealed that outer wards viz Soura, Channapora, Sonawar, have recorded comparatively more in-migration due to sub-urbanization and expansion of the city in these wards. Batamaloo and Rajbagh wards have also recorded high in-migration because of their commercial and administrative importance.

Nativity

Among the first set of indicators that were enumerated based on the samples was the nativity of respondents (Fig. 3) in different areas of Greater Srinagar. The result reveals that Srinagar South- West and North- West zones had about 65 percent natives while Srinagar East and North-East zone had more than 85 percent natives similar to most of the zones in the periphery. It appeared that most migrants were in Hyderpora, Peer Bagh, Baghe Mehtab, Gulshan Nagar, Bemina and Narbal followed by Ahmad Nagar, Habbak, Zakurah, Nishat, Harwan and Sadrbal area (Figs. 1 and 2).

House ownership, type and criteria for housing

The analysis of residential house ownership reveals that the percentage of residents living in owned houses appeared to be higher than those living in rented houses in all the parts of the City. Further, majority of the houses were brick-walled with Metal roofing except for fewer instances in single storied houses, with RCC roofing. The mud walled type of houses mostly belonging to urban poor settlements were observed from rural peripheries in West and north-west zones (Fig. 4).

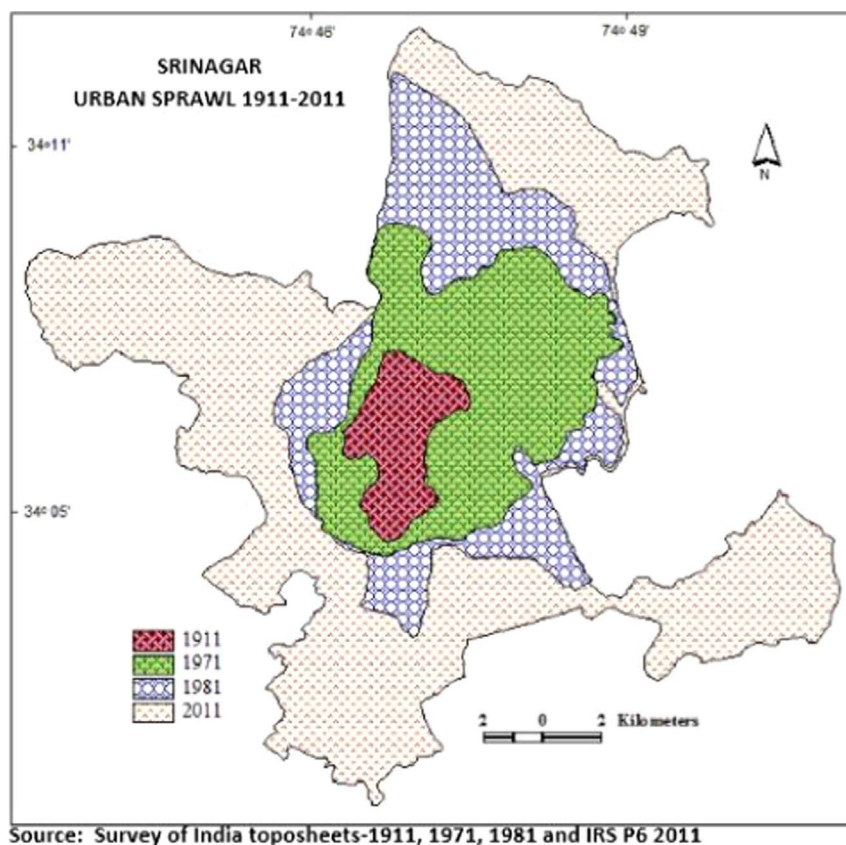


Fig. 1. Urban sprawl of Srinagar.

The criteria for choosing the new residence were ranked on a scale of 1 to 5, where 1 was the most preferred and 5 the less preferred. Among the choices provided were: access to services, access to education, access to workplace, land prices or rent value and proximity to city centre or main roads.

Accordingly, the mean rankings for all the criteria are shown in Table 3 and Fig. 5 with respect to each zone. It showed that 'access to services' emerged as the top criteria with a mean ranking of 1.97 followed by access to land prices or rent value (2.13), access to workplace (2.68), proximity to city centre or main roads (3.00) and access to education (3.04). The criteria of access to education getting the least rank amongst the rest of the ranks suggests that the city limits are not excessively large and people can traverse daily for education (Fig. 6) (Tables 4–6).

Environment and resources

The second set of indicators capture the environmental variables and the resource consumption that chiefly include land-use,

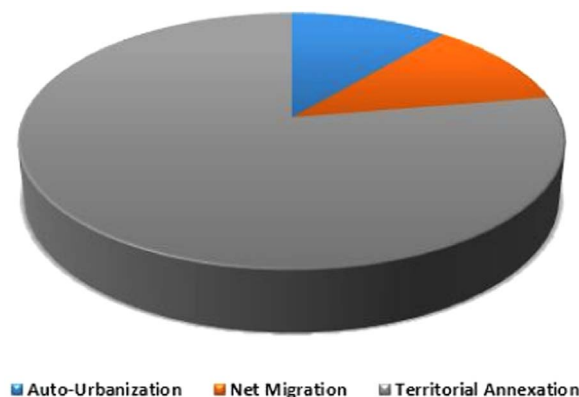


Fig. 2. Population growth of Srinagar City.

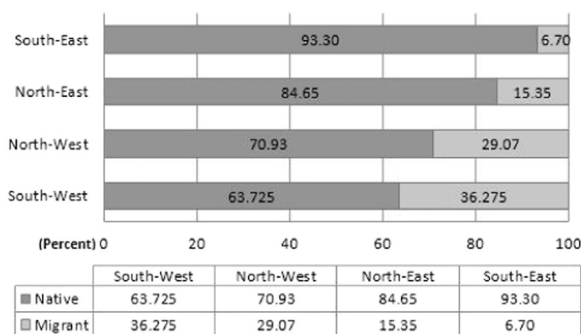


Fig. 3. Nativity among the residents.

solid waste generation and collection, water consumption and wastewater generation, and energy-consumption, sources and end uses. The different land-uses considered are: built-up, water bodies (includes tanks and wetlands), open land, and vegetation. The solid waste management metrics consider per-capita generation and mode of collection. The water consumption per capita per day and the corresponding wastewater generated and the treatment capacities form the metrics under water and wastewater.

Land use

Typically the degree of urban growth or sprawl is attempted by quantifying the amount of paved surface or built-up area in a given region obtained from the superimposing multi-temporal geospatial data (Barnes et al., 2001; Galster et al., 2001; Epstein, Payne & Kramer, 2002; Koomen and Stillwell, 2007). Characterizing the pattern of urban sprawl would then rest on noting the extent of built-up areas and its associated measures that depict sprawl based on the notion of built-up or paved area (Maryama and Thappa, 2010). A key aspect in the expansion of built-up area is its engulfing of surrounding open spaces within the landscape. It is revealed that the built-up area of the City has increased by 173 percent from 1911 to 1971 at the decadal rate of 28 percent. However, this rate steepened from 1971 to 2010 at the decadal rate of 33.25 percent.

Energy sources

The assessment of access to energy sources reveal that electricity and LPG were among the most widely accessed source (Fig. 7). Firewood is also used by all the city zones mainly for heating purposes during the chilling winters of the valley. However, the non-availability of firewood compelled even urban poor to switch over to L.P.G, Kerosene and electricity as the main source of energy. It was further interesting to note that solar energy is being tapped mostly in the newly constructed houses in the south-eastern zone of city. The other energy sources like charcoal and biogas are totally absent while as cow dung is minimally used by the poor people of urban periphery. Electricity and L.P.G were the most accessed source for cooking, heating and lighting purposes.

Water, mode of disposal of wastewater and solid waste

The source and supply of water constitutes one of the significant component of urban services. In the past, people of Srinagar were using the waters of lakes, rivers and different *khuls*/canals for domestic purposes. It was in 1894 A.D when piped water supply was for the first time introduced in some parts of the Srinagar City during Dogra Rule.

In the year 1932 the first treatment plant of 2.25 million gallons per day (MGD) was introduced at Nishat for qualitative improvement of water supplied from impounding reservoir at Harwan. Similarly a number of other treatment plants were built e.g Nishat treatment in 1959 with a capacity of 4.8 MGD, Alusteng Treatment Plant in 1964 with 4.8 MGD capacity, Doodganga in 1972 with 2.25 MGD capacity. The main source of water for Nishat treatment plant was Dachigam Nallah and Dal Lake, Sindh Nallah for

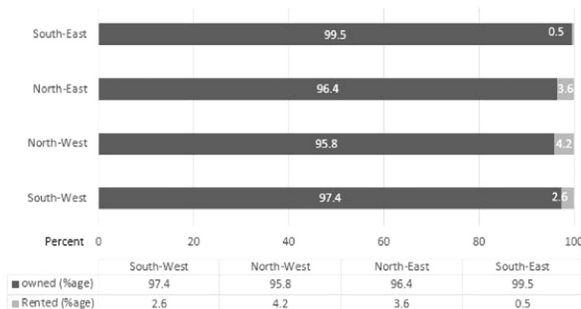


Fig. 4. Housing ownership.

Table 3

Criteria for housing.

Criteria for Housing	Mean Ranking
Access to Services	1.97
Land Prices/Rent Value	2.13
Access to Workplace	2.68
Proximity to City/Main Roads	3.00
Access to Education	3.04

Alusteng and Doodganga river for Doodganga treatment plant. Furthermore a number of treatment plants have been built e.g two at Nishat with a capacity of 8 MGD, one at Doodganga with a treatment capacity of 1.5 MGD, Pokhribal treatment plant with 2.0 MGD, one at Alusteng with 2.0 MGD and Rangil Treatment Plant having 20 MGD capacity. At present Srinagar city has a cumulative water supply of 49.55 MGD drawn from different sub-systems catering to population of 11.50 lacs. However, even after commissioning of such a large number of sub-systems, problems of water supply in Srinagar City have not been eradicated.

In spite of shortfalls in supplying water to all zones by the SMC and respective municipal councils, the sewage collection in the zones appeared to be well serviced through higher sewer connections (Fig. 8). It was revealed that the South-west zones of Srinagar followed by north-west and East was serviced with sewer connections to almost 100 percent. However, the outer zones of South-east viz., Pathachowk, Zewan, Khanmoh areas were serviced below 40 percent. Sewage disposal by way of open ground trench tank was more prevalent in the areas of South-eastern zones of city.

Similar to the water supply and sewage collection, the solid waste collection too indicated that the South-West zone is better serviced with more than forty five percent of solid waste collected through door-to-door collection (Fig. 9). Among the outer zones, only North-West had a significant coverage for the door-to-door collection with about 35 percent, while North-East zone had coverage of about twenty percent and the South-East zone had only two percent for door-to-door collection. In the zones where the door-to-door collection was poor, road-side dumping was more prevalent.

Mobility

One of the key city functions that is regarded as a metric, is mobility, which determines why and how citizens are commuting within the city. This throws some light on the composition of people commuting for different purposes and modes employed for their commuting.

This revealed that among the respondents in the different zones that 78.45 percent commuted for their work, while 15 percent commuted for education and other purposes. However, in the outer fringe zones, 71 percent commuted for work, about 20 percent for education, 0.34 percent for recreation, 2.31 percent for shopping and 5.41 percent for other purposes (Fig. 10).

Addressing the modes employed for commuting, it was revealed that in all, 28.5 percent used the bus-based and 22.56 percent commercial cab-based public transport service, followed by individual motor transport (four wheeler 12 percent and 2-wheelers with 15 percent). It was found that 7 percent preferred to commute by 'walk', while 13 percent used a combination of different modes, only 1.94 percent people prefer to use bicycles for daily commuting. More than 60,000 people commute between Anantnag and Srinagar daily. Large scale commuting also takes place from other regions and areas like Pulwama, Ganderbal, Badgam and Chadoora which is one lakh persons daily (R.T.O Kashmir, 2007). The significant percentages who commute daily strongly suggest adequate measures for facilitating congestion free and safer pedestrian commuting.

Planning and governance

The last set of indicators captures the aspect concerning planning and governance. These variables include: preparation and publication of master plans, public participation, and integration of city functions. For measuring the effectiveness of governance, the level of accessibilities to city centre, different amenities, services (including healthcare) and infrastructure are estimated. The presence/absence of elected local body and their participation in planning are also considered.

Table 4

Built-up and non-built-up land ratio, 1911–2010.

Land-use	1911 (Hectare)	1971 (Hectare)	2010 (Hectare)	Percentage Change (1911–1971)	Percentage Change (1971–2010)
Built-up	2645	7222	16875	+173.04	+133.66
Non Built-up	104455	99878	90225	-4.34	-9.66

Table 5

Composition of people commuting to Srinagar City.

Source: Sample Survey

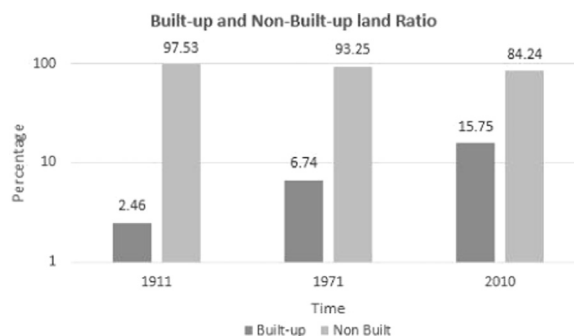
	Work	Education	Recreation	Shopping	others
Srinagar City (percent)	78.45	15.26	1.8	3.35	1.14
Outer Fringe Areas (percent)	71.62	20.32	0.34	2.31	5.41

Table 6

Srinagar City: different modes of commuting, 2011 (in Percent).

Source: Regional Transport Office, Srinagar, 2011

	Public Transport		Private Transport				
	Bus	Cab/Sumo	L.M.V Four wheelers	Two Wheeler	Bicycle	Combined Modes	
Srinagar City Percent)	28.5	22.56	12	15	1.94	13	7

**Fig. 5.** Criteria for housing.**Fig. 6.** Built-up and non-built-up land ratio.

Planning

Planning and governance are imperative for ensuring effective service delivery and management of resources. As noted earlier, this set of indicators includes both quantitative and qualitative variables. The presence/absence of elected local body and their participation in planning are also considered. The indicators under planning and governance included: nature of urban local governance that prevailed until the formation of Srinagar Development Agency, preparation and publication of master plans and public participation. Planning function is completely taken over by the parastatal agency, Srinagar Development Authority (SDA) and thus the local bodies have to abide by the policies formulated by the parastatal body.

Accessibilities

The level of accessibilities to different amenities, services and healthcare were estimated based on the sample survey in all the zones. The level of access of services is meant as a proxy to assess the effectiveness of governance in different zones. The respondents

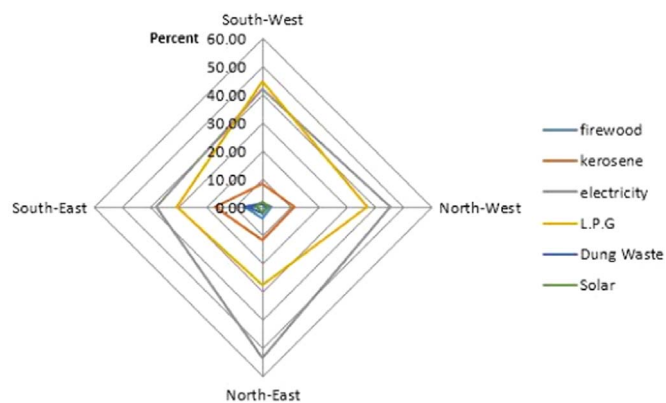


Fig. 7. Energy consumption.

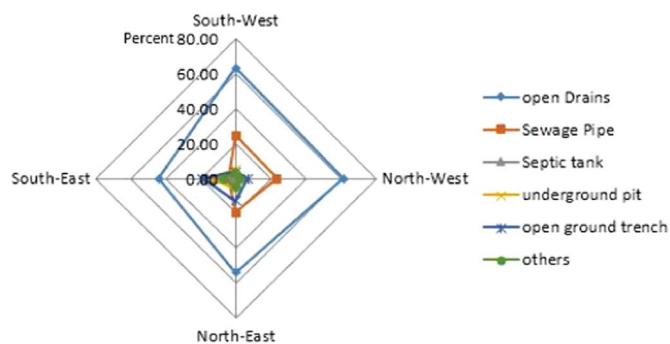


Fig. 8. Waste water disposal.

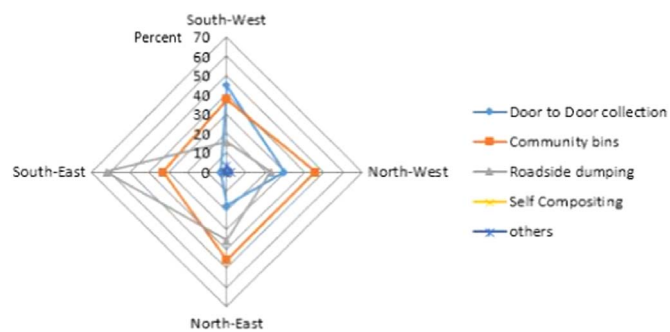


Fig. 9. Solid waste disposal.

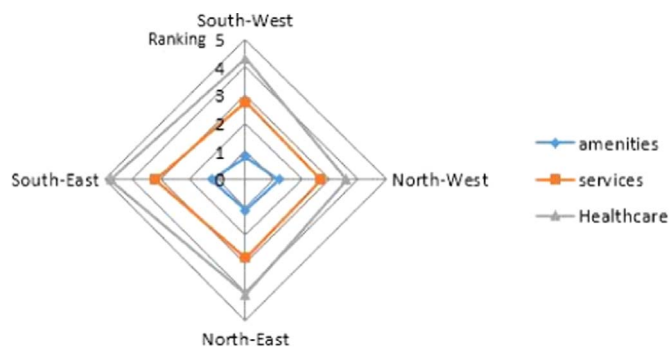


Fig. 10. Composition of people commuting to Srinagar City.

were asked to rate according to the distances for accessing the different amenities.

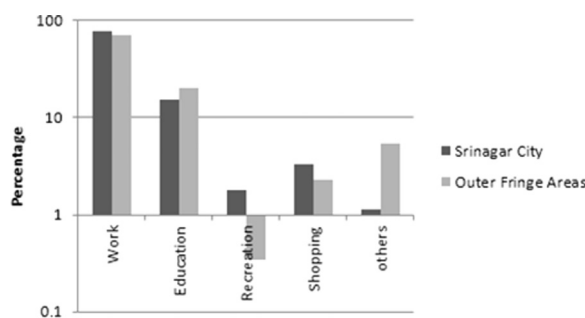


Fig. 11. Mean ranking of level of access to amenities, services and healthcare.

The ranking based on distances were useful in enumerating the proximity of the different services as accessed by the respondents. The mean ranking was considered for determining the overall level of access in different zones. In all, it was observed that the level of access scores (ranking) was almost similar in all the zones irrespective of the administrative differences (town and city municipals and city corporation limits) (Fig. 11). This perhaps suggests that irrespective of the administrative jurisdictions, the level of services ranged almost similarly across the entire urban agglomeration. It was found that irrespective of governance and their level of services (mean rank of 3.57), the accessibilities to basic amenities (mean ranking of 2.34) were better and same in both central and outer zones.

Conclusion

From the above analysis of various indicators across the different zones of Greater Srinagar, it was evident that South-western zone and the outer areas were clearly different in several aspects. It is observed that the outer zones are considered the sprawl areas though they have been only recently merged with Greater Srinagar. Although the level of access to different services and amenities were the same across the different zones, the access to resources (water supply, energy, wastewater and solid waste disposal) was different across the central and outer zones. Further, with the effectiveness of planning and governance on the overall level of services (including that of resources), the outer south-eastern zone (Panthachowk, zawan, khanmoh) had poor delivery of services while the south-western zone (Hyderpora, Baghi-mehtab, peer Bagh, Rawalpora) had better delivery of these services. Perhaps, with this outcome, this would suggest more effective governance in the outer zones of Panthachowk, Zewan, Lasjan, Khanmoh, Narbal, Gulab bagh etc., to ensure better delivery of services through greater allocation of funds for the same. This can be further possible when planning and governance is proactive in forecasting the respective amenities, services along with necessary infrastructure in the these zones.

The analysis revealed that Srinagar city has effectively been the victim of urban sprawl characterized by low density of population and disproportionate distribution of various urban amenities. The study is first such attempt to measure the sprawl of city and will act as reference work for future research on urban sprawl in ecologically fragile Himalayan city of Srinagar.

Acknowledgement

The authors are highly indebted to University Grants Commission (UGC), New Delhi, India(F 37-422/2009 (SR)) for funding the research project entitled “Urban Sprawl of Srinagar City- An Impact Assessment Analysis- Using Geo-spatial Tools”.

References

- Asian Development Bank (2003). Cities Data Book: Urban Indicators for Managing Cities.
- Barnes, K., Morgan, J. I., Roberge, M., & Lowe, S. (2001). *Sprawl development: Its patterns, consequences, and measurement*. Towson University.
- Batty M., Chin N., and Besussi E. (2002). State of the Art Review of Urban Sprawl Impacts and Measurement Techniques, *Sprawling Cities And Transport: from Evaluation to Recommendations (SCATTER)*, Work package 1, Version 1.0.
- Benenson, I., & Torrens, P. M. (2004). *Geosimulation: Automata-based modeling of urban phenomena* Chichester, UK: John-Wiley and Sons.
- Batty, M., Besussi, E. & Chin, N. (2004). Traffic, urban growth and suburban sprawl, centre for advanced spatial analysis. University College London, Working Paper Series, Paper 70.
- Epstein, J., Payne, K., & Kramer, E. (2002). Techniques for mapping suburban sprawl. *Photogrammetric Engineering and Remote Sensing*, 63, 913–918.
- Galster, G., Hanson, R., Wolman, H., Coleman, S., & Freihage, J. (2001). Wrestling sprawl to the ground: Defining and measuring an elusive concept. *Housing Policy Debate*, 12(4), 681–717 (Fannie Mae Foundation).
- Gayda S., Boon F., Schailée N., Batty M., Besussi E., Chin N., Haag G., Binder J., Martino A., Lautso K., Noël C., and Dormois R. (2003). The SCATTER Project - Sprawling Cities and Transport: From Evaluation to Recommendations”, Paper presented at the European Transport Conference 2003, Strasbourg, Germany.
- Gayda, S. et al. (2005). The SCATTER Project - Sprawling Cities and Transport: From Evaluation to Recommendations. Final Report, Version 2, Contract No. EVK4-CT-2001-00063. European Union.
- Kamat, S. R., & Mahasur, A. A. (1997). *Air pollution: slow poisoning* Chennai: The Hindu Survey of Environment.
- Kashmir, R.T.O. (2007). Annual Report, Government of Jammu and Kashmir, India.
- Koomen, E., & Stillwell, J. (2007). *Modelling land-use change; progress and applications* Dordrecht: Springer, 1–21.
- Kulkarni, V., & Ramachandra, T. V. (2009). *Environmental management, Commonwealth of Learning, Canada and Indian Institute of Science, Bangalore New Delhi: Printed by TERI Press.*
- Maryama and Thappa (2010). *Urban sprawl and public health: designing, planning and building for health communities* Washington DC: Island Press, 279 p.

- Mitsova, D., Shusterb, W., & Wang, X. (2010). A cellular automata model of land cover change to integrate urban growth with open space conservation. *Landscape and Urban Planning*, 99(2), 141–153.
- Ramachandra, T. V., & Kumar, Uttam (2009). Land surface temperature with land cover dynamics: Multi-resolution, spatio-temporal data analysis of Greater Bangalore. *International Journal of Geoinformatics*, 5(3), 43–53.
- Reddy, A. K. (2004). Science and technology for rural India. *Current Science*, 87, 889–898.
- Sierra Club (1998). *The dark side of the American dream: The costs and consequences of suburban sprawl*.
- Sudhira, H. S., Ramachandra, T. V., & Jagadish, K. S. (2003). Urban sprawl: Metrics, dynamics, and modelling using GIS. *International Journal of Applied Earth Observation, and Geoinformation*, 5(2004), 29–39.
- Sudhira, H. S., Ramachandra, T. V., & Bala Subramanya, M. H. (2004). City profile: Bangalore. *Cities*, 4(379–390), 124.
- Theobald, D. M. (2001). Land-use dynamics beyond the American urban Fringe. *Geographical Review*, 91, 544–564.
- Transportation Research Board (1998). *The costs of sprawl-revisited, Washington, DC, USA: Transportation Research Board and the National Research Council*. National Academy Press.
- Transportation Research Board (2002). *Costs of sprawl-2000, Washington, DC, USA: Transportation Research Board and the National Research Council*. National Academy Press.
- United Nations (2004). *Executive summary, world urbanisation prospects: The 2003 Revision* New York: Population Division, Department of Economic and Social Affairs, United Nation.
- United Nations (2007). *The millennium development goals report 2007* New York, USA: United Nations Department of Economic and Social Affairs.
- UN-Habitat (2002). *Urban safety and good governance: the role of the police, UN habitat*.
- World Commission on Development (1987). *Our common future* New York: United Nations.
- Torrens, P.M. & Alberty, M. (2000). "Measuring sprawl". Working Paper Series, Centre for Advanced Spatial Analysis, University College London.