Monitoring Urban Growth in Delhi: An Inter-Ward Analysis

Kushala Devi*
Sanjit Kumar*

Abstract-This present study shows that Delhi is experiencing much urban expansion than expectation due to favorable urban conditions. The core area of the city has become more compact than earlier and surrounding region getting clusters. This can be seen by the Shannon's entropy value which has seen a great change in peripheral areas. The most expansion happened along major roads as Delhi is one of the fastest growing cities of India. In order to restrict consequences of urban sprawl, there is need of proper management of new built-up.

Keywords: Shannon's Entropy, Urban growth, Cellular Automata (CA) model, Population growth

Introduction-Today the cities of developed and developing countries are experiencing a rapid change. They are growing in area, population and at the same time they are acquiring a new character as their people perform new tasks in the physical environment, that increasingly reflect the use of new technology. In India, currently 31.16% of the population(Census of India, 2001) lives in urban centers, while in the next 15 years it is projected to be around 35%.This indicates the alarming rate of urbanization and the extent of urban growth that could take place. One of the important features of urbanization in India is dualism—urban growth at macro level is decelerating but in class I cities it is growing.

An analysis of the distribution of urban population across size categories reveals that the process of urbanization in India has been large city oriented (Kundu, 2006). There is massive increase in the percentage share of urban population in Class I cities (i.e. cities with a

***Project Fellow, Haryana Space Research Center, Gurugram, Haryana**
***Research Associate1, Haryana Space Research Center, Gurugram, Haryana**

population of 1, 00, 000 or more) from 26.0 in 1901 to 68.7 in 2001. As a result of this, million plus cities of India are expanding at a very rapid rate. The direction and rate of growth of such sprawl depends upon factors such as, the quality of land, accessibility, industrial development, and so on (Pathan et al., 1993). The extent of urbanization or its growth is one such phenomenon that drives the changes in land use pattern. These changes in the city margins or urban sprawl are characterized by haphazard patchwork of development, which leads to a disorganized development in any city.

Techniques to Monitor Urban Growth-Geographers, planners and people from other discipline have a keen interest in the study of this type of phenomena. The conventional surveying and mapping techniques are expensive, and time consuming for the estimation of urban growth. Statistical techniques along with remote sensing and GIS have been used in many urban growth studies (Sudhira et al., 2004 and Jat et al., 2008). In recent years it has been found that remote sensing is a cost effective, technologically sound and an increasingly used technique for the analysis of urban growth (Yeh and Li, 2001). As a result, increased research interest is being directed to the mapping and monitoring of urban growth using remote sensing and GIS techniques (Epstein et al., 2002). By using the satellite data, it is easy to identify the temporal and spatial changes which have occurred over the city landscape. Apart from the change detection methodologies, there are studies in which statistical techniques along with remote sensing and GIS have been used to quantify, estimate, map & monitor the urban growth and urban sprawl. In this category, there are two major types of methodologies which have been followed by the different scholars in quantifying, assess, mapping and monitoring urbangrowth which are Shannon's entropy and Cellular Automata (CA) model.

Shannon's entropy is based on information theory. Shannon's entropy is the mathematical estimation of urban growth which occurs in a haphazard way. Shannon's entropy (H_n) is used to measure the degree of spatial concentration or dispersion of geophysical variables (X_i) among n spatial units/zones. Entropy can also be used to indicate the degree of urban growth or sprawl by examining whether the land development in a city is dispersed or compact (Lata et al.,2001). Shannon's entropy has been used in some of the studies to quantify the urban forms, such as impervious area in terms of spatial phenomenon (Joshi et al.,2006).

The Shannon's entropy, H_n is given by,

$$H_n = - \Sigma P_i \log (P_i)$$

Where $P_i = X_i / \pounds X_i$, and x_i is the density of land development, which equals the amountof builtup land divided by the total amount of land in the i^{th} of n total zones, and n = Total number of zones.

The value of entropy ranges from 0 to log n. If the distribution is very compact then the entropy value would be closer to 0 and when the distribution is much dispersed the value will be closer to log n. large value of entropy indicates the occurrence of urban sprawl. This methodology is adopted to study the distribution of built up in different wards, around the core, and along the National Highway.

Urban Growth of Delhi: Ward-Wise-The entropy of the urban areas in 2001and 2011 for each ward is shown in fig 1 and 2.The entropy indicates that there was substantial internal variation in the patterns of urban sprawl among the wards of the study area. In general, urban sprawl is quite obvious in the whole region, but spatial difference shave been observed on large scale. Delhi municipal area and ward area have remained the same but the entropy shows the growth in all directions. The wards under Delhi (given in table) grew phenomenally with dispersed growth during the study period (2001 to 2011) and reached higher value of entropy during 2011. From fig 1, it can be seen that the comparatively higher value of entropy (between 0.15 and 0.02) was observed in the parts of old Delhi, Karol Bagh and across Yamuna towards Shahdara and Patparganj. The rest periphery areas, especially the north and western parts had lower value (below 0.01), meaning by the areas had less population and land resource was largely available to meet human requirements. But with time and pace of population growth, mainly associated with migration due to better employment opportunities and better transport infrastructure led to decrease in the per capita land resource availability. The entropy value increased to multifold in 2011 (Fig 1 and 2). The central region became denser and compact with the peripheral areas too receiving countryside population to avail urban facilities for increasing their living standard.

Fig 3 indicates the change in entropy value from 2001 to 2011. Greater change in the value indicates larger urban growth in as far as the settlement is concerned. The ward-wise analysis suggests that the areas which had high entropy value in 2001 went through minor change

in its entropy value, meaning by the population growth was limited in these wards. On the other hand, the wards which were on the northern and eastern periphery of Delhi went through major population change. The settlement grew faster than expected. Threshold population pressure on the central parts of the state forced the in-migrants to settle at the outskirts in the periphery of Delhi. Better road facility and increase in public transport (DTC busses and metro) may be one of the reasons for the change in population of peripheral areas. Congestion in the center might be another pushing force for the upper middle and higher class to move to decongested areas of periphery.

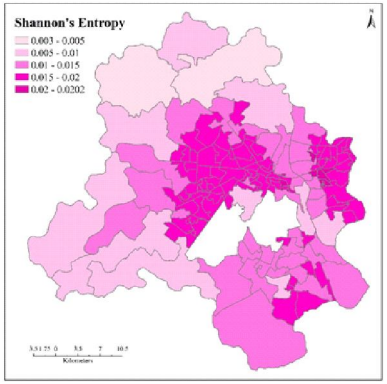

Fig 1: Urban Sprawl in Delhi, 2001

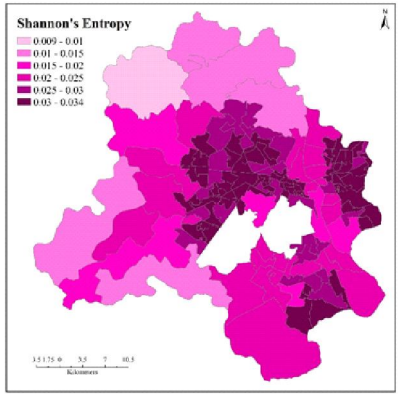

Fig 2: Urban Sprawl in Delhi, 2011

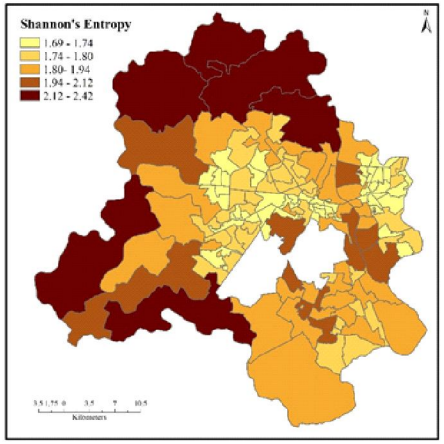

Fig 3: Change in Entropy Value for Urban Sprawl in Delhi, 2011-2011

Conclusion-This study shows that the city of Delhi is experiencing much urban expansion rather than expectation due to favorable location conditions like water supply, road, railways, electricity, labor's etc. The past area of built-up in 1992 was just 199.29sq.km and it is enormously increased up to 259.60sq.km. The core area of the city has become more compact than earlier and surrounding region getting clusters. Somewhere sprawl has been expanded beyond Delhi Municipal Corporation boundary.The most expansion happened along major roads for Delhi is one of fast-growing city of India, the flow of migrations from all India. In order to restrict consequences of urban sprawl, there is need of proper management of new built-up.

References

- Census of India (2001). Government of India.
- Epstein, J., Payne, K., Kramer, E., 2002. Techniques for mapping suburban sprawl. Photogrammetr. Eng. Remote Sens. 63 (9), 913–918.
- http://chesapeake.towson.edu/landscape/urbansprawl/download/Sprawl_ white_paper.pdf.
- Jat, M. K., Garg, P. K. and Khare, D. (2004). Modelling of urban growth using spatial analysis techniques: a case study of Ajmer city (India). International Journal of Remote Sensing, Vol 29, Issue 2.

- Joshi, P.K., Lele N., and Agarwal, S.P., (2006), Entropy as an indicator of fragmented landscape - Northeast India case study, Current Science, 91(3), pp 276- 278.
- Kundu, A (2006). Globalization and the Emerging Urban Structure: Regional Inequality and Population Mobility, India: Social Development Report. New Delhi: Oxford.
- Lata K. M., Sankar Rao C. H., Krishna Prasad V., Badrinath K. V. S., Raghavaswamy, 2001. "Measuring urban sprawl: a case study of Hyderabad", GISdevelopment, Vol. 5(12).
- Pathan, S. K., Sastry, V. C., Dhinwa, P. S., Rao, M., Majumdar, Kl. L., Kumar, D. S., Patkar, V. N. and Phatak, V. N. (1993). Urban growth trend analysis using GIS techniques – a case study of the Bombay Metropolitan Region. International Journal of Remote Sensing, Vol 14, Issue 17.
- Sudhira, H. S., Ramchandra, T. V. and Jagadish K. S. (2004). Urban sprawl: metrics, dynamics and modelling using GIS. International Journal of Applied Earth Observation and Geoinformation Vol. pp 529–39
- Yeh, A.G.O. and Li, X. (2001) Measurement and Monitoring of Urban Sprawl in a Rapidly Growing Region Using Entropy. Photogrammetric Engineering and Remote Sensing, 67, 83-90.