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Efficacy of GIS, Remote sensing and Entropy in the Analysis of Urban Systems – A review

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Abstract- **Urban sprawl in general is discussed as the expansion of human population, away from, a central high-density urban area, to its surrounding low-density areas. This phenomenon is instigated by urbanization, population growth, industrialization, housing and commercial expansion and so forth. The pros of attraction of living in a nice neighborhood with better schools and lower crime rates must be weighed against the cons. Many a time the term 'Urban Sprawl' has a negative connotation, because on many environmental implications like loss of agricultural land, forests and habitat, disturbance of local flora and fauna, increase in Public Expenditure, Increased Traffic, Environmental Issues, Impact on Social Lives etc. Planned urbanization in the wake of development will have a low impact on the environment and social aspects. Unplanned urban sprawl is sure to escalate the harmful impacts on the environment.**

Geographical information systems in hands with Remote-sensing have the technology and tools for spatial and attribute data capture, storage, analysis, inference and reports. They are commanding in the sense that the analysis of the trends of the past and present sprawls over a period of time can be used to predict the future trend and hitherto recommend decision makers and stake-holders are aware and sensibly direct urbanization with very limited hack on the environment. Entropy in urban sprawl is the mode in which its distribution takes place. Urban Sprawl is characterized as, Low density, Strip development, scattered development and Leap-frog development. Entropy plays a definitive role in studying the mode of urban sprawl in a geographical area of interest. Geographical Information system, Remote sensing technology and Entropy together make a resilient group in the study, analysis and planning of the urban sprawl of a geographical area. This paper is a review of the efficacy of GIS, Remote sensing and Entropy in the analysis of Urban sprawl.

Keywords: Entropy monitoring; Remote Sensing; Spatial entropy; Urban sprawl; Urban systems.

INTRODUCTION

Development of a society is inevitable in this information era. Normally this happens in and around an urban geographical location. Development leads to increase in job opportunities and an urban style of living which appeals to the inflow of a populace from far and near. Land never grows or shrinks – 1 kilometre square has always remained the same. Invariably the growth in infrastructure, industries, population etc. demand a change in the land, which in turn takes a toll on social, ecological, agricultural and economical aspects. People tend to move from a dense urban place toward the periphery with less dense population. The pattern of spreading varies based on assorted factors. Geographical data –spatial and attributed, a system to capture, store and analyze the data, design recommendation models for sustainable future urban sprawl have become a mandate today for a better tomorrow. For the above said, Remote-sensing technology, Geographical information systems and Shannon's entropy together pave an effective path in monitoring and modeling the urban sprawl of geography on which a review has been conducted.

GEOGRAPHICAL INFORMATION SYSTEMS (GIS)

Information with respect to land cover, their types, classes, density, quality and distribution, is of prime need for adopting conservation measures, eco-balance and planning-cum management aspect (Pant et al., 1992; Mohammed, and

Tassew, 2009; Bhagawat, 2011). These applications referred to urban expansion, and vegetation loss. At the same time, in the past decade, a major international initiative to study land use change, the land use and LULC (land use and land cover change) project, had gained great momentum in its efforts to understand driving forces of land use change (mainly through comparative case studies), developed diagnostic models of land use change, and produce regionally and globally integrated models (Lambin, 1997; Lopez and Bocco, 2001, Rawat, and Manish, 2015). As Houghton (1994) pointed out, the major reason of land use change was to increase the local capacity of lands to support the human enterprise. Yet, together with the "positive" changes – i.e., those that made land more productive- there were also unforeseen impacts that could reduce the ability of land to sustain the human enterprise. Today, localized changes around the world added up to massive impacts. Thus, it could be argued that even modest changes in land use had some unintended consequences. So it was necessary to discuss the impacts of land use change on society, environment and economy, especially economic growth in developing countries such as India, Ethiopia, China, etc.

REMOTE-SENSING (RS)

Satellite remote sensing had been widely applied on detecting LULC change (Weng, 2002; Weng et al., 2003) especially urban expansion (Schneider et al., 2003; Weng, 2001, Woldeamlak, 2003), urban planning (Yeh and Li, 1998) and vegetation loss (Li and Yeh, 2004; Prenzel, 2004). Many change detection techniques, which were the processes of identifying differences in the state of an object or phenomenon by observing it at different times (Howarth, 1986; Singh, 1989), were used in these studies, such as image differencing, vegetation index differencing, selective principal components analysis, direct multi-date classification, univariate image differencing, image rationing, change vector analysis and post-classification and so on (Mas, 1999; Cho, 1999). At the same time, these were available in achieving different level of success in monitoring a variety of LULC changes (Fung, 1990; Dai and Khorram, 1999; Kaufmann and Seto, 2001).

Land use land cover classification is a time consuming and expensive process. Remote sensing though costly, offers a quick and efficient approach to the classification and mapping of land uses/land cover changes over space and time. Such studies are particularly important because the spatial characteristics of LULC are useful for understanding the various impacts of human activity on the overall ecological condition of the urban environment (Yeh and Li, 1999). LULC change due to human activities is currently proceeding more quickly in developing countries than in the developed world, and it has been projected that by the year 2020, most of the world's mega cities will be in developing countries (Sustainable Development Unit, 2007). In developing countries, where urbanization rates are high, urban sprawl is a significant contributor of the land use change. Information on changes in resource classes, direction, area and pattern of land uses/land cover classes form a basis for future planning (Kebrom and Hedlund, 2000; Sudhira and Ramachandra, 2007).

Shannon's Entropy

The concept of entropy was conceived by Shannon(1948) in the field of thermodynamics which represents the degree of randomness in a system.The disorder or the randomness in the organization od a system is called its entropy (Miller, 1969) Entropy can be used in the analysis of the degree of disorder in urban settlement. It is an effective tool in the sense that it is not affected by factors like size and shape of the objects (Barnes et al., 2001).

Today, with rapid urbanization and industrialization, there is increasing pressure on land, water and environment, particularly in the big metropolitan cities. Urban sprawl has been criticized for inefficient use of land resources and energy and large-scale encroachment into the agricultural lands. There are many problems associated with fragmented conversion of agricultural land into urban use. 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. Inadvertently this is resulting in increase in the built up area and associated changes in the spatial urban land use patterns causing loss of productive agricultural lands, forest cover, other forms of greenery, loss in surface water bodies, depletion in ground water aquifers and increasing levels of air and water pollution.. There has been lot of debates on how to confine urban sprawl and conserve agricultural land resources (Bryant and Zobrist, 1982; Ewing, 1997; Pedro et al., 2013). There is a demand to constantly monitor such changes and understand the processes for taking effective and corrective measures towards a planned and healthy development of urban areas.

Entropy is an efficient technique for comparing urban sprawl patterns (Adeniyi, 1980; Sudhira et al., 2004; Jat et al., 2007), therefore, the Shannon's entropy for each zone and time period must be calculated, and the degree of sprawl can be measured by the value of entropy which varies from 0 to logarithm of number of zones or time period. The more compact of the structures and the built up areas is closer to zero entropy value, while the closer to the logarithm number

of zones is the more dispersed the region (Sudhira et al., 2004; Sun et al., 2007).

The image processing and classification in geographical information system and the remote sensing combined with statistical methods like Shannon entropy can be used to analyze, and detect Urban expansion and sprawling (Li, and Yeh, 2004; Deka et al., 2012).

CONCLUSION

Rapid urban development and increasing land use changes due to increasing population and economic growth in selected landscapes is being witnessed of late in India and other developing countries. The measurement and monitoring of these land use changes are crucial to understand land use cover dynamics over different spatial and temporal time scales for effective land management. 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 center. There is a demand to constantly monitor such changes and understand the processes for taking effective and corrective measures towards a planned and healthy development of urban areas. In the recent times, Remote sensing data is being widely used for mapping and monitoring of urban sprawl of cities from the study Fung which has been done, we get very clear cut idea that Remote Sensing and Geographical Information System have proved to be very powerful technique in measuring Urban Sprawl. This technique can be applied in other fast growing developing cities of India. India has undergoing this kind of unplanned development. It is must to monitor them Having the advantage of availability of our own Indian Satellite IRS 1C , IRS 1D Cartosat of high resolutions, we can use the Satellite Data for Urban Studies.

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