URBAN SPRAWL MAPPING AND MONITORING USING GIS AND REMOTE SENSING - SALEM CITY,TAMILNADU

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ABSTRACT: ***This paper has been described byanalyzing the future growth of cities, monitoring its growth, in other words, determining land-use changes has an important role in urban development. Immigration, especially emerged from improvement of industry and college, is an important factor causing urban land use changes. Major changes in land utilization during 2008-2016 periods have been analyzed to understand urban sprawl pattern in and around Salem area town using GIS (geographic information system). Salem is a district of tamilnadu which is a state of India. It is located about 160 kilometers northeast of Coimbatore, 186 kilometers southeast of Bangalore and about 340 kilometers southwest of the state capital, Chennai. The total area of Salem is 124 km².The population of salem in 2010 is 154,637. The location of Salem according to Survey of India is 11.669437^{o} N and 78. 140865^{o}. False Color Composite. In this project the software we used to analyze urban sprawl of Salem city is Arc Geographical Information System.***

Keywords- False Color Composite (FCC), Geographic Information System (GIS), Satellite images, lnsat images.

I. INTRODUCTION

The process of urbanization is a universal phenomenon taking place the world over, where humans dwell. All countries are prone to this bewildering phenomenon chiefly responsible due to the increase in population growth, economy and infrastructure initiatives. The extent of urbanisation or the sprawl is one such phenomenon that drives the change in land use patterns. The sprawl normally takes place in radial direction around the city Centre or in linear direction along the highways. Usually sprawl takes place on the urban fringe, at the edge of an urban area or along the highways. The study on urban sprawl (The Regionalist, 1997; Sierra Club, 1998) is attempted in the developed countries (Batty et al., 1999; Torrens and Alberti, 2000; Barnes et al., 2001, Hurd et al., 2001; Epstein et al., 2002) and recently in developing countries such as China (Yeh and Li, 2001; Cheng and Masser, 2003) and India (Jothimani, 1997; Lata et al., 2001; Sudhira et al., 2003). In India alone currently 25.73% of the population (Census of India, 2001) live in the urban centres, while it is projected that in the next fifteen years about 33% would be living in the urban centres. This indicates the alarming rate of urbanisation and the extent of sprawl that could take place. In order to understand this increasing rate of urban sprawl, an attempt is made to understand the sprawl dynamics and evolve appropriate management strategies that could aid in the region□s sustainable development..

However, monitoring of urban land use change using the techniques of remote sensing and GIS and its subsequent modeling to arrive at a conventional approach is lacking in the context of India. The objective of this investigation is to analyse and understand the urban sprawl pattern and dynamics to predict the future sprawls and address effective resource utilization for infrastructure allocation.

In order to quantify the urban forms such as built-up in terms of spatial phenomenon, the Shannon□s entropy(Yeh and Li, 2001) and the landscape metrics (patchiness, map density) were computed for understanding the built-up dynamics.. Computation of these indices helped in understanding the process of urbanization Salem.

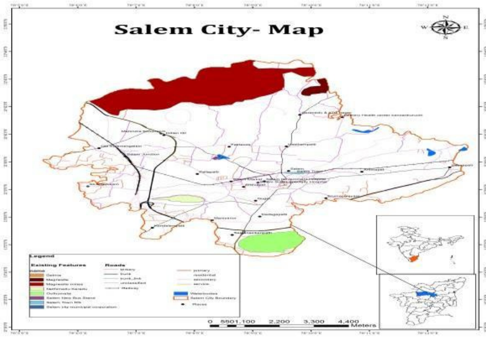

Fig-1 Salem City Map

II. METHODOLOGY

A stepwise normative gradient approach was adopted to understand the dynamics of the city, including (i) first step to derive land use and land cover (ii) a zonal-gradient approach of 4 zones and 1km radius gradients to understand the pattern of growth during the past 4 decades.(iii)understanding the change in the land use dynamics using Landscape metrics analysis. Various stages in the data analysis are as shown below.

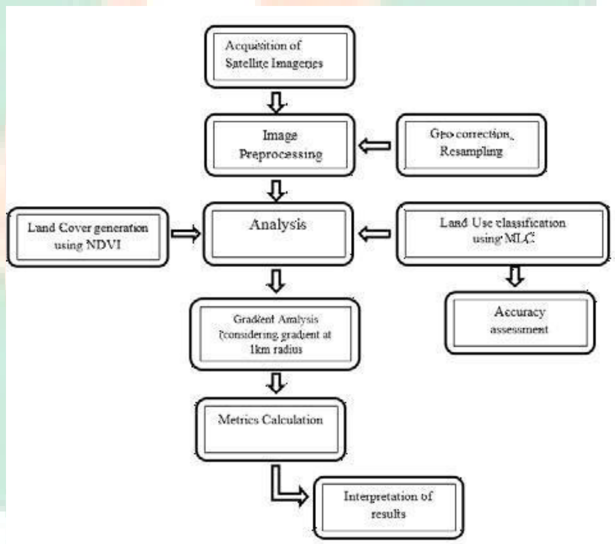

Fig 2. Block diagram

1) Preprocessing: The remote sensing data of landsat were downloaded from GLCF (Global Land Cover Facility) and IRS LISS III data were obtained from NRSC, Hyderabad. The data obtained were geo-referenced, rectified and cropped pertaining to the study area. The satellite data were enhanced using histogram equalization for the better interpretation and to achieve better classification accuracy. Furthermore, the images including topographical sheet and ward map were rectified to a common Universal Traverse Mercator (UTM) projection/co-ordinate system. All data sets were resampled to 30m spatial resolution using the nearest neighborhood re-sampling technique.

Vegetation Cover Analysis: Vegetation cover analysis was performed using the index Normalized Difference Vegetation index (NDVI) that was computed for all the years to understand the change in the temporal dynamics of the vegetation cover in the study region. NDVI value ranges from -1 to +1, where -0.1 and below indicates soil or barren areas of rock, sand, or urban built-up. NDVI of zero indicates the water cover. Moderate values represent low density vegetation (0.1 to 0.3) and higher values indicate thick canopy vegetation (0.6 to 0.8).

3) Land use analysis: Further to investigate the different changes in the landscape land use analysis was performed. Categories listed in Table II, were classified with the training data (field data) using Gaussian maximum likelihood supervised classifier. This analysis includes generation of False Color Composite (bands – green, red and NIR), which basically helps in visualization of the different heterogeneous patches. The further use of the training data Polygons were digitized corresponding to the heterogeneous patches covering about 40% of the study region and uniformly distributed over the study region. These training polygons were loaded in pre-calibrated GPS (Global

position System). Attribute data (land use types) were collected from the field with the help of GPS corresponding to these polygons. In addition to this, polygons were digitized based on Google earth (www.googleearth.com) and Bhuvan (bhuvan.nrsc.gov.in). These polygons were overlaid on FCC to supplement the training data to classify landsat data.

4) Further each zone was divided into concentric circle of increment radius of 1 km (Fig. 2.) from the center of the city to visualize the changes at neighborhood levels. This also helped in identifying the causal factors and the degree of urbanization (in response to the economic, social & political forces).

5) Urban sprawl analysis: Shannon□s entropy (Hn) is computed (equation 1) direction-wise to understand the extent of growth: compact or divergent. This provides an insight into the development (clumped or disaggregated) with respect to the geographical parameters across ,,n□ concentric regions in the respective zones

6) Spatial pattern analysis: Landscape metrics provide quantitative description on the composition and configuration of the urban landscape. These spatial metrics have been computed for each circle.

III.RESULT AND ANALYSIS

Land use Land Cover analysis

Vegetation cover analysis: Vegetation cover of the study area assessed through NDVI (Fig. 3), shows that area under vegetation has declined by about 19%. Temporal NDVI values are listed in Table III, which shows that there has been a substantial increase in the Non Vegetative area. There has been an increase from 3 % to 17%, tells us that there has been staggering growth of impervious cover in the region resulting from decrease in vegetative cover.It illustrates the temporal dynamics of number of patches. Urban patches are less at the center in1970□s as the growth was concentrated in central pockets.

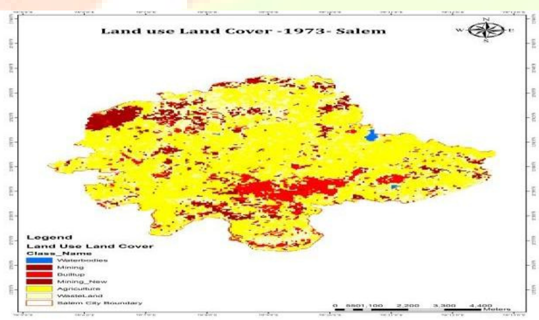

Fig-3 Salem City in 1973

the results indicated that there were a small number of urban patches existing in all direction and in every circle.

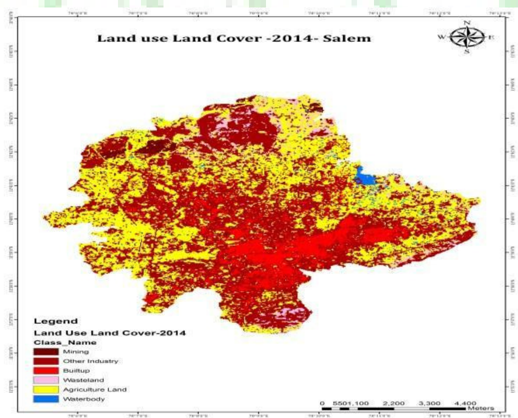

Fig-4 Salem City in 2014

Year	Vegetation	Non vegetation
	%	%
1975	96.32	3.68
1989	92.18	7.82
2001	89.36	10.64
2010	82.48	17.52

Tab-1 Temporal Land Cover Details.

Year	Kappa coefficient	Overall accuracy (%)
1973	0.69	69.28
1989	0.83	81.69
1999	0.83	84.53
2010	0.89	88.12

Tab-2 Kappa Statistics And Overall

AccuracyNumber of urban patches (zonewise, circlewise) that increase in the number of patches in 80□s and further in 2001, but these patches form a single patch during 2010, indicating that the urban area get clumped as a single patch at the center, but in the buffer regions there has been a tremendous increase in 2001. Clumpiness and aggregation indices exhibit similar temporal trends and highlights that the center of the city is more compact in 2010 with more clumpiness and aggregation in NW and NE directions. In 1973 Post 2000 and in 2010, a large number of urban patches close to each other almost form a single patch especially at the center and in NW and NE direction in different gradients (Fig. 8e, Fig. 8f). Lower values of these metrics in the outer circles indicate that there is a tendency of sprawl in the outskirts. Percentage of Like Adjacencies (Pladj), the percentage of cell adjacencies involving the corresponding patch type are like adjacent. This metrics also indicates (Fig. 8g) that the city center gets more and more clumped and the adjacent patches of urban much closer have formed a single patch in 2010 and outskirts relatively sharing different internal adjacencies with patches not immediately adjacent but have a trend to become adjacent to each other, which is also indicative of sprawl.Patch cohesion index measures the physical connectedness of the corresponding patch type. Fig. 8h indicates physical connectedness of the urban patch with higher cohesion value (in 2010).

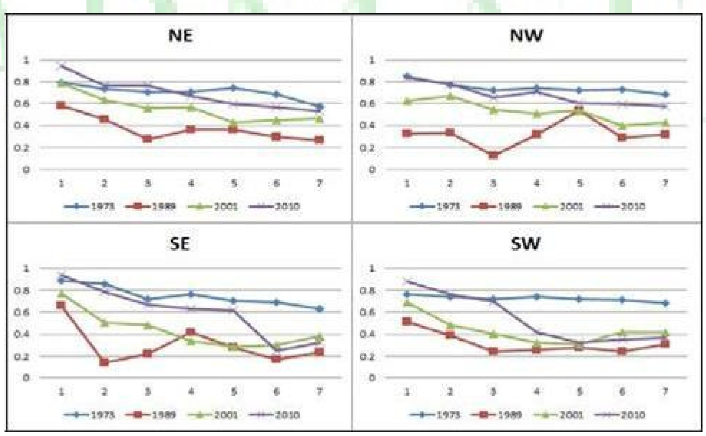

Fig-4 Comparison of Analysis

Lower values in 1973 illustrated that the patches were rare in the landscape. In the outskirts the patch density has increased in early 2000s, which is indicative of sprawl in the region and pd is low at center indicating the clumped growth during late 2000s, which is in accordance with number of patches.landscape shape index (lsi): lsi is equal to 1 when the landscape consists of a single square or maximally compact (i.e., almost square) patch of the corresponding type and lsi increases without limit as the patch type becomes more disaggregated. results (fig. 8c) indicated that there were low lsi values in 1973 due to minimal and concentrated urban areas in the center. since 1990s the city has experienced dispersed growth in all direction and circles, towards 2010 it showed a aggregating trend at the center as the value was close to 1, whereas it was very high in the outskirts indicating the peri-urban development. Normalized landscape shape index (nlsi): nlsi is 0 when the landscape consists of single square or maximally compact almost square, and increases as patch types becomes increasingly disaggregated.

IV.CONCLUSION

Urbanisation with its Spatio-temporal form, pattern and structure has been quantified for Raichur, atier II city in Karnataka through the gradient approach using temporal remote sensing data, land use analysis, Shannons entropy, and spatial metrics.Land use analysis shows an increase of urban area from 1.44% (1973) to 8.51% (in 2010) in and around Raichur. The present land-use is predominantly cultivation or agriculture. Shannons entropy, a measurement on the degree of sprawl in city, highlights the tendency of sprawl in recent times at outskirts. Spatial metrics in accordance with theShannons entropy indicates a clumped growth at city centre and dispersed growth at outskirts. This analysis visualizes the spatial patterns of urbanisation which helps in the regional planning to provide basic amenities and infrastructure. It is imperative to maintain the environmental quality through the judicious use of land by checking the haphazard growth of urbanization. Spatial models provide vital inputs for the decision makers and city planners to visualize and plan a sustainable growth process.

REFERENCES

[1] Angel, S., Parent J., and Civco, D., "Urban sprawl metrics: an analysis of global urban expansion using GIS," Proceedings of ASPRS 2007 Annual Conference, Tampa, Florida May 7–11, (2007).

[2] Banzhaf, E., Grescho V., and Kindler, A. "Monitoring urban to peri-urban development with integrated remote sensing and GIS information: A Leipzig, Germany case study," Int. J. Remote Sens., 30(7) (2009):1675–1696.

[3] Barnes, K. B., Morgan, J. M. III, Roberge, M. C., and Lowe, S. "Sprawl Development: Its Patterns, Consequences, and Measurement," Towson University, 2001.

[4] Congalton, R. G. "A review of assessing the accuracy of classifications of remotely sensed data" Remote Sensing of Environment, 37(1991):35-46.

[5] Cushman, S.A., Wallin, D.O. "Rates and patterns of landscape change in the Central Sikhote-alin Mountains, Russian Far East," Landsc. Ecol. 15(2000): 643–659.

[6] Duda, R.O., Hart, P.E., Stork, D.G. Pattern Classification, a Wiley-Interscience Publication, 2nd Edition, 2000.

[7] Epstein, J., Payne, K., and Kramer, E. "Techniques for mapping sub-urban sprawl," Photogramm. Eng. Remote Sens., 63(9) (2002):913–918,.

[8] Eryilmaz, S.S., Cengiz, H., Eryilmaz, Y. "The Urban Sprawl Model For An Affected Metroplolis: Bursa – Istanbul Example," 44thISoCaRP Congress, (2008)