

# Simulation of Spatial Concentration of Urban Built-up Lands through GIS and Remote Sensing Techniques: A Study of Mysore City, Karnataka, India

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## Abstract

*The present study is conducted to simulate the spatial concentration of urban built up lands in Mysore City. In order to model the urban concentration, the method of Shannon entropy were utilized which gives degree of compactness or degree of dispersion. The formulae have brought to the Geographical Information System environment. Study used 3 set of remote sensing Landsat data with 11 years temporal resolution such as 1992, 2003 and 2014. The Urban built up land were extracted using the visual image interpretation and supervised classification scheme with set of sample signature file. Then 150m fishnet have created to define an equidistant zones. After all, Landscape metrics of Shannon entropy have computed and the Shannon entropy for the year 1992, 2003 and 2014 showed the value 0.99880, 0.96945 and 0.9437 respectively, which indicates the concentration of Urban built up lands is compacting year to year.*

## Keywords

*Simulation, Shannon Entropy, Urban Area, Built-up Lands, Geographical Information System, Remote Sensing.*

## 1. Introduction

Urban and Urbanization both are dynamic activity in land use phenomenon. The Urban centres have the unique characteristics that they pull in populations from the rural areas due to the availability of employment, education and health centres which therefore increases the population. This increasing population converts open spaces and vegetation into built areas (B.Mahalingam et. al 2014). So, there is a need of understanding the dynamicity of changing landscape and their growth. Several researchers (McGarigal 1995, Yeh&Li 2000, McGarigal 2005)

have used different methods to assess the spatial concentration of landscape such as among those Relative Shannon Entropy is familiar and provides a meaningful result and it is widely accepted in GIS and Remote sensing environment. So, the study have followed Shannon Entropy method to assess the spatial concentration of urban built-up lands that indicates either compacted built-up or dispersed built-up land.

## 2. Study Area

The study area (map1) named Mysore City which is located in Mysore District and it is second largest city in Karnataka apart from Bangalore.

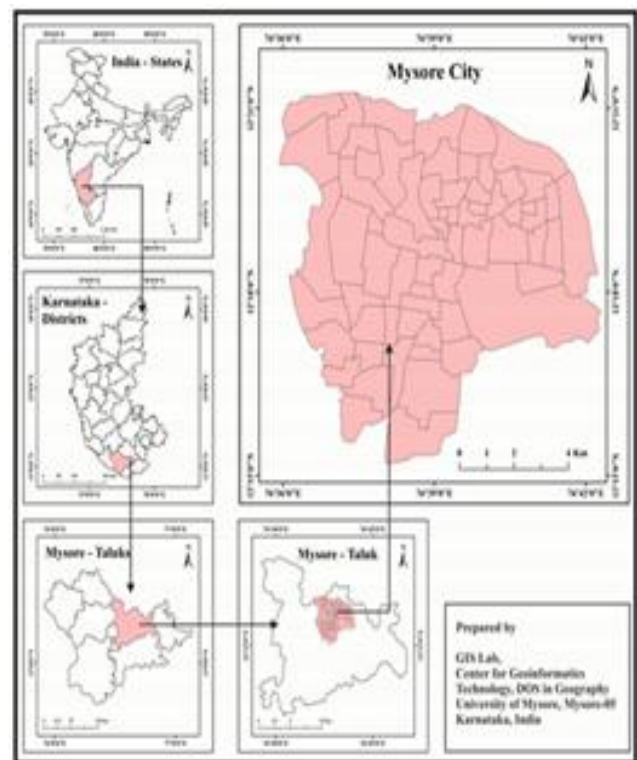


Figure 1:Location of Study Area

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Mysore City geographically extends from 12°15'10" to 12°21'10" Latitude and from 76°36'0" to 76°42'20" longitude. It consists of area with 84.35 Km<sup>2</sup>. The present study is important for these kind of urban area for monitoring and managing built up lands in an efficient way.

### 3. Methodology

The methodology starts with base data acquisition of Landsat imagery from <http://earthexplorer.usgs.gov/> for the year 1993, 2003, 2014. The pre-processing were done by applying atmospheric correction using ACTOR 2. Then False Color Composite (FCC) image were generated with band combination of 4, 3, 2. Then The Urban built up land were extracted using the visual image interpretation and supervised classification scheme with set of sample signature file. Yeh&Li, (2001), Sudhira (2003) and Heng.S (2007) have used multi-ring buffer from the city centre. But uneven distribution of buffer size will makes the result problematic and could not able to shows spatially through raster format. So, that new method is followed by creating 150m fishnet to define an equidistant zones. Totally 3937 fishnet grids have created. Then to find out the area of built up lands within the one fishnet grid, Polygon in Polygon Analysis is performed with the help of Hawth's Toolbox. Then the relative Shannon entropy is computed.

### 4. Results and Discussion

**Built-up Extraction:** For extracting a built-up land, Landsat imagery for the year 1992, 2003 and 2014 have downloaded with sensors of Landsat TM, Landsat ETM+ and Landsat OLI respectively. The supervised classification of Maximum likelihood classification have performed with set of training signature files for (Map2). Then classified built-up image were converted to feature class (Map3). For the year 1992 it was 15.74 Km<sup>2</sup>, for 2003 it was 34.93 Km<sup>2</sup> and for the year 2014 the built-up land found to be 44.13 Km<sup>2</sup> to proceed for the next process.

**Shannon Entropy for Measuring Urban Concentration:** Shannon's entropy ( $H_n$ ) can be used to measure the degree of spatial concentration or degree of spatial dispersion of a geographical variable ( $X_i$ ) among  $n$  zones (Theil, 1967; Thomas, 1981; Yeh&Li 2001). It is calculated by

$$\text{Shannon Entropy } (H_n) = \sum_{i=1}^n P_{i_{th}} \text{Log} \left( \frac{1}{P_{i_{th}}} \right)$$

Where

$$P_{i_{th}} = \frac{X_{i_{th}}}{\sum X_{i_{th}}}$$

$$\text{Relative Shannon Entropy } (H_n) = \sum_{i=1}^n \frac{P_{i_{th}} \text{Log} \left( \frac{1}{P_{i_{th}}} \right)}{\text{Log} (n)}$$

Where  $n = \text{Total number of Grids}$

Where  $P_i$  is the proportion of occurrence in  $i$ th zone,  $X_i$  is the observed value (built-up area) of the phenomenon in the  $i$ th zone (i.e., area of built-up land within one Fishnet Grid 150m and it is found by dividing the area of built-up land to the area of fishnet). The value of entropy ranges from zero to  $\log_e (n)$ . Suppose the distribution is extremely concentrated in one zone (one fishnet grid of 150m), the lowest value of zero will be obtained and if the distribution is dispersed means the value up to  $\log_e (n)$  will be obtained(Yeh&Li, 2001). Also Relative entropy can be used to scale the entropy value into a value from 0 to 1(Thomas, 1981).

By using the Relative Shannon Entropy method the result have found as shown in Map4 and summation of all fishnet grids for the year 1992, 2003 and 2014 found to be 0.99880, 0.96945 and 0.9437 respectively.

### 5. Conclusion

The GIS and Remote Sensing is a Key tool for asset management and for efficient urban planning and development. The spatial concentration of Mysore city is assessed through the Landscape metrics of Shannon Entropy method. The entropy is quite simple and efficient to assess the distribution of certain phenomena. The entropy value of Shannon index for study area is compacting year to year and found to be 0.99880, 0.96945 and 0.9437 for the year 1992, 2003, 2014 respectively. The Mysore City is compacting in urban built-up lands year to year and it needs to be frequently monitored and to be managed to meet urban sustainability.

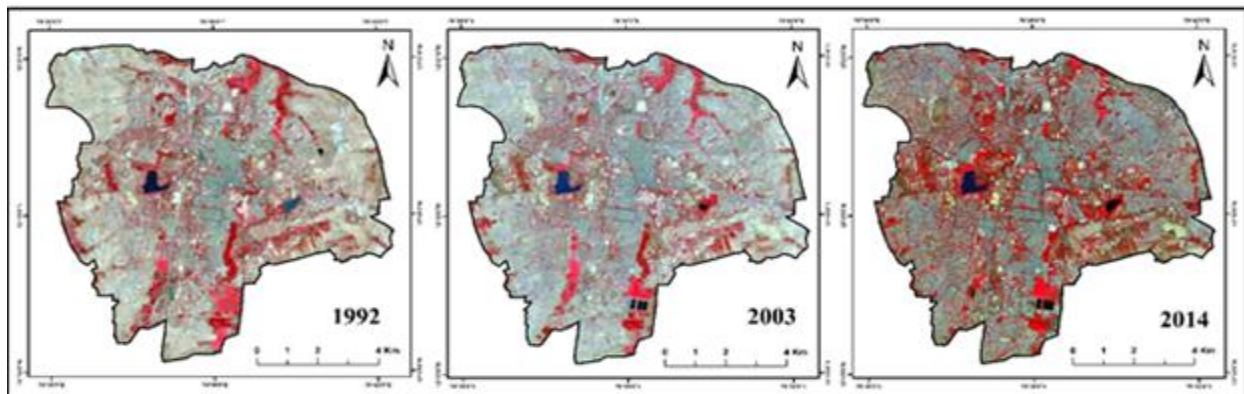


Figure 2: False Color combination(4,3,2) of landsat Imageries

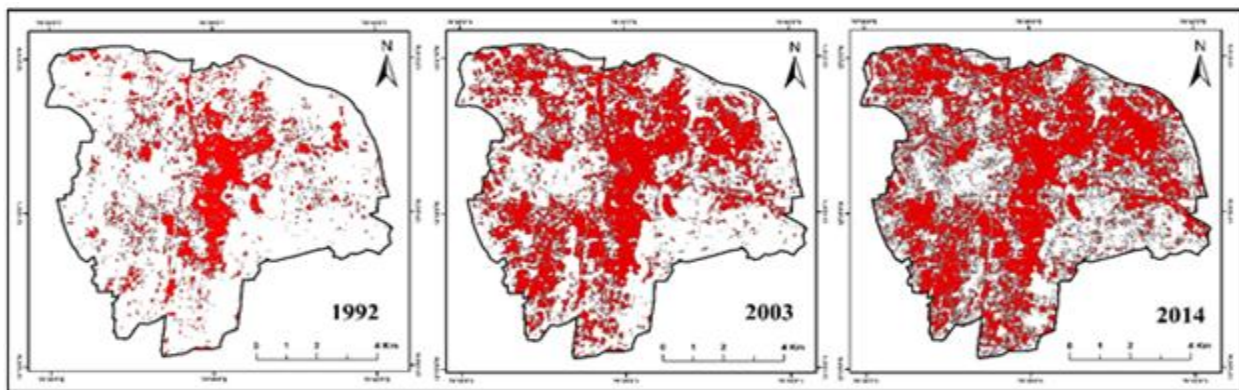


Figure 3: Extracted Builtupland Feature from landsat Imageries

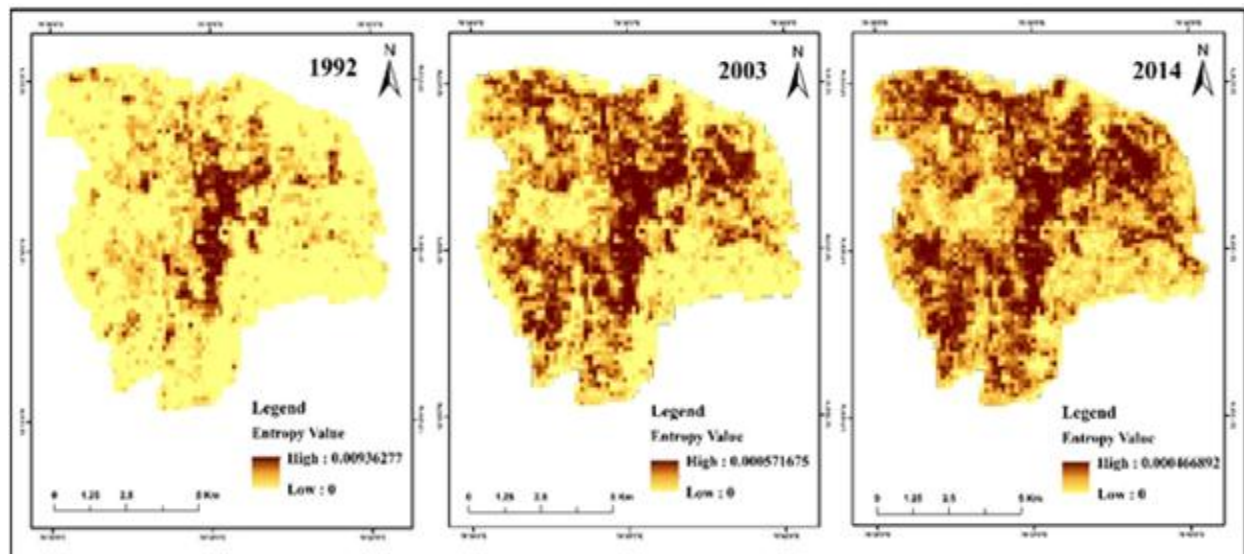


Figure 4: Spatial Concentration of Urban Builtuplands, Mysore City, karnataka

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