

A SURVEY ON URBAN SPRAWL METHODOLOGIES

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Abstract – The increase in population has an importance to increase in sprawl. The accurate analysis and detection of urban sprawl has been a major challenge. In this paper an effort has been made to summarize all the technique for detection of sprawl. The known shortcoming of all the methods can be removed by a combination of them. The GIS and RS can be combined to obtain more accurate results. The primary benefit of the use of tool is that it provides accurate data for city planners. Nowadays a hybrid tool is developed which is combination of GIS, RS and Shannon’s Entropy. The primary benefit of all the three methods is combined with hybrid technique.

Index Terms – Urban Sprawl, Shannon’s entropy, GIS, RS

I. INTRODUCTION

As the population on earth has been increased more and more people are migrating to cities. These results in overcrowded cities, development begin to stretch outwards in a pattern known as Urban Sprawl. Normally, when rural areas are connected to a city by roads, in the initial stages, development in the form of service centers such as shops, cafeteria, hotels, etc. is seen on the roadside, which eventually become the hub of economic activities leading to sprawl. Eventually a significant amount of upsurge could be followed on these roads. This type of upsurge caused by a road network between urban / semi-urban / rural centers are very much prevalent and persistence in most places of developing countries.

Urban sprawl is ever present and continues to increase almost every year in every city of any country. The one line definition of urban sprawl is low density and inefficient development around cities, occurs as a result of the population explosion and high immigration rate. This results in a change in land use. It is very important to differentiate the

difference between the sprawl of the city and urban growth.

1.1 The need of study

The study of urban sprawl is really significant because there are many elements that are touched on by the increase in sprawl. Over 80% of the human civilization lives in cities in industrialized countries, therefore the effect of sprawl is modest in such countries. Whereas in developing countries most of the population still resides in rural or semi-urban area. The effect of sprawl is higher in such countries. This poses a threat in the development of such countries. Hence it is very necessary to effectively detect sprawl for better development of any country.

1.2 Urban sprawl – forms, patterns, types

Sprawl development consists of three basic spatial forms:

1) Low density sprawl

This means consumptive use of land for urban purpose along the outskirts of existing metropolitan areas. This case of sprawl is supported by small extension of basic urban infrastructure such as water, sewerage, power, roads and so on.

2) Ribbon

Ribbon sprawl is development that follows major corridors outwards from urban centers. Lands adjacent to roads connecting urban to rural area are developed, but those without direct access remain in rural uses/covers. Over time these nearby “raw” lands may be won over to urban uses as land values increase and infrastructure is extended perpendicularly from the major roads and businesses.

3) Leapfrog development

This type of development is a discontinuous pattern of urbanization, with patches of developed lands that are widely separated from each other and from the boundaries albeit blurred in cases of recognized urbanized areas. This development is the most costly with respect to providing urban facilities such as water, sewage etc.

II. STUDY AREA AND DATA

2.1 Study area

The study area can be taken as any image of any city. Sprawl affects anything and everything around it. Effect of sprawl can be seen on wildlife, marine life, agricultural land, etc. Climatic conditions also play very significant role in the widespread development of sprawl

2.2 Data

There are mainly two types of data used to measure sprawl: 1) Vector data 2) Raster data

- 1) **Vector data** is defined as a representation of the world using shapes like point, line and polygon. Vector data are useful for storing data that has discrete boundaries, such as country border, streets etc.
- 2) **Raster data** type is, in short, any type of digital image represented by reducible and enlargeable grids. Raster models are useful to store data which are continuously variable, as in aerial photograph, a satellite image etc.
For this study, we can use any type of data mentioned above. Which data is best suited depends upon the method that we have used.

III. METHODOLOGY

Digital image processing may involve various procedures, including the formation and correction of the data, digital enhancement to facilitate better visual interpretation, or even automated classification of targets and features entirely by computers.

3.1. The Impervious metric

The assumption behind this approach is that sprawl is defined as a relationship between population and the built-up environment. Increase in impervious surface leads to degradation of stream habitat, the pollution of surface water, the raising of air and water temperature, etc. The major challenge with this method involves the calculation of impervious surface. The drawback of this method is that it is not suitable for pattern analysis.

3.2. The Neighborhood metric

The city with sprawl is highly dependent on the use of automobiles. This is the case as the residential area is not within walking distance of their workplace. This method aims at using a variation on population density change analysis to assess the change in transit-friendly development as defined in the literature on public transit viability. This method has a limitation in pattern analysis that the data required for dissymmetric mapping of population distribution and the utilization of the convolution kernel to assess the density distribution at a map pixel scale.

3.3. The permit metric

The fact considered in this method is that jurisdiction of both the state/province level and the local/county level are responsible for setting policy and implementing strategies that contain new growth within established urban growth boundaries (UGBs). The key factor in the failure of this method is the non-availability of the data on building permits because even in developed society the data are very expensive to obtain and analyze. Alike all techniques this is also limited in the sense that it fails to take into account the spatial dynamics of sprawl as represented by resultant pattern.

3.4. Shannon-Wiener index

Shannon-Wiener entropy works on the principle that naturally occurring virgin lands and landscapes are viewed as the normal and orderly state of things. Shannon's entropy is the measure of the disorder occurring due to excessive use of naturally occurring land by humans. This measure is based on the idea that landscape

entropy (H_n) or disorganization increases with sprawl. The dispersal of built up areas from city centers will contribute to an increment in the entropy value.

The Shannon's Entropy of a variable is defined as:

$$H_n = \sum P_i (\log n)$$

Where: P_i = proportion of the variable

in the i^{th} zone

n = Total number of zones under study

The value of Shannon entropy ranges from 0 to $\log n$. If the distribution is very compact then the entropy value would be near 0 and when the distribution is dispersed the value will be near $\log n$, a large value of entropy indicates the occurrence of urban sprawl.

3.5. GIS and RS

RS and GIS can be combined or separately used in study of sprawl. When used separately, both this method helps to recognize the sprawl pattern, mapping of patterns and spatial analysis to some extent. The consolidation of GIS and remote sensing with the aid of good examples and additional database management systems (DBMS) is the technically most advanced and applicable approach today. The limitation of these two technologies is that they cannot correctly compute magnitude of sprawl and sprawl indices.

IV. ADVANTAGES AND DISADVANTAGES

4.1. Advantage

- Affordability - The cost of a house with a yard in the suburbs is always less than the cost of a quality apartment in the city.
- Better Schools - People with school-aged children find that smaller, less crowded schools with better-funded programs are preferable in comparison to schools in the city.

- Low Crime Rates - It is observed that serious crime in the suburbs is less than that in the city.
- Sense of Community - An individual in a city can often feel lost in the crowd, while being in a less densely populated area can provide more of a sense of belonging to a community.

4.2. Disadvantage

- Automobiles – As the distance between places is increased the use of automobiles is also increased.
- Loss of unconstructed land – The building of roads and buildings destroys the farmland and forest areas.
- Higher taxes – With sparse distribution of people there will be more government agencies which leads to salary to be paid to more employees which ultimately results in higher taxes.

V. CONCLUSION

In this study, we have examined various methods to measure sprawl. All the methods have their own advantages as well as disadvantages. This survey paper gives idea and analyses the performance of various and different sprawl detection techniques. Furthermore the study area and the type of data needed to perform this type of study is also mentioned here. To conclude, we can say that the increase in urban sprawl in any area has ill effects on its development as well as their residence. It is very important to monitor sprawl.

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