# SPATIAL PATTERN ANALYSIS IN GEOSPATIAL APPROACH REFERENCE TO KADUWELA MUNICIPAL COUNCIL, SRI LANKA

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**Abstract**

Cities play a significant role in our lives, providing a place for fulfilling social, economic, and physical needs for more than half of the population in the entire world. The city is a dynamic entity with complex activities, and it faces gradual physical changes or urban growth. Urban growth occurs in a planned or unplanned way. Unplanned urban growth or urban sprawl aggravated huge urban problems in cities and the fringe. Identification of urban growth pattern is significant and measuring and predicting the urban growth in a methodical way is an essential for the decision-making process. Measuring the urban growth pattern is essential and ArcGIS 10 provides an impressive analytical tool for geographic pattern analysis that helps to understand the geographical phenomenon using spatial autocorrelation. Spatial autocorrelation can be applied to detect the pattern of urban areas at a specific time. This study used those tools to analyse spatial pattern in the Sri Lankan urban area. Results show type of spatial pattern of the area.



**Keywords**: Spatial Pattern, Geospatial Approach, Cities

## Introduction

With a fast-growing population in this century, an undesirable urban growth has occurred all over the world, but in the developing countries, this situation is aggravated and it requires to be addressed seriously. The present urban population in the developing countries is more than half of the population lives in urban areas. All developing countries are responsible for accommodating this surge of population in liveable areas, which they are unable to do in the right way. Therefore urban studies are very important for countries to identify their spatial urban pattern. Many studies have attempted to explain urban growth in diverse ways such as a pattern (Forman, 1995; Coleman, & Freihage, 2001; Heimlich & Anderson, 2001), a process (Galster et al., 2001; Herold, et.al., 2005), a cause and consequence (Barnes et al., 2001; Benfield et al., 1999; Brueckner, 2000; Grimm et al., 2000) and counter measures (Alterman, 1997; Anderson, 1999; Asif & Shachar, 1999; Bhatta, 2009c; Brueckner, 2000; Burby, Nelson, Parker, & Handmer, 2001; Coughlin, 1991; DeGrove & Deborah, 1992) as well cited by (Bhatta et.al.,2010). Urban change is directly related to space as well as time.

Urban growth is a continuous process that keeps changing the spatial structure of cities (Bahtta, 2009; Herold et.al., 2005). Some scholars have considered it as a static phenomenon, whereas some have analysed it as a dynamic phenomenon; however, most researchers have accepted both as spatial-temporal processes. In 2010, Andrienko et al. mentioned that everything in the

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physical world is purely spatial and temporal; everything is a process. Change must be seen as a combination of processes that occur along the time scale in the space concerned. Cheng (2003) mentioned that a process is a sequence of changes occurring in space and time, initially as a spatial process and the latter as a temporal process. Measurement of urban growth pattern is important in the Sri Lankan context and this study attempted to measure urban growth pattern in the Sri Lankan urban area. Which are very closed to City of Colombo and it consist of urban as well as completely rural features.

## Method

Identification of the urban pattern is important for the measurement of urban growth. ArcGIS 10 provides an impressive analytical tool for geographic pattern analysis that helps to understand the geographical phenomenon using spatial autocorrelation. Spatial autocorrelation can be applied to detect the pattern of urban areas at a specific time . It also analyses the degree of dependency among observation in a space. Global Moran I [2, 4], is a measure of spatial autocorrelation, which is not only based on feature locations or attribute values itself, but uses both feature locations and feature values simultaneously. It classifies the growth pattern as clustered, dispersed, or random. The tool calculates index value I ranging from +1 to -1 showing clustering and dispersion, as well as a Z value showing the significance of

The Spatial Autocorrelation (Global Moran's I) tool computed the observed Index value and the Expected Index value. The Expected and Observed Index values were then compared. Given the number of features in the dataset and the variance for the data values overall, the tool computed a z-score and p-value indicating whether this difference is statistically significant or not. Index values cannot be interpreted directly; they can only be interpreted within the context of a null hypothesis. In the case of the Spatial Autocorrelation tool, the null hypothesis states, "there is no spatial clustering of the values". When the Z score is large (or small) enough such that it falls outside of the desired significance, the null hypothesis can be rejected. When the null hypothesis is rejected, the next step is to inspect the value of the Moran's I Index. If the value is greater than 0, the set of features exhibit a clustered pattern. If the value is less than 0, the set of features exhibit a dispersed pattern.

## Study Area

The Kaduwela Municipal Council (KMC) was selected as a case study area. KMC is located at 6°54'N, 79°51'E, 7 m. and it is sited about 11 miles away from the city of Colombo, within the Colombo district of the Western province. The Kelani River flows from East to West along the Northern boundary of the KMC. Another important factor of physical characteristics of the area is the depth of water table. General picture of water table depth has a shallow ground water table, lying between 0 and 1 meter from the ground surface in more than 60% of the total area. However, later, urban expansion and new development projects gave incentives for people to in this area.

KMC administratively is divided into three main divisions namely, Battaramulla, Kaduwela and Athurugiriya. Battaramulla area is highly developed and the other two divisions show a rural urban mix. At present, the entire area face rapid land use changes due to new development projects and the entire area functions as a transition zone.

In 2012, the total population in KMC was 252,100 it shows an average annual growth rate of 2.01, compared with 2001. However, it is lower than the growth rate from 1981 to 2001, which was 2.6%. Thus, an increasing trend of population growth is seen in the KMC Area over the last two decades and this trend continues. It is caused by the natural growth of the population as well as migration mainly due to the availability of developable land. Overall population density depicts 3 different variations in the different administrative units.

**Table 1: Population Distribution**

| Administrative unit | Extent (ha.) | 2001 | Density per ha. | 2012 | Density per ha. |
|---|---|---|---|---|---|
| Battaramulla | 2191 | 84,961 | 39 | 88,020 | 40 |
| Kaduwela | 3727 | 63,820 | 17 | 77,743 | 21 |
| Athurugiriya | 3258 | 60,960 | 19 | 86,337 | 27 |
| Total | 9176 | 209,741 | 23 | 252,100 | 27 |

Source: Analysis Data, (2020).

Furthermore, the three administrative units progressively display increasing population densities. Nevertheless, significant variations of the population density are seen across administrative units of the area.

The entire land use classified into six categories namely urban built up, low residential, agriculture, green areas, water bodies and other uses. The classified land use using land use classification index shown in Table 2 It shows land use pattern of the four different years.

**Table 2 : Land Use Change Index in Different Land Uses**

| Year | Urban LUCI % | Low Residential LUCI % | Agriculture LUCI % | Green Area LUCI % | Water bodies LUCI % | Other LUCI % |
|---|---|---|---|---|---|---|
| 1972 | - | - | - | - | - | - |
| 1984 | 5.14 | -0.99 | -0.3 | -0.75 | - | -0.4 |
| 2004 | 3.22 | -0.66 | -1.48 | -39.46 | - | -0.28 |
| 2014 | 3.54 | -4.33 | -4.8 | 1.96 | 1.27 | 2.93 |

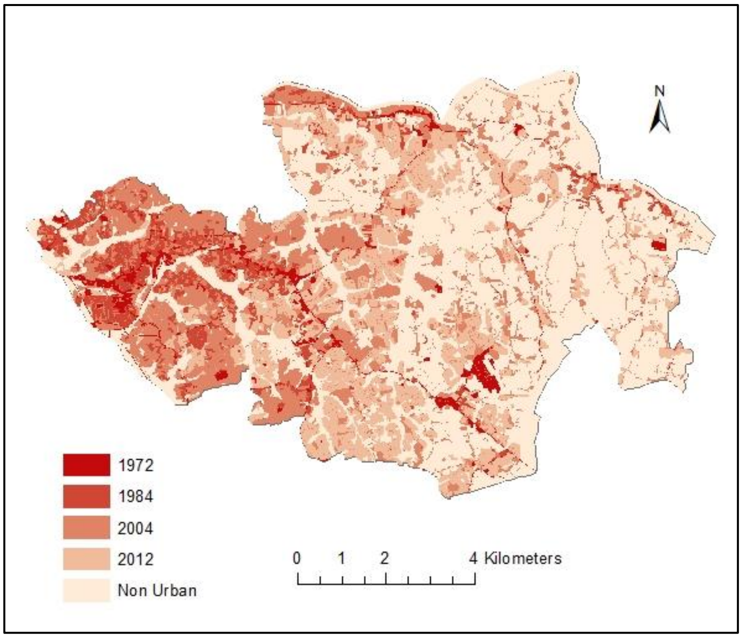
Source: Analysis Data, (2020).

Accordingly table 2, from 1972 to 2014 built up area changed gradually. From 1972 to 1984, a gradual increase is seen. The land use from 1984 to 2004 increased but LUCI decreased from 5.14 to 3.22.

Civil disturbances existed in the country during this period was one of the reasons for LUCI decrease. However, when compared with the 2014 figures, it has slightly increased to 3.54. Low residential are shows gradual decrease from – 0.99 to - 4.33. During this period agriculture uses have significantly reduce from -0.3 to -4.8 annually.

Urban expansion is a significant factor to measure urban growth and the urban built up category is important in this context. The above figures show the LUCI about urban built up expansion. Figure 7.3 shows urban built up area in these four different years and it shows the urban growth direction has taken place through west to east. Accordingly, the nature of expansion in 1972 indicates a linear development. In 1984, urban expansion shows a scattered growth. In 2004, expansion is shows different pattern with the western part of the study area showing infill growth and other parts show a scattered growth. However, in the present situation illustrated, in the 2014 map, 2/3 of the area shows a high infill growth and rest shows a scattered growth.

**Figure 1 : Urban Built-Up Changes from 1972 -2014**




Source: Analysis Data, (2020).

There are some relationship between population growth and urban expansion. Table 3 indicates the relationship between urban growth and population growth.

**Table 3: Population Growth and Urban Growth 1972 - 2012**

| | |
|---|---|
| **Population growth** | |
| Population 1972 (thousands) | 209,741 |
| Population 2012 (thousands) | 252,100 |
| Net growth | 42,359 |
| Change | 16.6 |
| Annual Growth rate | 0.41 |
| **Urban Area Growth** | |
| Urban Area 1972 (ha) | 270 |
| Urban Area 2012 (ha) | 4140 |
| Net growth (ha) | 3870 |
| Change | 93.5% |
| Annual Growth Rate | 2.33% |
| **Population Vs total Area (persons per ha)** | |
| Population Density 1981 | 23 |
| Population Density 2012 | 28 |
| Change (persons per ha) | 5 |

Source: Analysis Data, (2020).

## Result and discussion

Identification of the urban pattern is important for the measurement of urban growth. Spatial autocorrelation can be applied to detect the pattern of urban areas at a specific time. It also analyses the degree of dependency among observation in a space. Global Moran I [2, 4], is used for that. The results of Moran I statistics of 1972 and 2014 are shown in the Table 4

**Table 4: Morgan I Index**

| | **1972** | **2014** |
|---|---|---|
| Morgan's Index | 0.385559 | 0.445693 |
| Z-score | 3.455928 | 4.364333 |
| p-value | 0.000548 | 0.000013 |

Source: Analysis Data, (2020).

In 1972 the Moran's I Index value of 0.385559, which is close to +1.0000, indicates clustering pattern. The statistical result is significant as p-value is 0.000548 ($p < 0.05$). Given the z-score of 3.45, the spatial distribution of urban pattern in 1972 is clustered.
In 2014, the Moran's I Index value of 0.44, which is near to +1.0000 indicates a clustering pattern. The statistical result is significant as p-value is 0.000013 ($p < 0.05$). Given the z-score of 4.36, the spatial distribution of urban pattern in 2014 is clustered.

Accordingly, Moran I statistics show that the urban growth of two years is clustered. This data is compared with the results matrix developed by experts and residents. The outcome of the analysis of their views indicates three types of views regarding the urban growth of the study area.

## Conclusion

Identification of urban growth pattern is significant and measuring and predicting the urban growth in a methodical way is an essential for the decision making process. First population density and land use pattern were evaluated and it shows clear relationship. Further land use pattern were evaluated using Moran I statistics and it shows the urban growth of two decades is clustered. This data is compared with the results matrix developed by experts and residents. The outcome of the analysis of their views indicates three types of views regarding the urban growth of the study area. The land use pattern presents a different picture and it shows the urban area gradually expanding by spreading out through peripheral areas with the urban fringe functioning as a transition zone.

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