A Geo-Spatial Analysis of identify the urban Sprawl Based on Accessibility in Surrounding Area of Negombo Municipal Council

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Abstract

Urbanization and Urban Development is a key concept for the development of the region or the country as well as the road connectivity plays a key role in urbanization. Road network is considered to be one of the keys to regional development in recent time. Based on the road network of urban to urban the transformation of the settlement is to be identified. Specially surrounding area of the main cities have been changed very fast based on accessibility and road connectivity. The objective of this study is to identify the spatial pattern of urban sprawl in relation to road connectivity in surrounding area of the Negombo Municipal Council. Negombo is identified as a second major town by Colombo Metropolitan Regional Structure Plan formulated by Urban Development Authority (UDA) and is the first in the order within the Gampaha District. This coastal tourism city is located near the Negombo lagoon mouth and approximately 35 km north of Colombo and a few kilometers away from the Colombo International Airport and Katunayake Free Trade Zone (FTZ). Due to the above reasons, Negombo is a highly demanded and services oriented city. The classified natural street network was used to build the properly connected axial lines network considering all junctions and edges using QGIS and space syntax was used to perform connectivity analysis. Road connectivity classified based on the level of integration. Higher connectivity can be identified along the main roads (class A and B roads), and both ends of other roads connected to the main roads. Further, the findings reveal that transport network factuality is directly varying with respect to connectivity and the coverage of the study area. Public transport availability and frequency are also used to identify the transport availability in the study area. It is notable that, there is a significant relationship between the level of road network connectivity with the population distribution and building distribution within the study area. Due to the spatial data availability and different years of data collection, some areas show mismatches. However, the results can be used to identify the urban sprawl in the study area. Depend on the connectivity level means higher connectivity roads are service oriented such as commercial, industrial developments and lower valued connectivity roads are residential oriented. Due to this, and according the field visits, the land values shows regular order as per the road connectivity values.

1. Introduction

Urbanization expands radially around a well-established city or linearly along a major road as per the pattern of transport accessibility for required day today services and facilities of citizens in a city. As per Mathivathany (2015) in the field of planning and urban design, spatial analysis is playing vital role.

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In recent years such developments have been built using a road design concept that uses poor road connectivity. Connectivity Analysis technique is one of the methods developed in the paradigm of Graph Theory. Road connectivity pattern is necessary to identify the accessibility and this supports for fulfilling day today citizens' needs. In Sri Lankan view, accessibility is mainly the public transport systems and private transport system fewer effects for the urban sprawl.

Geospatial technology software such as GIS is capable and can be adopted to identify the hierarchical network connectivity. Based on the connectivity, transport accessibility can be mapped and analysis for making better decisions. The objective of this study is to identify the urban sprawl in the Katunayake Airport centric region including Negombo city. With the development of Negombo as a tourism city, Airport and the related activities and biggest Export Processing Zone in Sri Lanka the reasons for urbanization in this region. Identification of urban sprawl is necessary to build urban rules and regulations, urban planning and zoning,

2. Literature Review

There has been a range of approaches to the analysis of certain aspects of sprawl, but most have focused on socioeconomic factors that utilize census and economic data on a county- or municipal-level (Ewing et al., 2002; Pendall et al., 2000; Fulton et al., 2000; Burchell and Shad, 1999; Orfield, 1997). With the development of information technology, geospatial technology plays a major role in location based decision making adding values to socio economic measurements. Urban sprawl is one the location based sector which can integrate with the transport network. Therefore, use of technological developments especially the Geographic Information Systems (GIS) developments help in identifying urbanization and the development trends in an urban area.

According to Stucki (2015) Limited availability of public transport services, in the form of scheduled bus and or rail services, is a concern in almost all of the case cities. Trends in respect of improvement of the supply of scheduled public transport service are negative in nine cities, while seven cities are actively implementing improvements. So, transport usage or the accessibility method impacts the urbanization and direction of urbanization.

As per Mathivathany (2015), network connectivity identifies the hierarchical structure and formation of the road network and to analyze the connectivity levels of the selected nodes in spatially. In this, connectivity builds hierarchical formation of the road segments connections. This vary depends on the road connectivity and based on roads distribution pattern. Less connected low level road segment connections have less connectivity values, and highly connected roads such as major roads have high values for connectivity.

3. Methodology

3.1. Study Area

Katunayake, Negombo coastal area is highly urbanized due to Colombo Bandaranaike International Airport (BIA), Free Trade Zone (FTZ) and the Negombo tourism city. However, the developments are controlled by implementing new rules and regulations such as height restrictions by the Civil Aviation Authority (CAA) and other related statutory bodies such as CAA. Therefore, airport centric study area was selected including Negombo city and the FTZ. The study area is bounded from west side to Indian ocean and located in the Gampaha district in Sri Lanka. Study area expands to Negombo Municipal

Council, Katunayake-Seeduwa Urban Council, Divulapitiya, Katana and Minuwangoda Pradeshiya Saba's. 273 Grama Niladhari Divisions (GNDs) are in the study areas, and in that 38 GNDs are urban and the balance GNDs are rural divisions. the total land extent is 537.3 sqkm. Figure 01 illustrates the study area location map.

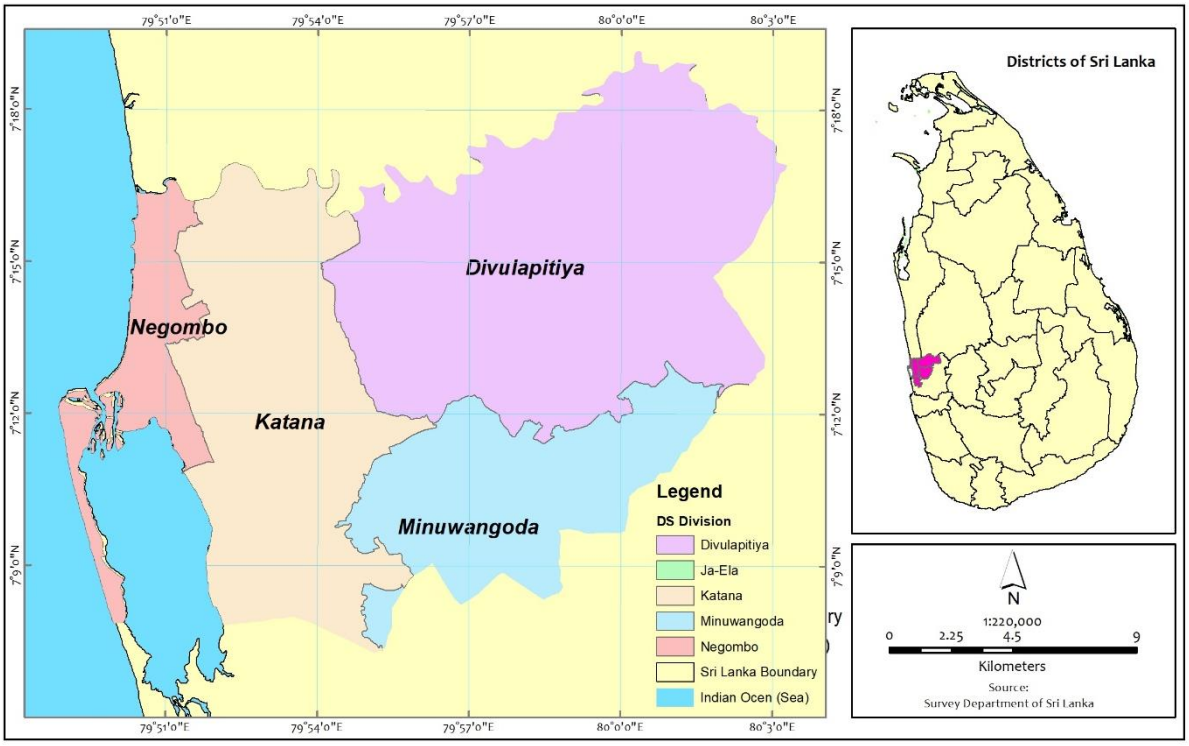

Figure 01: Map of the Study Area

3.2. Data and Data Collection

Airport centric study (aerocity) area boundary collected from the Ministry of Megapolis and Western Development. It consists of Grama Niladhari Divisions from Department of Census and Statistics - 2012, and Road network and Major towns data collected from 1: 10,000 scaled data from Survey Department of Sri Lanka. Such data included road category, distance etc. Public transport information collected from the Western Provincial Road Passenger Authority to identify the available public transport and the frequency for finding the accessibility. Population data collected from the Department of Census and Statistics by Gram Niladhari (GN) Division.

3.3. Analysis

Classified all roads to main roads (expressway and A class roads), main roads B, minor roads C and D class roads and created buffer zones 36m, 30m, 20m and 12m accordingly to road categories (Figure 2) to draw axial lines from the natural road segments (Figure 3). All the axial lines are connected and verified to run the connectivity using Space Syntax software and connectivity analysis methods.

Figure 2: Buffered Road Network

Figure 3: Axial Lines Network

Collected public transport availability and frequency are mapped as per the given information, and overlaid on the results of connective analysis to further identification of services availability. Most of the public transport facilities are limited to major roads such as Class, A and B roads and sot few C class roads.

4. Results

According to the road classification, main road Class A runs parallel to the coastal boundary and across the Negombo town area from southern to northern connecting Class B roads expressway at Katunayake. Most of the Class B roads connect to Class A road horizontally and runs landward direction from towards the land. Transport network categorized and calculated the extent (in ha) for identification of the total accessibility percentage of the study area. Table 1 shows the road extent by category.

Table 1: Transport network by extent and percentage

Road Category	Extent (ha)	Study Area Extent (ha)	Percentage by Road Category (%)	Total Percentage
Expressway	90.95	53725.92	0.17	7.67
Class A	141.04		0.26	
Class B	814.52		1.52	
Class C	957.13		1.78	
Class D	2114.71		3.94	

As per the road classification and the connectivity analysis, it shows the high connectivity can be identified along the Colombo – Chillaw (A 03) road and secondly connected B class roads have the highest connectivity values. Figure 4 shows distribution of connectivity analysis results. When the population density (per ha) data by GN division overlaid, results show the relationship accordingly

(Figure 5). Public transport availability and frequency distribution helps to identify the transport availability in the study area (Figure 6). Figure 7 shows the spatial distribution of buildings by GN division.

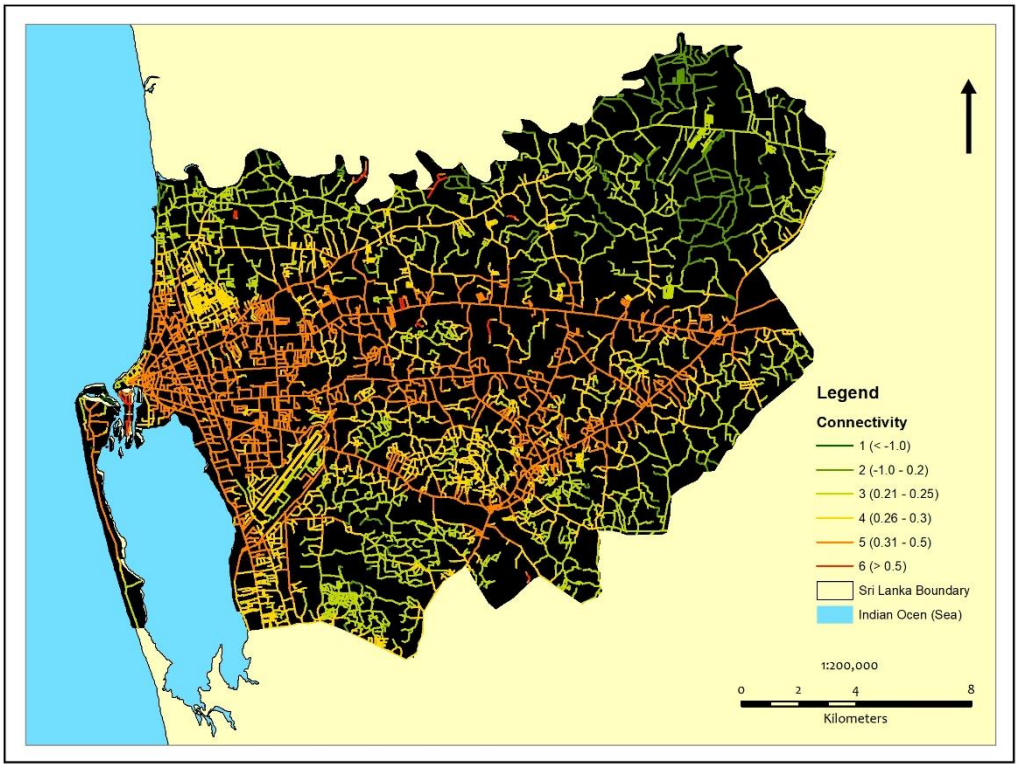

Figure 4: Spatial Distribution of Connectivity Analysis

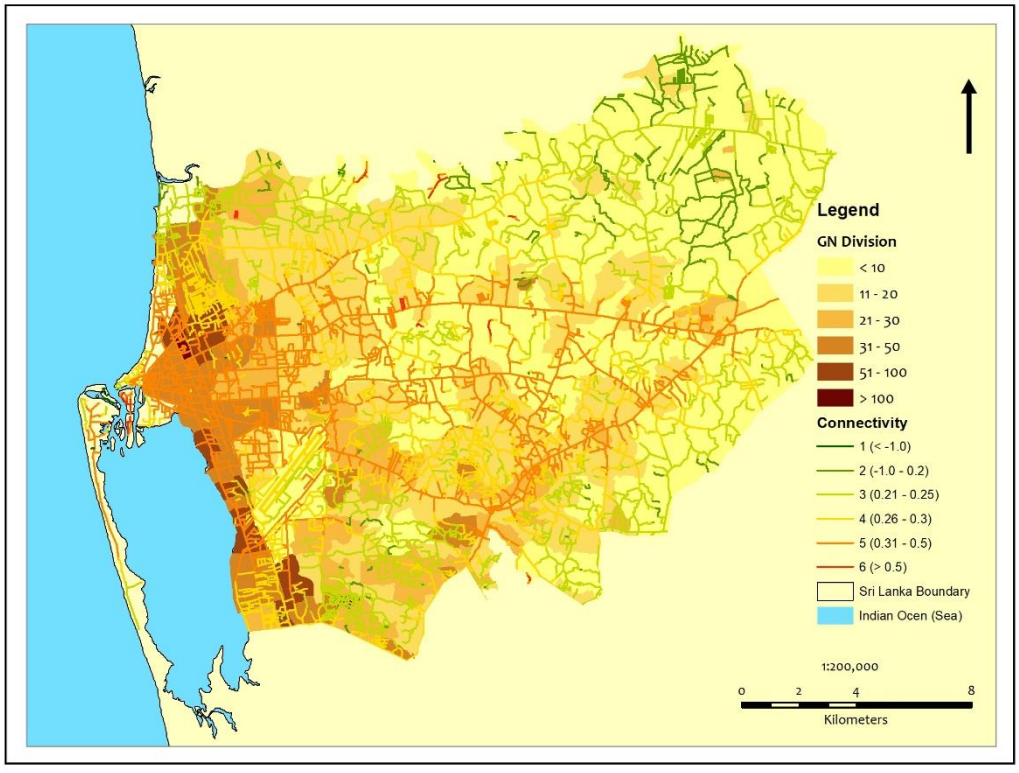

Figure 5: Population Density by GN Division and Distribution of Connectivity Analysis

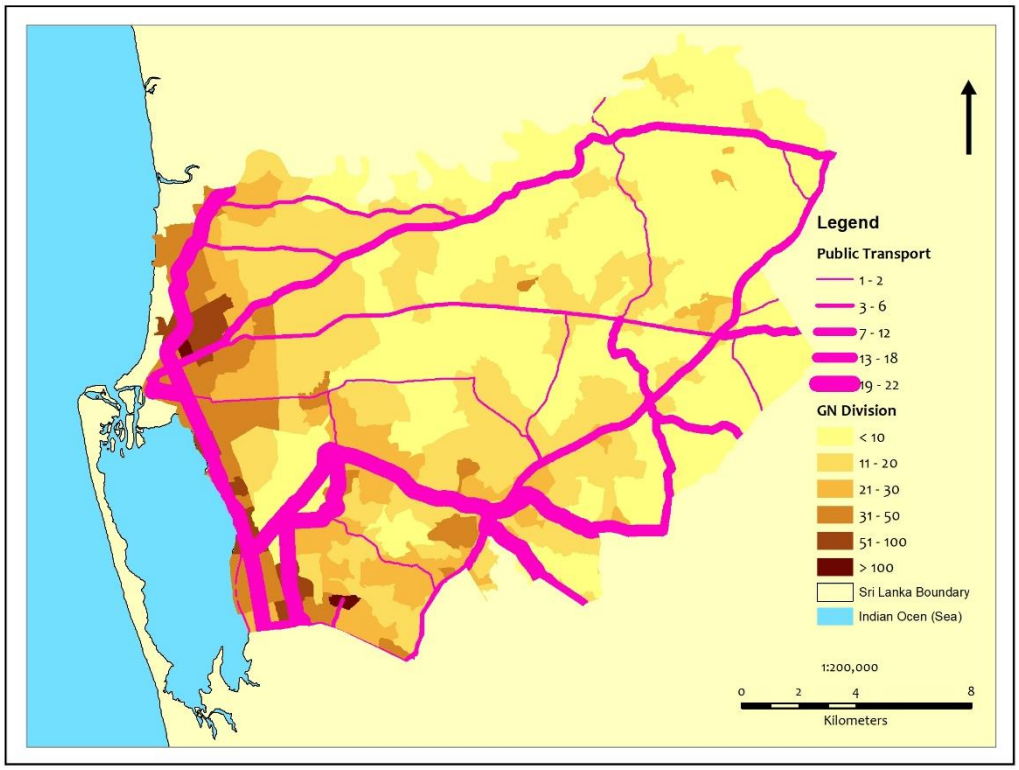

Figure 6: Public Transport Availability and Frequency Distribution.

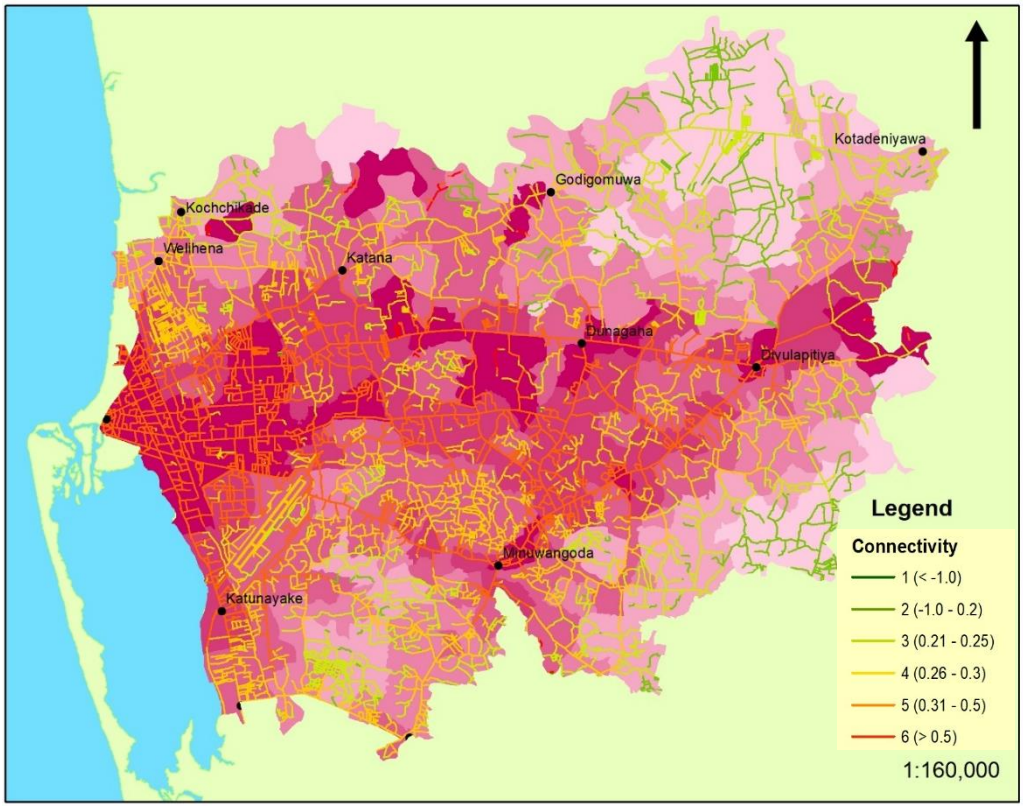

Figure 7: Spatial Distribution of Buildings by GN Division.

4. Conclusion and Recommendation

As per he above results, it is notable that there is a significant relationship between the level of road network connectivity with the population distribution, public transport frequency and availability and building distribution within the study area. Service oriented to residential buildings distribution and land values changed according to the connectivity values. Means fewer connectivity valued roads are more residential rural developments and higher connectivity valued roads are more to services oriented such as commercial, industrial etc. developments. So, this unplanned urbanization is need to be manage for solving urban challenges including environmental management and to provide better services, facilities and future expansions.

So, it is necessary to implement development rules and regulations for controlling the accessibility based unplanned development. Due to the spatial data availability and different years of data collection, some areas show mismatches. With the smart city concepts, digitization of cities and up-to-date data availability bring more results for making better planning oriented decisions. However, these results can be used to identify the urban sprawl in the study area.

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