

Urban agglomeration and spatial formation of urban growth in the Colombo District

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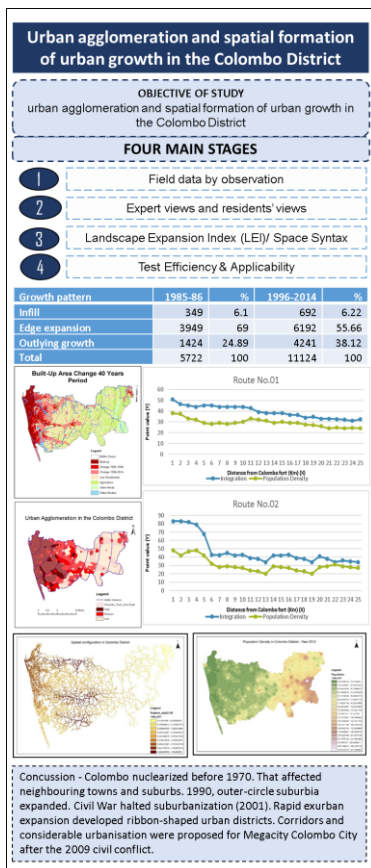
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ABSTRACT

An urban agglomeration is one of the biggest drivers of national or global economic development since its cities are interconnected. The world's population was 55% urban in 2020, compared to 52% in developing countries (United Nations, 2020).

Land usage statistics for small and medium-sized town centers were analyzed using primary and secondary sources. Semi-structured interviews capture 30 experts' thoughts. Reviewing historical planning papers, maps, census records, and other secondary data. Hybrid data analysis. GIS and qualitative research study urban agglomeration and spatial formation. Space Syntax and its integration measure street-to-street transitions to define urban design. Space syntax illustrates population integration and interaction. The Landscape Expansion Matrix controls dynamic systems.

Research shows Colombo urbanized nuclear style before 1970. That impacted neighboring municipalities and suburbs for 50 years. After the 1990 Open Economy, outer-circle suburbia expansion began. The Civil War halted suburbanization (2001). Rapid exurban growth created ribbon-shaped urban districts. Development plans for Megacity Colombo City after the 2009 civil conflict advocated corridors and extensive urbanization.

1. Introduction

Urbanization and urban growth are common phenomena throughout the

Western and the Eastern worlds. In 2020, the world's urban population amounted to 55% of its total population. In developed countries, 78% of the population live in urban areas while in the developing countries the figure is around 52%. This indicates that currently more than half of the world's population is urbanized (United Nations, 2020) and the current decade shows higher urban densities in the mega cities of the world compared to previous decades. "Close to half of the world's urban dwellers reside in relatively small settlements of less than 500,000 inhabitants, while only around one in eight live in the 28 mega-cities with more than 10 million inhabitants" (United Nations, 2014 p2). These high urban densities occur due to urban growth fueled by migration, and this is the ultimate result of urbanization. Globally, all regions are responsible for accommodating and adjusting to urban growth in a sustainable manner.

Sri Lanka is facing urbanization and is continuously in the process of transforming from a rural economy to a service and manufacturing-oriented economy. Urbanization in Sri Lanka shows a slow growth rate compared to the fast urbanization found elsewhere in South Asia. The country has one of the lowest population growth rates among developing countries (1.0 percent a year). According to official statistics, its urban population growth averaged 0.3 percent a year from 2005 to 2015. However, Sri Lanka's urbanization rate does not reflect the true picture since it is computed purely based on the official urban definition. There is consensus that the country is urbanising faster than the statistical figures suggest, although more slowly than other South Asian and Southeast Asian countries. The Western Region has undergone the highest rate of urbanization in the country and its urban concentration has been accompanied by higher economic density and higher productivity. When the three districts of the Western region are compared, the growth rate and urban agglomeration of Colombo District appear to be higher than that of the other two districts. This high urban agglomeration is seen in both ribbon type as well as node type patterns and sometimes can be considered as town agglomerations. During the past four decades, urban growth in the city of Colombo has occurred vertically and spread haphazardly to the countryside without clear directions of spread.

Therefore, the urban agglomerations have formed haphazardly in different patterns and identification of this spatial formation is vital for urban planners and decision makers for future planning and developments. Spatial formation of urban growth in Colombo district is a complicated phenomenon due to haphazard urban development. For instance, the government needs to understand how to expand the city outwards and how it could serve the population better with public services, infrastructure development, etc. From an urban planning point of view, the planners need to identify how and where the urban agglomerations have formed. Possibly due to lack of data and expertise, Sri Lankan urban scholars have paid minimal attention on the uneven spatial formation of Colombo district. Hence, a clear research gap exists in the Sri Lankan urban studies. This research intends to minimise the above gap by exploring urban agglomerations and spatial formation of urban growth in the Colombo district. The findings will offer greater insight and suggest new ways for planners and decision makers to think, analyse, and solve problems relating to urban agglomerations.

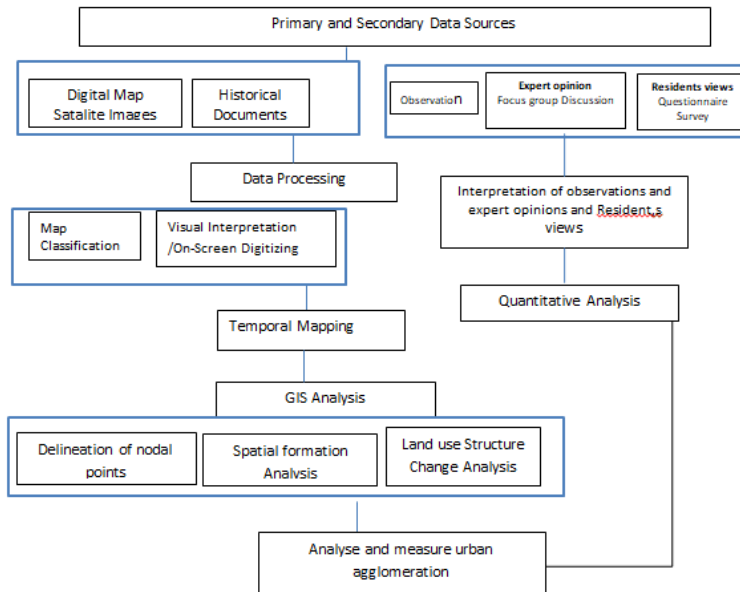
Urban agglomerations of the Colombo district are seen in patterns such as ribbon development, growth pockets, and infill growth. Spatial formation of the Colombo district shows an uneven growth pattern. This distribution pattern shows the dynamics of the interaction between population growth and urban growth. In the inner-city area, the population growth has declined whilst the urban growth has increased due to high land demand. However, higher population growth and higher uneven urban growth are both seen when moving towards the suburban areas. Detailed clarification of this spatial formation pattern is a vital necessity for urban planners and decision makers to set their future priorities correctly in respect of the locations of establishments and resource allocations. It is inappropriate to apply the South Asian or Southeast Asian urban forms to the Sri Lankan urban scenario because it is unique and different. Sri Lankan urban growth pattern is linked intimately with the social and cultural background of the people. Hence, this study intends to answer the following research questions.

- How to explore spatial formation of the Colombo district during the past 50 years
 - How to identify the present urban agglomerations in Colombo district
 - What is the relationship between spatial formation and urban agglomerations in the Colombo district?
 - How to add these findings to the present urbanization process
- To answer the above research questions, this study analyses the urban agglomeration and spatial formation of urban growth in the Colombo District. To accomplish this task, the following four specific objectives were formulated:
- To explore spatial formation of the Colombo district during the past 50 years
 - To analyze the present urban agglomerations in Colombo district
 - To develop a spatial formation model to explore urban agglomerations.
 - To develop guidelines to formulate future urban agglomerations.

2. Materials and methods

The Proposed Methodology Flowchart was displayed bellow. According to the Proposed Methodology Flow Diagram The first step of the investigation was to acquire data from primary and secondary sources. After collecting data, a study was formulated using Digital maps, historical documents, Observations, expert options, and Residence view. After processing operations have been initiated, forms are derived through temporal mapping and quantitative analysis. Following this, a Space syntax and Land use structure change analysis was performed to determine the urbanization type and growth agglomeration point.

Primary Data



Flow Chart of Proposed Methodology

Field data by observation

Windscreen surveys are systematic observations made from a moving vehicle for the purpose of urban planning. It also aids the researcher comprehend the situation on the ground. In urban growth monitoring investigations, Chang (2003) identified the existing growth pattern through observation. Using a windscreen survey, all minor and medium-sized urban centers were observed. All were indicated on the 2014 paper land use map in the field. In the second phase, the identified minor urban centers and changes in land use were considered. At this stage, additional supporting data (population, availability of physical and social infrastructure) were collected from local authorities and used to confirm the medium or small urban patterns of town centers.

Then, urban centers were determined through observation. The changes in land uses of the identified minor urban centers were then revised. Additionally, additional supporting data (population, availability of physical and social infrastructure) will be gathered.

Expert views and residents' views

30 Western Sri Lankan urban planners, environmentalists, and architects were interviewed for their opinions. This type of study usually polls 10% of specialists for planning. Over-10-year town planners were chosen for the study. The sample frame was the Institute of Town Planners, Sri Lanka membership directory. It has 243 municipal planners with over 30 years of expertise. About 84 worked in Colombo. The Urban Development Authority, Land Use Planning Department, and National Physical Planning Department picked urban planners with more than 10 years of experience. Town planners with private project expertise and planning education were also considered. 30 planners—35% of

the population—were interviewed. Structured questionnaires (Appendix 13) guided the interviews. It asked about urban expansion in Colombo District over the previous four decades, specific urban development projects, and personal experiences. Transcribed and organized data were added. Residents were surveyed to determine spatial formation pattern. Urban centers were sampled randomly.

Secondary Data

Historical documents

Examine the historical documents, including old planning documents, maps, and census reports, with care.

Tables containing information about historical documents.

Historical Document	Data
1978 Colombo Master Plan	Historical development of Colombo up to 1978. Land use and population details of urban centres in the period 1978. Data about urban core and suburban areas in the same period
CMR Structure Plan	Population and land use data from 1978 to 1997 and details of structure plan proposals
Western Region Megapolis Plan	Population and land use data from 1978 to 1997 and details of proposals made
Development Plans	Detailed land use and population data in the local authority areas in the urban fringe
Newspapers & magazines	Other notable features over four decades of urban growth

Digital maps, Images

Source (year)	Scale	Coverage	Map Source
Land use map (1985)	1:10000	100%	Survey department
Land use Map (1996)	1:10000	100%	UDA
Updated Land use map (2014)	1:10000	100%	Land use Planning
Road Map	1:10000		Survey department
Administrative boundary map	1:10000		Survey department

Data Analysis

Data Preparation for analysis

The data analysis employed a hybrid method. Utilizing GIS spatial analysis, quantitative analysis, and qualitative analysis, urban agglomeration and spatial formation are analyzed. It was accomplished through thematic analysis based on the opinions of experts and residents and centred on objective 1. Using GIS, analysis of the urban agglomeration pattern through density analysis, proximity analysis, and spatial configuration. In addition, quantitative analysis is used to identify the relationship between the factors that influence urban agglomerations through statistical analysis.

Analyse Population Growth - Landscape Expansion Index (LEI)

Various scholarly works discussed Landscape Expansion Matrix for identifying type of growth. In Sri Lanka, the urban growth type cannot be identified using

these applications due to limitations of data. Therefore, for convenience of application, a simple quantitative method was developed to measure the three growth types using the following equation.

$$GT = LCB/PNA$$

GT = urban Growth Type

LCB = Length of the Common Boundary of early and new urban patches

PNA = Perimeter of New growth Area

Urban growth type is generalized by value of GT, which when less than 0.5 indicates infill growth. When GT is greater than 0.5 growth type is described as edge expansion and a GT of 0 indicates outlying growth. Figure 3.2 shows the different types of urban growth using this simple index.

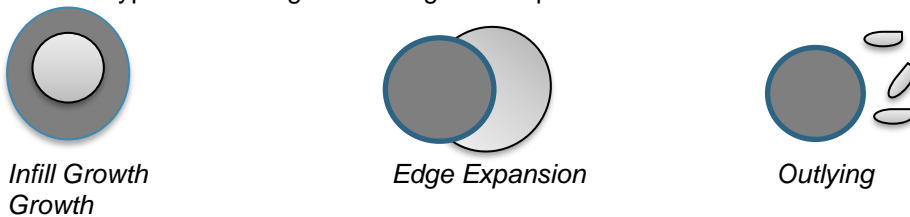


Figure 3.2 Types of urban growth

Space syntax is used as a quantitative method to evaluate spatial integration (configuration). 'Integration is a normalized measure of distance from any a space of origin to all others in a system. In general, it calculates how close the origin space is to all other spaces and can be seen as the measure of relative asymmetry (or relative depth)' (Sources Hillier, B. & Hanson, J. (1984), *The Social Logic of Space*, Cambridge University Press: Cambridge.). Through space syntax spatial area can be divided into components based on connectivity and integration of a space. Space syntax considers space and the spatial structure as the fundamental concept of urbanism. Originally it was comprehended by Bill Hillier and Julienne Hanson at University College London in the late 1970s to early 1980s.

Space syntax comprises four fundamental components (<https://www.spacesyntax.online>). It's are as follows;

- Representation of space - Spatial features are represented through their geometric forms. These geometric forms can be derived as point, axial line, segment, convex space etc.
- Analysis of spatial relations - Relationship between above mentioned spatial elements outcome from their configuration. These relationships can be analyzed using various measures. Integration is one of them.
- Interpretive models - Spatial models are developed to analyze, describe and forecast different kinds of spatial and socio-economic phenomena.
- Theories - Theories explore the relationship between spatial and social patterns.

Case Study development

Other than official urban boundaries, exact urban boundaries are not defined in the Colombo district. Official urban definition defined all MC's and UC's as urban, but UDA defined all local authorities in the Colombo district as urban. Apart from that, other categorizations do not exist. Therefore, clearly demarcated fringe does not exist. However, entire urban areas never show similar urban growth and different local authorities show different characters. Therefore, taken into consideration of all population and land use variations during last three decades' new urban zones were classified.

Boundary Classification of the Colombo District

Administrative divisions considered for derived different zones, fringe is identified as separate zone, and next section focuses on that. Administratively, Colombo District is divided into twelve local authorities, which consist of five Municipal councils, four Urban councils and three local councils. Each local authority is divided into small administrative units named Grama Niladari Divisions (GND) (Figure 4). Within these local authorities, urban expansion occurs in different ways.

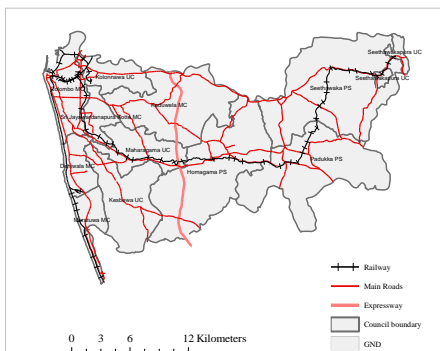


Figure 4 Administrative Divisions in the Colombo District.

Those 12 local authorities need to be categorised based on the type of urban growth discussed in the previous section to identify the urban growth demarcations. Population density, housing density, results of land use structure change, and spatial pattern analysis were used as other indicators to demarcate the urban fringe. Those indicators were considered GND-wise, where GNDs are small administrative boundaries in the country. Using ArcGIS 10 grouping analysis the entire district was classified into four zones based on administrative boundary-based indicators.

The 11 local authorities are located around the City of Colombo that is administered by the Colombo Municipal Council. Colombo is the main commercial hub in the district as well as in the country. Hence, the Colombo Municipal Council area is named as the core city. The contiguous municipal council areas that are located around the Colombo MC no longer show suburban characteristics. At present, most of the land in these areas are used for services

and commercial uses. This is evidenced by the fact that the population growth rate was negative in 2012 compared to that in 2001. It implies that land conversion from residential to commercial and service uses was high. Therefore, this area shows a continuous change pattern from suburban to high-rise urban uses. At present, those areas function as the expanded business and service centers of the core city. Hence, these areas fall under what could be named as the inner crescent. The inner crescent consists of three municipal councils, namely, Dehiwala-Mt.Lavinia, Kotte, and Moratuwa

Table 3 Average Annual Population Growth Rate in 2012 Colombo District

Local Authority	Population growth rate	Location
Colombo MC	-1.36	Core City
Sri Jayawardenepura, Kotte MC	-0.72	Inner crescent
Dehiwala MC	-0.91	
Moratuwa MC	-0.56	
Kaduwela MC	2.01	Urban fringe
Kolonnawa UC	0.67	
Maharagama UC	0.85	
Kesbewa UC	1.29	
Homagama PS	2.86	
Seethawakapura UC	2.45	Outer crescent
Kotikawatta-Mulleriyawa PS	2.49	
Seetawaka PS	2.27	
Homagama PS	2.86	

Source: Department of Census & Statistics, 2012

It clearly illustrates that four of the municipal councils experienced negative (minus) average annual growth while one Municipal Council, located in the inner crescent named Kaduwela MC, showed a high growth rate.

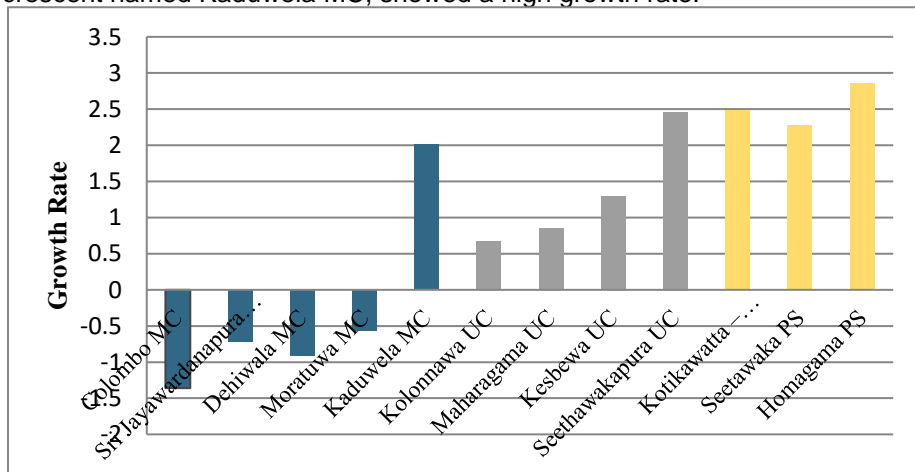


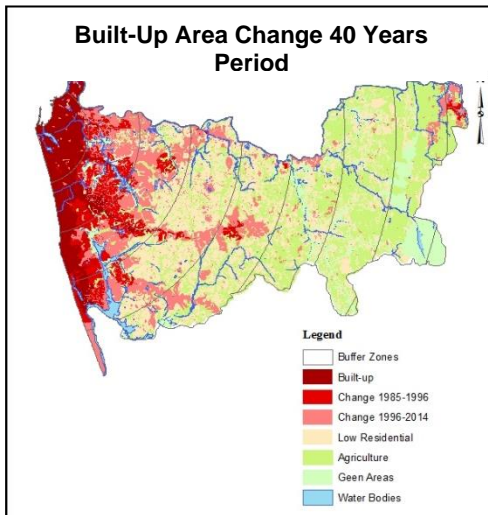
Figure 6 Average Population growth rate in 2012 – Colombo District

The above discussion highlighted different population growth rates in different

local authorities. Accordingly, the local authorities that belong to the transition crescent show similar land use features and plus population growth. transition zone shows edge expansion growth as its land use type. When considered the growth pattern over the three decades, a high land conversion from agriculture to non-agriculture is seen and it is especially high in the transition zone. Hence, transition zone plays a major role as a development potential zone. Previous extensive discussion presented the spatial pattern of urban growth in the Colombo urban fringe in a comprehensive manner.

Results/outputs

Analysis of Past Urban Growth Pattern with Spatial Analysis



Urbanization is one of the major driving forces behind the formation of today's land use systems. It almost always involves the conversion of land use from non-urban to urban uses. However, urban land use change can occur in relatively diverse forms in terms of layout, building density and speed of change, to name but a few aspects. In recent decades, researchers discussed and empirically addressing the various forms of urban land use and its change over time. For identify urban agglomeration changes of urban form is significant. This research first attempted to analyses

land use changes occurred from non-urban to urban during last four decades period. It was done through urban gradient analysis, landscape expansion index and land use structure change analysis. Distance is one of the main factors that affect Colombo District's urban growth and urban gradient analysis was used to explore different urban growth types at different proximity buffer zones from Colombo City (Figure 1). Some scholars [Luck and Wu (2002), Zhang et al. (2004), and Nong et al. (2014)] have compared the built-up area change with buffer distance and quantified the growth types that spread outwards from the urban core in a concentric pattern. Following figure 2 shows results of urban gradient analysis. Different growth types were calculated for the two periods, 1985-1996 and 1996-2014. At first, within each buffer zone the annual urban growth was calculated and after that the different growth types were analysed using the landscape expansion index.

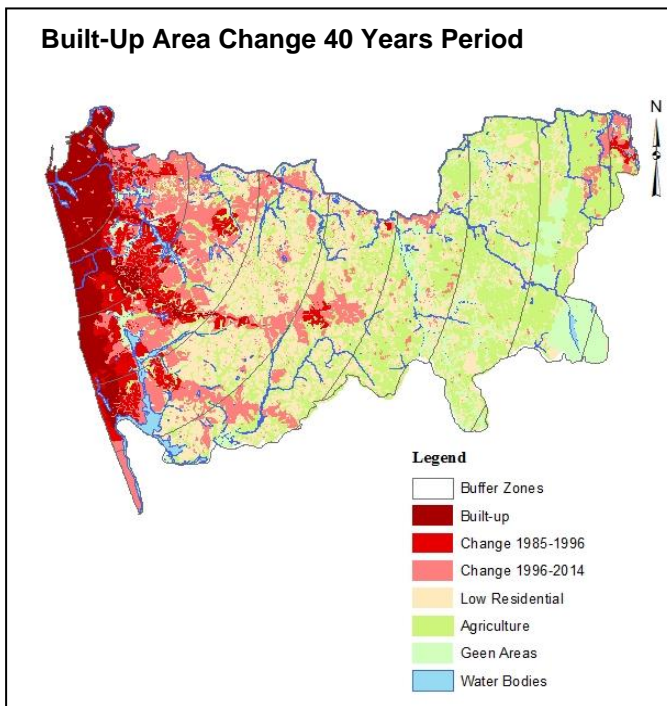


Figure 2 Built-up Area Change over 40 years period

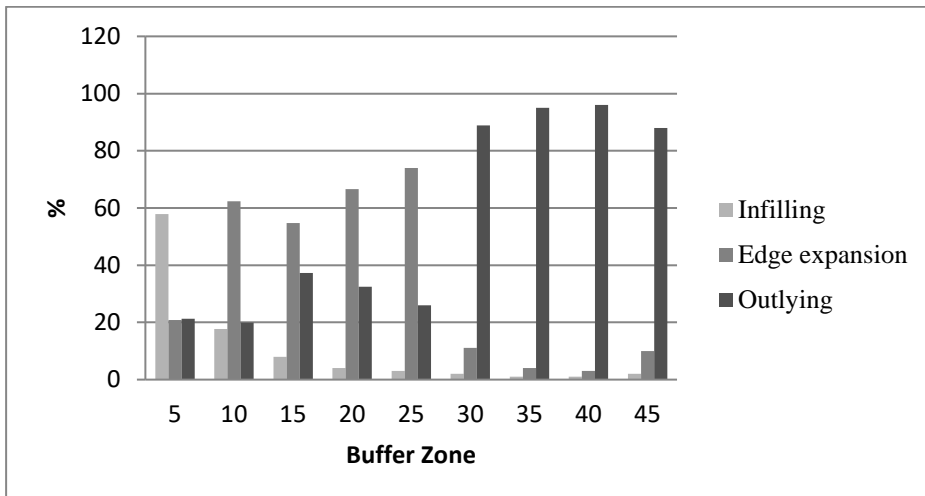
Those changes are measured using the Landscape Expansion Index (LEI) and it calculated different growth types for the two different periods. Those growth types were named as infill, edge expansion, and outlying growth. Table 2 shows calculated land extent in hectares coming under different growth patterns and their percentages.

Table 2 Types of Urban Growth in Colombo District

Growth pattern	1985-86	%	1996-2014	%	Total
Infill	349	6.1	692	6.22	1041
Edge expansion	3949	69	6192	55.66	10005
Outlying growth	1424	24.89	4241	38.12	5572
	5722	100	11124	100	21147

Throughout the 27-year period, edge expansion was considered as the primary growth type. During the first period, (1985-96) infill growth was an insignificant percentage at 6.1% while the edge expansion type accounted for 69%. Between 1996 and 2014 infill growth never showed a significant increase. However, edge expansion accounted for a considerable amount of growth, but it was less than what it was in the first period. Between these two periods the outlying growth increased by 14% (from 24% in 1985-1996 to 38% in 1996-2014).

Further, urban built-up changes calculated using buffer gradient and the calculated values of the different growth types within the various buffer zones are shown in Figure 3. According to Figure 3 more than 50% of urban growth in the 5 km buffer zone was of the infilling type but it gradually decreased as it neared the 45 km buffer zone. Edge expansion growth gradually increased as it moved from the 5 km to 25 km buffer zones. After that it decreased up to the 40 km buffer zone but showed a 10% increase in the 45 km buffer zone. Outlying growth was less than 40% from the 5 km to the 35 km buffer zone, and then it increased to more than 80% in the 30 km to 45 km buffer zones.



These changes happened mainly due to the high demand for land and the increasing land values. Residents of these areas sold their land for commercial or other urban uses and moved to the surrounding suburban areas. The improved road and transport networks provided a further incentive to people to move to the periphery. Therefore, this urban fringe located close to the immediate suburbs of the urban core can be considered as the transition region. The other part, where no significant land conversion occurred, could be considered as the outer region. Taken into consideration past urban pattern, population density moves from Colombo to outer areas and urban land uses move from Colombo to outer areas. This movement shows different variations and in different zones.

Analyses of the present urban agglomerations in the Colombo district Urban Density

Urban density is the concentration of people, buildings, occupancy, activity, and development in an area. Urban density is the city's population or development concentration. Urban density—the number of people living in each urban area—shows city function and is the most significant criterion for urban agglomeration. Population and housing density were evaluated in Colombo. To calculate density, census and statistics create small administrative units. The Census and

Statistics of Sri Lanka uses GN boundary scale data to measure urban density in Grama Niladhari Division, the smallest administrative division. Data on population and building density measured urban density.

Population Density

In 2001, the Colombo District had 2605 people per sq. km. In 2012, it had 3438. This figure shows the district's demographics without spatial fluctuations owing to changeable area unit problem. This study calculated density using solely built-up area to minimize the problem.

Distance increasing population density over the past decade. Densely inhabited 5 km and 10 km buffer zones. Two maps show a 10-km decrease in the high-density zone. It matches core area and inner-city negative growth. Most locations went from 10-25 persons per acre to 26-50 within 10 km. The 25-kilometer buffer zone is special. In 2012, 26-50 persons per hectare occupied the area, up from 11-25 in 2001. In 2001, one-fourth of the 30 km buffer zone had 26-50 people per acre; in 2012, two-thirds did. Since 2001, the 35-kilometer buffer zone had remained dense. A substantial settlement in the North-East corner of the 40km and 45km buffer zones increased density.

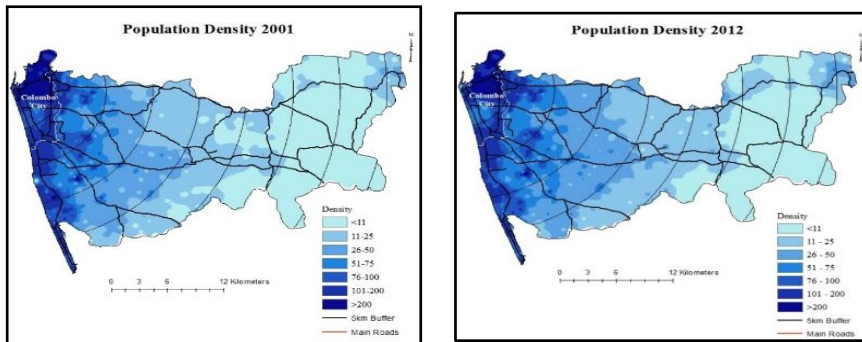


Figure 8 Population Density

Housing Density

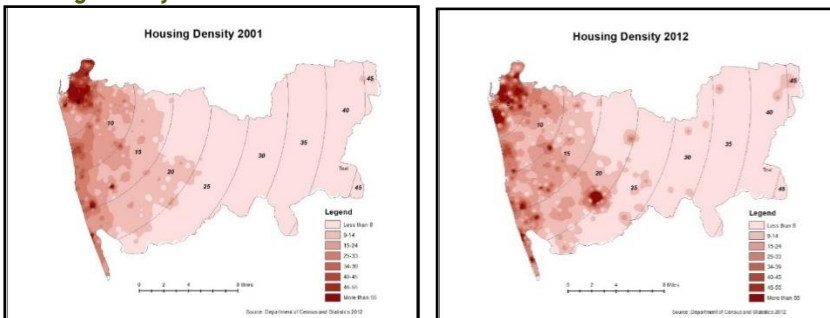


Figure 9 Housing Density

Housing density and distance in Colombo throughout two census years. 2012 maps indicate a higher 15km gradient density than 2001. 25 kilometers steeper in 2012. 25km density patches. The 2001 45km gradient features houses. These details determine city boundary-to-urban periphery housing density. City dwellers prefer suburbs. 2012 population and housing density were used to determine the common density factor.

Proximity

Proximity drives urbanization. Nearby important center, use, or activity. City Center, road, and major growth adjacent generated urban agglomeration. Three closeness types measured Colombo District agglomeration:

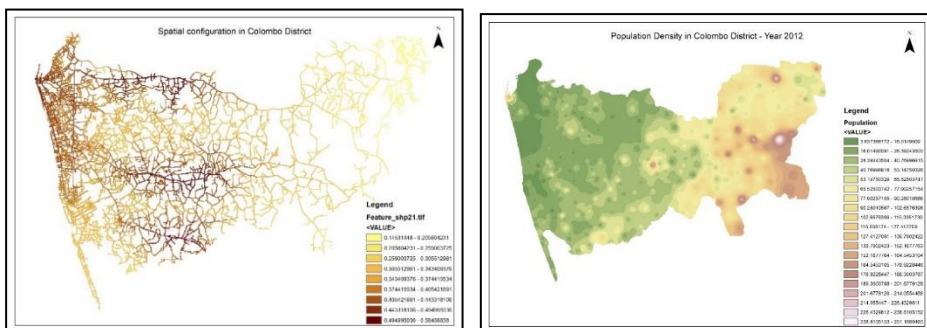
Proximity	Factor
Center related Proximity	First order town centers
	Second order town centers
	Third order town centers
Road related proximity	Main roads
	Railway roads
Development activities related proximity	Major development projects

The proximity related towns and road show in figure 11.

Spatial Configuration

Three stages were used to understand population agglomeration and spatial arrangement. First use "Space Syntax" to identify Colombo district's spatial layout. Next, it determined population density in Colombo. Spatial configuration correlated with population density last. Road connectivity determines space syntax. High-connectivity roads have high spatial arrangement. That shows how road accessibility creates high spatial configurations.

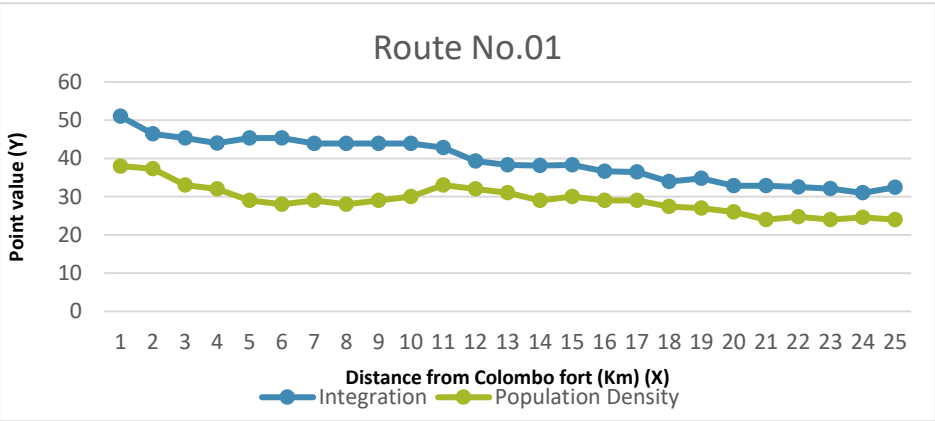
Second, examine population density distribution in Colombo district using 2012 census data based on GND divisions. Arc GIS receives raster files for spatial syntax and population density analysis. QGIS converts space syntax file to Arc GIS polyline and then to raster. After converting to a raster file, population density data was interpolated in Arc GIS.



Correlation between spatial configuration and population density

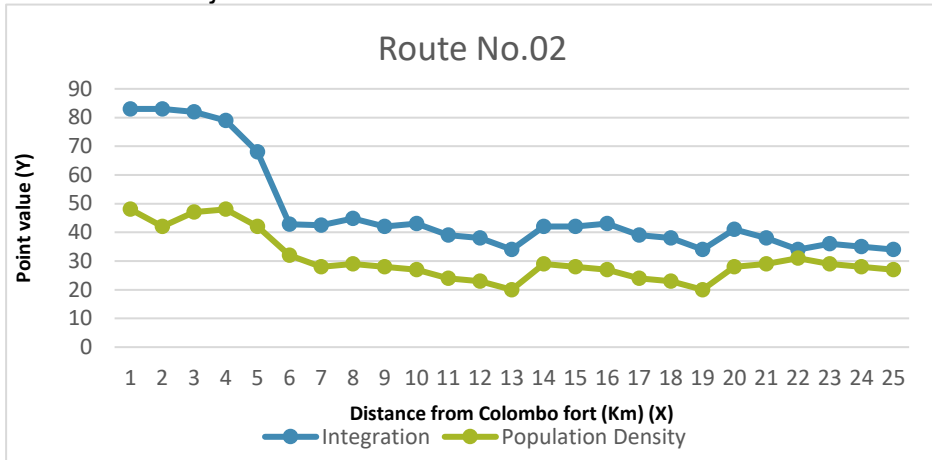
Point values indicate population density and spatial organisation in a Grama Niladhari Division (GND). Each data point receives both values after recovery. For display, the value was multiplied by 100. Integration yields decimals. These graphs show distance in kilometres from the Colombo Fort on the 'X' axis and values on the 'Y'.

Route No.01 - Galle Road



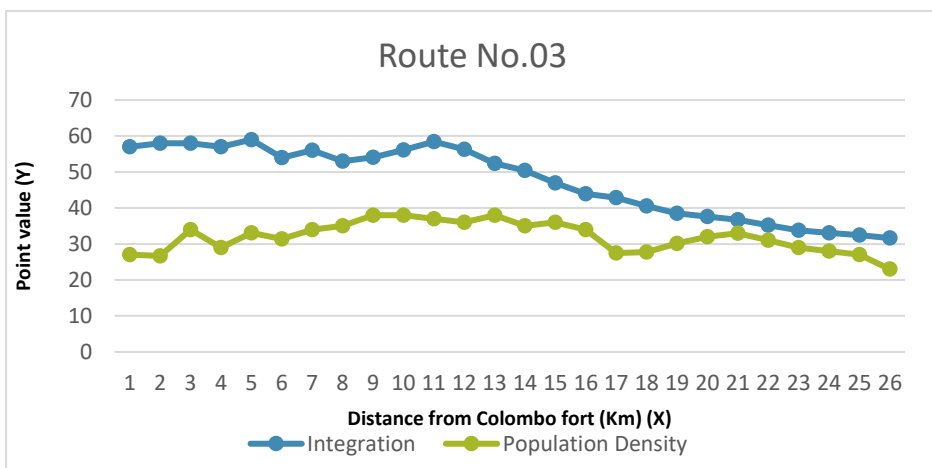
The Colombo-Galle Road is an iconic study of spatial design and population density in the Colombo District. Colombo Fort to Panadura Bridge (Southern Colombo District) is the trip. This analysis covers 25 km. As seen in the figure above, population density and spatial configuration are contemporaneous and reliable in the Colombo core region. Population density and spatial configuration of Colombo's center have been debated. Due to the high number of commuters, integration numbers do not match population density. From the Colombo fort to Panadura, integration value rapidly decreases. This directly lowers population density. It also shows that the integration value is set for the first 11 kilometres and thereafter begins to follow the population. This fluctuation is explained by the discovery of many active communities within 11 km. However, it becomes clear that residential population affects road network spatial organization. Time passes before this revelation.

Route No. 02-Kandy Road



Kandy Road is the second route. This road is 25 kilometres from Colombo Fort. The figure at the top shows that population density and spatial configuration in the Colombo core region are correlated and reliable. Population density and spatial arrangement in central Colombo are contested. The heavy commuter population masks population density changes in integration data. The road's commencement features considerable spatial agglomeration and challenging spatial confinement up to 6 kilometres. The population also cares. This is because GN divisions like Maligawaththa have many low- and middle-income housing schemes. Spatial configuration is diverse. Population and geographical arrangement correlate after a threshold. 7km–8km points have reduced variability and skewness. These warehouse-dominated areas have a low population density, making them visible.

Route No. 03 - B435 Awissawella road

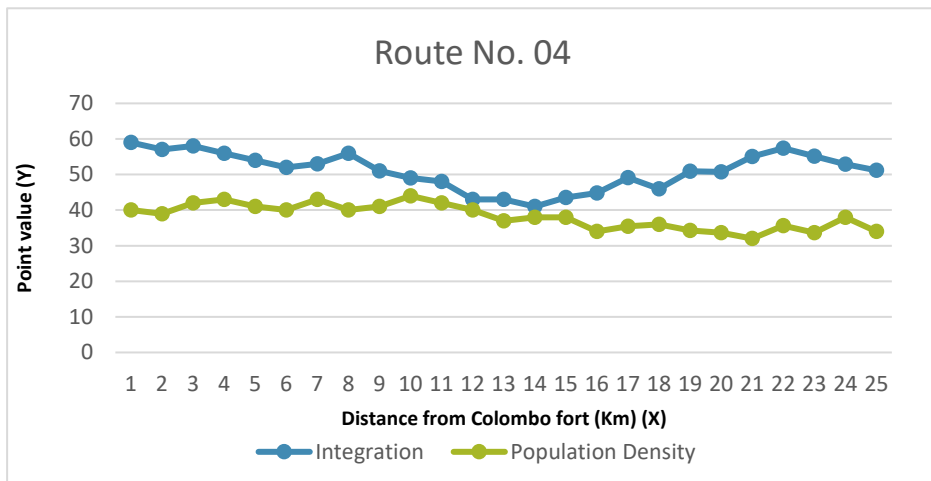


Route 03 is B435 Awissawella Road from Orugodawatte to Ambatale AB10

Colombo-Hanwella Low Level Road from Ambatale to Hanwella. According to the numbers above, population density and spatial layout in the Colombo core region are simultaneous and reliable. Colombo's core population density and spatial arrangement are debatable. Due to the huge commuter population, integration values do not match population density changes.

The population also cares. 11 kilometres also vary in simultaneity. The Southern motorway Kaduwela junction is important at the eleventh integration point. Population density and integration variation match the Kaduwela Area.

Route No.04 - A04 Colombo - Batticaloa road



Route 04 connects Fort Colombo to Awisswelle. According to the numbers above, population density and spatial configuration in the Colombo core region are simultaneous and reliable. Population density and spatial arrangement in central Colombo are disputed. Due to the huge commuter population, integration values do not match population density changes. Location-specific integration. Population density and integration vary greatly from 11 to 13 Km, although the numbers are equivalent. Kirulapane, Nugegoda, Navinna, and Maharagama are highly urbanised. It's densely populated and urbanised.

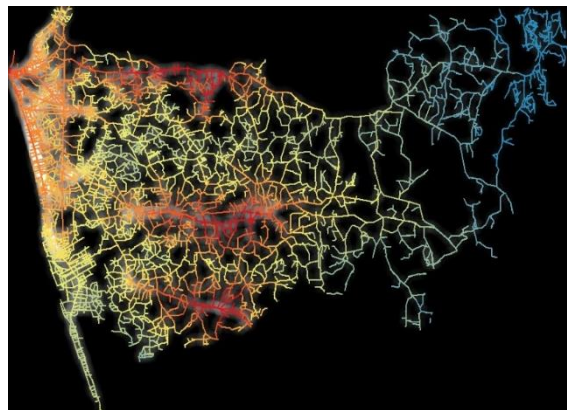
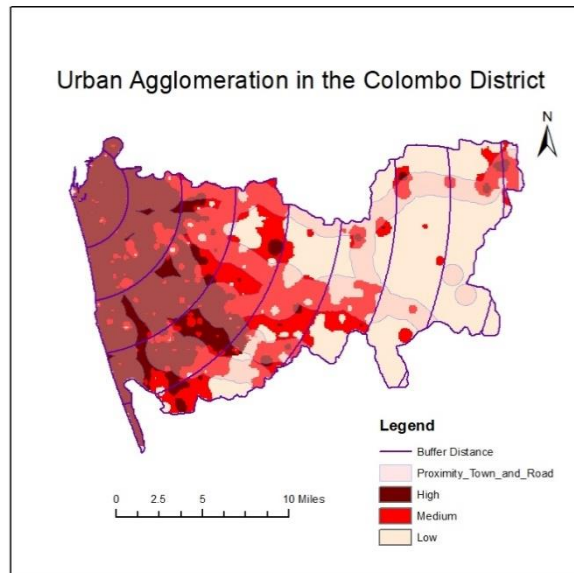
Spatial Integration

Spatial interaction can be used to any form of link between places (convexity, similarity, fluxes, and proximity) and assimilated to spatial analysis or geography. To integrate, several authors consider how places are related. Social analysis defines places now. Modern spatial planning tools and methodologies varied and dual ways for city development participation, and the mix of economic, social, and physical activities is spatial integration.

Space Syntax integrates space. Integration quantifies the street-to-street transition needed from a street section to reach all other street segments in the network utilizing shortest pathways. Space syntax analysis shows best to lowest integrated areas. Red and yellow indicate highly integrated areas. Colombo District space syntax index map. Integration increases accessibility. Accessibility boosts development. This potential justifies urban agglomeration.

Development is high in the accessible area.

Level of agglomeration determined through analysis. Based on the proximity, density, and connectivity of the spatial pattern in the Colombo district, an urban agglomeration map was created. According to the two maps presented previously, spatial integration and urban agglomeration display the same pattern and plainly indicate the agglomerated area. Then, interventions should be planned in areas of duress.



Discussion

Land use changes happen in diverse patterns and may involve different types of growth, such as infill, edge expansion, and outlying growth. When relating these patterns to distance, infill growth was the prominent growth type within the 5 km buffer distance and beyond that edge expansion was the main growth type until the 25 km mark was reached. Beyond that, outlying growth was prominent. This pattern proved that the main growth type in the fringe was edge expansion; with increasing distance and density factors the rest of the area showed outlying growth. The land use pattern presents a salient picture, and it shows the urban area gradually expanding by spreading out through peripheral areas with the urban fringe functioning as a transition zone. As a result, fringe land keeps getting converted to urban uses on a massive scale. It is important to measure this conversion pattern as well as the conversion type.

The existing urban development policies in Sri Lanka provide a pathway for movement of the population to the other two districts in the Western region and outer regions. Apart from that, an advanced transport network, good road infrastructure, low land values, and less pollution are some of the reasons why developers were able to attract people from the core area to the edge of the district and outer regions. The outer regions show rural land uses and major urban nodes exist at the main road junctions. New developments had taken place at these urban nodes, and this was another key reason that attracted people. The above pattern needs to be recognized and understood for future planning and growth directions and identification of present spatial form indicating rural urban fringe is one of the best approaches that can be adopted to achieve this.

Population growth rates were influenced by several invisible factors, some of them showing a negative relationship with minus growth rates and some of them showing a positive relationship with plus growth rates. As distance from the city increased, the minus population growth rate progressively changed to a plus growth rate. This unusual situation emphasizes the existence of a large commuting population involved in urban activities. On the other hand, Colombo District shows a tapering off runaway urbanization as this trend gradually moves to the outer regions. The recently introduced Megapolis Plan too aims to develop the other two districts in the Western Region and shift some of the urban functions and population there. Calculate urban agglomeration density, proximity and spatial integration were considered and both three factors show high spatial integration shows gradual outward growth.

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