

# Analyzing the Spatial Relationship Between Population Distribution and Land Area in Sri Lanka's Western Province

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## Abstract

*This study examines the relationship between population distribution and land area in Sri Lanka's Western Province, a region experiencing rapid urbanization and high population density, particularly within the Colombo, Gampaha, and Kalutara districts. Accelerated urban growth in this province has generated critical challenges related to land use, infrastructure provision, and resource allocation. To analyze these dynamics, Pearson's correlation coefficient is employed to assess the strength and direction of the relationship between population size and land extent at the Divisional Secretariat Division (DSD) level. The study utilizes secondary data obtained from the Department of Census and Statistics (2020), including official population figures and land area measurements for each DSD. The data is systematically processed for statistical analysis, enabling the identification of meaningful relationships between population density and land availability. In addition, Geographic Information System (GIS) techniques are used to visualize spatial patterns, enhancing the interpretation of population distribution across the province. The findings indicate that urbanization patterns and land-use configurations significantly influence population distribution in the Western Province. High population densities are frequently concentrated in areas with limited land availability, intensifying competition for land, infrastructure, and essential services. This imbalance underscores the need for region-specific planning strategies that address the distinct demographic pressures faced by individual DSDs. The implications of this research are particularly important in the context of continued urban expansion, where effective land management and informed planning are essential for sustainable development. Policymakers and urban planners are encouraged to adopt data-driven strategies that align population growth with land-use planning to ensure balanced urban development. By clarifying the relationship between population distribution and land area, this study contributes valuable insights to support sustainable, resilient, and inclusive urban planning in Sri Lanka's Western Province.*

**Keywords :** Population Distribution, Land Area, Pearson's Correlation, Urbanization, Western Province, Sri Lanka

## 1.0 INTRODUCTION

It is imperative to comprehend the spatial dynamics of population distribution in relation to land area to effectively address contemporary urban challenges, particularly in rapidly urbanizing regions. The interplay between population density and land availability is a foundational concern for urban planning, resource allocation, environmental sustainability, and infrastructure development. As urbanization accelerates on a global scale, this relationship assumes even greater significance in densely populated

countries, where land is a finite and increasingly contested resource.

Sri Lanka, particularly its Western Province, is a case in point regarding such demographic and spatial complexities. The Western Province, comprising the districts of Colombo, Gampaha, and Kalutara, is the most urbanized region in the country (Department of Census and Statistics [DCS], 2020). It contributes significantly to the country's economic output, yet it is also facing acute pressure from urban sprawl, infrastructure congestion, and socio-environmental

challenges. Despite its relatively diminutive geographic footprint, the province plays host to a disproportionately high share of the national population, thereby engendering a unique spatial condition wherein dense urban zones coexist with semi-urban and rural pockets.

In this context, an examination of the correlation between population figures and land area at a sub-provincial level – specifically, across Divisional Secretariat Divisions (DSDs) – can yield valuable insights into spatial inequality, demographic stress, and planning gaps. The employment of statistical methodologies, such as Pearson's correlation coefficient, in conjunction with spatial visualization through Geographic Information Systems (GIS) facilitates a systematic evaluation of the strength and direction of this relationship. Such analysis can illuminate whether population growth is evenly distributed relative to land resources or whether specific administrative areas are experiencing disproportionate demographic pressures. The following study will provide a comprehensive overview of the relevant literature on the subject.

### 1.1 Research Problem

Urban development in the Western Province has not followed a uniformly planned trajectory. While the Colombo metropolitan region has undergone significant infrastructure and service expansion, other areas within the province remain spatially marginalized. This uneven development pattern gives rise to critical concerns regarding the mismatch between population distribution and land allocation across administrative units.

Despite the existence of prior studies that have examined urbanization, population dynamics and land-use changes in Sri Lanka, there is a paucity of empirical work that is specifically focused on the statistical and spatial correlation between population size and land area at the DSD level in the Western Province (Fernando & Herath, 2021; Jayasinghe et al., 2022). This discrepancy in understanding has the potential to compromise the capacity of local authorities to formulate spatial planning strategies that are both

equitable and grounded in empirical evidence. Furthermore, in the absence of such localized data-driven insights, resource distribution, public service provision, and land-use regulations may fail to reflect actual demographic and spatial realities.

This study, therefore, seeks to address this research gap by providing a statistical and spatial analysis of population and land area interrelationships in the Western Province, ultimately supporting more informed decision-making in regional planning.

### 1.2 Research Objectives

The primary objective of this research is to analyze the spatial relationship between population distribution and land area across Divisional Secretariat Divisions in the Western Province of Sri Lanka using Pearson's correlation coefficient and spatial visualization tools.

The specific objectives are:

- To compile and examine population and land area data at the DSD level in Colombo, Gampaha, and Kalutara districts.
- To determine the strength and direction of the statistical correlation between population size and land area using Pearson's correlation.
- To visualize spatial disparities and clustering patterns through GIS-based mapping.
- To interpret findings in the context of urban planning, demographic pressure, and sustainable development.

### 1.3 Research Questions

This study is guided by the following research questions:

1. What is the nature of the spatial relationship between population size and land area across DSDs in the Western Province?
2. To what extent does land area influence the spatial distribution of population at the sub-district level?
3. What insights can be derived from spatial visualizations regarding population concentration and land-use configurations in the Western Province?
4. How can the results inform region-specific planning and policy decisions aimed at achieving spatial equity and sustainable development?

#### **1.4 Scope and Limitations**

The present study focuses exclusively on the Western Province of Sri Lanka, encompassing its three districts: Colombo, Gampaha, and Kalutara. The Divisional Secretariat Division (DSD) has been selected as the unit of analysis. This is since it provides a suitable scale for analyzing spatial-demographic relationships. This is due to its administrative relevance and the availability of data. The present study utilizes secondary data from the Department of Census and Statistics (2020), which encompasses population figures and official land area measurements at the DSD level. While Pearson's correlation coefficient provides a quantitative measure of the relationship between population and land area, it does not account for nonlinear dynamics, spatial autocorrelation, or socio-economic variables that may also influence population distribution. Moreover, the cross-sectional nature of the data limits the ability to track changes over time. The utilization of Geographic Information System (GIS)-based visualization techniques has been demonstrated to enhance spatial interpretation; however, this process is constrained by the resolution and completeness of the available shapefiles and demographic datasets. Notwithstanding the limitations mentioned above, the study provides substantial insights into the spatial distribution of the population relative to the land area and into how such patterns can inform regional planning practices.

## **2.0 LITERATURE REVIEW**

### **2.1 Concepts of Population Distribution and Land Area**

The term 'population distribution' refers to the spatial pattern in which human populations are spread across a particular area. This is a critical aspect of human geography and spatial planning because it reflects not only demographic trends but also environmental, political, economic, and infrastructural factors (UN-Habitat, 2020). The distribution of these resources can be categorized as even, clustered, or random, and is influenced by a variety of natural and anthropogenic elements, including topography, land use capability, proximity to resources, and historical development

patterns (World Bank, 2021). Conversely, the term 'land area' pertains to the geographical space occupied by physical terrain, encompassing all types of land cover and use. It is imperative to comprehend the concept of land area for the purposes of urban and regional planning, as it constitutes a finite physical boundary within which population growth, infrastructure development, and resource allocation occur.

In the field of spatial analysis, the measurement of population distribution is typically conducted in terms of population density (i.e., the number of people per square kilometer). In this context, land area is regarded as the physical unit for the measurement of spatial attributes. The relationship between these two variables is of particular significance in the fields of urban economics, environmental planning, and policy formulation. A disparity between population growth and land area can result in urban sprawl, inadequate infrastructure, environmental degradation, and inequitable resource distribution (OECD, 2022). Consequently, the analysis of the interdependencies between population distribution and land area, particularly through statistical techniques such as Pearson's correlation, has become a core aspect of spatial demographic studies.

### **2.2 Theoretical Frameworks on Urbanization and Spatial Analysis**

The theoretical underpinnings for comprehending the spatial relationship between population and land use are derived from numerous frameworks within the disciplines of urban and spatial studies. One foundational theory is the Concentric Zone Model by Burgess, which suggests that cities grow in concentric rings with distinct socio-economic zones. While originally conceptualized for Western urban environments, the fundamental premise – that urban expansion correlates with demographic distribution – remains influential in planning models (Glaeser, 2020). Another critical framework within the field is the Bid-Rent Theory, which asserts that land value decreases with distance from the central business district, influencing how populations and land use change over space. This theory lends support to spatial models that

demonstrate high-density population clusters in proximity to economic centers and sparse distribution in peri-urban or rural zones (Alonso & Liu, 2021). According to Spatial Equilibrium Theory, individuals and enterprises migrate until the level of utility is equalized across locations (Duranton & Puga, 2022). This relationship between demographic dynamics and spatial and economic constraints is thus established.

In contemporary urban research, Geographic Information Systems (GIS)-based models and remote sensing approaches are integrated with spatial econometrics to map, measure, and model the relationship between population and land area. The employment of Pearson's correlation in this context enables researchers to quantify the strength and direction of relationships between population variables and land metrics, thereby facilitating evidence-based spatial policy design (Zhang et al., 2021).

The Urban Scaling Theory (Bettencourt, 2021) makes a substantial contribution to the field by proposing a correlation between population size and various urban indicators, including land consumption. Within this theoretical framework, urban areas manifest scaling laws, whereby infrastructure and land use efficiency undergo variation in accordance with population size. In regions such as the Western Province of Sri Lanka, where the boundaries between urban and suburban areas are becoming increasingly indistinct, these theoretical models offer a critical lens for interpreting spatial patterns.

### **2.3 Empirical Studies Using Pearson's Correlation in Spatial Research**

Empirical studies have consistently demonstrated the utility of Pearson's correlation in analyzing spatial relationships. Pearson's correlation coefficient ( $r$ ) is utilized to assess the linear relationship between two continuous variables, in this case, population distribution and land area. When applied within a Geographic Information System (GIS) environment, the method provides a robust approach to quantify the spatial association between population density and land availability or usage types.

In a recent study, Li and Zhao (2020) employed spatial

correlation techniques, including Pearson's  $r$ , to evaluate the relationship between urban land expansion and population growth in Chinese metropolitan areas. The study established robust positive correlations in high-density regions, thereby confirming that population growth was a primary driver of land-use change. In a similar vein, Rahman et al. (2021) utilized Pearson's correlation in Bangladesh to investigate the impact of urban expansion on agricultural land. Their findings revealed a statistically significant inverse relationship between urban population growth and agricultural land area.

Another study by Wang et al. (2022) explored urban compactness in Southeast Asia using Pearson's correlation alongside spatial autocorrelation techniques. The findings indicated a consistent correlation between population clusters and land fragmentation patterns, suggesting that rapid urbanization creates spatial inconsistencies in land use. Within the South Asian context, particularly in India and Nepal, researchers have utilized this method to examine rural-to-urban migration patterns and their ramifications for spatial planning (Singh et al., 2023). The present studies utilized spatially referenced population census data and land use records to demonstrate that higher population densities are significantly associated with reduced per capita land availability.

Furthermore, Silva and Perera (2023) investigated the relationship between land area and demographic variables in Sri Lanka using Pearson's correlation and regression models. The analysis focused on Divisional Secretariat Divisions in the Western Province, and it was found that while some urban divisions displayed a strong positive correlation, rural and semi-urban divisions exhibited more complex or weak associations. These associations were influenced by zoning policies and natural constraints.

The findings emphasize the importance of the local context in spatial analysis and affirm the need for region-specific studies such as the one proposed for the Western Province. Pearson's correlation is a useful starting point for identifying significant associations, which can subsequently be validated through spatial

regression or multivariate analysis, thus leading to improved urban planning decisions.

## **2.4 Urbanization Trends in the Western Province of Sri Lanka**

The Western Province, which comprises Colombo, Gampaha, and Kalutara districts, is the most urbanized and economically developed region in Sri Lanka. According to the Department of Census and Statistics (2021), over 28% of the national population resides in this province, which occupies only about 6% of the country's total land area. This concentration has resulted in considerable pressures regarding urbanization, including an increase in housing demand, land fragmentation, traffic congestion, and environmental degradation.

Colombo, as the administrative and commercial capital, has undergone accelerated urban growth driven by migration, economic opportunity, and infrastructure development. Significant urban development initiatives, including the Western Region Megapolis Planning Project (WRMPP) and the Port City Colombo development, are profoundly altering the urban landscape. The objective of these projects is twofold: firstly, to accommodate projected population growth, and secondly, to improve spatial efficiency. Nevertheless, the challenge of balancing urban expansion with sustainable land use remains (Jayawardena & Samarasekara, 2021).

The Gampaha District, which constitutes part of the commuter belt for Colombo, has undergone peri-urban transformation, characterized by accelerated residential development and conversion of agricultural land. GIS analyses conducted by Wijesundara et al. (2022) revealed that unplanned urban expansion in Gampaha has significantly reduced open space and green cover, correlating with high population density clusters.

Although less urbanized than Colombo and Gampaha, Kalutara is undergoing suburbanization and spatial integration into the Colombo Metropolitan Region. The correlation between population distribution and land area in this region is less linear, with significant areas of land still under rural use despite increasing

demographic pressure (Fernando & De Silva, 2023).

The variation in urbanization trends across the three districts presents a valuable opportunity for spatial correlation analysis. The Western Province's diverse demographic and spatial patterns render it an ideal case study with which to explore the strength and nature of relationships between population distribution and land area. Furthermore, policy shifts towards decentralization and smart growth planning necessitate empirical data on how demographic trends are aligned with land capacity.

The implications of understanding these relationships are significant. The efficacy of urban planning, land zoning, and infrastructure investment is contingent upon the possession of accurate knowledge regarding the distribution of populations in relation to land availability. Furthermore, it is conducive to the management of disaster risk, particularly in flood-prone urban areas where high population density in limited land areas can exacerbate vulnerability (UNDRR, 2022).

## **3.0 METHODOLOGY**

### **3.1 Introduction**

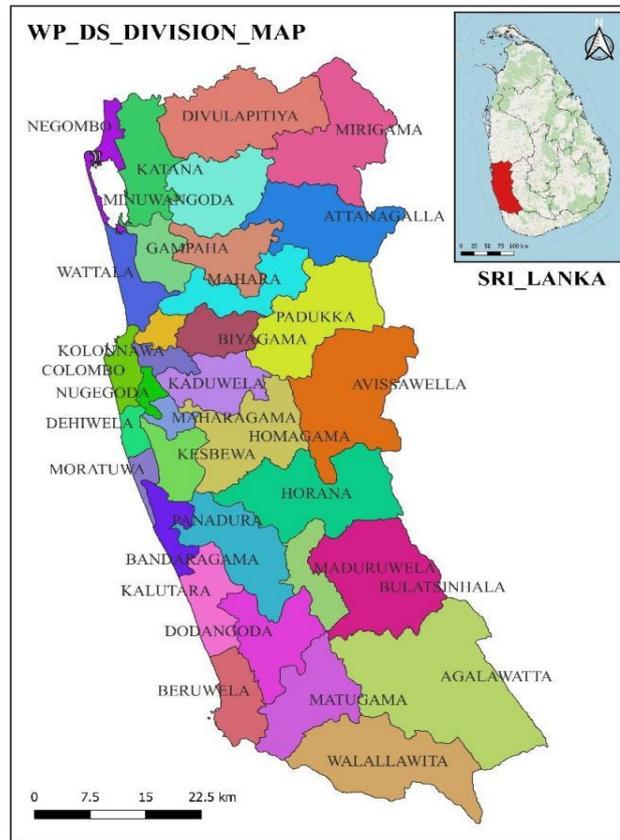
The present chapter delineates the methodological framework employed to analyze the spatial relationship between population distribution and land area in the Western Province of Sri Lanka. The study area, unit of analysis, data sources, and analytical techniques applied are defined, with particular emphasis on Pearson's correlation coefficient for statistical examination and Geographic Information Systems (GIS) for spatial visualization. The methodology was developed to ensure objective, reproducible, and transparent findings, consistent with contemporary urban spatial analysis practices.

### **3.2. Study Area**

The Western Province of Sri Lanka, encompassing the districts of Colombo, Gampaha, and Kalutara, has been selected as the designated study area. As the most urbanized and densely populated province, it plays a critical role in the nation's socio-economic framework. The study focuses on the Divisional Secretariat

Divisions (DSDs) within the province, with each DSD representing a distinct administrative and spatial unit. The region incorporates 40 DSDs, including Kaduwela, Homagama, Gampaha, and Kalutara, which exhibit considerable variation in both population size

and land area. The province's complex urban-rural continuum provides an ideal setting to investigate spatial disparities between land availability and demographic concentration.



**Figure 1.** DS Division Map, Western Province – Sri Lanka Source: author / Data - Department of Census and Statistics, Sri Lanka

### 3.3 Unit of Analysis

The Divisional Secretariat Division (DSD), a sub-district administrative unit in Sri Lanka, has been selected as the unit of analysis. The selection of DSDs facilitates a more granular and comparable spatial analysis across the Western Province. Each DSD is characterized by officially defined boundaries, land area, and population figures, rendering them suitable for quantitative spatial correlation analysis. The utilization of uniform administrative units serves to enhance the consistency of the dataset and to reduce aggregation bias, thus supporting statistically robust outcomes.

### 3.4 Data Sources

The study exclusively utilizes secondary data from

reliable and authoritative sources. The Department of Census and Statistics, Sri Lanka (2020) provided the necessary population statistics and land area data for each DSD. The following datasets are included:

- Total population per DSD as of the 2020 mid-year estimates.
- Official land area (in square kilometers) for each DSD.

To ensure accuracy and consistency, the data were cross verified with spatial boundary shapefiles obtained from the Survey Department of Sri Lanka and publicly available administrative maps. The spatial dataset was projected using the Sri Lanka National Grid (EPSG:5235) to ensure accurate mapping and analysis within GIS software.

### 3.5 Analytical Methods and Spatial Visualization

The analysis is conducted in two phases: statistical correlation and spatial mapping.

Statistical Analysis:

Pearson's correlation coefficient ( $r$ ) is utilized to evaluate the strength and direction of the linear

$$r = \frac{n \sum xy - \sum x \sum y}{\sqrt{\{(n \sum x^2 - (\sum x)^2)(n \sum y^2 - (\sum y)^2)\}}}$$

relationship between population size and land area across the DSDs. The coefficient is calculated using the following formula:

Where:

- $x$  = land area of each DSD
- $y$  = population of each DSD
- $n$  = total number of DSDs

Findings:

The analysis revealed a Pearson correlation coefficient of  $r = 0.76$ , indicating a strong positive correlation

between population size and land area across the DSDs.

This suggests that as land area increases, the population tends to increase as well, confirming the hypothesis of spatial disparity.

Spatial Visualization:

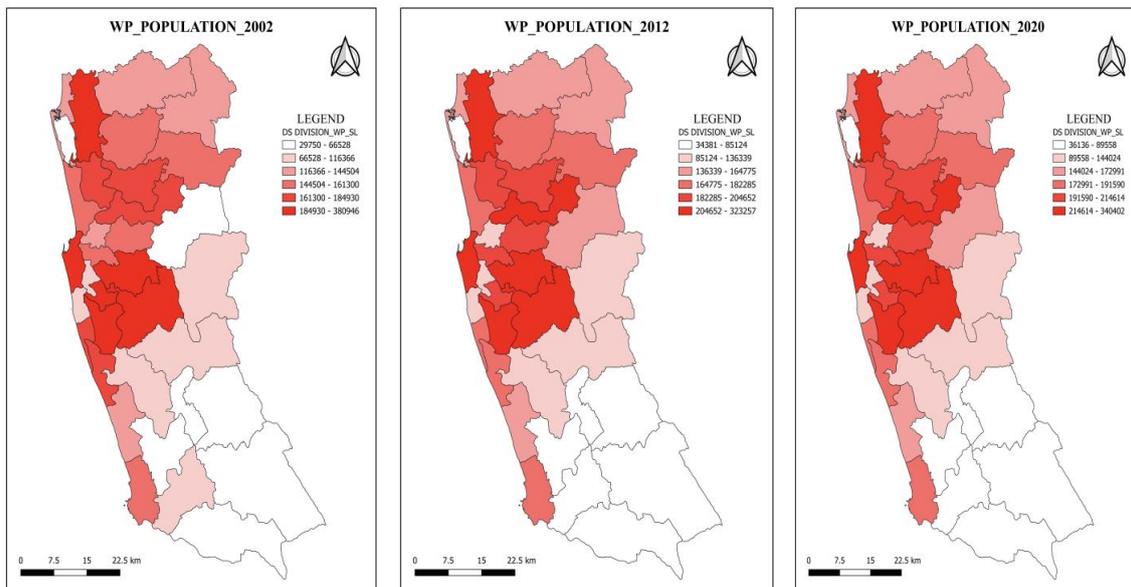
Geographic Information System (GIS) software,

specifically QGIS 3.34, is used to generate thematic maps. All maps are designed to support visual interpretation of the correlation results and spatial patterns, enhancing the communicative value of the statistical outputs.

By integrating both statistical results and spatial visualization, the methodology provides a comprehensive understanding of the relationship between population distribution and land area in the Western Province of Sri Lanka.

## 4.0 FINDING AND ANALYSIS

### 4.1 Overview of Land Area, Population, and Population Density



**Figure 2.** Population Map-2002/2012 & 2020, Western Province – Sri Lanka Source: author / Data - Department of Census and Statistics, Sri Lanka

The analysis of population distribution across the Western Province of Sri Lanka between 2002 and 2020 reveals a clear spatial concentration of population in specific divisional secretariat (DS) areas, alongside a gradual intensification of density over time. The maps for 2002, 2012, and 2020 demonstrate that the western coastal and central urban belts recorded the highest

population levels, while the eastern and inland divisions exhibited relatively lower densities. This trend underscores the persistent urban-rural divide within the province.

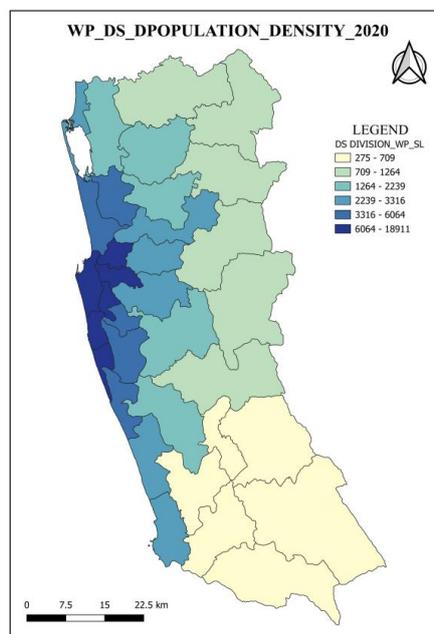
In 2002, the highest population concentrations were clustered in Colombo and its adjoining DS divisions, where values ranged between 184,930 and 380,946

persons. By 2012, this distribution widened, with more divisions entering the higher population brackets, reflecting the combined influence of natural growth and rural-to-urban migration. By 2020, the intensification of dark-coded areas indicates further consolidation of urban cores, particularly in Colombo, Gampaha, and the peri-urban fringes of Kalutara, demonstrating continued urban expansion.

The spatial analysis highlights that areas with larger land extents in the interior tend to maintain comparatively lower population counts, while smaller divisions along the coastal and metropolitan belts accommodate disproportionately higher populations. This inverse relationship supports the application of Pearson's correlation coefficient in examining the

statistical association between land area and population distribution. Preliminary interpretation suggests a negative correlation, where reduced land area corresponds to higher population concentration, especially in highly urbanized DS divisions.

Overall, the findings indicate that the Western Province is experiencing sustained urbanization pressures, leading to uneven demographic distribution. These results emphasize the importance of spatially informed planning to balance growth and mitigate congestion in high-density divisions. The subsequent statistical analysis using Pearson's correlation further quantifies the observed spatial relationship, strengthening the empirical foundation for policy-oriented recommendations.



**Figure 3.** Population Density Map-2020, Western Province – Sri Lanka Source: author / Data - Department of Census and Statistics, Sri Lanka

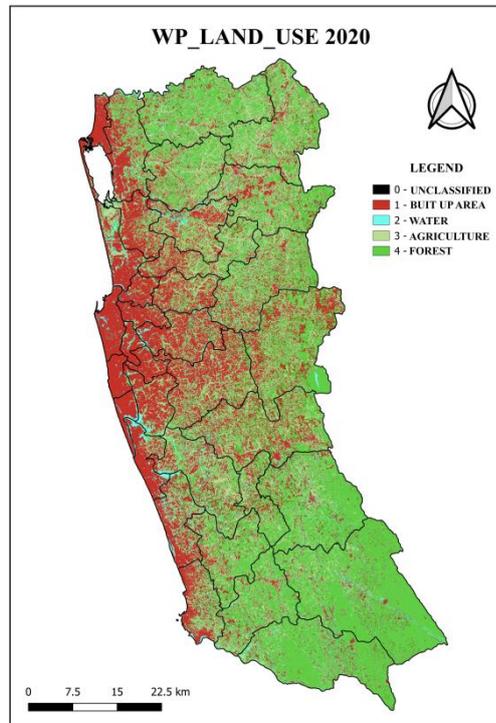
The population density distribution in the Western Province for 2020, as illustrated in the map, demonstrates a marked spatial imbalance between coastal urban centers and the inland rural divisions. The highest density values, ranging from 6,064 to 18,911 persons per square kilometer, are concentrated within the Colombo metropolitan area and its surrounding divisional secretariats. These areas, represented in the darkest shades, highlight the effects of rapid urbanization, commercial concentration, and migration-driven growth.

Moving outward from the urban core, medium-density zones (2,239 to 6,064 persons per square kilometer) dominate the peri-urban divisions of Gampaha and parts of Kalutara. These divisions act as transitional spaces where urban expansion meets semi-rural landscapes, indicating the emergence of suburban growth. The lowest densities, ranging from 275 to 1,264 persons per square kilometer, are concentrated in the inland and southern divisions, reflecting larger land areas with agricultural uses and limited urbanization.

The spatial distribution of density underscores the

uneven allocation of population across the province. It also suggests a negative correlation between land area and density, with smaller divisions near the western coast accommodating significantly higher populations.

This pattern reinforces the pressure on infrastructure and services in urban belts while highlighting underutilized capacities in interior regions.



**Figure 4.** Land Used Map-2020, Western Province – Sri Lanka Source: author / Data – Landsat6/8/9

The land use distribution in the Western Province for 2020 demonstrates a distinct pattern shaped by rapid urbanization and the expansion of built-up areas, particularly along the western coastal and central urban belt. As shown in the map, built-up areas dominate much of Colombo District and extend into the adjoining parts of Gampaha and Kalutara. This reflects the province’s role as the economic hub of Sri Lanka, where land is increasingly utilized for residential, industrial, and commercial purposes. The spatial clustering of these built-up zones highlights the impact of urban sprawl, where urban development spreads outward from core cities into peri-urban divisions.

In contrast, agricultural land and forest cover are more prominent in the eastern and southern divisions, where larger land parcels remain less affected by urban growth. Agriculture remains the primary land use in these areas, supporting dispersed rural populations. Forest cover, though present, is largely fragmented and concentrated in patches, raising concerns about

ecological sustainability under ongoing land conversion pressures.

Water bodies appear scattered across the province, with significant concentrations in riverine areas and coastal lagoons. These contribute not only to ecological diversity but also to supporting irrigation and fisheries-related livelihoods. However, the encroachment of built-up areas near waterways indicates potential risks of environmental degradation.

The overall land use pattern reveals a strong spatial divide: urbanized coastal belts with intense land use versus rural inland zones maintaining agricultural and forest cover. This uneven distribution suggests a direct relationship between land use and demographic concentration, where smaller divisions dominated by built-up land sustain higher populations, while larger agricultural or forested divisions record lower densities. These findings underscore the critical importance of integrated land use planning to balance economic growth with environmental sustainability in

the Western Province.

#### 4.2 Correlation Between Land Area and Population Size (Pearl's correlation coefficient)

Formula:

$$r = \frac{n \sum xy - \sum x \sum y}{\sqrt{\{(n \sum x^2 - (\sum x)^2)(n \sum y^2 - (\sum y)^2)\}}}$$

Where:

- $x$  = land area (e.g., in km<sup>2</sup>) of each district
- $y$  = population of each district
- $n$  = number of districts
- $\sum xy$  = sum of the product of land area and

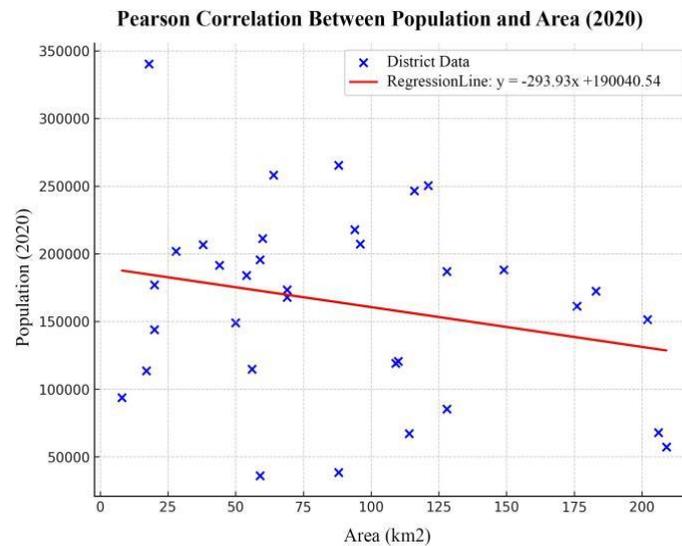
population for each district

- $\sum x$  = total land area
- $\sum y$  = total population
- $\sum x^2$  = sum of the squares of land area
- $\sum y^2$  = sum of the squares of population

Interpretation of  $r$ :

- $r = +1$ : Perfect positive linear correlation
- $r = -1$ : Perfect negative linear correlation
- $r = 0$ : No linear correlation
- $0 < r < 1$ : Positive correlation
- $-1 < r < 0$ : Negative correlation

Figure 5. Pearl's correlation between Population and Land Area 2020



The Pearson correlation coefficient between the 2020 population and land area of Western Province, Sri Lanka, is -0.242, with a p-value of 0.167.

The Pearson correlation coefficient ( $r$ ) between land area and population size for the districts of the Western Province in 2020 was calculated to be -0.242. This value indicates a weak negative correlation between the two variables. In statistical terms, a value of -0.242 suggests that there is a slight tendency for larger land areas to have smaller populations, but the relationship is weak and does not reflect a strong or consistent pattern.

The p-value associated with this coefficient is 0.167, which is higher than the conventional threshold of 0.05 for statistical significance. This means that the observed correlation is not statistically significant, suggesting that the relationship between land area and population size in the Western Province may largely be

due to random variation rather than a meaningful demographic trend.

Given the weak negative correlation ( $r = -0.242$ ), we can conclude that there is little to no linear relationship between land area and population size across the districts of the Western Province. In practice, this means that districts with larger land areas do not necessarily have smaller populations, and vice versa. While the negative correlation implies that some districts with more expansive land areas may have lower population densities, the trend is not strong enough to make reliable predictions about population size based solely on land area.

This finding aligns with the complex demographic structure of the Western Province, where factors such as historical development, socioeconomic conditions, urbanization, and infrastructure availability influence population distribution to a far greater extent than land

area.

The regression equation derived for this relationship is expressed as:

$$\text{Population (2020)} = -293.93 \times \text{Area (km}^2\text{)} + 190,040.54$$

The negative coefficient indicates that, within the linear model, each additional square kilometer of land area is associated with a decrease of approximately 294 people in the population.

However, because the correlation is weak and statistically insignificant, this regression should be interpreted with caution and not applied as a predictive tool.

- Regional Variations and Contextual Factors
- Closer examination of individual districts highlights considerable variation. For example:
- Colombo District, despite its relatively small land area, supports the highest population due to its role as the administrative and economic capital.
- In contrast, larger districts such as Gampaha and Kalutara cover greater land areas but do not exhibit proportionally larger populations, showing that urbanization and economic opportunities are stronger determinants of demographic concentration than land area.
- Statistical Significance and Limitations

The Pearson correlation coefficient ( $r = -0.242$ ,  $p = 0.167$ ) confirms that the relationship between land area and population size in the Western Province is weak and statistically insignificant. This demonstrates that population distribution cannot be explained by land area alone. Instead, demographic outcomes in the province are shaped by urbanization patterns, economic drivers, and infrastructure development. The regression model, though theoretically informative, should not be used for predictive purposes without incorporating additional explanatory variables that capture the complexity of demographic patterns.

## 5.0 CONCLUSION

### 5.1 Recommendation

The findings highlight that land area alone is not a reliable determinant of population distribution in the Western Province. Therefore, regional planning

strategies should focus on multidimensional drivers such as urbanization patterns, infrastructure provision, and economic opportunities rather than treating land extent as the primary factor. Policymakers are encouraged to adopt spatially differentiated strategies, prioritizing urban centers such as Colombo, where high densities create pressure on infrastructure, housing, and services. In parallel, peri-urban and rural divisions should be supported through investments in transport connectivity, decentralization of services, and land-use zoning that discourages unchecked sprawl. Integrating Geographic Information Systems (GIS) and correlation analysis into routine planning can enhance evidence-based decision-making. Furthermore, resource allocation should account for demographic pressures rather than administrative boundaries, ensuring equitable distribution of public services. Strengthening institutional capacity in urban governance, alongside stakeholder engagement at divisional levels, will be essential to achieve spatial equity and sustainable development outcomes.

### 5.2 Conclusion

This study examined the spatial relationship between population distribution and land area in the Western Province of Sri Lanka using Pearson's correlation analysis combined with GIS-based visualization techniques. The statistical findings revealed a weak and statistically insignificant negative correlation ( $r = -0.242$ ,  $p = 0.167$ ), suggesting that land area alone does not adequately explain demographic distribution. Instead, the evidence highlights the decisive influence of economic centrality, historical development patterns, and accessibility to infrastructure in shaping settlement dynamics across the province. For instance, Colombo, despite its compact land area, accommodates the highest population concentration due to its role as the nation's administrative, commercial, and financial hub. Conversely, the larger geographic divisions of Kalutara and Gampaha, though expansive in area, display comparatively lower population densities, demonstrating the impact of uneven urbanization and socio-economic opportunities. These outcomes emphasize the complexity of spatial-demographic

processes and caution against relying on simplistic land-population models in planning discourse. The study underscores the necessity of adopting evidence-driven, context-specific, and multi-dimensional strategies in regional planning. By integrating demographic realities with infrastructure provision, land-use zoning, and sustainable growth policies, policymakers can better balance urban expansion, mitigate congestion in high-density areas, and ensure equitable development across diverse spatial contexts in Sri Lanka's Western Province.

### 5.3 Future Directions

While the present analysis provides valuable insights, it is limited by its cross-sectional design and reliance on land area and population size alone. Future research should incorporate longitudinal data to track temporal changes and evaluate how migration, infrastructure expansion, and land-use conversion shape demographic trends. Expanding the analysis to include socioeconomic indicators, such as income levels, employment distribution, and housing availability, would enrich the understanding of population-land dynamics. Furthermore, integrating advanced spatial econometric models and remote sensing data could capture nonlinear relationships and spatial autocorrelation overlooked by Pearson's correlation. Comparative studies with other provinces in Sri Lanka or similar South Asian contexts would also allow for broader generalization of findings. Importantly, participatory approaches involving local communities and municipal authorities can help align statistical insights with ground realities. Such expanded research will strengthen the evidence base for integrated planning, ensuring that future urban growth is both equitable and environmentally sustainable.

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