MODELLING AND FORECASTING OF POPULATION CHANGES IN JAFFNA DISTRICT FROM 2000-2025

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1. Introduction

Human births, deaths, and migration are the main three demographic components that can lead to population changes in any geographical area (Hornby & Jones, 1990). Especially, deaths, migration patterns, the decline of fertility levels, and non-demographic factors such as rapid economic and social changes will impact on changing or decreasing the population growth (Clarke, 1984). However, political and civil issues and other spatial, cultural, and ethnic related barriers also can impact on population growth of a country or a specific area. A large population in an area directly impacts the resources available in that location. Especially it can be directed to enhance the population density, infrastructure issues, food consumption-related issues, and so on (Awate & Todkari, 2011). Especially when considering small-scale regions, those tend to be more conservative and it can be influenced to produce different life patterns as well as different social and demographic patterns (Walsh, 1984).

Jaffna district is a small peninsula belongs to Sri Lanka and it was badly faced with thirty years of a civil war between the Sri Lankan government and LTTE. These long-lasting social, civil, and political issues influenced rapid population changes in the Jaffna district and tend to create a diverse population pattern in the district within the war period and after the post-war period. It can be assumed that these population patterns could create different environmental, demographical, and socio-economic implications. Therefore, the main objective of this study is to analyze changing spatial patterns of population density and forecasting future population growth in the Jaffna district.

2. Methodology

This research is mainly based on secondary data collected from Statistical Information -Northern provincial council (NPC) published from 2000 - 2019 and data gathered from the Department of Census and Statistics publications. Data analysis was done using ArcMap 10.3 and EXCEL 19 software packages.

For growth rate calculations, the following formula was used.

$$\textbf{Growth Rate (r)} = \frac{\textbf{Pn} - \textbf{Po}}{\textbf{Po}} \times \textbf{100} \ldots\ldots\ldots\ldots \textbf{Equation 1}$$

Where 'r' means the population growth rate, 'Pn' is the population of the following year, 'Po' is the population of the base year and 100 is for the percentage calculation. Further, an exponential growth model was used to forecast future population as given below. The main purpose of using the exponential growth model was, hypothetically the population either increases or decreases exponentially due to the birth rates and death rates are increased or decreased in a proportionality constant manner.

$$\textbf{Pn} = \textbf{Poe}^{\textbf{rt}} \ldots\ldots\ldots\ldots \textbf{Equation 2}$$

Where 'r' means the percentage of growth per year, 'Pn' is the population following year, 'Po' is the population of the base year, 't' means time duration and 'e' means exponential function.

Jaffna district is the study area which is located in the northern province of Sri Lanka. It is surrounded by the Gulf of Mannar to west, Bay of Bengal to the eastern, Palk Strait to the north and Kilinochchi district to the south. Jaffna is the capital city of the Northern Province and occupies as the second-level administrative division of the country. Jaffna is situated within the Latitude: 9° 44' 59.99" N and Longitude: 80° 04' 60.00" E. There are 15 Divisional Secretariats within the area of 1025 sq. km. The total land utilization of the Jaffna district was 102500 ha (2018). It included agriculture, forest, range-lands, urban and other lands.

3. Results and Discussion

The total population of Jaffna District was 615,493 as shown in the statistics of 2018. Jaffna is one of the most densely populated districts of Sri Lanka. The crude birth rate (CBR) was 15.4 per 100,000 (2018) in Jaffna and the crude death rate was 7.2 per 100,000 (2018). However, the crude death rate (CDR) was higher in the Jaffna district than the rate of the Northern Province (CDR-6.0) in 2018. According to the statistics of 2018, the total male population was 298,401 and the female population was 317,092. According to the ethnic composition, the majority was represented by Sri Lankan

Tamils while, Muslims and Sinhalese represented in as minor proportions. Majority (77%) of the population here are living in rural areas and 23% are living in urban areas (Statistical information handbook, 2018).
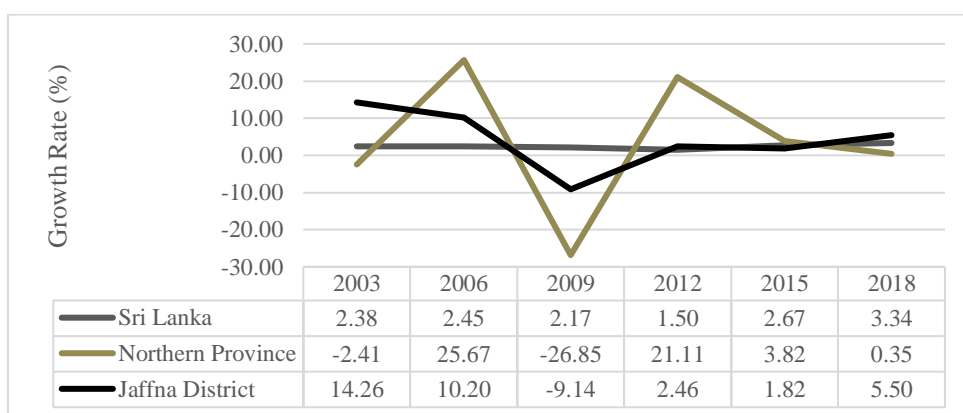
According to the analysis, the population density for the Jaffna district is 600.48 Sq.km. However, when it is analyzed spatially (Divisional Secretariat - DS) and temporally (from 2000-2018) a diverse pattern can be identified within the area (Map: 01). In the year 2000, Jaffna, Nallur, and Uduvil DS divisions can be identified as areas with high density. Nevertheless, excluding the Jaffna DS division other two highly dense areas were transferred to upper-middle dense areas since the year 2006.
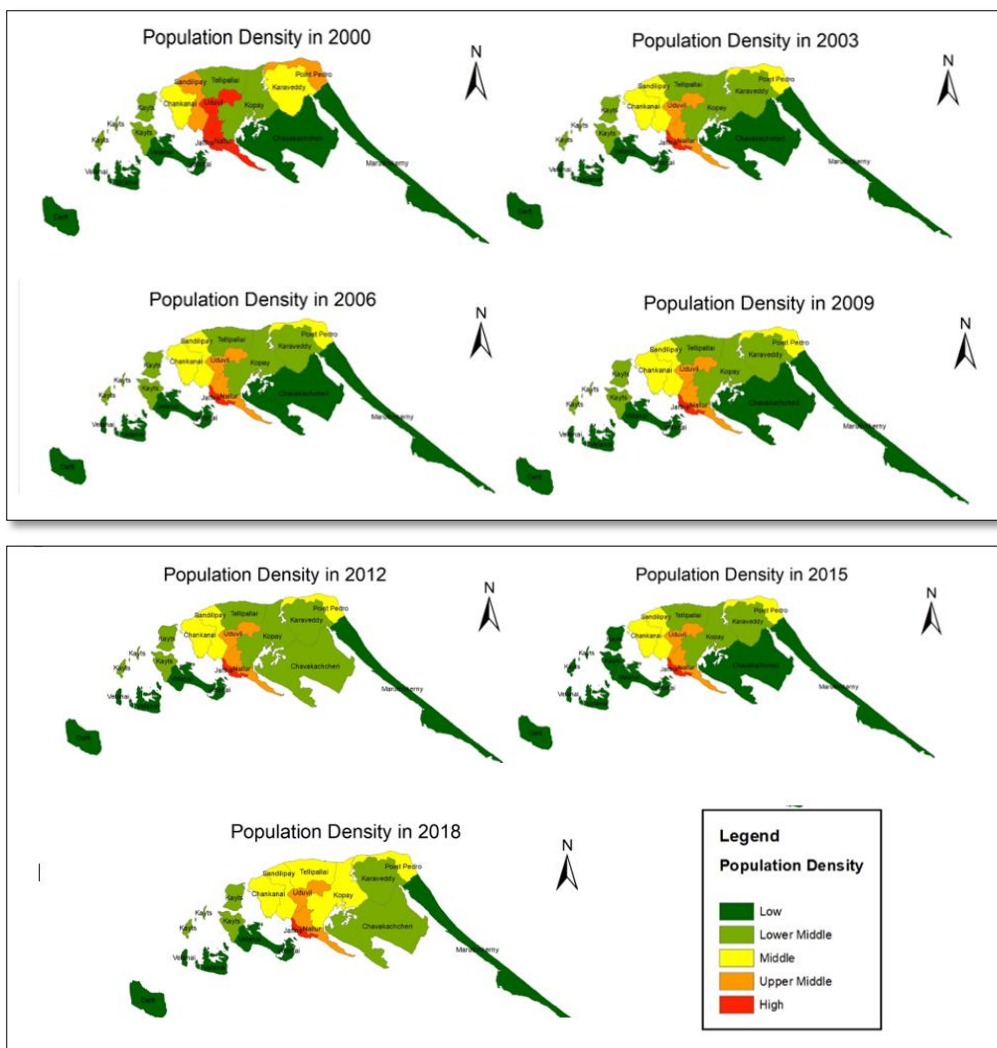
Map 01: Population Density in Jaffna District from 2000 – 2018
Source: Prepared by Author based on statistical data from NPC, 2021

On the other hand, Chawakachcheri DS division has been changed its population density in a fluctuated manner within the period of post-war into low to lower-middle. Notably, when it comes to 2018, the majority of low dense areas were changed into medium-dense areas due to resettlements, infrastructure developments and regional development projects carried out by governments after the postwar period. Significantly the most of the DS divisions have been dense after the year 2012 since Thellipai and Kopai DS divisions can be identified as newly dense DS divisions at the end of 2018.

Population growth can be one of the major factors that can be influenced by changing the population density of a given area. Thus, between the 2003 to 2018 period the population growth rates of the Jaffna district have fluctuated from negative to positive growth rates. Remarkably when the Jaffna district growth rates are compared with the national level trend, a quite similar pattern can be seen after the postwar period since 2012. (Graph: 01).

Growth Rate (%)	2003	2006	2009	2012	2015	2018
Sri Lanka	2.38	2.45	2.17	1.50	2.67	3.34
Northern Province	-2.41	25.67	-26.85	21.11	3.82	0.35
Jaffna District	14.26	10.20	-9.14	2.46	1.82	5.50

Graph 01: Population Growth Rate from 2003 – 2018
Note* The base year for the calculation of growth rate is the year 2000.
Source: Statistical data handbook of NPC, 2021

However, from the regional point of view, a similar pattern of growth rates can be seen among the district and provincial levels within the period from 2000 to 2009. As well, a severe deviation of growth rates can be recognized in 2009 due to the population of the district have been heavily affected by the latter part of thirty years of the civil war. Several hundred thousand Sri Lankan Tamils and other ethnic minorities immigrated to other countries and some of them have been expelled by the LTTE to other parts of the country. These reasons have been influenced to fluctuate the growth rates and change the population densities within districts in the Province. When considering the population growth in the post-war era it has been increased mainly due to

resettlements, infrastructure development, and emigration of people who have been migrated due to the influence of civil war.

When considering the population growth of Jaffna district, from 2000 to 2020 period, it shows a rapid population increment and fluctuations within that period. When forecasting population from 2021 to 2025, an exponential growth model was used with the prediction of the average growth rate will be continuing the same until the year 2025. According to the forecast, by 2025 the Jaffna district's population is projected to reach approximately 721,700 with an annual average growth rate of 0.01.
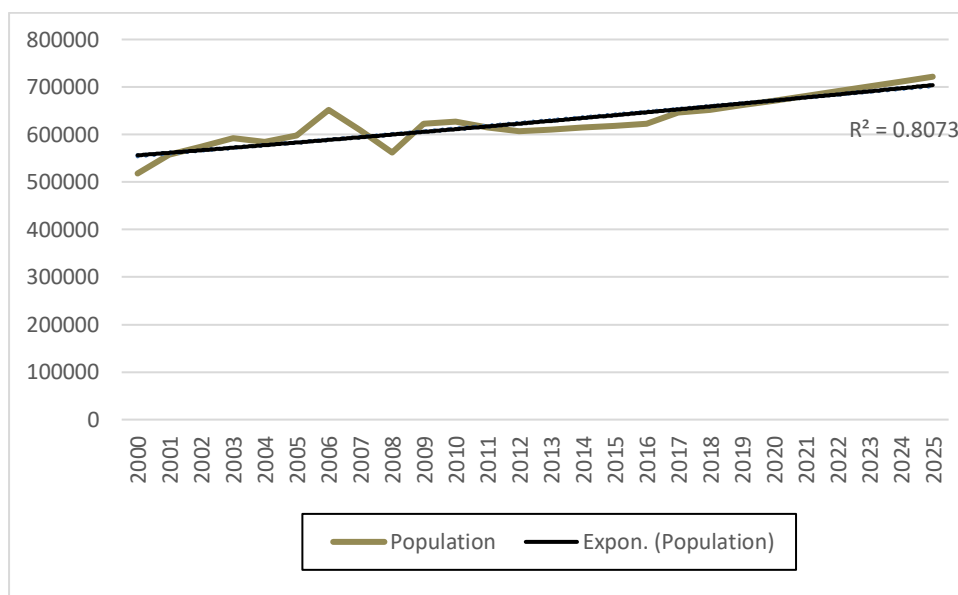
Graph 02: Population Trend in Jaffna District from the Year 2000 – 2025
Source: Statistical data handbook of NPC, 2021

Further, according to the population forecast, it reveals that the data are close to the fitted trend line and it can be justified by the R squared (R^2) equals 0.8073. According to the analysis, it has been predicted that the population of the Jaffna district will increase within the next five years exponentially.

4. Conclusion

As a summary, it can be concluded that, within the past 20 years, the population density of the Jaffna district has experienced consistent acceleration since 2010. Further, population growth rates revealed different trends between 2000 to 2018. Therefore, the population of the Jaffna district in the future can be predicted as an area having an increasing tendency of population growth. Especially it can occur due to the regional development,

economic development, and social changes of people who are living in the Jaffna district. From a planning point of view, it can be suggested that developments are essential in economic, social, and environmental fields to fulfill the requirements of the future population in the Jaffna district.

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