Spatial Study on Covid-19 Community Spread in Trivandrum Corporation using GIS

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Abstract - *The coronavirus (COVID-19) pandemic have been a public health threat worldwide, particularly in densely populated countries. Geographic information system (GIS) can be used to map the geographical distribution of disease, trends in community spread of disease and to identify significant hotspots and cluster zones of COVID-19. The aim of the study is to analyse the spatial extent of disease transmission through mapping and preparation of graphs at ward level and to prepare a web mapping application to get the COVID-19 information from July 2020 to February 2021 related to 100 wards in Trivandrum Corporation in Kerala.*

Key Words: **COVID-19; GIS; Trivandrum Corporation**

1.INTRODUCTION

The novel coronavirus disease 2019 (COVID-19) infection, caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), first emerged in December of 2019 in Wuhan city, China. The first case of the COVID-19 pandemic in Kerala was confirmed in Thrissur on 30 January 2020, which was the first case reported in India. As of 11 January, there have been 29,14,557 confirmed cases with 28,08,062 (96.13%) recoveries and 13,197 (0.45%) deaths in the state. A high number of cases was reported on March in India, Kerala had reduced the rate of increase of new cases to less than 0.25% per day by April 30. However, in mid-May, there was an increase in new confirmed cases, following the return of Keralites from other countries and other Indian states. In July, a large local group of cases was identified at the Kumarichantha fish market in Thiruvananthapuram. There has been a third surge in cases post Onam and a high number of new cases was reported in late- October in Malappuram, Kozhikode, Ernakulam and Thrissur districts. The state has the lowest case fatality rate compared to the confirmed cases. The largest single-day spike of 42,464 cases was reported on May 6, 2021 in Kerala. As of October 2020, more than 90% of known cases were due to community spread. Kerala is presently at 3rd position in daily number of COVID-19 cases state wise in India. Vaccines like Covishield and Covaxin have been introduced in Kerala which is found to be effective. In Kerala, 30.01% of people, ie, 1,06,49,645 people have taken the vaccination of which 30,99,039 have taken both doses of vaccine. Early detection of the virus and

isolation is an important preventive intervention measures for containing the disease spread initially.

1.1 OBJECTIVE

The objective of the study is to analyse the extent of community spread of COVID-19 for Trivandrum corporation by the creation of map showing the ward wise COVID-19 cases for Trivandrum corporation from July 2020 to February 2021 and to find any possible relationship between COVID-19 cases and population density. Then to create a web mapping application to obtain the COVID-19 related information in Trivandrum Corporation.

2. STUDY AREA

The Thiruvananthapuram municipal corporation is spread over 214.86 km2 with 100 wards and a population of 9, 57,730 inhabitants. It is located between latitude 8'25" North and longitude 76'55" East. It has got a population density of 4457 per square kilometre. It includes the Legislative Assembly constituencies of Thiruvananthapuram, Vattiyoorkavu, Nemom, Kazhakkoottam and 5 wards of the Kovalam constituency.
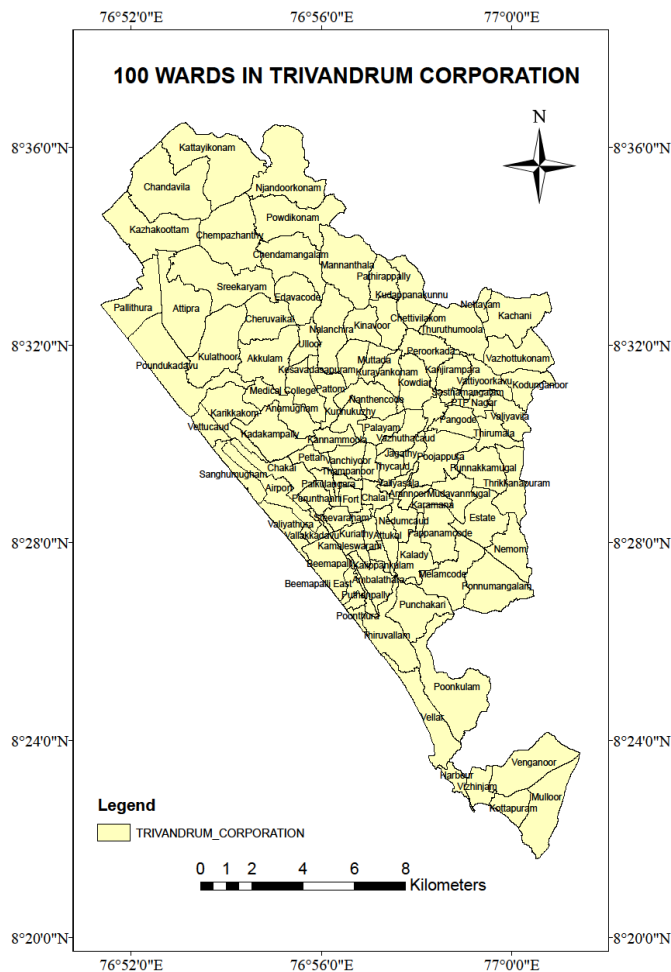
Fig -1: Trivandrum Corporation with 100 wards

3. METHODOLOGY

The methodology is a nine-step procedure. It consist of collection of population and location of wards in Trivandrum corporation, collection of ward wise daily number of COVID-19 cases from Trivandrum District Administration, tabulation of daily COVID-19 cases for each ward with the aid of Excel sheet, location of each ward is pinned with corresponding COVID-19 cases by opening the shapefile in ArcGIS platform and the Excel sheet with COVID-19 positive cases were added in ArcMap and the Excel sheet was joined with the attribute table of Trivandrum Corporation, mapping spatially the number of COVID-19 cases for each ward, showing the spatial progress of COVID-19 in Trivandrum corporation with two week time duration, creation of map showing change in COVID-19 in different patterns in ArcGIS environment, to identify any correlation between COVID-19 cases and population density for each ward in Trivandrum corporation by using Data analysis tool in MS Excel and correlation analysis was performed to find whether COVID-19 cases have any correlation with population density. Pearson correlation coefficient r was calculated and the value of r was used to determine their relationship. Finally for the creation of web mapping application with ArcGIS Online platform, the shapefile of Trivandrum Corporation was imported to ArcGIS Online platform. The attribute table had data about COVID-19 cases with 14 days time interval from 0-240 days. Then a web map was created to produce a web application. The web application helps to get the full COVID-19 information about each ward by clicking on the ward and search panel is also provided in which name of ward of user's interest can be entered and ward gets focused and information about it appears in the pop-up window.

4. RESULT

The number of cases has increased about 740% from first 14 days and reached maximum in 84-98 days and showed a decrease of 56% at the end of 240days which is shown in Chart 1. Some wards which showed a hike in COVID-19 like Poonthura, Beemapalli, Valiyathura, Vallakadavu and Pallithura during the beginning had shown a decline in positive cases and zero cases and some other wards like Kazhakoottam, Sreekaryam, Peroorkada, Vattiyoorkavu, Nemom and Poojapura ward showed a hike on COVID-19 cases. Some wards like Manacaud, Karamana, and Medical College showed a consistent number of positive cases during the entire time period with slight decrease in some of the time interval.
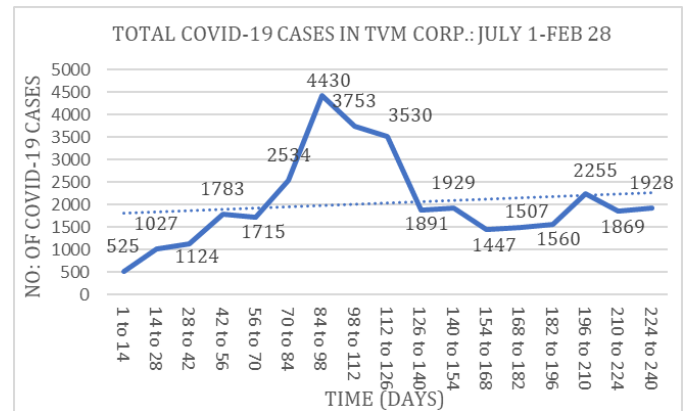

Chart -1: COVID-19 progress from July 1 to February 28

The map with total number of COVID-19 cases is shown in Fig 2. In the onset of July, positive cases were more in the coastal wards as two fisherman who returned from Tamil Nadu carried the virus. The virus was spread in Kumarichantha fish market and Poonthura ward showed the highest number of 323 cases in first 14 days. Since the houses and households lives as joint family there is high population density in the coastal ward so, the community spread was rapid and most of the people was affected. The virus started to spread from the coastal wards to the nearby wards from 0 to 56 days. A community spread occured in Poojapura Central Jail with 473 positive cases during 42 to 56 days. Manacaud ward and Karamana ward showed a hike in positive cases from 56 to 70 days. The spread in Medical College ward started from 70

days. The highest number of cases were reported during 84 to 98 days (September 22 to October 6). Ninety nine wards was infected during this time period and most of the wards showed a hike in positive cases with cases above 60, 4% surge in cases were seen than the previous time interval. From 98 days of the study duration, no wards had shown cases above 150 and the spread of cases was seen in wards within the city limits. The community spread which had occurred in coastal wards declined. All the wards had a consistent number of cases from 98 to 126 days and the spread was more in Manacaud, Medical College, Karamana wards during this period. After 126 days, decrease in the intensity of COVID-19 cases were seen in most of the wards and cases were between 10 and 50. No wards had cases above 100 from 126 to 196 days and cases were comparatively lower during this time. After 196 days, cases above 100 was reported from Peroorkada ward and a hike in total number of COVID-19 cases could be seen in Trivandrum Corporation till the end of 240 days. The wards which initially had higher rates had declined at the end of the study period and new wards which are situated in the city limits had shown increase in positive cases due to high people and freight movement, presence of amenities, and reopening of malls, theaters etc during this period.

Fig -2: COVID-19 Infected wards from 1-240 days (July 1 – February 28)

All wards have been infected in this study period with 20 wards showing positive cases above 500, 69 wards have cases between 100 and 500 and 11 wards had cases below 100. The wards which are infected more are in the city limits and it is caused due to people and freight movement and high population density.

Table -1: Wards with higher number of total COVID-19 cases (July 1 – Feb 28)

Name of Ward	Number of Total Cases (July 1 – February 28)
Manacaud	1282
Medical College	1197
Poojapura	1146
Poonthura	999
Karamana	944
Peroorkada	911
Nemom	797
Vattiyoorkavu	780
Thiruvallam	713
Sreekaryam	679
Pattom	669
Thirumala	663
Pettah	619
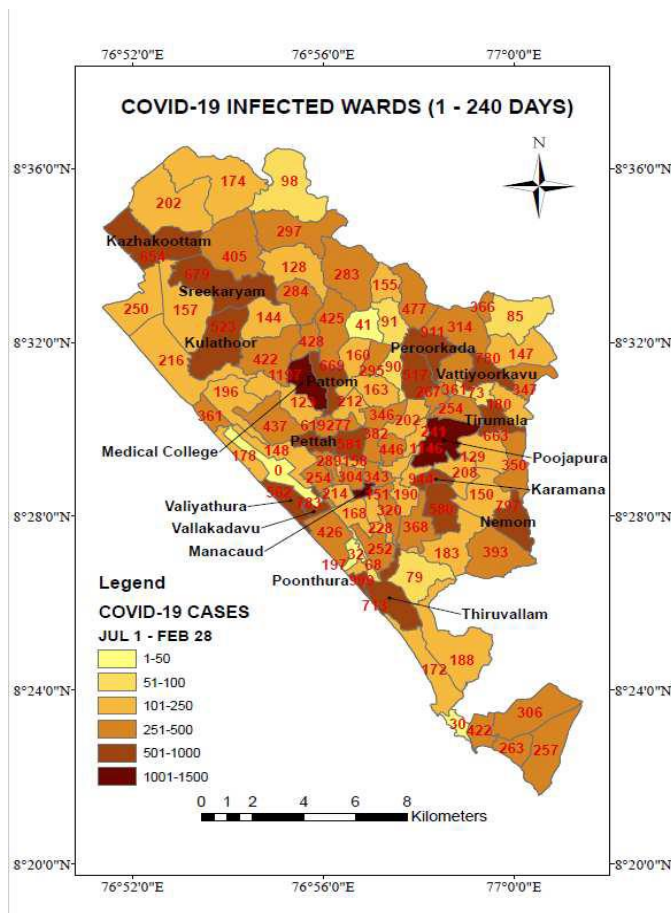
4.1 POPULATION DENSITY AND COVID-19 CASES

The analysis between COVID-19 cases and population density was carried inorder to find any possible relationship. A map showing population density was prepared and COVID-19 cases were shown with bubbles for each of the 100 wards in Thiruvananthapuram Corporation as in Fig 3
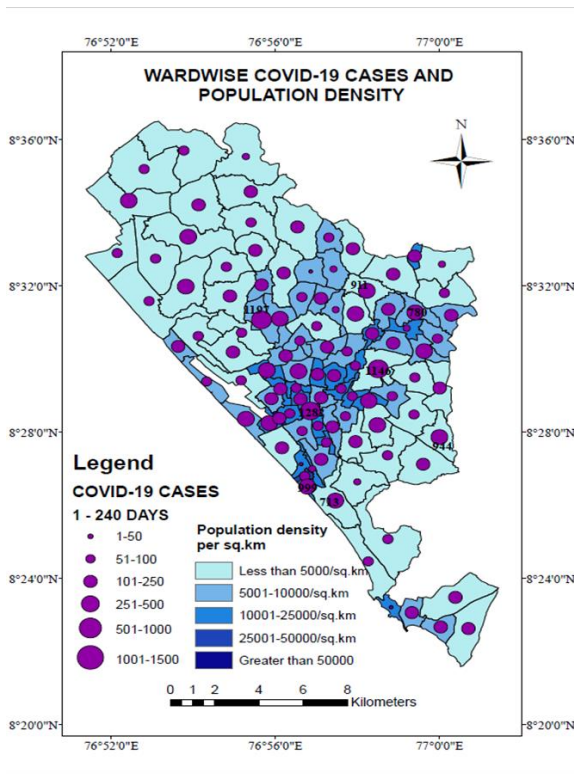
Fig -3: COVID-19 Infected wards from 1-240 days (July 1 – February 28)

A fewer no: of wards having high population density like Manacaud (23520.71/sq.km), Poonthura (24901.09/sq.km), Karamana(11401.86/sq.km),Vallakadavu (15,681.29/sq.km), higher COVID-19 cases could be seen. But in some wards, there is no such trend. Puthanpally (17944.85/sq.km), Beemapalli East (14171.97), Manikkavilakom (26327.74) and Sreekandeswaram (20870/sq.km) having high population density have the least number of cases in the overall study period. Wards in northern side like Kazhakoottam (2152.58/sq.km), Sreekaryam (1974/sq.km) and Kulathoor (2077.65) having Population Density less than 5000/sq.km is showing high COVID-19 cases. This shows that physical and ground truth conditions have greater significance in the wards having high COVID-19 cases.

The quantitative analysis between ward wise total COVID-19 cases and Population density was done with correlation analysis. Pearson correlation coefficient r was determined. The formula for Pearson correlation coefficient r is

$$r = \frac{\sum(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum((x_i - \bar{x})^2)\sum(y_i - \bar{y})^2}}$$

where, r = correlation coefficient, x_i= values of x- variable in sample, $\bar{x}$ = mean of the values of the x-variable, y_i = values of the y variable in the sample, $\bar{y}$ = mean of the values of the y- variable.

Data Analysis was installed in MS Excel to perform the Correlation analysis. The value of Pearson correlation coefficient r was calculated with x value as ward wise total COVID-19 cases for the study period and y value as ward wise population density of 100 wards

The value of r was obtained as 0.0965 which means high population density have smaller effect on high number of COVID-19 cases. If the value of Pearson correlation coefficient is 1, then its perfect positive correlation and -1 shows perfect negative correlation. But here, the value obtained is very low and hence it can be concluded that population density has least effect on high COVID-19 cases in Trivandrum Corporation.

This web mapping application was created in ArcGIS Online platform. The map of Trivandrum Corporation with the complete COVID-19 information was published in ArcGIS Online. Then a web map was created in ArcGIS Online and then web mapping application was created. This application gives the complete COVID-19 information related to any ward by just clicking on the ward of interest. The count on COVID-19 cases is given with 14 days time interval. A search panel is also provided and by inputting the ward name, the particular ward will be focussed and COVID-19 information can be obtained. It's a user-friendly application and users can access it by logging into ArcGIS Online and the pasting the URL https://arcg.is/5C0DH0. This application can be updated by filling the data in the attribute table of the web map. This web mapping application will help the decision makers to focus on the wards having COVID-19 cases.
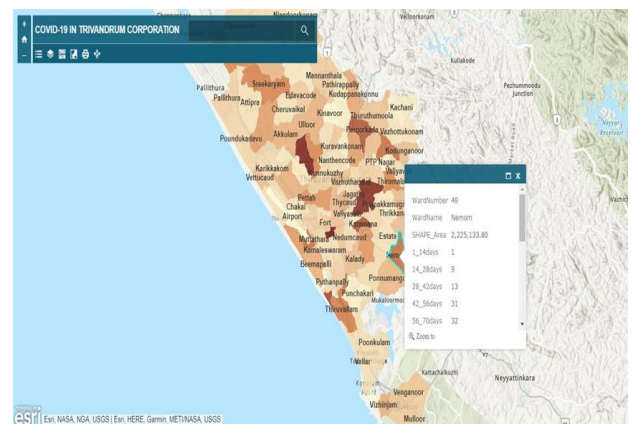

Fig -4: COVID-19 Infected wards from 1-240 days (July 1 – February 28)

5. CONCLUSIONS

The wards with high COVID-19 cases were Manacaud, Medical College, Poojapura and Poonthura. Manacaud ward has a Population density of 23520.71/sq.km has highest COVID-19 cases of 1282 cases. It may be due to higher population density, densely crowded main road, presence of restaurants, textiles, religious centres, schools, offices, prison

and it is near to Thampanoor and Eastfort bus station and the prominent Chalai market. The daily passenger movement is higher in this region since it is the region which connects the main city to the National Highway. Medical College ward has a Population density of 5237.022/sq.km and have a high toll of 1197 COVID-19 cases. It is situated in the main city area of the corporation and is densely populated. The reason for high toll in COVID-19 is that thousands of patients and bystanders daily visits the prominent Trivandrum Medical College and there is so many laboratories, medical shops and other amenities in that region. Poojapura ward has a population density of 2753.646/sq.km has a high toll of 1146 COVID-19 cases. The main cause was the community spread in Poojapura Central Jail and majority of the about 500 prisoners was tested COVID positive. This ward is in the main city area of the corporation and consists of important offices such as Pareeksha Bhavan etc. Poonthura ward has a population density of 24901.09/sq.km has a high toll of 999 COVID-19 cases. This ward is in the coastal region and has a total of 650 houses and 712 households. The city corporation was focusing on containment activities and regulations in Palayam and Chalai market but Kumarichantha was off the radar and this caused the community spread in market and people living in coastal area as two fishermen who returned from Tamil Nadu carried the virus. The community spread was faster due to lack of social distancing because 68 households are landless and most of them are living as a joint family and due to high population density. The wards having lower COVID-19 cases are Kinavoor, Harbour, Beemapalli East and Puthenpally. It may be because these wards are located beyond city limits, and movement of people in these regions are low due to lower amenities, shops etc. The trend line of COVID-19 was showing an upward trend even though the cases were comparatively lower than the mid period. The return of Keralites from other countries and states caused a surge in positive cases during September and October month.

The correlation analysis showed population density has less effect on COVID-19 cases but wards with higher cases was influenced by the physical conditions like high rate of people and freight movement because those wards were in the city limits and the presence of amenities were more in those regions.

The web mapping application will help the decision makers to focus on wards with high COVID-19 rates.

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