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santosh shrivastava
IMT Ghaziabad, sksrivastava@imt.edu

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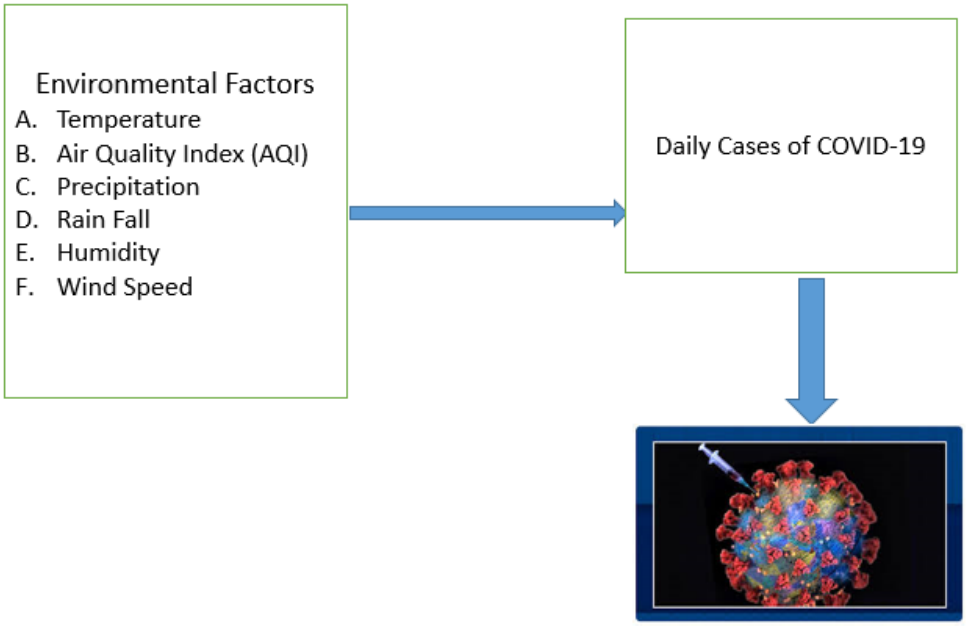
Effect of Environmental Factors on Daily New Cases of COVID-19 pandemic in Delhi, India

Anup Kumar, IMT Nagpur
Santosh Kumar Shrivastava, IMT Nagpur

Highlights

1. The Air Quality Index one of the factors affect the spread of Covid-19
2. The spread of COVID-19 in India was slow and now its gains the acceleration so the results of this study will be useful in efforts to prevent the spread of COVID-19 disease

Graphical Abstract



Abstract

This research study investigates the effect of environmental factors such as Maximum Temperature (TMAX), Minimum Temperature (TMIN), Average Temperature (TA), Rainfall mm per inch (RF), Air Quality Index AQI, Precipitation (PP), Humidity (HM) and Wind Speed (WD) on the daily new cases and deceased cases of COVID-19 pandemic in New Delhi, India. The secondary data of COVID-19 is taken from the Department of Health & Family Welfare Government of Delhi, India, while AQI data is extracted from the Meteorological Department of the government of India. The correlation approach is used to test the effect of AQI and temperature on the Daily Cases of COVID -19. The results reveal that the weather is an important factor in determining the incidence rate of COVID-19 in New Delhi. The weather indicators such as

minimum temperature, maximum temperature, precipitation are statistically significant for daily new cases, and minimum temperature, maximum temperature, air quality index and precipitation are statistically significant for total cases and minimum temperature, maximum temperature, average temperature, and precipitation are statistically significant for mortality among New Delhi citizens. The findings may become important information to control the pandemic in New Delhi, India.

Keywords: COVID-19; Air Quality Index; Coronavirus; Temperature; India

1.Introduction

The World Health Organization (WHO) declared the coronavirus outbreak a Global Public Health Emergency On January 30, 2020 (Anderson, Heesterbeek, Klinkenberg, & Hollingsworth, 2020). The Virus has infected 4,385,155 people and has taken 294,833 people's life in 212 countries to date.

In India the first case of coronavirus was reported on 30 January 2020 originating from China (Zhu et al., 2020). Since then as of 13 May 2020, the Ministry of Health and Family Welfare has confirmed a total of 74,281 cases, 24,386 recoveries (including 1 migration) and 2,415 deaths in the country (https://www.mohfw.gov.in/). The infection rate of COVID-19 in India is reported to be 1.7, significantly lower than in the worst affected countries. On 30 January, India reported its first case of COVID-19 in Kerala[1], which rose to three cases by 3 February; all were students who had returned from Wuhan, China. No significant rise in cases was seen in the rest of February. On 4 March 22 new cases came to light, including those of an Italian tourist group with 14 infected members.

The transmission escalated during March after several cases were reported all over the country, most of which were linked to people with a travel history to affected countries. On 12 March, a 76-year-old man who had returned from Saudi Arabia became the first victim of the virus in the country. The weather conditions that consist of humidity, temperature, air quality index, wind speed and rainfall had been affected the speed of the coronavirus as per research (Dalziel et al., 2018; Yuan et al., 2006). The temperature average (°C) was significantly correlated with the COVID-19 pandemic (r=0.392; p b .01) in Jakarta(Indonesia)(Tosepu et al., 2020). In China, research shows that the metrological conditions have also affected the count of COVID-19 Cases(Liu et al., 2020). Recent research in New York, USA reveals that the average temperature, minimum temperature, and air quality were significantly associated with the COVID-19 pandemic (Bashir et al., 2020).

The current research study conducted to investigate the effect of environmental variables Temperature, Air Quality Index (AQI), Precipitation, Rain Fall, Humidity and Wind Speed on the daily confirmed cases COVID-19 in Delhi.

2. Materials and Methods

[1] Reid, David (30 January 2020). "India confirms its first coronavirus case". CNBC.

2.1. Case setting

Delhi is the capital of India. Delhi situated between 28.7041° N latitude and 77.1025° E longitude. The land area of Delhi is 662.33 km^2. The population of Delhi as per the 2011 census was 1.9 crores (2012). The current population of Delhi was expected to be 5 crores (2020) with an annual growth rate of 3.8%. The **COVID-19 pandemic** was confirmed in the Indian union territory of Delhi, with the first case reported on 2 March 2020. In Delhi, the number of infected people reported till 13 May 2020 is 7,998 consisting of 106 deaths and 2,858 recoveries (https://www.mohfw.gov.in/). In Delhi 404 out of every 1 million people have tested positive for the virus. The number of active cases was 62.94% for every 100 confirmed cases, the Recovery Rate was 35.73% for every 100 confirmed cases. Mortality Rate was 1.33% for every 100 confirmed cases, Avg. Growth Rate was 5% between 06 May - 12 May. In this week, the number of new infections has grown by an average of 5% every day.

2.2. Data Collection

Data for the COVID-19 were collected from https://www.covid19india.org/ a crowdsource platform. The Environmental data is collected from 15th March 2020 to 11th May, 202 for the province Delhi. The data contains the various features such as daily confirmed cases (DNC), Total confirmed cases (TCC), deceased Cases (DC), recovered Cases (RC), the environmental factors like Maximum Temperature (TMAX), Minimum Temperature(TMIN), Average Temperature(TA), Rainfall mm per inch (RF), Air Quality Index AQI, Precipitation (PP), Humidity (HM) and Wind Speed (Km/h)) (WD.

2.3 Methodology and Data Analysis

In the first phase of the analysis, we have used graphical representation to understand the relationship between the various features of Covid-19 for Delhi. The total confirmed cases (TCC) and daily confirmed cases (DNC) are positively associated and increasing in the positive direction with the time as shown below in figure-1. We can observe a sharp increase, both in daily new cases (DNC) and total confirmed cases TCC) for Delhi from March 14, 2020, onwards. The figure-2 contains the three graphical representations of COVID-19 features. The first and second graph of figure-2 shows that the daily and total confirmed, deceased and recovered cases have a positive trend with time. The number of COVID-19 patients cases is increasing continuously with time and is a dangerous symptom for the country as well as the economy. The one positive thing we can observe from the second graph of figure-2 that the number of recovered cases is also increasing but the speed of daily recovered cases is slow in comparison to daily new cases. The Last graph of figure-2 shows the trend of Covid-19 cases state-wise. It is clear that the cases are increasing with time most of the states but Maharashtra is on top in the COVID-19 list.

The first graph of figure-3 shows that the trend of the number of COVID-19 patients cases is increasing very fast in all the states in comparison to starting days. The second graph of figure-2 shows that the proportion of Male patients are significantly higher than the female COVID-19 patients. The third graph of figure-2 shows that the majority of the COVID-19 patients have ages between 25-45 years. This is another dangerous symptom for the government.

The figure-4 shows the trend of TMAX, TMIN, and TA over time. This graph indicates that the TMAX and TMIN are increasing over time but TA initially increases and then decreases in the last two weeks. Figure-4 shows the maximum, minimum, and average temperature. Lowest maximum temperature of 29 ^{o}C, lowest average temperature was 22 °C and the minimum lowest temperature was 15 ^{o}C.

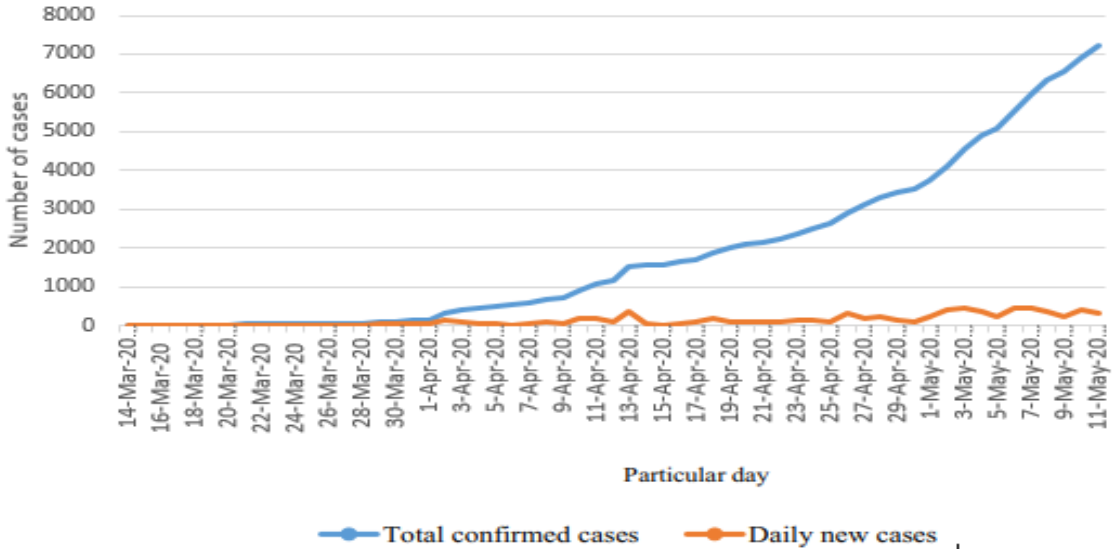


Figure 1. This figure represents the trend of total confirmed cases and daily new cases.

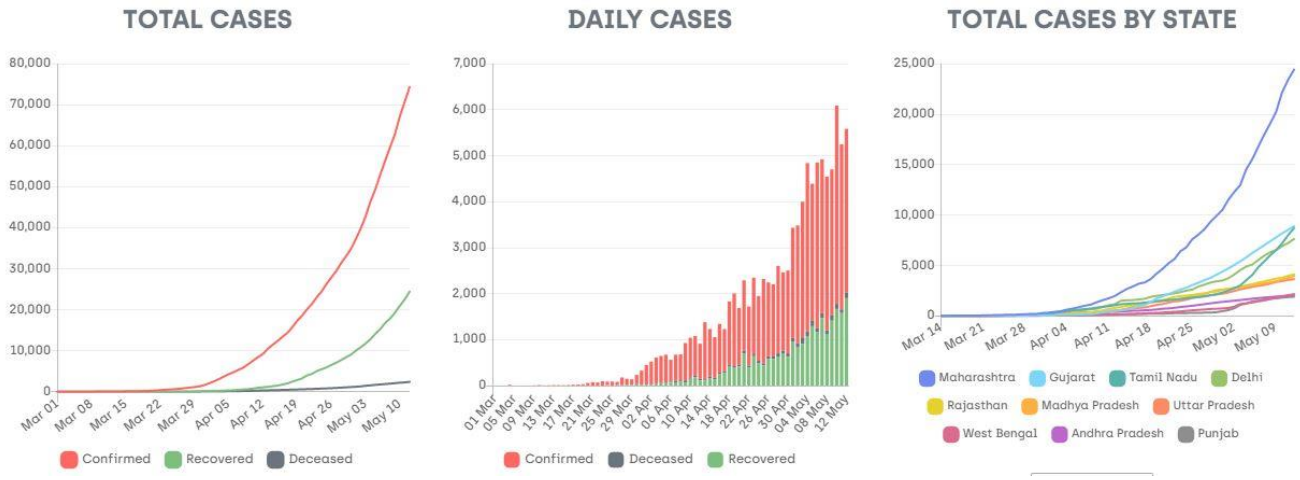


Figure-2 This figure represents the trend between the various features of COVID-19 patients.

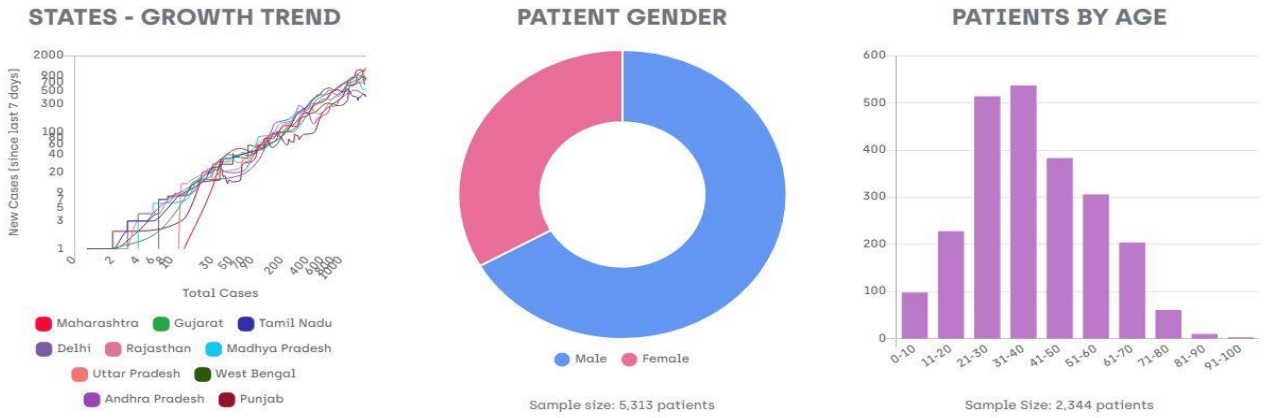


Figure-3 This figure shows the growth trend of COVID-19 patients in different states for the last 7-days, genderwise distribution of COVID-19 patients, and age distribution of COVID-19 patients.

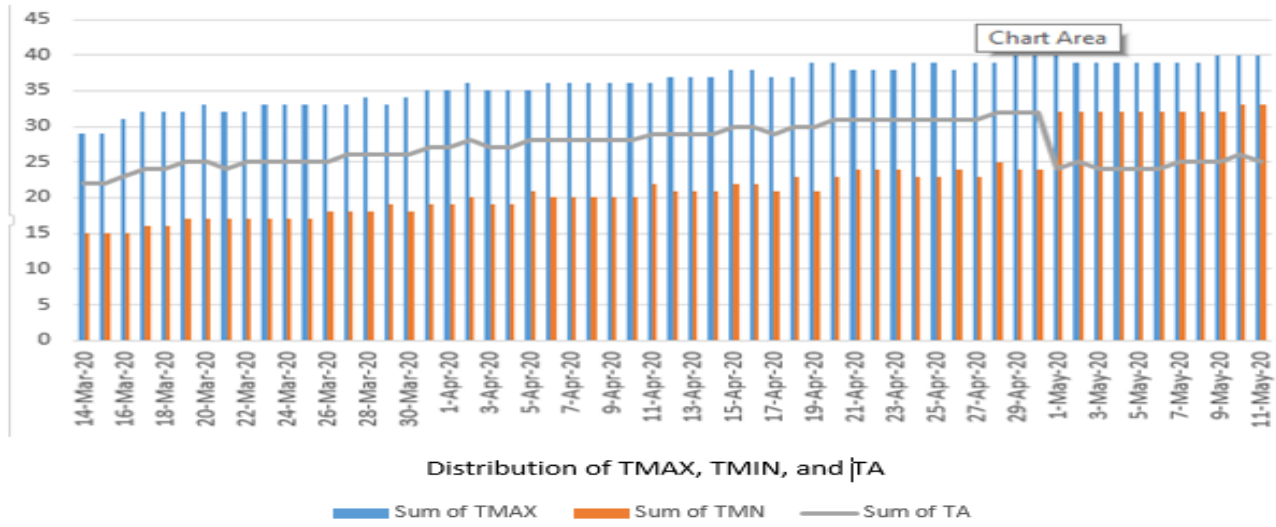


Figure-4 This graph shows the distribution pattern of maximum temperature, minimum temperature, and average temperature

3. Data Analysis and empirical results

The figure-5 of the analysis shows the clusters of variables based on the Spearman correlation method. The hierarchical cluster given below shows that broadly, we can divide the various COVID-19 variables into three clusters. The first cluster contains the variables precipitation, rainfall, AQI, TA, DC, the second cluster contains the TMAX, TMIN, DCN, RC, and humidity.

The third cluster contains a single feature WD. Cluster one shows the impact of environmental factors such as PP, RF, AQI, and TA on deceased cases while cluster two shows the impact of various factors like TMIN, TMAX, HM on confirmed and recovered cases.

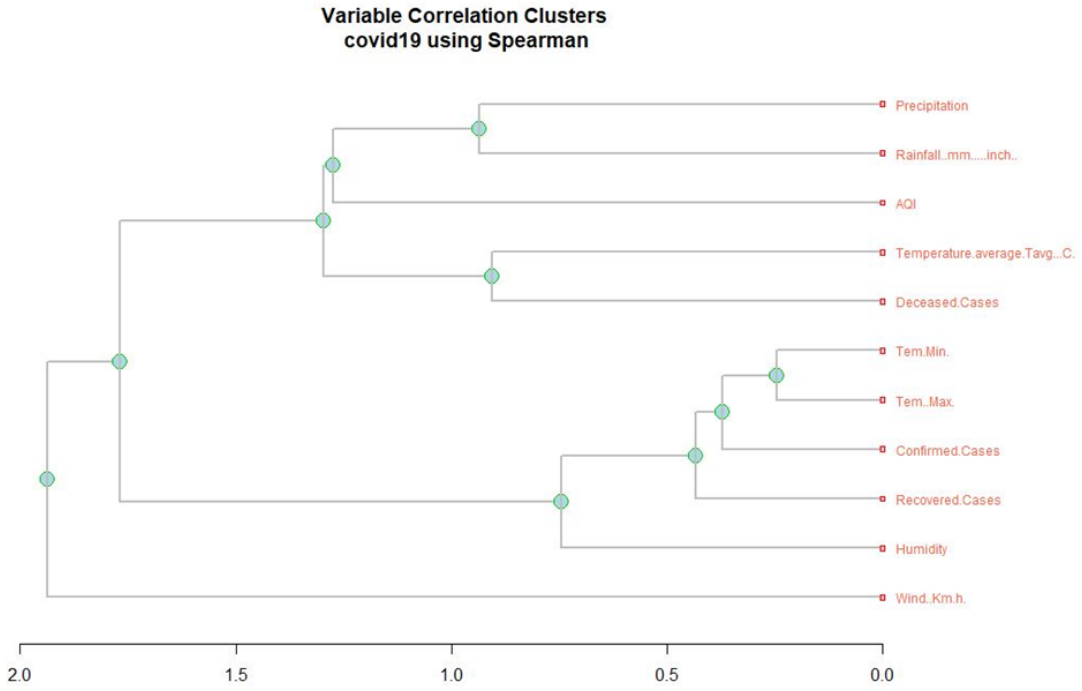


Figure-5 This figure shows the cluster of various COVID-19 features

Empirical results.	Climate Variables	DNC	TCC	DC
Kendall Correlation Coefficient	TMAX	0.64**	0.86***	0.37**
	TMN	0.74**	0.92***	0.29**
	TA	0.08	0.18*	0.36**
	RF	-0.07	0.02	0.18*
	AQI	0.06	0.14*	0.10
	PP	0.11*	0.18**	0.21**
	HM	0.06	0.03	-0.12*
	WD	0.06	0.01	-0.07
Spearman Correlation Coefficient	TMAX	0.81***	0.95***	0.47**
	TMN	0.90***	0.98***	0.38**
	TA	0.06	0.16*	0.48**
	RF	-0.09	0.02	0.20**
	AQI	0.05	0.18**	0.14*
	PP	0.20**	0.26**	0.26**
	HM	0.11*	0.06	-0.14*
	WD	0.08	0.02	-0.08

****, **, * stands for 1%, 5% and 10% level of significance*

*Table-1: This table the **Kendall and** Spearman correlation coefficients between various features and their statistical significance at various levels.*

In this study, the pattern of climate change provides a picture of the occurrence of COVID-19 in New Delhi, India. The table-1 shows the Spearman correlation coefficients and their statistical significance at different levels. The reason for using Kendall's tau and Spearman's (rho) rank correlation is that it is a non-parametric test that is used to measure the degree of association between two variables. There are two accepted measures of non-parametric rank correlations: Kendall's tau and Spearman's (rho) rank correlation coefficient. Correlation analyses measure the strength of the relationship between two variables. Kendall's Tau and Spearman's rank correlation coefficient assess statistical associations based on the ranks of the data. Ranking data is carried out on the variables that are separately put in order and are numbered. Correlation coefficients take the values between minus one plus one. The positive correlation signifies that the ranks of both variables are increasing. On the other hand, the negative correlation signifies that as the rank of one variable is increased, the rank of the other variable is decreased.

Table-1 indicates the empirical estimations of eight weather indicators. For Kendal correlation test minimum temperature, maximum temperature, PP is statistically significant for daily new cases, and minimum temperature, maximum temperature, and PP are statistically significant for total cases and minimum temperature, maximum temperature, average temperature, and PP are statistically significant for mortality among New Delhi citizens. For Spearman correlation test minimum temperature, maximum temperature and PP are statistically significant for daily new cases and minimum temperature, maximum temperature, AQI and PP are statistically significant for total confirmed cases (TCC) and minimum temperature, maximum temperature, average temperature RF and PP are statistically significant for mortality among New Delhi citizens. The result of this analysis is somewhat similar to the previous findings of Vandini et al. (2013) and Tan et al. (2005) for weather transmission and Syncytial Virus Respiration.

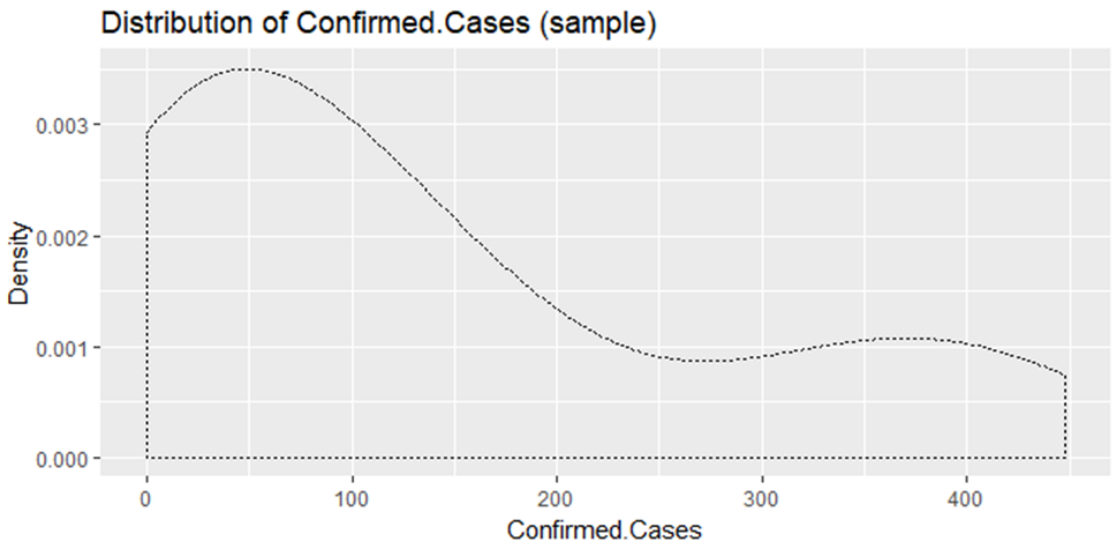


Figure-5 This figure indicates the probability distribution of Covid-19 confirmed cases for Delhi.

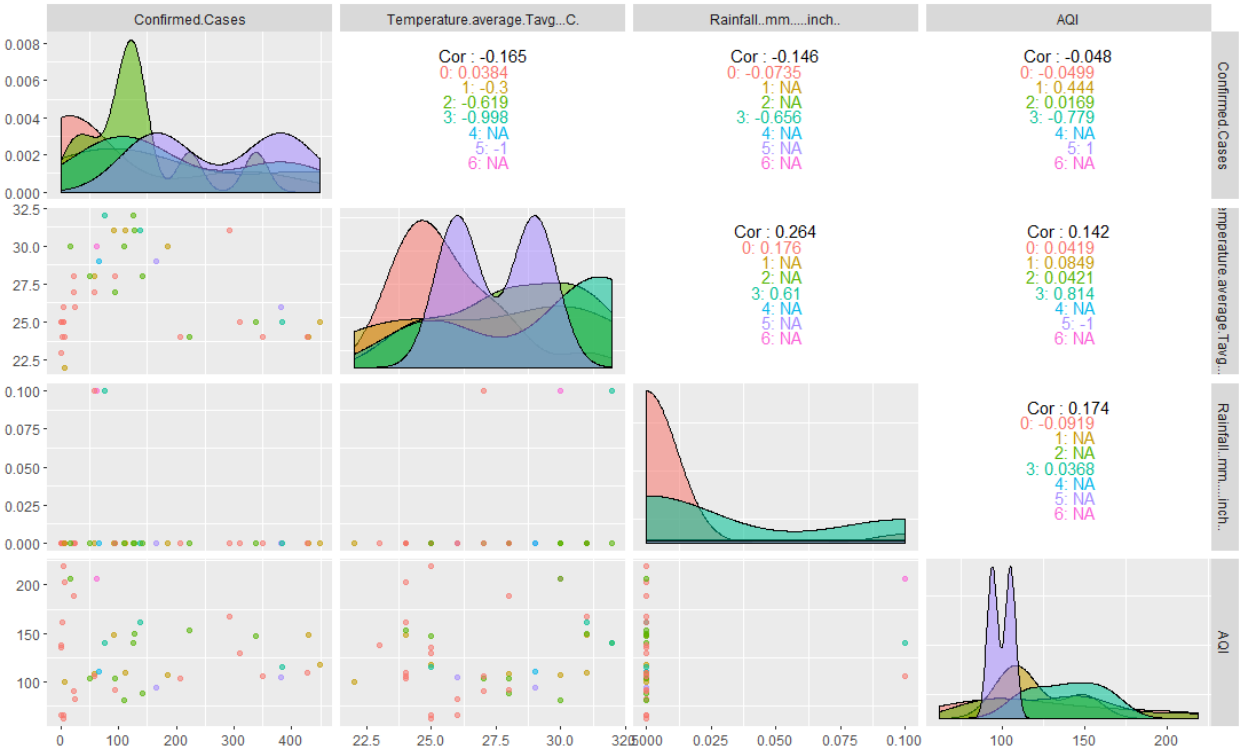


Figure-6 This shows the correlation between confirmed cased and environmental features such as TA, RF, and AQI for the simulated data for future

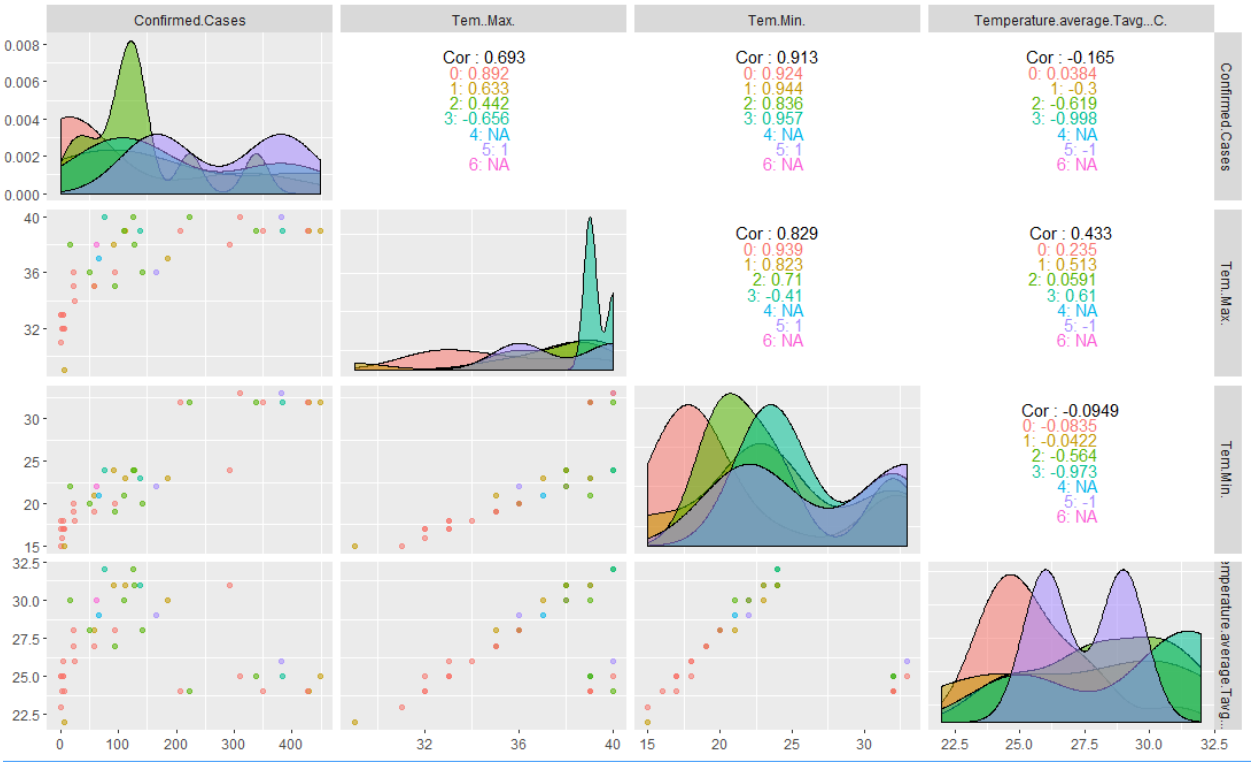


Figure-7 this shows the correlation between confirmed cased and environmental features such as TMAX, TMIN, and TA for the simulated data for future

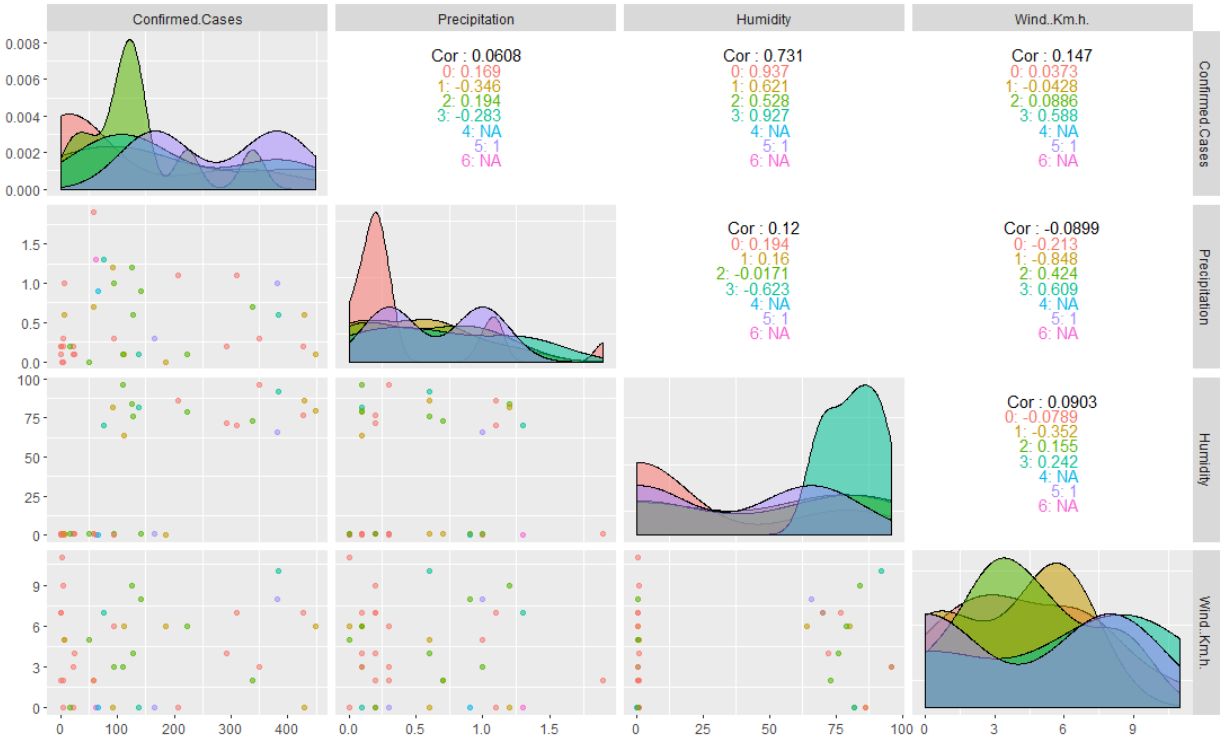


Figure-8 This shows the correlation between confirmed cased and environmental features such as TCC, PP, HM and WD for the simulated data for future

Since the distribution of the confirmed cases as given in figure-5 has multiple peaks and doesn't satisfy any possible distribution. The basic reason for multiple peaks in the confirmed cases is related to the other factors like the intensity of lockdown declared by the government, population per kilometer, and the awareness about this pandemic that is not captured by the data. The distribution of confirmed cases with the simulated data for various environmental factors like features such as minimum temperature, maximum temperature, PP, AQI, RF, HM, and WD as given in figure-6,7 and 8 also shows the existence of multiple peaks in the graph. The temperature is one of the important factors for the spread of Covid-19 in China (Shi et al., 2020). Not only the environmental factor but the high number of COVID-19 cases in New Delhi is due to the mobility of the people and the low intensity of lockdown.

Since New Delhi is the capital of the country (India) and being the major place for the economic destination, the people come to Delhi for their livelihood from different parts of India. The majority of the people who come to New Delhi for livelihood prefer to choose allocation in the same area. The population density of the city is very high and this allows the high spread of COVID-19 cases. As per the national census conducted in 2011, New Delhi has a population of 1.6 crores people, exceeding the projected population of 2.2 crores for 2025. Despite the significant finding of the weather on COVID-19, this study has limitations: First, as the disease is caused by the virus, many factors are needed to be investigated such as virus resistance, population mobility, and population endurance. Second, individual health factors such as hand washing habits, personal hygiene, and use of hand sanitizers may be the other related factors of COVID-19 that are necessary to be explored. However, this study is just a preliminary analysis. The strong conclusion requires time and a long data set.

4. Conclusion

Thie study shows that the weather is an important factor in determining the incidence rate of COVID-19 in New Delhi. The weather indicators such as minimum temperature, maximum temperature, precipitation are statistically significant for daily new cases, and minimum temperature, maximum temperature, air quality index and precipitation are statistically significant for total cases and minimum temperature, maximum temperature, average temperature, and precipitation are statistically significant for mortality among New Delhi citizens. The findings of the research study may prove useful to decrease COVID-19 patients in New Delhi.

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