

Analyzing Correlation between AQI and Spread of Covid Cases in India

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Abstract: Covid-19 led to a total of 6.4 million deaths to date worldwide and deaths in India accounted for 528k. This study looks at the spread of covid-19 in India and the effect of the Air Quality Index on it. Air Quality Index (AQI) is the combination of particulate matter, various gases, and pollutants found in the air. A high AQI signifies a more polluted environment. This study focuses on 2 particular matters, pm2.5 and pm10. PM 2.5 are those particles that have a diameter of fewer than 2.5 micrometers while PM10 is used to classify those particles which have a diameter of fewer than 10 micrometers. It analyses the AQI data of the Mumbai district and maps the data to the Covid cases recorded during the lockdown period. The dates analyzed in this study are before the start of vaccinations to make the study as unbiased as possible. This study aims to find reasons for the spread of viruses and thus hopes to prevent such a deadly outbreak in the future.

Keywords: Covid-19, AQI, Regression

1. INTRODUCTION

Covid-19 is a viral disease spread by a virus closely related to the SARS-CoV virus [1]. The covid virus is said to have spread through the air and it was later realized that human-to-human transmission played a major role in the transmission of the virus at such a global and pandemic level. It mainly affects the respiratory system of the body although other organs might be affected too [2]. The study done in this paper focuses on the effects of AQI on the virus spread and the relation between AQI and the multiple Lockdowns being imposed in India. The study looks at PM2.5 and PM 10. PM refers to Particulate Matter which includes but is not limited to microscopic matter suspended in air or water. Airborne particles are called aerosols. PM 2.5 are those particles that have a diameter of fewer than 2.5 micrometers while PM10 is used to classify those particles which have a diameter of fewer than 10 micrometers [3]. Covid-19 is one of the biggest pandemics faced by the world. It had a devastating effect on the planet and the way humans function. Many changes in human society were brought about by Covid-19. Vaccines have already been developed and a preventive cure has thus been found for this virus. Medicines that stop the severity of the disease and help in the recovery of the patients affected by Covid-19 have also been developed. Even though all these measures have been taken, who is to say that a similar virus will not affect human lives in a similar fashion in the future? The study focuses on AQI and correlates it with the spread of the virus as well as observes the effect of lockdown. The study shows quantitatively the percentage increase in the number of Covid cases 10 days before the lockdown was lifted was 4.12%. When the lockdown was lifted the percentage increase in the number of Covid cases from 8th June 2020 to

30th June 2020 was 5.42%. As soon as the lockdown restrictions were back, we analyzed the percentage increase for the next 10 days which was 3.2%.

2. Literature Review

In a previous study [4], the Spearman and Kendall tests were used to examine the relationship between air quality, the Covid-19 outbreak, and the number of fatalities in various regions of India. The statistical correlation test showed a correlation between the Covid-19 spread and fatality cases in 25 Indian cities and air quality measures like PM 2.5, PM 10, and overall AQI. The most important air quality indicator for Covid-19 distribution and fatality cases, however, is determined to be PM 2.5.

A study was done to provide additional evidence on the potential effects of surface levels of air pollution on fast diffusion effects of SARS-CoV-2, and COVID-19 in Milan metropolitan city, Lombardy region of Italy, the researchers used a comprehensive time series analysis of the primary airborne pollutants particulate matter PM2.5, PM10 and Air Quality Index data together with climate and coronavirus data for period 1 January–30 April 2020. Their research [5] demonstrated a negative link between COVID-19 and relative air humidity, demonstrating that dry air encourages viral continuing dispersion, and a positive correlation between COVID-19 and air temperature, demonstrating that COVID-19 will continue to spread throughout warm seasons.

The paper “Forecasting Transmission Dynamics of COVID-19 Epidemic in India under Various Containment Measures- A Time-Dependent State-Space SIR Approach” [6] concluded that the lockdown's success in stopping the spread of the SARS-CoV-2 infection is supported by a significant decrease in the reproduction rate R_0 during the partial lockdown and total lockdown phases. R_0 is calculated to have fallen below 1 for the full lockdown phase using an average recovery (or infectious) of 14 days. Even during the total lockdown, the estimate of R_0 remained over 1 assuming a 24-day recovery period.

The study [7] provided an overview of Mumbai's statistics on COVID-19 infections, population density, exposure to particular pollutants, and city infrastructure. According to the authors' estimates, the mean population exposed to SO₂, NO₂, and PM₁₀ was 415 thousand, 238 thousand, and 0.78 thousand correspondingly. The estimated population density per square kilometer was 33,000. In Mumbai, there were about 100 slums per ward, 31 drains on average per ward, 4 police stations on average per ward, and a road density of about 6 km/sq. km.

The correlation study [8] showed that air quality reported in terms of AQI might serve as a crucial antecedent to determine the key phase of COVID-19 dissemination and the efficacy of different control measures implemented during each phase. However, due to the variability introduced by a series of mutually exclusive events like the administration of massive vaccination drives and approval to hold local gatherings, the study was unable to identify any significant correlation between AQI and COVID-19 database for Tier-I cities, except for the vaccination cases and recovery cases. The second wave of the pandemic has begun, and the most recent trends in vaccination campaigns have revealed a negative association between AQI and the number of positive confirmed cases in Delhi, Mumbai, and Kolkata.

The relationship between the local AQI and the number of COVID-19 cases in each city was examined in a paper in the international journal of infectious disease [9]. The data demonstrated that AQI was strongly and favorably correlated with the number of daily COVID-19 incidence cases in both Wuhan ($R^2 = 0.13$, $p < 0.05$) and XiaoGan ($R^2 =$

0.223, $p < 0.01$), indicating the considerable contribution of AQI to COVID-19 transmission. As a result, the study investigated the relationship between each air pollutant and the number of daily newly diagnosed COVID-19 cases in Wuhan. Interesting correlations between daily COVID-19 incidence and all ambient air contaminants were found. They showed statistical significance for NO₂ ($R^2 = 0.329$, $p < 0.01$), PM_{2.5} ($R^2 = 0.174$, $p < 0.05$), and CO ($R^2 = 0.203$, $p < 0.001$).

The research done by Jay Naresh Dhanwant and V. Ramanathan[10] indicates that the number of instances will not drop even during the lockdown. Because of its large bias, this model will become more accurate after being trained on further lock-down data that will be seen shortly. Actual Soon, there will be far more cases than have been documented on any given day. The exponential growth will stop when these two values converge. The graph indicates that the exponential development will reduce during the lockdown, but a growth halt requires stricter social seclusion.

3. Data

The data was taken from the official website of the AQI centers in India. the format of the data we received was the district and the particular center of that district[11]. The average value of the PM_{2.5} and PM₁₀ levels were recorded for a particular day. Many values were missing from the data that was taken and hence multiple techniques such as logistic regressions were applied to fill in the null values. The districts that were considered for our study were the following Mumbai and Bhopal. Such wide arrays of districts were taken to increase the variety of the AQI levels in the testing dataset. The experiment consisted of at least one district for all six categories of the AQI levels. This was done because we wanted to incorporate data from all various levels and then draw conclusions on them based on it.

The data for Covid cases were taken from the official website provided by the Indian Government [12]. The district data was taken from these data endpoints because it matched on a similar geographical level to the AQI data that we could find. The data for Covid cases were taken from 26-04-2020 to 13-12-2020. This timeline was selected to keep the data unbiased as the vaccinations had started in January for doctors. Since vaccinations would affect the rate of spread of Covid, the dates after the vaccinations were avoided. The columns in the dataset were the date, confirmed cases till that date, recovered cases till that date, and the total number of deaths till that date. From this dataset we constructed a few more columns that would help in our analysis which were mainly, the number of daily cases found that day and the number of active spreaders on that day. Getting the number of daily cases detected was a case of simple math, just subtracting the total cases found on the day before from that day's total cases. Spreaders were the number of active cases on that day that had the potential to spread the virus to other people. We subtracted the recovered cases from the total cases and integrated the cases of seven days because from previous research it was proved that a person infected can spread the virus for seven days.

4. Research

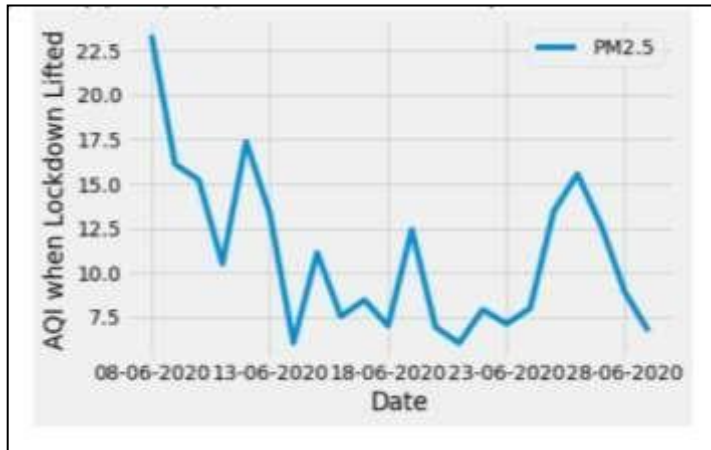


Figure 2. AQI when Lockdown Lifted

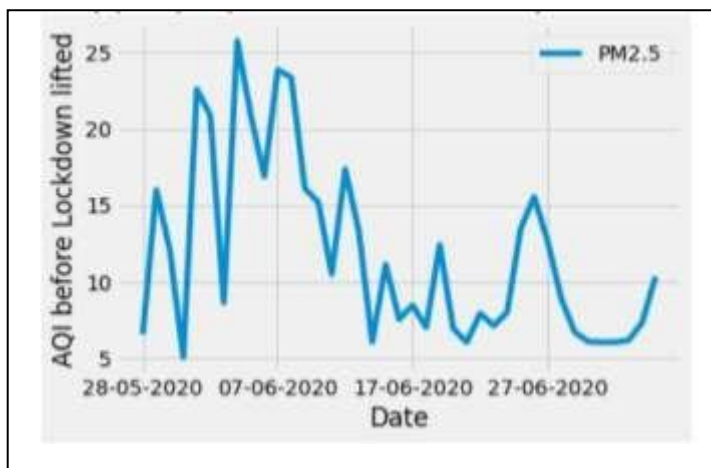


Figure 3. AQI before Lockdown lifted

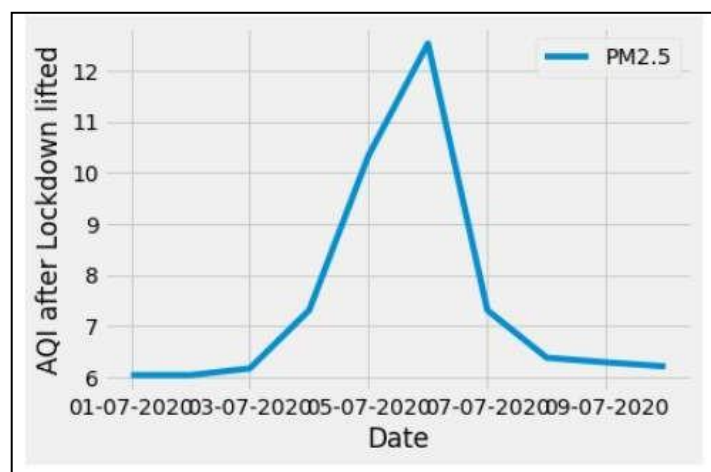
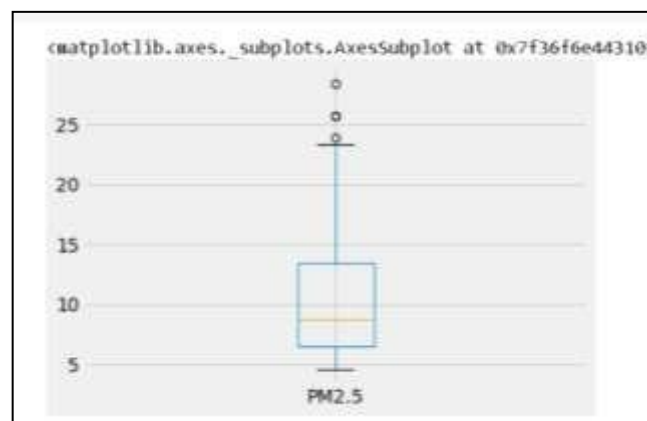


Figure 4. AQI after Lockdown Lifted

To depict the effect of a rise in AQI on the Covid cases the above graphs depict the AQI in Mumbai during the first lockdown, before the lockdown, and after the lockdown. The first lockdown was lifted on 08/06/2020. Before this lockdown was lifted the previous 10 days from 28/05/20 to 07/06/2020 showed a slow rise in the number of Covid cases at 4.12%. As soon as the lockdown was lifted, the number of cars running on the road increased, factories started working at a full-fledged pace, and people started traveling although most of the public transport was still closed. This led to a rise in the AQI of Mumbai as pollution increased. Covid infection is transmitted through air particles and the virus sticks to the PM2.5 and PM10 particulate matter. An increase in AQI meant an increase in PM2.5 particulate matter which helped in the spreading of the virus. A few days after the lockdown was lifted there was a huge spurt in the number of covid cases. The percentage increase in the number of Covid cases was 5.42%. This had set a record as thousands of people had to be quarantined and the government had to curb public travel as much as possible. We have calculated the percentage increase as the percentage increase in the number of deaths between the specified period divided by the increase in the number of Covid cases. Using the box plot we can visualize that for the majority of the pandemic the AQI level has been ranging from 6.8 to 13. During the first ease of lockdown restrictions, the average AQI had been 19.4 which explains why the Covid cases increased. The air quality index has been proven to affect the spread of the virus. In countries where AQI levels were low, even after the lockdown was lifted the Covid cases were under control.

**Figure 5. Box-plot**

5. Conclusion

On analyzing the effect on AQI during the Covid pandemic, we calculated the percentage increase in the number of Covid cases relative to the AQI when the first lockdown restrictions were lifted all over the state of Maharashtra. The first ease of lockdown restrictions happened on 8th June 2020 and lasted till 30th June 2020 until restrictions were brought back.

The percentage increase in the number of Covid cases 10 days before the lockdown was lifted was 4.12%. When the lockdown was lifted the percentage increase in the number of Covid cases from 8th June 2020 to 30th June 2020 was 5.42%. As soon as the

lockdown restrictions were back, we analyzed the percentage increase for the next 10 days which was 3.2%. A major reason for this was pollution too. Before restrictions were removed the average value of PM_{2.5} particulate matter was 10.5 when the lockdown was lifted and more vehicles were on the road it led to an increase in pollution which led to an increase in PM_{2.5} particulate matter which when calculated rose to 11.9. As soon as the lockdown was brought back in Maharashtra, the pollution decreased and hence the average value of PM_{2.5} particulate matter was just 7.46. This shows how the air quality index was affected due to restrictions during the Covid pandemic and played an important role in the spreading of the virus. Cleaner air during restrictions curbed the spread of the virus through particulate matter but as soon as the restrictions were eased and the air became polluted the virus had more PM_{2.5} matter to attach and hence increase the spread of the disease.

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