A Study during Lockdown Period Based on AQI over Indian Mega cities during COVID-19

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Abstract. The COVID-19, the most deadly challenge human being could have imagined, has become a reality now and the whole world is passing through the worst pandemic situation. From the challenges of invention of life saving vaccine or medicine to keeping economy at right track are the most talked about hurdles in front of all of us. But if we look at the other side of the coin, the blessings that came in form of disguise could be realised. The paper emphasizes on those aspects during lockdown that was imposed in India for three weeks initially that is 24th March to 14th April 2020 and later on till 3\textsuperscript{rd} of May 2020. As a result of this forced restrictions, pollution level in whole India, specially in metro or mega cities where large population and pollution is a deadly combination, drastically changed. For analysing air quality, the metro-cities like Delhi, Kolkata, Chennai and Mumbai has been investigated here. The pollutant parameters PM\textsubscript{2.5}, SO\textsubscript{2}, NO\textsubscript{2}, along with CO, O\textsubscript{3} and overall AQI (Air Quality index) has been collected and comparative study was done before and after lockdown and even for the year 2018 and 2019 too. Reduction of level of pollutants in significant amount of percentage is observed for all the metro cities where variation of reduction level from city to city is also significant. The effectiveness of lockdown over different metro cities are also very significant, pointing towards alertness of local people and population concentration. Finally, the study can be used in future as case study for controlling pollution with controlled lockdown and this can be practiced in future once or twice yearly to save our motherland.

Keywords: Lockdown; AQI; Mega Cities

1. Introduction
As per the report of the World Urbanization Prospect 2018, Asia and Africa will have 90\% increase of population by the year 2050. Delhi, the capital of India, also known as highest contributor to the whole population of urban India where 1.9 crore people are distributed over 1485 km\textsuperscript{2} area, Kolkata.
1.49 crore in 206.1 km², Chennai 70.9 lakhs in 426 km² and Mumbai 1.84 crore with 603 km². It is very obvious that density wise Kolkata is having highest population per square km. The impacts of the high population along with extreme urban growth are effecting the environment significantly. The effect is becoming worst with subsequent increase of number of industry and vehicle day by day. And as result the degradation of air quality is shown in the review literature [1]. In our country, as per the reports of PHFI, ICMR, and IHME (2017) [2], every eighth death is due to air pollution and Mumbai along with Kolkata topped the list. As per Pollution Control Board Report of Kolkata, though because of some government policies, the pollution reduced in 2019 November-December than 2018 but in the year 2016 World Health Organization (WHO) report [3] showed Kolkata as the second-most polluted Indian metropolis, behind Delhi. Where Chennai, a important port city is behind them. Apart from business and shipping, in Chennai the industries like automobile, software services, medical care, chemical, petrochemical and manufacturing industries also play a vital role for strong economical background. Manufacturers like Ford, Hyundai, Mitsubishi, Ashok Leyland, Massey Ferguson, Eicher, and their production units have started their operation in this area due to port service, as well as presence of skilled worker in the region, has changed the economy of Chennai, thus controlling 30% of India’s whole auto industry. For that reason Chennai shows concentration of PM2.5 as 57.5 ± 16.8 μg/m³ which is greater than the national standard (40 μg/m³) and 5 times more than the WHO guideline as per report [4] where Mumbai has an average annual PM 2.5 concentration greater than four times the World Health Organisation (WHO)’s limit [3]. A report in 2018-2019 suggests that Mumbai air pollution has increased by 50% of its permissible level which is really a deep concern being another sea faced densely populated city.

December 2019, COVID-19, the deadly contagious disease was firstly reported in Wuhan, Central China. Within March 23, 2020, globally, over 14,000 people have already died, and more than 334,000 people have already been infected by the virus (WHO, 2020) [3]. The death touched 200,000 as on 26.04.2020 over the world. Due to that, in India also, a nationwide shutdown was imposed from 24th of March up to 14th of April that is almost three weeks and later extended up to 3rd May. As a result, the industrial activities and mass transportation were completely stopped or restricted. Railway, inter-state movement, international flight got shut down completely. As a result, in 88 cities, the pollution level significantly reduced down [5] as per the official data from the CPCB. Therefore, lockdown is assumed to be the most effective alternative that can be used as precautionary measure for controlling air pollution in future and the present work explores the degree of change in air quality during lockdown for four megacities like Delhi, Kolkata, Chennai and Mumbai.

2. Measurements
A study on the air quality of the metro cities have been done, first of all the data of 2018, 2019, 2020 (before lockdown and after lockdown) has been collected from Central Pollution Control Board site [6] and further the data is segregated year wise, month wise and place wise and even air quality controlling parameter wise for analysis. The data are later plotted using Python programming for deep analysis and plotted together for result and Conclusion.

3. Result Analysis:
The study was done only on megacities of India basically for the period of lockdown duration for 2020 and at the same time the values of air pollutants for the year 2018 and 2019. Among that, for the year 2020 before and after lockdown effect is mainly focused to identify the value of AQI parameters like PM 2.5, SO2, NO2, CO, O3 and nature of curve is evident enough of reduction in quite satisfying level.
Figure 1. Delhi PM 2.5, SO2, NO2, CO for the period of 22nd March to 30th June, 2018, 2019 and 2020.

The figure 1 of Delhi is clear evident of reduction of PM$_{2.5}$, SO$_2$, NO$_2$, CO during lockdown in the year 2020 but at the same time in the year of 2019, the rise of SO$_2$ level is a deep concern for this place.
Figure 2. Kolkata PM$_{2.5}$, SO$_2$, NO$_2$, CO for the period of 22$^{nd}$ March to 30$^{th}$ June, 2019 and 2020.

The figure 2 of Kolkata is clearly showing decrease of PM$_{2.5}$, SO$_2$, NO$_2$, CO during lockdown in the year 2020 but at the same time in till 15$^{th}$ of April the effect of PM 2.5 and SO$_2$ is not satisfying and at the same time rising a question on strategy behind implementation of lockdown and its success rate and local peoples’ seriousness about the issue. The data of 2018 for Kolkata was unavailable so could not be plotted.

Figure 3. Chennai PM$_{2.5}$, SO$_2$, NO$_2$, CO for the period of 22nd March to 30th June, 2018, 2019 and 2020.

The figure 3 of Chennai and Figure 4 of Mumbai is clear evident of reduction of PM$_{2.5}$, SO$_2$, NO$_2$, CO during lockdown in the year 2020 but at the same time in the year of 2019, the rise of SO$_2$ level is a deep concern for Chennai where as PM$_{2.5}$ and presence of SO$_2$ in the middle of lockdown in Mumbai pointing that a colourless gas having pungent taste and odour suddenly has increased during the lockdown. While it decreases from 15.4 µg/m$^3$ pre-lockdown to 12.5 µg/m$^3$ during the first phase of lockdown, a sudden rise was seen during the second (24.6 µg/m$^3$) and third phases (36.2 µg/m$^3$) but as NO$_2$ in Mumbai is under controllable level, surge of SO$_2$ is pointing towards coal-based consumption from power plants and cooking or heavy fuel oil use as possible reason behind.
In next study the overall Air Quality Index and corresponding Ozone (O₃) is plotted before and after lockdown for four cities in Figure 5.

Figure 5 explains the nature of overall AQI across all the cities, the nature is observed to be decreasing in nature but AQI started rising in Delhi at the month of May concludes mobility enhancement where Mumbai, Chennai, and Kolkata maintaining the same nature of slope means
lockdown mobility is restricted for these cities at the month of May. If we analyse the reduction rate of AQI pollutant parameters all together then reduction of pollutants in average is observed for Delhi, Kolkata, Chennai and Mumbai respectively as 49%, 23%, 29% and 28%. That concludes effectiveness of lockdown on pollution is less in Kolkata indicating again local people’s alertness and lack of obedience. Mobility of people and vehicle was observed to be minimum and restricted in Delhi followed by Chennai. If we conclude the impact on environment the figure 6 is evident enough that the O3 layer has been increased in Delhi the most, clearly indicating toward the effectiveness of lockdown on environment too.

4. Conclusion

Mega-cities of India like Delhi, Kolkata, Chennai and Mumbai are considered as the world's highly polluted cities where the standard of air quality index is been violated regularly. In this work the effectiveness of lockdown on environment over four megacities of India has been studied. The parameters mostly were taken from Pollution Control Board of India. The study concludes that we need to focus on how far we, the human being are responsible. It also indulges to rethink whether lockdown could be an unconventional way or alternative for saving the environment and providing a much healthy ecosystem to urban Indians. In China near about 30% of total NO₂ and 25% of total carbon emission have been reduced in the lockdown state where in India different rate of reduction of NO₂ and CO is observed. In 2019, Kolkata experienced average value of CO as 0.53902 micrograms per cubic meter where in 2020 it came down to 0.41707 micrograms per cubic meter. Though the comparative study between mega cities, effectiveness of lock down is found minimum in Kolkata and maximum in Delhi. The lack of consciousness in Kolkata could be due to lack of proper alertness and social responsibility along with socio-economic condition. Finally, effectiveness of lockdown in environment and corresponding enhancement of longevity of mother earth needed to be studied further.

5. References

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