

# An Exploratory Study of Impact of Lockdown on the Air Quality of Delhi

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**Abstract** Delhi is among the most polluted cities in the World. The level of air pollution is many times the unsafe limits as prescribed by the WHO and Indian government. There have been many interventions by the government to contain the pollution like Odd-Even scheme of vehicle rationing, prohibiting heavy traffic into the city, condemning old vehicles, construction of peripheral highways etc. However, none of the interventions have been effective to provide the desired results. On the contrary the ongoing Lockdown due to Covid-19 pandemic has brought overwhelming improvement in the air quality in not only Delhi but entire country. Multiple media reports have mentioned about clear skies, cleaner air, improvement in quality of water in rivers etc. While the deterioration of environmental conditions is linked with the anthropogenic activities, the absence of these activities during the Lockdown has brought the impact into prominence. While the Covid-19 pandemic is an unprecedented health and economic crisis, it also provides a rare opportunity to study this impact. Author has carried out this exploratory research in his city of Delhi to determine the impact of Lockdown on the Air Quality.

**Keywords:** *air quality, Covid-19 Pandemic, Delhi, impact, polluted cities*

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## 1. Introduction

At the moment the World is grappling with the unprecedented spread of novel corona virus Covid-19. About 1.7 Million individuals are infected with more than 106 thousand deaths reported in 213 countries across the globe at the time of writing of this paper. [1] Discovered in the Wuhan city of China in December 2019 the Covid-19 spread rapidly across the World necessitating the World Health Organisation (WHO) to declare it as a pandemic on 11 March 2020. [2] As a response to the situation many countries and regions initiated the Lockdown protocol by closing their boundaries and halting routine activities. In the Lockdown, all activities related to industrial, commercial, institutional category and transportation are totally restricted. People are required to stay at home and in extreme cases even the supplies are provided by the government. Only the emergency and essential services are allowed to function.

India responded to the Covid-19 situation in a staggered manner. In the early part of March when isolated cases were reported, schools were shut. As the number of cases grew in the mid March, the closure of all educational institutions was implemented. Simultaneously, the efforts to detect and isolate the infected and contacted persons were carried out. In the third week of March when the threat of community spread was anticipated, the Lockdown became inevitable. Consequently, a one day

self isolation under the name Janta (Public) Curfew was carried out on 22 March 2020 and subsequently nationwide Lockdown was initiated from 25 March 2020 to 14 April 2020, for a period of 21 days. [3] After passing of 20 days of Lockdown (at the time of writing of this paper) the number of cases in India are reported to be over 10000 with over 300 deaths. [4] With the cases still on a rise, the extension of Lockdown period is under active consideration by the government.

The Lockdown is expected to contain the spread of virus to masses and thus bring the situation in control. While the effectiveness of Lockdown in controlling the spread of Covid-19 is yet to be determined, it has definitely yielded substantial improvement in the environmental conditions across the world. It is reported from multiple cities that the air and water has become cleaner, animals are seen on the streets and noise pollution has decreased. Similarly, in India the unprecedented halt in the anthropogenic activities during the Lockdown has resulted in the significant improvement in the environmental conditions. Since, India has most number of polluted cities in the World, this development brought pleasant surprise to the people facing the Covid-19 crisis. [5]

The Lockdown has adversely impacted the economy. As per World Trade Organisation estimates the drop in the global trade is expected to be between 13% to 32% due to the disruption in the normal activities. [6] In India, the people engaged in the informal sector are severely affected by the halt in the economic activities. On

the contrary, the improvement in the environmental conditions, which is crucial for the survival is like a silver lining during this moment of health and economic crisis. Simultaneously, the scholars of environmental sciences and related disciplines are offered an opportunity by the Lockdown to evaluate the impact of anthropogenic activities on the environmental conditions and to perhaps revise the strategy and interventions in place. This study is significant because several projects with huge expenditure to remedy environmental degradation in the country have failed to attain desired results; which the few weeks of Lockdown has brought. In the following sections, Author will discuss the improvement in the air quality of Delhi during the Lockdown.

## 2. Materials and Methods

This study was carried out during the Lockdown period in India. The objective of this study is to document the immense decrease in the pollution as a result of the Lockdown. As the phenomenon of Lockdown as well as its impact on the air quality was temporary, its documentation and study was carried out in real time by using air quality data available from official sources which can be considered as reliable as primary sources.

For this study Air Quality Index (AQI) data for a period of one month from 12 March 2020 to 12 April 2020 was studied from the official source of Central Pollution Control Board (CPCB) under Ministry of Environment, Government of India. This study period of one month comprises of 13

days of pre-Lockdown and 19 days of Lockdown period to evenly assess the change in the air quality.

This study is carried out in an exploratory mode in order to convey the ongoing situation. Needless to say that because of this it may occasionally lack details which can be filled in future researches based on this study.

## 3. Impact of Lockdown on the Air Quality

One of the most amusing incident (that prompted this research) was reported in various sections of the media was that of visibility of the Himalayan range from the city of Jalandhar. The distance between Jalandhar and the Himalayas is about 150 kms. It was surprising to know that the drop in the air pollution during the first week of Lockdown was so pronounced that it offered uninterrupted view of the mountains from that distance. It was also mentioned that the Himalayas were visible about 30-40 years back from that region, highlighting that the Lockdown has reversed the air pollution accumulated during past few decades. [7] Taken by the surprise, the Author conducted a pilot study of the AQI data for the city of Jalandhar to ascertain the extent of reduction in the air pollution. For this study AQI Data for a period of one month from 12 March 2020 to 12 April 2020 was studied and sourced from CPCB. This period of one month comprised 13 days of pre-Lockdown and 19 days of Lockdown period to evenly assess the change in the air quality.

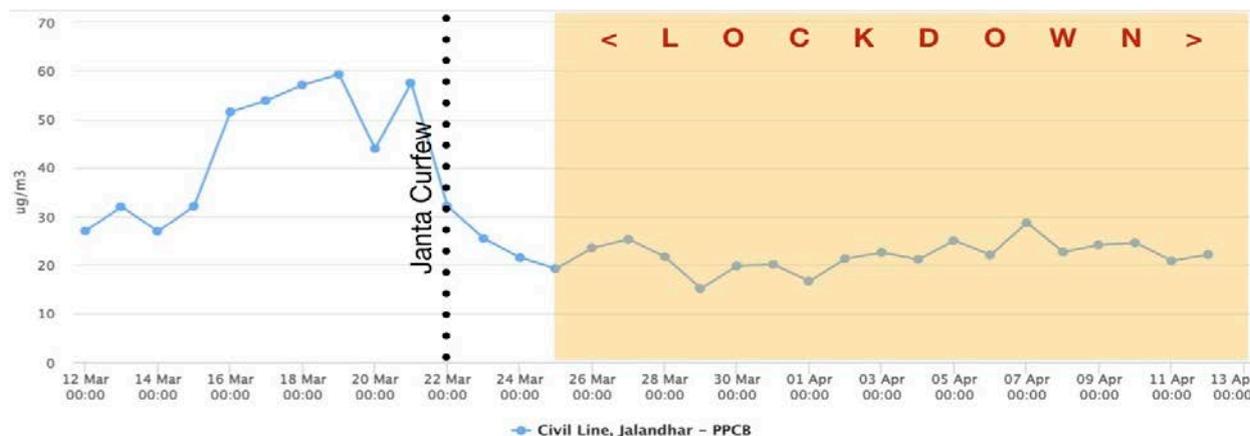


Figure 1. PM<sub>2.5</sub> Data for Jalandhar (12.03.2020 to 12.04.2020)

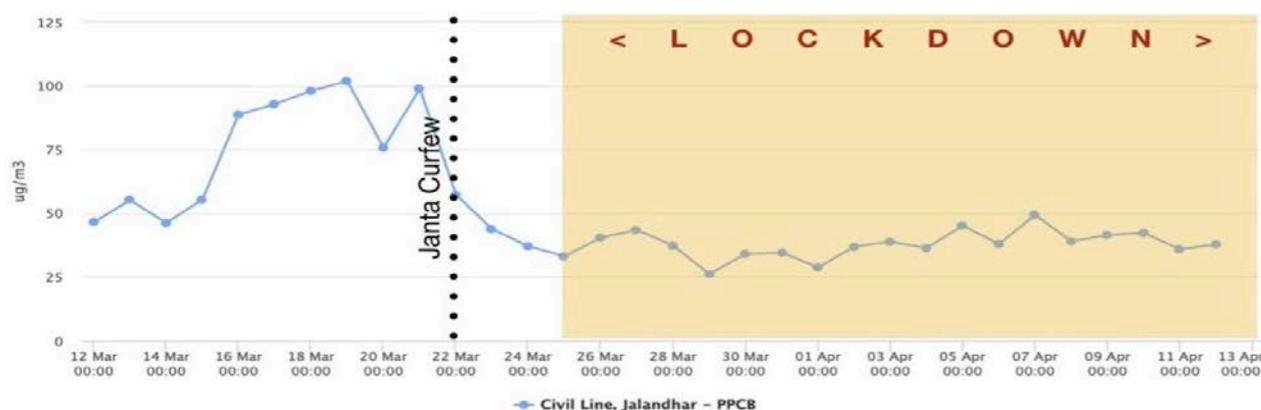


Figure 2. PM<sub>10</sub> Data for Jalandhar (12.03.2020 to 12.04.2020)

The study of AQI for the city of Jalandhar showed a drastic and consistent drop in both  $PM_{2.5}$  and  $PM_{10}$  concentration in the air. Referring to the Figure 1, it can be seen that the amount of  $PM_{2.5}$  has declined from the high of  $60\mu g/m^3$  to the low of  $15\mu g/m^3$ . The average concentration of  $PM_{2.5}$  ranges between  $20\mu g/m^3$  to  $25\mu g/m^3$  during the Lockdown, while the same being  $40\mu g/m^3$  to  $50\mu g/m^3$  in pre-Lockdown period.

Similar pattern is observed in Figure 2. The concentration of  $PM_{10}$  has dropped from the high of  $100\mu g/m^3$  to the low of  $25\mu g/m^3$ . The average concentration of  $PM_{10}$  fluctuates between  $35\mu g/m^3$  to  $40\mu g/m^3$ . [8]

By looking at both the Figs, it can be said that the reduction in the air pollution for Jalandhar is to the extent of 50% to 75%. Since, the reduction of the pollution is substantial and consistent over time and geographic region, the improvement in air quality is immense. The visibility of Himalayas highlighted the magnitude of air pollution that anthropogenic activities have caused in the past few decades.

#### 4. Impact of Lockdown on the Air Quality of Delhi

The findings of AQI data for the city of Jalandhar prompted the Author to extend the study to the city of Delhi, which is the most polluted city in the World. [9] Delhi is the capital city of India with an urban and regional population of approximately 18 million and

22 million respectively. [10] The insufficient urban infrastructure combined with most number of vehicles in the country has resulted in the extremely poor air quality in the city. [11,14] Apart from Delhi, India is home to the 21 most polluted cities among 30 in the World. [5]

The study of AQI in the city of Delhi was conducted for the ITO monitoring station, which is one of the busy junctions located in the central part of the city. The AQI data is obtained from CPCB for a period of one month from 12 March 2020 to 12 April 2020. It may also be noted beforehand that the concentration of  $PM_{2.5}$  and  $PM_{10}$  is higher in Delhi as compared to Jalandhar, which is indicative of the difference in the size and population of the cities.

#### 4.1. Change in the $PM_{2.5}$ Concentration in Delhi

Similar to the findings in the case of Jalandhar, it can be seen in Figure 3 that a decrease in the  $PM_{2.5}$  concentration has occurred in Delhi from 22 March 2020 onwards when Janta Curfew was imposed. The decline in the concentration becomes substantial 25 March 2020 onwards when Lockdown is initiated. The concentration of  $PM_{2.5}$  prior to the Lockdown was varying between  $60\mu g/m^3$  to  $125\mu g/m^3$ . However, post Lockdown the range of concentration of  $PM_{2.5}$  is seen as  $25\mu g/m^3$  to  $60\mu g/m^3$  indicating a significant drop of more than 50%. The average concentration in pre Lockdown situation was  $80\mu g/m^3$  and it almost halves to  $45\mu g/m^3$  during the Lockdown period. [8]

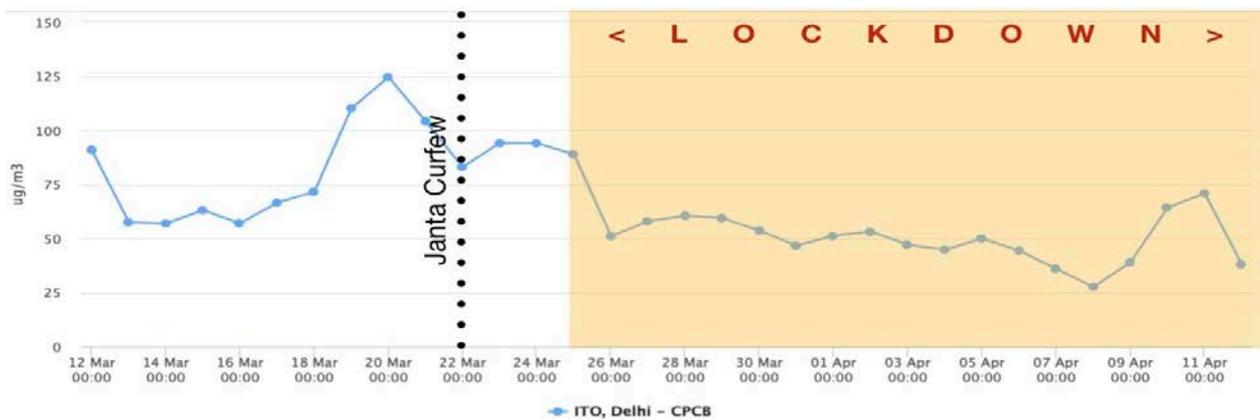


Figure 3.  $PM_{2.5}$  Data for Delhi (12.03.2020 to 12.04.2020)

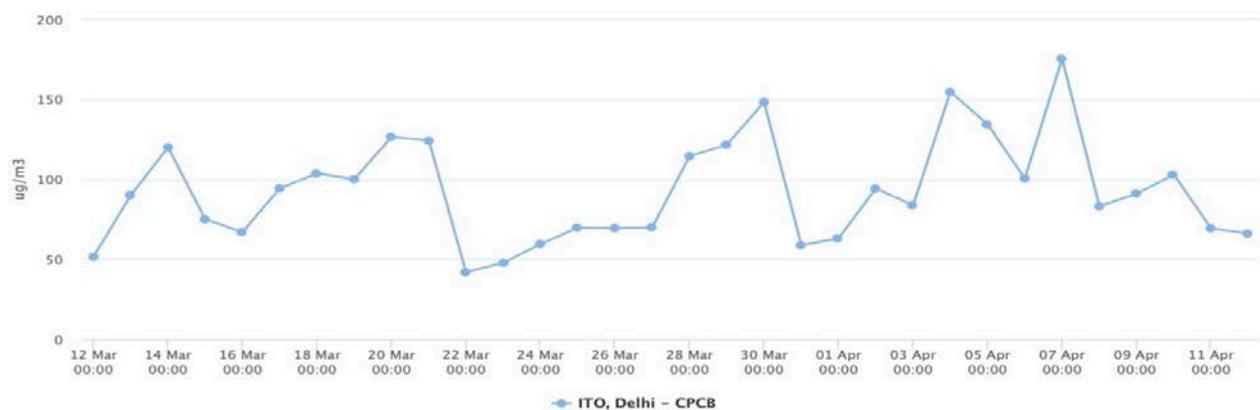


Figure 4.  $PM_{2.5}$  Data for Delhi (12.03.2019 to 12.04.2019)

In order to further verify that the decrease in the air pollution is due to the Lockdown, a comparative study of the AQI data for the same period in the previous year 2019 is conducted and shown in Figure 4. It can be seen that the AQI data keeps varying between  $50\mu\text{g}/\text{m}^3$  to  $175\mu\text{g}/\text{m}^3$ .

There is no sustained drop in the  $\text{PM}_{2.5}$  concentration during the same period in the year 2019, as seen in the Lockdown period of the year 2020. Moreover, the average  $\text{PM}_{2.5}$  concentration in the year 2019 for the study period is  $110\mu\text{g}/\text{m}^3$ , which is much higher than the average of the same period in the current year. [8]

#### 4.2. Change in the $\text{PM}_{10}$ Concentration in Delhi

Similar decrease in the concentration of  $\text{PM}_{10}$  in Delhi is noticed during the Lockdown period. Referring to Figure 5, it can be seen that the highest  $\text{PM}_{10}$  concentration which is  $175\mu\text{g}/\text{m}^3$  on 20 March 2020 drops to  $100\mu\text{g}/\text{m}^3$  on 22 March 2020 on the day of Janta Curfew. The concentration further drops to  $60\mu\text{g}/\text{m}^3$  on 26 March 2020, a day after the Lockdown is imposed. This drop is sustained almost throughout the period of Lockdown, where the maximum value of concentration is  $100\mu\text{g}/\text{m}^3$

and minimum drops down to  $35\mu\text{g}/\text{m}^3$ . The average value of concentration in pre Lockdown period is  $120\mu\text{g}/\text{m}^3$  while for during the Lockdown period is  $60\mu\text{g}/\text{m}^3$ . It can be easily deduced that the Lockdown has resulted in the reduction of  $\text{PM}_{10}$  concentration by a remarkable 50%. [8]

On comparing the  $\text{PM}_{10}$  data for the same period in the previous year 2019, it may be seen in Figure 6 that the minimum  $\text{PM}_{10}$  concentration is  $100\mu\text{g}/\text{m}^3$  while the maximum is  $350\mu\text{g}/\text{m}^3$ . The average  $\text{PM}_{10}$  concentration for the one month study period in the year 2019 is  $175\mu\text{g}/\text{m}^3$ .

While the values of  $\text{PM}_{10}$  concentration are higher in the year 2019 than the values in the same period in the year 2020, however, it may be seen that in both the years 2019 and 2020 the range is similar in the pre Lockdown period, while the decrease becomes more pronounced only during the Lockdown. The maximum concentration of  $\text{PM}_{10}$  during the Lockdown is  $100\mu\text{g}/\text{m}^3$  while it is more than three times at  $350\mu\text{g}/\text{m}^3$  during the same days in the year 2019. The minimum concentration of  $\text{PM}_{10}$  in the period concurrent to Lockdown in the year 2019 is  $100\mu\text{g}/\text{m}^3$  while it is only a quarter of that at  $25\mu\text{g}/\text{m}^3$  in the Lockdown. The reduction in the  $\text{PM}_{10}$  concentration during lockdown as compared to the same period in 2019 is a staggering 66%. [8]

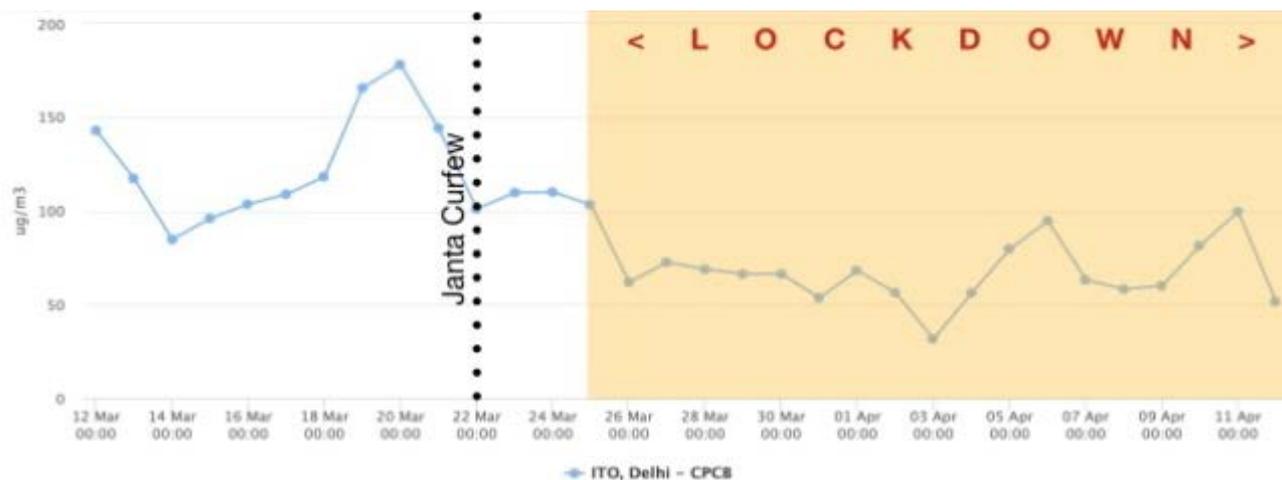


Figure 5.  $\text{PM}_{10}$  Data for Delhi (12.03.2020 to 12.04.2020)

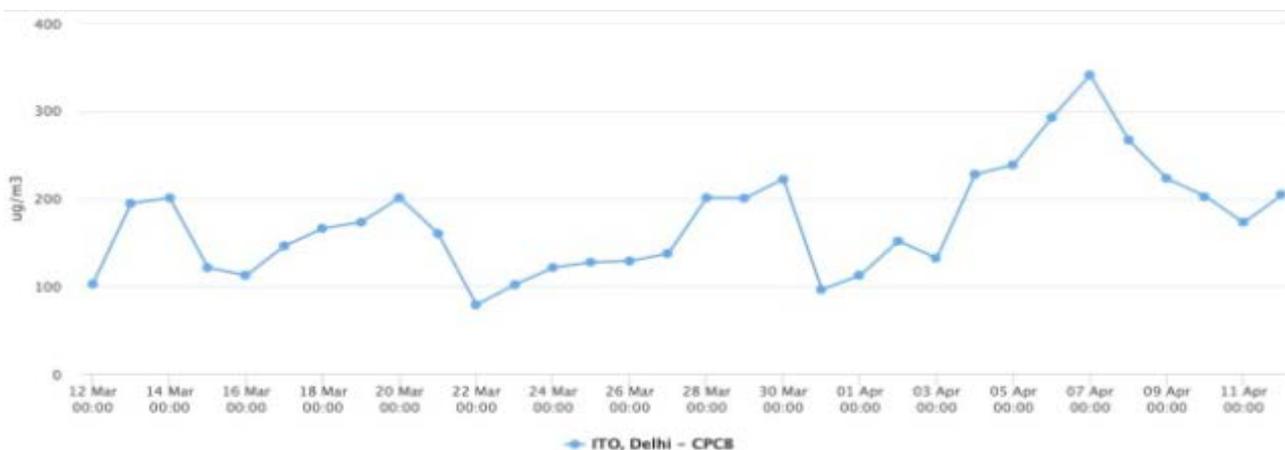


Figure 6.  $\text{PM}_{2.5}$  Data for Delhi (12.03.2019 to 12.04.2019)

### 4.3. Change in the Concentration of the Harmful Gases

It is not only the PM content of the air, the concentration of harmful gases like NO, NO<sub>2</sub>, NO<sub>x</sub>, NH<sub>3</sub>, CO, Ozone, Benzene, SO<sub>2</sub> have harmful impact on environment and health. Along with the reduction in the PM concentration as seen the previous sections, the Lockdown has caused drastic decrease in the content of harmful gases in the air. [8]

Considering, the example of NO<sub>2</sub> concentration in the air, it can be seen in the Figure 7 that there is a decrease from the peak of 65µg/m<sup>3</sup> to 40µg/m<sup>3</sup> after Janta curfew. The concentration drops further to

30µg/m<sup>3</sup> at the beginning of the Lockdown. The actual effects of Lockdown on the concentration of NO<sub>2</sub> is seen more pronounced after a week when the value decreases to 20µg/m<sup>3</sup> and remains at that level. The decrease in the average value of NO<sub>2</sub> concentration in pre Lockdown is from 40µg/m<sup>3</sup> to its half at 20µg/m<sup>3</sup>. [8]

On comparing the NO<sub>2</sub> concentration with the 2019 data the impact of Lockdown is very well corroborated. Figure 8 indicates that the NO<sub>2</sub> concentration in the year 2019 for the study period is varying between 20µg/m<sup>3</sup> to 45µg/m<sup>3</sup>, which is similar to pre Lockdown period in the year 2020. The average concentration of NO<sub>2</sub> in the year 2019 is 30µg/m<sup>3</sup>. [8]

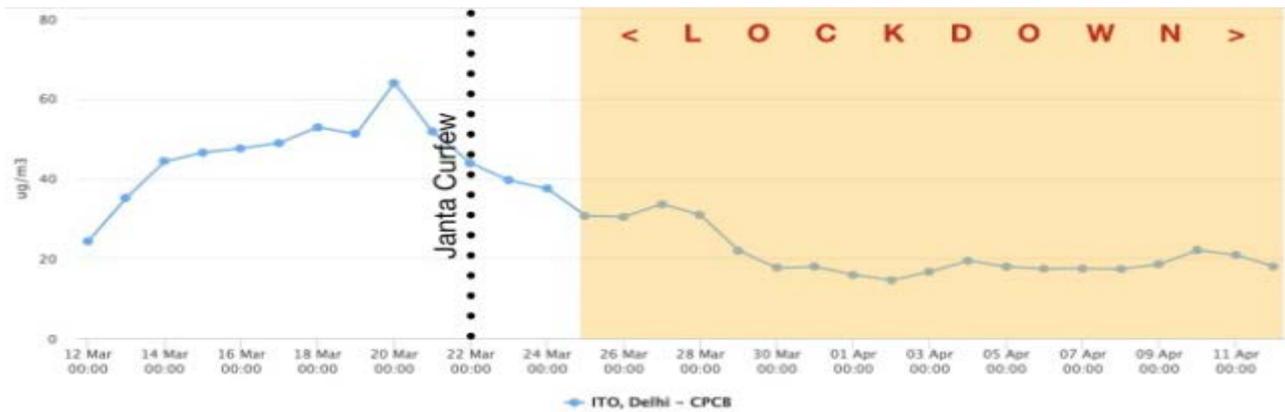


Figure 7. NO<sub>2</sub> Data for Delhi (12.03.2020 to 12.04.2020)

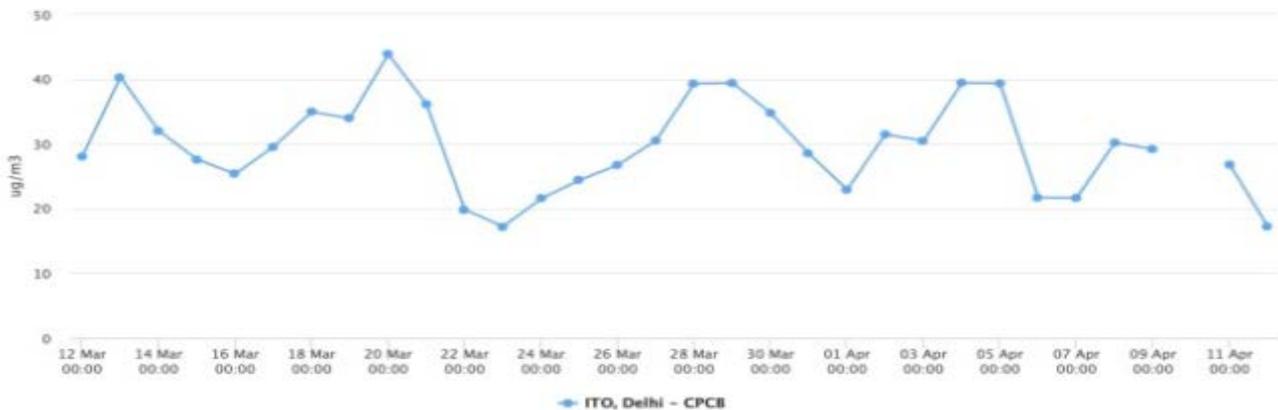


Figure 8. NO<sub>2</sub> Data for Delhi (12.03.2019 to 12.04.2019)

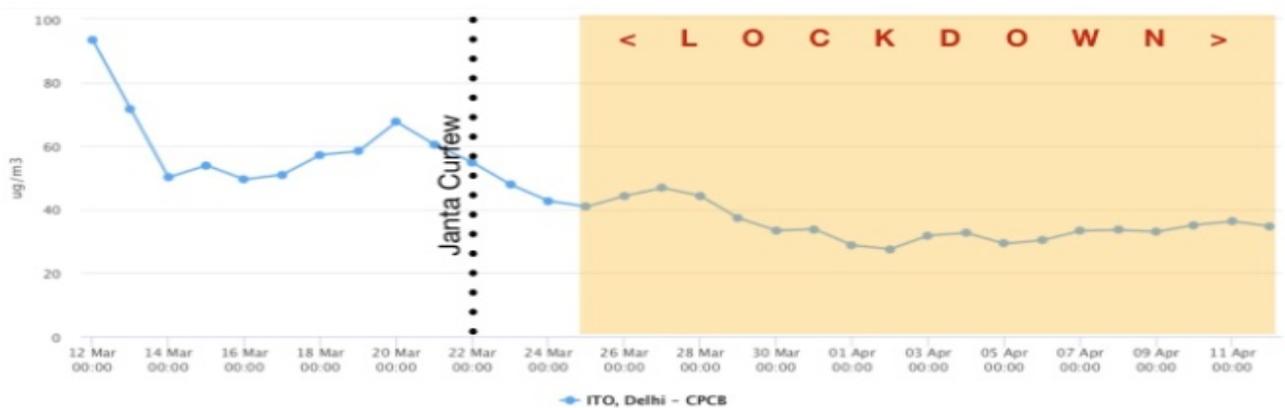


Figure 9. NO Data for Delhi (12.03.2020 to 12.04.2020)

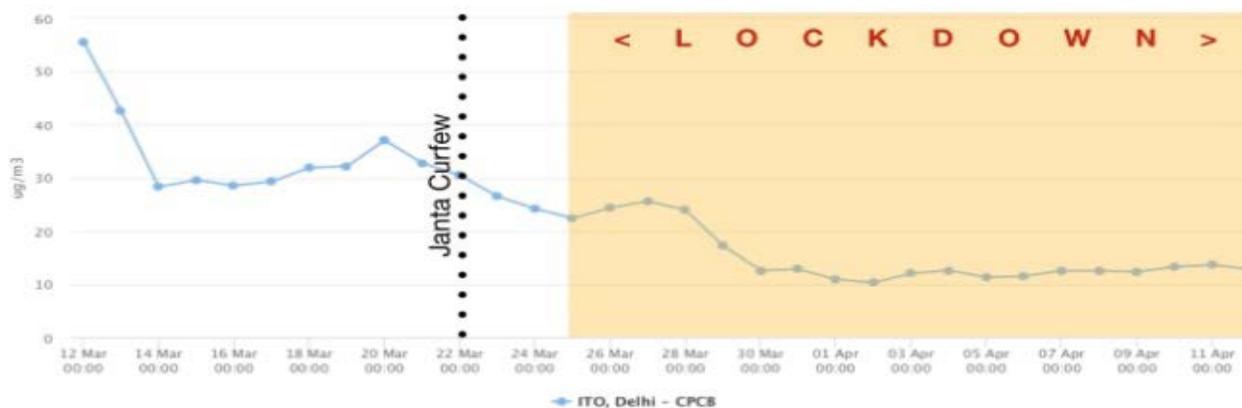


Figure 10.  $\text{NH}_3$  Data for Delhi (12.03.2020 to 12.04.2020)

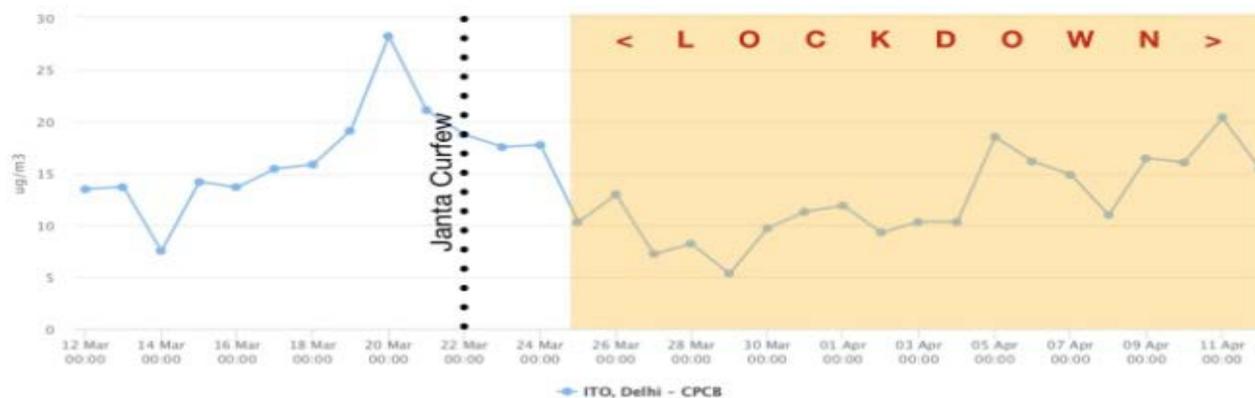


Figure 11.  $\text{SO}_2$  Data for Delhi (12.03.2019 to 12.04.2019)

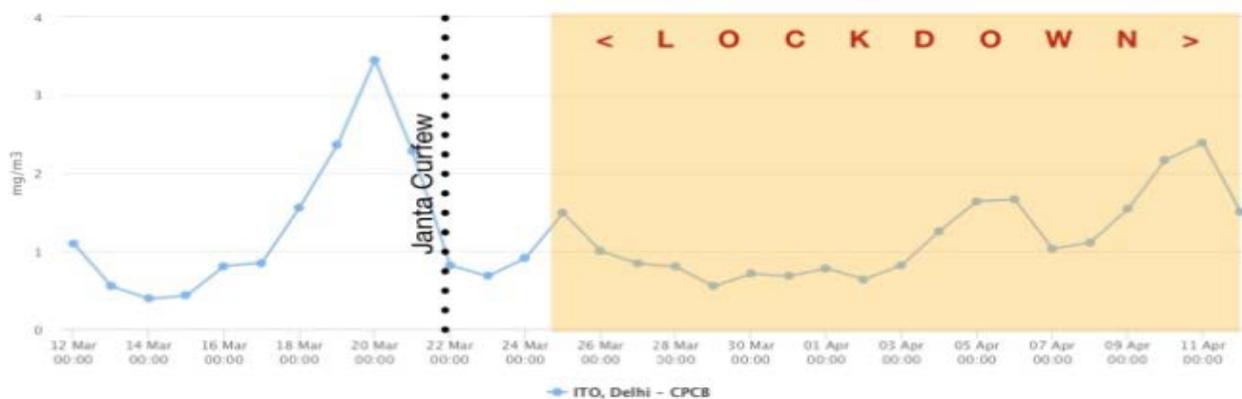


Figure 12. CO Data for Delhi (12.03.2020 to 12.04.2020)

The impact of Lockdown can be seen in other gases as well. Figure 9, Figure 10, Figure 11, Figure 12 depict the decrease in the concentration of  $\text{NO}$ ,  $\text{NH}_3$ ,  $\text{SO}_2$  and  $\text{CO}$  respectively in the air of Delhi. Similar to the case of  $\text{NO}_2$ , there is decrease in the concentration of  $\text{NO}$  (See Figure 9) to almost half from  $50\mu\text{g}/\text{m}^3$  to  $25\mu\text{g}/\text{m}^3$  with the beginning of the Lockdown, which became more pronounced as the Lockdown progressed.

The concentration of  $\text{NH}_3$  (See Figure 10) shows a greater decrease from  $30\mu\text{g}/\text{m}^3$  to  $10\mu\text{g}/\text{m}^3$  between pre-Lockdown and Lockdown period. In the case of  $\text{SO}_2$  and  $\text{CO}$  as seen in the Figure 11 and Figure 12 respectively, the decrease in the concentration of these gases is seen soon after the Janta Curfew similar to that of other pollutants discussed above. This decrease is sustained for about 10 days of the Lockdown period,

after which the levels start to rise again. However, the difference in the peak value of concentration remains significant between pre Lockdown and Lockdown period. [8]

The rise in the concentration in the  $\text{SO}_2$  and  $\text{CO}$  during the later part of the Lockdown is unlike other pollutants where the decrease in the levels is maintained throughout. This increase may thus be due to some specific reason and can be investigated separately. Author chose not to compare the data for the  $\text{NO}$ ,  $\text{NH}_3$ ,  $\text{SO}_2$  and  $\text{CO}$  gases from the previous year 2019 to avoid repetition in the writeup. However, it is safe to assume that the pattern seen in the previous sections is true for these gases as well. It is very well established that the Lockdown has resulted in the decrease in the emissions of these gases from industries and vehicles.

**Table 1. Decrease in the concentration of pollutants in Delhi during Covid-19 Lockdown**

Pollutant	Standard Value as per EPCA ( $\mu\text{g}/\text{m}^3$ )	Average Value ( $\mu\text{g}/\text{m}^3$ ) Year 2019	Average Value ( $\mu\text{g}/\text{m}^3$ ) Year 2020		Decrease (%) 2019 vs 2020	Decrease (%) Pre-Lockdown vs Lockdown
			Pre-Lock Down	Lockdown		
PM <sub>2.5</sub>	40	110	80	45	60%	44%
PM <sub>10</sub>	60	175	125	60	66%	50%
NO <sub>2</sub>	40	30	40	20	33%	50%
NO	-	-	50	25	-	50%
NH <sub>3</sub>	-	-	30	10	-	66%
SO <sub>2</sub>	-	-	18	12	-	33%
CO	-	-	1.8	1.2	-	33%

## 5. Results and Discussion

The above study of the AQI in Delhi proves that the Lockdown has resulted in the significant decrease in the pollution of the city. The decrease in the average concentration levels (See Table 1) is in the range of 33% to 66% across the category of pollutants. This decrease brought down the levels of pollutants at par with the standard limits. As per Indian standards the average standard for PM<sub>2.5</sub> is  $40\mu\text{g}/\text{m}^3$  which is acceptably close to the value of  $45\mu\text{g}/\text{m}^3$  measured during the Lockdown. For PM<sub>10</sub> the values of  $60\mu\text{g}/\text{m}^3$  during the Lockdown are at par with the average standard. In the case of NO<sub>2</sub> the concentration of  $20\mu\text{g}/\text{m}^3$  during the Lockdown is half of the average standard of 40. [12]

It may be noted that many activities like educational institutions were already closed from the beginning of March 2020, causing some decrease in the pollution in the pre Lockdown period. [13] This is evident from the year on year comparison with the data of previous year 2019. In Table 1, it can be seen that the drop in the concentration levels during the Lockdown is far more significant when compared to the previous year 2019. Thus, the effective impact of Lockdown on the air quality is even more than what is perceived in the current scenario.

Another important finding of this study is that the improvement in the air quality was immediate and didn't require time to manifest. This implies that the pollution in the city is caused by the everyday activities and is not a result of any long term phenomenon. Further, it can be seen that the concentration of pollutants continue to decrease for a few more days as the Lockdown progresses, finally stabilising to the optimal levels. The stabilised levels are at par with the acceptable and prescribed levels.

## 6. Conclusion

For Delhi, which is the most polluted city; the findings of this exploratory study may help in revising the strategies for the air pollution control. Many schemes and projects in the past like Odd-Even rationing of private vehicles, imposing pollution compensation charges on heavy vehicles, increase in the parking rates, construction of peripheral highways etc have failed to yield the desired results. The air pollution in Delhi and many other cities in the country are a perpetual health crisis and causes chronic medical conditions in thousands of people including

premature deaths. [12] The magnitude of the crisis can be gauged by the fact that in Delhi the air pollution results in the irreversible damage to the lungs of 2.2 million children. And in India air pollution accounts for the death of 2 million people every year. [9]

It is ironical that the health emergency caused by the Covid-19 pandemic has indirectly catalysed a solution to another health crisis i.e. pollution. This solution is albeit temporary as the pollution level will rise again once the Lockdown is lifted. The Lockdown is unprecedented but has given us a rare opportunity to understand the impact of anthropogenic activities on the environment. This exploratory research highlights the capacity of nature to quickly reverse the damage and initiate the healing process as soon as given a chance. Policy makers, professionals and researchers can emphasise on this aspect while formulating their actions.

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