Original Research Article

Effect of COVID19 lockdown on Air Quality and Solid Waste generation: A Case study in a Metropolitan City, Mumbai, India

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Abstract

Background: There is limited information describing the change on Quality of Air and Solid Waste Generation if there is limited and efficient use of Vehicles and the shutdown of Industries producing hazardous air pollutants that have been achieved by the lockdown.

Objective: To describe the changes in the Quality of air and Solid Waste Generation due to Lockdown.

Materials and methods: It was an analytical study where the data was received from Maharashtra Pollution Control Board data for Mumbai during the period from December 2019 to July 2020. Analysis of Air pollutants like PM10, SO2, NO2, Air quality index, and Solid waste generated were taken into consideration.

Results: Air quality data has been analyzed from December 2019 to July 2020 and the data were compared before lockdown (December, January, February, March) and during lockdown (April, May, June, and July) where the Mean Air Quality Index before the lockdown was 251 which is very unhealthy and During lockdown was 62 which is Moderate which is a 75% reduction in the pollutants and the Solid waste generation before the lockdown was 6338.63 metric tons per day which have been reduced to 4121.23 metric tons per day which was a reduction of 34.98 %.

Conclusion: This study provided information about how the environment would heal itself if there is a restriction on the use of vehicles and shutting down factories producing hazardous pollutants. This would provide the evidence for the Maharashtra Pollution Control Board to implement policy to

improve Air Quality and Solid waste generation, which would have a positive impact on human health and ecosystem.

Key words

COVID19, Lockdown, Mumbai, Air Quality Index, Solid waste, PM10.

Introduction

Imagine a world where the pollution producing vehicles, Industries are forced to be at halt, leading to clean air to breathe. Since December 2019, novel coronavirus (2019-nCoV) infected pneumonia (NCIP) have been identified first in central China in Wuhan [1]. The outbreak rapidly spread across the globe in a very short period. As per the latest situational report by the WHO – 9 million people have been infected by Novel coronavirus all around the world and about – 0.4 million deaths have been reported [2]. Following world trends, the disease has also spread in India. The first case was reported in India on 1st February 2020. One of the most effective preventive measures India has adopted is Complete Lockdown. India has followed a nationwide lockdown for about 60 days which is one of the largest pan nation lockdowns. Nationwide Lockdown for Corona in India was started on 25th March-2020 ended on 31st May-2020 and it has been started lifting from 1st of June in a phase-wise manner. Maharashtra which has a population of 12 million, ranks top on the total cases and deaths in India. Mumbai which is the capital of Maharashtra has the highest number of cases in India which is the economic capital of India and ranks top in poor Air quality in the world.

Air pollution is considered as one the accelerator of COVID19 transmission because PM can act as a carrier of viable virus particles and can spread it beyond 2 meters distance. Setti, et al. studied the role of air pollution in the spread of SARS-CoV-2 in Italy. The study noted the Lombardy and Po Valley region in northern Italy has the highest number of COVID19 cases and the most polluted air in the country. Based on the univariate analysis, it was established that PM10 value exceedances (>50 µg/m^3) were a significant predictor of SARS-CoV-2 infection while comparing the infection and air pollution data of 43 cities with higher and 67 cities with lower PM10 Concentrations [3].

Human life has come to a standstill as many countries shut themselves off from the work due to the Novel Coronavirus disease pandemic COVID-19 that hit the world severely in the first quarter of 2020. All types of industries, vehicle movement, and people's activity suddenly halted, perhaps for the first time in modern history. For a long time, it has been stated in various literature that the increased industrialization and anthropogenic activities in the last two decades polluted the atmosphere, hydrosphere, and biosphere. Since the industries and people's activities have been shut off for a month or more in many parts of the world, it is expected to show some improvement in the prevailing conditions in the aforementioned spheres of environment [4].

Air is one of those fundamental necessities, without which life cannot exist in its current form. Air pollution is one of the foremost and grave public health and environmental anxiety in most of evolving countries. In the Indian context, cities such as Mumbai have shown a reduction of 34% in PM level respectively during the lockdown from March 25th March (Source: Atmos Real-Time Air Quality, Respirer Living Science, Mumbai, India.)

Air pollution plays a major role in Comorbid conditions such as hypertension, diabetes, and coronary artery diseases that are exacerbated by air pollution. COPD and other chronic respiratory morbidities are worsened in high pollution states. Every year almost six lakh Indians die due to side effects of air pollution [5].

Air pollution is the fifth leading risk factor for mortality worldwide. It is responsible for more deaths than many better-known risk factors such as malnutrition, alcohol use, and physical activity. Each year, more people die from air pollution-related diseases than from road traffic injuries or malaria. Mass scale health problems due to air pollution also impose a considerable burden on the national economy, particularly for developing countries where the government is the foremost contributor to the health facilities [6].

During lockdown people are urged to stay and work from home, restaurants, shopping complexes are closed and people go out only to meet the most urgent needs like buying food. Therefore COVID19 caused a drop in solid waste generation. It's interesting to consider these changes in people's behaviour in the longer term. Interestingly COVID19 has accidentally contributed to progress towards meeting several sustainable development goals in particular SDG 12 (Ensure sustainable consumption and production patterns), including a target to halve per capita food waste at the consumer level by 2030 [7].

Mumbai generates waste approximately 7,025 tonnes of solid waste per day. It is collected by garbage collectors and dumped at the dumping grounds at the northern part of Mumbai. In this study, we assessed the Impact of Lockdown on Quality of Air and Solid Waste generation in a Metropolitan City (Mumbai), India.

Materials and methods

Hypothesis
Ho- There is no impact of lockdown on Air Quality and Solid Waste generation.
H_A- There is an impact of lockdown on Air Quality and Solid Waste generation.

Methodology
Study design: A Retrospective analytical study.
Study Area: A Metropolitan City
Study duration: December 2019 to July 2020

Independent Variable: Time
Dependent Variable: Real-time Air quality (µg/m3) and Quantity of Waste generated (Metric Ton).
Patient and Public Involvement: There was 'No patients involved 'in the study.

Method of data collection
- Data was available with the Maharashtra pollution control board.
- Permission had been taken from the Member secretary of Maharashtra Pollution Control Board and data was collected from the Air Quality and Solid waste Management department.
- Air Quality Data was received as an Excel file for the period from December-2019 to July- 2020 and Solid Waste Generation data was received as an Excel file for the period from 1st March to 30th April.
- Data of various parameters have been compared before and after Lockdown.
- The comparative and impact Data analysis had been done and formulated in Figures and Tables.
- Data analysis had been done using Appropriate statistical methods.

Materials used
- Laptop with internet access
- Excel
- SPSS software

Statistical analysis
Data thus collected had been compiled and analyzed in Microsoft Excel sheets. For the application of the test of significance and correlation, SPSS statistical software had been used. A P-value less than 0.05 had been considered as statistical significance

Ethical
The Study had been started after receiving permission from Member Secretary of Maharashtra Pollution Control Board (MPCB)

and the data was used only for educational purposes.

Results

Figure - 1 indicates the decline in Month wise per day average on Air Quality Index and Air Pollutants after the lockdown was implemented on 25th March.

Figure - 2 showed a comparison of Nitrogen Dioxide level between (1st January – 24th March 2019 and 2020) and between (25th March – 20th April 2019 and 2020) which showed the reduction in NO_2 levels from 24th March – 20th April 2020 compared to 2019 whereas there was no reduction in NO_2 level from 1st January – 24th March 2020 and 2019. This signified the effect of lockdown on NO_2.

Figure - 1: Month-wise per day average Comparison of Air quality index and Concentration of air pollutants before and during the lockdown.

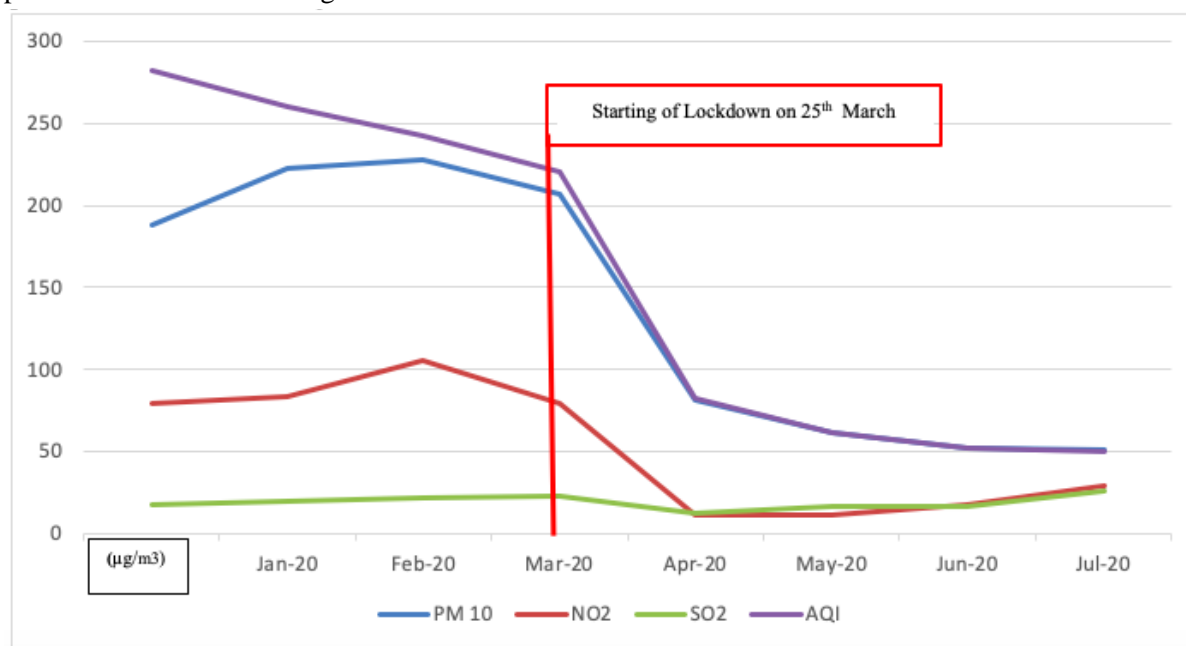**Table - 1** shows the reduction in Air Quality Index, PM10, NO_2 and SO_2 by 75%, 71 %, 79% and 14%. There was a significant decrease in Air pollutants during lockdown compared to before lockdown. If the p-value is <0.05 then there is a significant effect of lockdown on air pollutants and the null hypothesis would be rejected.

There was statistical significance among AQI, PM10, and NO2, but not with SO2 the reason behind this is that vehicular halt doesn't have an impact, due to the Bharath stage six (BS6) emission which reduces the Sulphur content released 5 times than BS4 and it also indicates the functioning of Industries (Power Plants) even during the lockdown.

Figure - 3 showed the reduction in the trend of daily solid waste generation during the lockdown.

Table - 2 showed the mean daily solid waste generated before lockdown was 6338 Metric tons and after lockdown was 4121 Metric tons which was a reduction of 34.9% reduction in Solid waste generation during lockdown compared to before Lockdown. If the p-value is <0.05 then there is a significant effect of lockdown on air pollutants and the null hypothesis would be rejected.

Figure - 2: Comparison of Nitrogen Dioxide level at troposphere in 2019 and 2020 by the European Space agency [8].
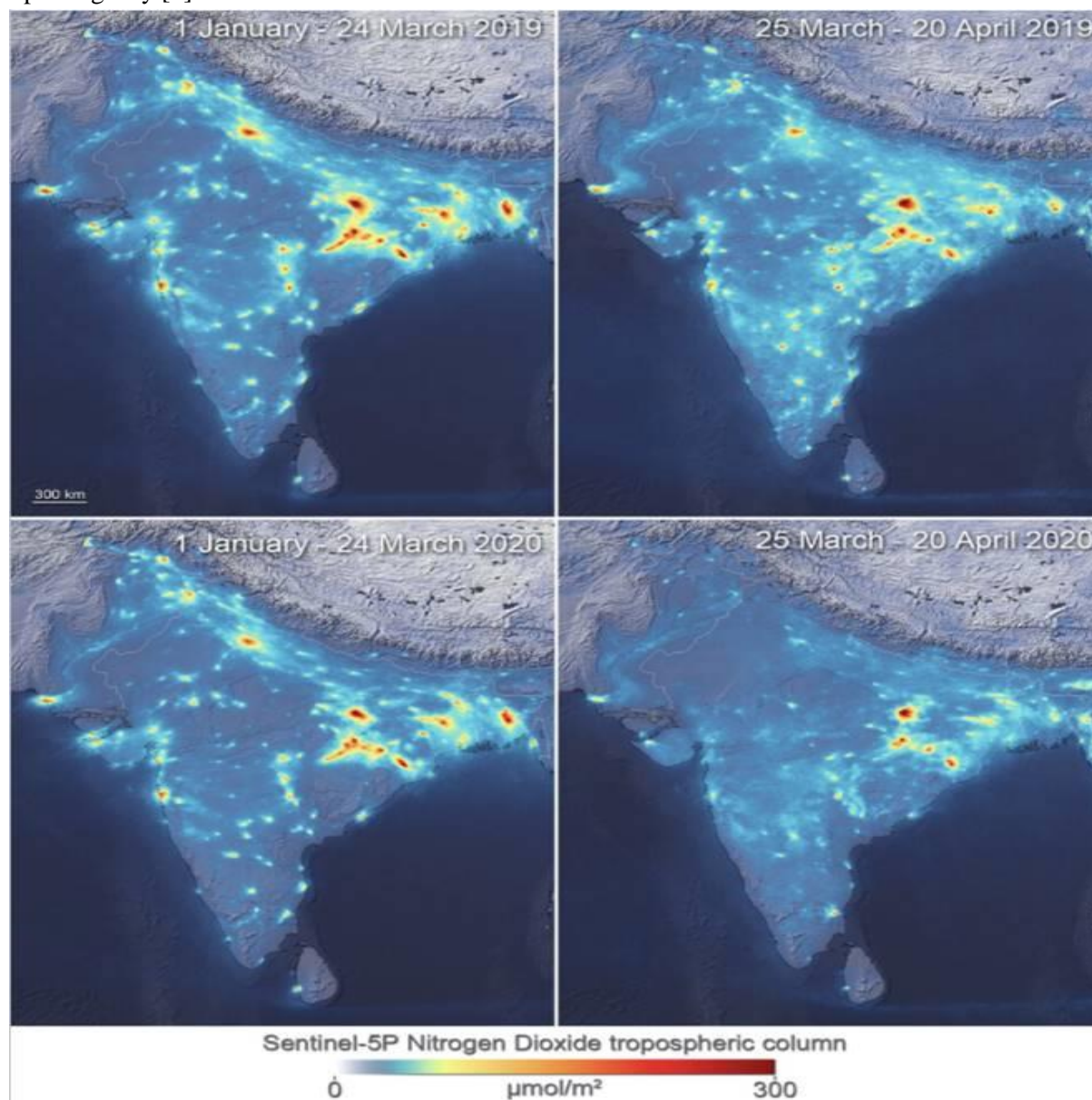
Discussion

Covid-19 which originated in Wuhan has spread to all parts of the world which has infected 13 million people of which 0.5 million have succumbed to it. Since there is no proven cure for the virus. Locking down in homes and social distancing is the only preventive step that the entire country is following. But as human activities are restricted in most of the areas, the natural environment of the country has started healing itself. Factories, transport, vehicles, and aviation have all been grounded to halt which has led to an improvement in the quality of air. Air quality Data which was taken from December to July shows a remarkable reduction in Air Quality Index, PM10, NO_2 and SO_2 by 74%, 70%, 79% and 12% during the lockdown and Data of Solid waste generation from March and April shows 35% reduction showing a significant effect of Lockdown on Environment.

Snehal, et al. [9], in his study on the indirect impact of COVID19 on the environment, demonstrated that the air quality in New Delhi which was horribly high between 300-400 before lockdown has become 94 which is moderate and

there is also a reduction in PM10, NO_2, and CO at India's most polluted city (Ghaziabad).

European space agency revealed that there is a significant reduction in Nitrogen dioxide (NO_2) levels (generally emitted in the atmosphere through vehicular exhausts, power plants, and industries) in the Indian atmosphere during the lockdown. NO_2 will have a negatively effect on the environment, as it leads to the production of acid rain. Acid rain will then disrupt food chains by impacting ocean acidic levels as well as harming multiple plants and trees, it may also lead to a decrease in aquatic animals.

Table - 1: Analysis of the effect of Lockdown on the environment using the Paired T-test for analysis.

VARIABLE	MEAN		P-Value	Interpretation	Remark
	BEFORE	**DURING**			
AQI	251	62	**0.0001**	Null Hypothesis is **rejected**	There is a significant effect of Lockdown on Air quality index
PM10 (μg/m3)	212	62	**0.002**	Null Hypothesis is **rejected**	There is a significant effect of Lockdown on PM10
NO2 (μg/m3)	87	18	**0.002**	Null Hypothesis is **rejected**	There is a significant effect of Lockdown on NO2
SO2 (μg/m3)	21	18	**0.278**	Null Hypothesis is **accepted**	There is no significant effect of Lockdown on NO2

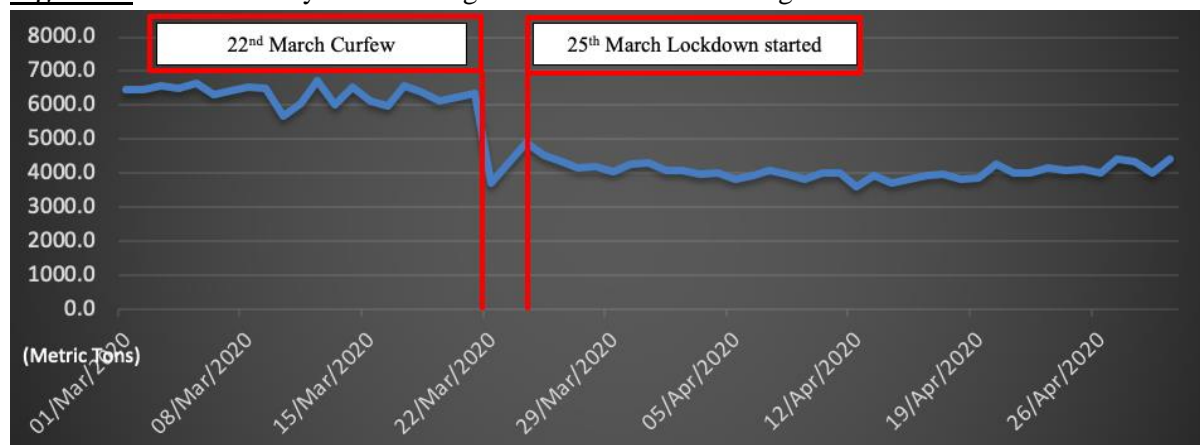**Figure - 3:** Trend of daily solid waste generated before and during the lockdown in Mumbai.

Table - 2: Analysis of the effect of Lockdown on Solid waste generation using a Paired T-test for analysis.

VARIABLE	MEAN		P-Value	Interpretation	Remark
	BEFORE	**DURING**			
SOLID WASTE GENERATED/ DAY	6338.63/MT	4121.23/MT	0.0003	There is a significant effect of Lockdown on Solid Waste generation	The Null Hypothesis is **rejected.** **There is a significant effect of Lockdown on solid waste generation**

Based on the results, the results support the hypothesis, that lockdown has a positive impact on the environment.

Conclusion

The observed effect due to lockdown has a significant effect on air quality. This significant improvement in the quality of air due to lockdown indicates the effect of factories and vehicles on the environment. The exposure to NO2, SO2, PM10, etc. can lead to severe health risks.

Lockdown has emerged as a blessing for the natural environment providing it a "recovery time". We have also learned that the environmental degradation caused by humans is not irreversible. In a period of just 1–2 months, "recovery of nature" is being witnessed by everyone. This is a signal for us to understand and react. Government and Policymakers should take necessary steps so that this healing process does not become a temporary thing.

Strengths

This was a Novel study and it could act as proof that how temporary controlling pollution can bring an impact on the environment.

Weakness

A weakness of the investigation would be that the data was taken from a secondary source. By using a secondary source, this questions the accuracy of the data used. The method of data collection was unknown so there may be some human error.

Solution

Motor-vehicles and industries are one of the main causes of air pollution. Since lockdown isn't a permanent solution, the introduction of eco-friendly methods of transportation, such as electrical vehicles, use of public transport, car-pooling, strict checks on vehicular servicing should be followed. People can cycle or walk short distances.

The strength of this solution would, not only be healthy but also reduce the number of pollutants released in the air. Pollution control methods such as the odd-even rule, car-free Sunday should also be implemented nationwide. There should be continuous monitoring of pollutants released by industries and the government should make sure that they are being treated properly before being released into the environment.

A weakness to the solution is that Electrical cars are much more costly, which means being a middle-income country it would be difficult to implement. But to implement this, our government has to provide electric tax-free so it would attract the buyers and spend money on infrastructure for the charging station. Due to an increase in demand for products and development, it would be difficult to stop industrialization and but it could be overcome by newer technologies called scrubbers captures carbon from the gases released out. That being said this strategy is not cheap and building it would be reflected in the consumer's goods costs.

The control of Air pollution and waste generation doesn't depend solemnly on Programs and policies, human behaviour place a major role. Programs and policies with community participation would be the solution for an eco-friendly environment.

Contributors

Dr. Joshua conceived the study and had oversight as Principal Investigator. Dr. Joshua wrote the protocol, developed the methodology used in the study, Permission for data collection was received with the help of Dr. Snigdha, conducted the statistical analysis with guidance from Dr. Monali. All members of the team were involved in the drafting and commenting on further revisions of the manuscript. All authors read and approved the final manuscript.

Data Sharing Statement

This study was based on the secondary data which had been received from Maharashtra Pollution control board, which does not permit data sharing unless the permission is received from the Pollution Control Board.

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