# Impact of Lockdown on Air Quality in India

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**Abstract**
*The Covid-19 crisis has forced activity freezes, Lockdowns and calls to shelter-in-place have closed schools and non -essential businesses. Minimal activities from industrial sites, factories and construction sectors have minimized the risks for toxins to escape, in turn improving air quality. People are forced to stay at home practicing social distancing and working remotely. It is all aimed at controlling the spread of Covid-19 and hopefully reducing the death toll. But all this change has also led to some unexpected consequences. One among them is pollution levels and the natural environment. Before the start of the Covid-19 pandemic, the air around us had been deemed very toxic to breathe in due to the number of greenhouse gases that had been emitted over the centuries. But after the coronavirus lockdown commenced, there were slight changes in the environment. In the above context, a study should be undertaken to analyze the air quality indicators during non-lockdown period and the lockdown period is inevitable and essential. In this regard, the researcher wants to analyze the air quality of Chennai City by comparing the air quality indicators values like P.M.2.5, NO2, SO2, CO for the year 2019 with 2020 (same period). Accordingly, the researcher has collected data information and analysed it with the help of regression analysis and trend lines. The results revealed that during the lockdown period, everything was shut down and it would decrease the values of the above said air quality indicators, especially the concentration of P.M.2.5 because it is the major factor contributing to air pollution. It was proved by many earlier studies and this study also proved the same. The data set revealed that nearly 80 percent of the air pollution was due to the concentration of P.M.2.5 and its concentration was lowered during the lockdown period. Hence, to avoid air pollution, authorities should be taken steps to reduce P.M.2.5 concentration. It is good for the environment, the health of the living organism and the sustainable development of the economy.*

**Keywords: Air Quality, Covid-19-Lockdown, Fine Particulate Matter, Air Quality Index**

## Introduction

In a matter of months, the World has been transformed.Thousands of people died and Lakhs have fallen ill from Coronavirus that was previously unknown. Due to the outbreak of the coronavirus, many countries had adopted lockdown procedures that stopped people from moving out and for shops and other establishments to close down. The Covid-19 crisis has forced activity freezes, Lockdowns and calls to shelter-in-place have closed schools and non -essential businesses. Minimal activities from industrial sites, factories and construction sectors have minimises the risks for toxins to escape, improving air quality.

(Mariecor Agravante, April, 2020). After authorities implemented strict lock down the streets of India are deserted, the strict travel restrictions are in place, the malls and theatres have been closed and people have been asked to stay in their homes; worldwide flights are being canceled or turning around in mid-air as the aviation industry buckles. People are forced to stay at home practicing social distancing and working remotely. It is all aimed at controlling the spread of Covid-19 and hopefully reducing the death toll. But all this change has also led to some unexpected consequences. One among them is pollution levels and the natural environment.

Before the start of the Covid-19 pandemic, the air around us had been deemed very toxic to breathe in due to the number of green house gases that had been emitted over the centuries. The Earth faced rising temperatures, which led to the melting of glaciers and rising sea levels. Environmental degradation was happening fast due to the depletion of resources such as air, water and soil . But after the coronavirus lockdown commenced, there were slight changes in the environment (Dianne Nongrum, 2020). This paper looks at the impact the Covid-19 lockdown has had on the Air Quality in Chennai City.

Covid-19 Lockdown had been implemented in Tamil Nadu in 7 Phases such as:

| | |
|---|---|
| First Lockdown: | From March 25 to April 14-21 Days |
| Second Lockdown: | From April 15 to May 3 19 Days |
| Third Lockdown: | From May 4 to May 17 : 14 Days |
| Fourth Lockdown: | From May18 to May 31:14 Days |
| Fifth Lockdown: | From June 1 to June 30- 30 Days |
| Sixth t Lockdown: | From July 1 to July 31-31 Days |
| Seventh Lockdown: | From August 1 to August 31-31 Days |

**Materials and Methods**

The air pollutants such as SO2, NO2,, CO, PM 2.5 and Air Quality Index are collected from Four Stations, namely Alandur Bus Station, Manali, Manli Village area and Villacherry Residential Area. Data is collected from the Central Pollution Control Board website and consolidated to represent the entire city. Data is collected from March 25th the beginning date of Lockdown, to August 31st 2020, which covers the 7 phases of Lockdown in Tamil Nadu. To facilitate comparison, similar data for the previous year 2019 is used. These pollutants are taken into account because of their effects on human health and the physical environment.

Regarding Sulphur Oxide (SO2), short-term exposure can harm the respiratory systems, making breathing difficult. It can affect visibility by reaching with other particulates to form haze and stain culturally important aspects such as statutes and monuments. Nitrogen oxide (NO2), Aggravates respiratory illness, causes haze to form by reaction with other air particles, causes acid rain, pollutes coastal water, Carbon mono oxide (CO), High concentration in air reduces oxygen supply to critical organs like the Heart and Brain. At very high levels, it can cause dizziness, confusion, unconsciousness and even death. Fine Particulate matter (PM2.5) pollution can irritate the eyes, nose and throat, coughing, chest tightness and shortness of breath, reduced lung function, irregular heartbeat, asthma attacks, heart attacks and premature death in people with heart or lung disease. The air quality index is based on the summary of the Air Pollutants present in the city.

The impact of above-mentioned air pollutants was studied by various authors in different parts of India in recent year. Chimurkar et.al (2020) examined the effects of the COVID-19 in national lockdown on Ambient Air Quality across Urban India. The hourly concentration of PM10, SO2, NO2, and CO over 17 cities, one Station in each city were considered for analysis. Sudhakar et.al (2020) used comprehensive air quality data in two cities of India, Lucknow and NewDelhi and Air Quality data were collected from 14 sites Viz, central school, GomtiNagar, Lalbagh and Talkotoria of Lucknow city and Anand Nagar Bawane, CRRI Mathura Road, Dwarka-Sector 8, IGI Airport (T3) Delhi University North campus, PUSA. Rohini, Vivek Vihar and Warinpur of Delhi City. Likewise, Nisar Kahan (2020), Prashant Kumar et.al (2020) , Ramesh et.al (2020) , Prattima Kumari and Durga Toshinwal (2020) and Snehal Lokhandwala and Pratibha Gautam Studied and stated the positive environment on air quality and positive externality on air pollution by Covid-19 lockdown period. These studies are a point of lock down period and mostly attempted to the north region of India. Hence, here

is an attempt to reveal about the southern region of India during the seven phase of the National Lock Down on Air quality.

As per 2020 statistics Area of the Chennai Metropolitan Area is 1189 sq km and the size of the population is 10.9 millon (1.09 crore) (population. com/cities/Chennai-population). As of 2012, 34260 identified companies in 15 Zones. Total employment in MSME is 4,49,309 1,36,175 MSME units. (2014-15) Chennai is home to over 4000 IT companies. Number of Tourist arrivals Domestic, 3,61,60,323 and foreign, 8,21,468 (2016=17). The Registered Vehicles in Chennai city as on 2017-2018 are 2,35,237 commercial consisting of Mini Buses, Auto Rickshaws, Omni Buses, School Buses, college buses, lorries etc., on the other hand, Registered Non-commercial vehicles are Moto cycles, Scooters, Mopeds Tricycles, Car, Jeep, Tractor, Station wagons etc are 48,36,702. The vehicle density per Km of Road in Chennai is 2093, which seems to be very high compared to Pune 1260, Mumbai 1074, Hyderabad 723, Kolkata 353 and Delhi NCR 245.

The general objective of this paper is to find out the impact of the lockdown period on Air Quality, and the following are specific objectives: (a). To trace the movement pattern of Air Pollutants and Air Quality Index of Chennai City during Lockdown Period, (b).To compare the variables between the years 2019 and Lockdown period year 2020.and (c). To suggest suitable measures to Government to frame future Strategies. Further, the authors attempted to test the hypotheses which are as follows: (1) No Change in the Air Quality Index during Lockdown Period in Chennai City, (2). No improvement in the Air Pollutants during Lockdown Period in Chennai City, (3). Between the 7 phases, no difference in the Air Quality in Chennai City, and (4). No difference in the Air Quality in Chennai City between the two years (2019 &2020). Data: Tables 1 to 7 gives the Air Quality status of Chennai City during 7 phases of Lock down. Regression analysis was made to find out the most influencing factor of air quality by applying the AMOS package.

## Results and Discussions

Data related to the air quality indicators for all the seven phases are taken into account for analysis. It is a comparative analysis for 2019 and 2020.

**Table 1: Air Quality in Chennai City -First Phase**

| Date | 2019 March 25-April 14-21 Days | | | | | 2020 March 25-April 14-21 Days | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | P.M2.5 | NO2 | SO2 | Co | AQI | P.M2.5 | NO2 | SO2 | Co | AQI |
| 25 | 46.75 | 17.5 | 6.5 | 26.75 | 49 | 29.5 | 7.5 | 9 | 32.75 | 36.25 |
| 26 | 51.25 | 20.75 | 7.5 | 30 | 56.5 | 30.75 | 5 | 6.25 | 25 | 30.75 |
| 27 | 48 | 18.74 | 5 | 32.25 | 58.25 | 39 | 9.75 | 8.75 | 28.5 | 41.25 |
| 28 | 52.25 | 12.5 | 6 | 31.25 | 57.25 | 37.25 | 4 | 4 | 22 | 37.25 |
| 29 | 49 | 15.75 | 5.25 | 24.5 | 50 | 42.25 | 5.25 | 4.5 | 23 | 24.75 |
| 30 | 51.25 | 15 | 6.25 | 23.25 | 55.25 | 36.75 | 10.25 | 8.75 | 28.25 | 36.75 |
| 31 | 48.75 | 9.5 | 4.25 | 18.5 | 48.75 | 37.75 | 12 | 6.5 | 24.75 | 37.75 |
| 1 | 96.75 | 12 | 5.5 | 31 | 96.75 | 45.75 | 11 | 8.25 | 26.5 | 45.75 |
| 2 | 95.25 | 11.75 | 6 | 37 | 86.5 | 54.75 | 13.25 | 6.5 | 29 | 74.75 |
| 3 | 83.25 | 8.25 | 6 | 30 | 84.75 | 45.75 | 9.75 | 6 | 28.5 | 71.25 |
| 4 | 49.25 | 9.25 | 6 | 33 | 53.75 | 40.25 | 9 | 6.5 | 32 | 66 |
| 5 | 50.75 | 9 | 5.5 | 34.75 | 59.75 | 33 | 9.5 | 5.25 | 29.25 | 54.75 |
| 6 | 48.75 | 9 | 6.5 | 36.5 | 59.25 | 26.25 | 10 | 6 | 28.25 | 29.25 |
| 7 | 46.5 | 10 | 5.75 | 35 | 58.5 | 23.5 | 12.5 | 5 | 30 | 51 |
| 8 | 47 | 9.25 | 6.25 | 33 | 59.75 | 18.75 | 12 | 5.5 | 28 | 47.5 |
| 9 | 66.5 | 13.75 | 6.25 | 34.25 | 67 | 22.75 | 10 | 5.25 | 30.25 | 50.75 |
| 10 | 50.25 | 16.25 | 6.75 | 38.25 | 58 | 30.5 | 15 | 4.5 | 22.5 | 31.25 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 11 | 55 | 17.5 | 6 | 38.75 | 55 | 33.5 | 15.25 | 4.75 | 30.25 | 53 |
| 12 | 78.75 | 17 | 8.5 | 43.5 | 83.25 | 25.75 | 13 | 8.75 | 29.25 | 50.75 |
| 13 | 60 | 16.75 | 8.25 | 41.25 | 67.25 | 26.25 | 14.25 | 8.5 | 31.75 | 56 |
| 14 | 54.5 | 15.5 | 7.5 | 43.5 | 66.25 | 31.5 | 13.25 | 7.5 | 31 | 61 |

**Source**: https://app.cpcbccr.com/AQI_India/

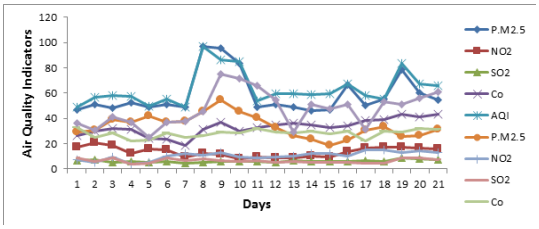



**Figure 1: Air Quality in Chennai City -First Phase**

The air quality of a particular region is mainly influenced by many factors like P.M.2.5, NO2, SO2 and CO. Among these factors, P.M.2.5 plays a vital role in determining air quality. On seeing the graph during 2019, all four air quality indicators are higher. Still, during lockdown except P.M.2.5, all values are at the lower level and the Particulate Matters have a zig-zag value and it is higher during the beginning of the lockdown and after that it has a downtrend.

**Table 2: Air Qualities in Chennai City –Second Phase**

| Date | April\10 15 to May 3,2019-19 days | | | | | April 15 to May 3,2020-19 days | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | P.M2.5 | NO2 | SO2 | Co | AQI | P.M2.5 | NO2 | SO2 | Co | AQI |
| 15 | 42.25 | 8.75 | 7.75 | 28 | 46 | 27.5 | 8 | 7.25 | 29.25 | 56 |
| 16 | 36 | 9.25 | 7.75 | 32.75 | 38.5 | 35.75 | 10.5 | 9.25 | 23.5 | 66.5 |
| 17 | 17.75 | 9.75 | 5.75 | 38.5 | 38.5 | 13 | 8.5 | 7 | 32 | 52 |
| 18 | 15.25 | 4.75 | 5.5 | 27.25 | 30 | 15.75 | 6 | 7.25 | 31.75 | 50.75 |
| 19 | 20 | 4.25 | 5.25 | 23.25 | 31.5 | 15 | 8.75 | 6 | 30 | 55 |
| 20 | 33.75 | 3.75 | 6.5 | 39.75 | 50.25 | 15 | 5.25 | 6 | 26.5 | 35.75 |
| 21 | 40.25 | 4.5 | 6.75 | 34 | 55.25 | 17.75 | 5.25 | 7.25 | 32.5 | 43.5 |
| 22 | 32 | 9.75 | 6.25 | 40 | 45.5 | 20.25 | 6.75 | 5.5 | 26.5 | 41.25 |
| 23 | 37 | 5 | 8.75 | 49.25 | 44.5 | 16 | 12.75 | 6 | 31.75 | 38.75 |
| 24 | 46 | 12.5 | 8.25 | 46.5 | 55 | 11.25 | 12.75 | 5 | 33.75 | 43 |
| 25 | 55 | 12 | 8.25 | 47.5 | 61.5 | 15.75 | 14 | 6.25 | 35.5 | 47.5 |
| 26 | 50.75 | 13 | 9 | 41.5 | 59.5 | 16.5 | 16 | 8.5 | 41 | 33.5 |
| 27 | 50 | 12 | 8 | 44.75 | 57.75 | 20 | 9 | 6.5 | 32.25 | 46.75 |
| 28 | 43.75 | 11.5 | 8.5 | 45 | 55.5 | 13.25 | 8 | 5.5 | 31.75 | 47.25 |
| 29 | 41 | 11.5 | 8.25 | 43.25 | 54.75 | 15.75 | 6.75 | 5.5 | 32 | 54.75 |
| 30 | 40 | 11.75 | 9.75 | 46 | 56 | 18.75 | 14 | 6.25 | 33 | 48.5 |
| 1 | 49.5 | 10.25 | 5.75 | 39.75 | 51.5 | 17 | 8 | 5.75 | 34.5 | 61.75 |
| 2 | 40.5 | 7.25 | 6 | 25.75 | 42 | 20 | 6 | 4.75 | 33.75 | 38.75 |
| 3 | 60.25 | 15.75 | 18.5 | 41.5 | 67.5 | 67 | 5 | 5.5 | 36.5 | 53.25 |

**Source**: https://app.cpcbccr.com/AQI_India/

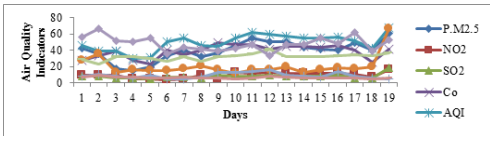


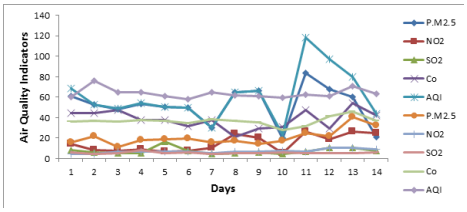

**Figure 2: Air Quality in Chennai City -Second Phase**

Considering the second phase of lockdown all the indicators are in the downtrend but considering P.M.2.5 it has higher values both at the beginning and at the end.

**Table 3: Air Qualities in Chennai City – Third Phase**

| Date | May 4 to May 17,2019-14 Days | | | | | May 4 to May 17,2020-14 Days | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | P.M2.5 | NO2 | SO2 | Co | AQI | P.M2.5 | NO2 | SO2 | Co | AQI |
| 4 | 61 | 14.5 | 8.5 | 44.25 | 68.25 | 15.75 | 4.5 | 6 | 36.5 | 60 |
| 5 | 52.75 | 8.5 | 5.75 | 44.75 | 52.75 | 21.75 | 4.25 | 4.5 | 36.75 | 76.25 |
| 6 | 48 | 7.5 | 5.25 | 47.75 | 49.25 | 11.5 | 6.5 | 5.25 | 36 | 64.5 |
| 7 | 53.25 | 9 | 5.25 | 37.75 | 54.5 | 18 | 7 | 8.5 | 38 | 64.5 |
| 8 | 50.25 | 6.75 | 16.5 | 37.5 | 50.25 | 18.5 | 6.5 | 5 | 36.75 | 60.75 |
| 9 | 49.75 | 7.75 | 7.5 | 32 | 49.75 | 19.25 | 6.75 | 6 | 34.75 | 58.25 |
| 10 | 30.25 | 10.75 | 4.25 | 37.75 | 30.5 | 16 | 5.5 | 4.75 | 38.5 | 64.75 |
| 11 | 64.5 | 24.25 | 5.5 | 20.75 | 64.5 | 17 | 6.75 | 5 | 37.25 | 62 |
| 12 | 66.5 | 20.5 | 5.75 | 29.5 | 66.5 | 14.5 | 6.75 | 5.5 | 35.25 | 61.25 |
| 13 | 19.75 | 5 | 4.25 | 30.75 | 23.25 | 17 | 7.25 | 6.25 | 28.25 | 59.5 |
| 14 | 83.75 | 26.25 | 7 | 47.75 | 118 | 25 | 6.5 | 5 | 31.5 | 62.75 |
| 15 | 68 | 18.5 | 10.75 | 29.5 | 97.25 | 21.5 | 10.5 | 5.5 | 41.75 | 61.25 |
| 16 | 60.25 | 26 | 10.75 | 54.25 | 80.25 | 40.75 | 10.75 | 5.25 | 46 | 70.5 |
| 17 | 21.25 | 25 | 7.25 | 42.5 | 44 | 32.5 | 9.25 | 6 | 37.25 | 63.25 |

**Source**: https://app.cpcbccr.com/AQI_India/




Regarding the third phase of lockdown, due to strict implementation of the rules and regulation and the co-operation of the people, all the four indicators have very minimum values and the P.M. 2.5 value will be lesser during the eighth and ninth days among the fourteen days period.

**Figure 3: Air Quality in Chennai City -Third Phase**

**Table 4: Air Qualities in Chennai City – Fourth Phase**

| Date | May 18 to May 31- 14 days | | | | | May 18 to May 31 ,2020,14 days | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | P.M2.5 | NO2 | SO2 | Co | AQI | P.M2.5 | NO2 | SO2 | Co | AQI |
| 18 | 48 | 9.5 | 16 | 25 | 56.75 | 18 | 8.75 | 4.75 | 48.25 | 63 |
| 19 | 51.5 | 11 | 5.75 | 27 | 53.25 | 37.25 | 14.75 | 5 | 41 | 61.5 |
| 20 | 43.75 | 11.25 | 5.5 | 21.75 | 46.5 | 56 | 19 | 5.25 | 48.5 | 78.75 |
| 21 | 25.25 | 12.5 | 6 | 28.25 | 36.25 | 45.25 | 16 | 5 | 51.25 | 66.75 |
| 22 | 31 | 12.5 | 6 | 35.75 | 47.75 | 34.5 | 9.75 | 6.75 | 32.5 | 40 |
| 23 | 37 | 12 | 5.5 | 27.75 | 42.25 | 41.25 | 13.25 | 10.25 | 52 | 70.5 |
| 24 | 91.5 | 15.5 | 7.5 | 25.75 | 93.75 | 38.5 | 12.25 | 8.5 | 51.75 | 72.75 |
| 25 | 78.25 | 14 | 7.25 | 37.5 | 86.25 | 36 | 11.75 | 8.5 | 48.75 | 69 |
| 26 | 77.75 | 15.25 | 8.25 | 37.25 | 87.75 | 47.75 | 12.75 | 10 | 52.5 | 113 |
| 27 | 71.75 | 14.75 | 7.25 | 30.75 | 79 | 39.25 | 12.25 | 8.5 | 50.5 | 68 |
| 28 | 81.25 | 15.5 | 7.25 | 36 | 100.25 | 38 | 11.5 | 9 | 51.75 | 72 |
| 29 | 81.5 | 11.5 | 6.75 | 22.25 | 104 | 65.5 | 16.25 | 8 | 57 | 89.75 |
| 30 | 66.75 | 11 | 7.5 | 41.25 | 81 | 54 | 15.5 | 7.25 | 45.5 | 80.25 |
| 31 | 87 | 16 | 10.5 | 36.75 | 94.75 | 60 | 8 | 5 | 40 | 54.75 |

**Source**: https://app.cpcbccr.com/AQI_India/

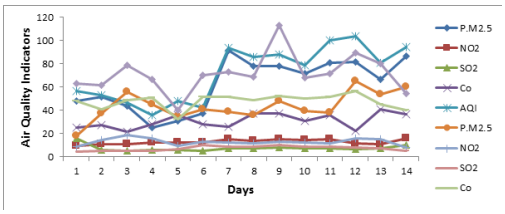



**Figure 4: Air Quality in Chennai City -Fourth Phase**

Figure 4 reveals the trend values of all air quality indicators. Here, the P.M. 2.5 values have an increasing trend compared to all other three values. It is due to the relaxation made by the Government. From the fourth phase onwards, the Government slowly made relaxation and that slow relaxation will be hiked the values of P.M. 2.5.

**Table 5: Air Qualities in Chennai City –Fifth Phase**

| Date/ June | June 1 to June 30 2019(30 DAYS) | | | | | June 1 to June 30 2020(30 DAYS) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | P.M2.5 | NO2 | SO2 | Co | AQI | P.M2.5 | NO2 | SO2 | Co | AQI |
| 1 | 71.25 | 13.5 | 6 | 39 | 78.75 | 54 | 11.5 | 8.75 | 49.5 | 93.25 |
| 2 | 80.25 | 12 | 7.75 | 24.5 | 90.75 | 30.75 | 12.75 | 11 | 33 | 75.5 |
| 3 | 90.75 | 11.75 | 9.5 | 37.25 | 103.25 | 26.75 | 7.75 | 5 | 53.5 | 37.75 |
| 4 | 78.75 | 14.5 | 10.5 | 36.25 | 90.5 | 28.25 | 7.75 | 9.75 | 51.75 | 51.75 |
| 5 | 95.5 | 10.25 | 9.5 | 42.5 | 104.25 | 28.75 | 11.75 | 5.25 | 55.5 | 62.75 |
| 6 | 101.75 | 13.5 | 10.25 | 47.25 | 114 | 32 | 12.5 | 7.25 | 56.75 | 68.5 |
| 7 | 55.25 | 15.5 | 10.25 | 45.75 | 63.75 | 55.55 | 14.25 | 6.5 | 57.25 | 88.75 |
| 8 | 20.75 | 18.5 | 6 | 36.5 | 29 | 32 | 16.75 | 6.5 | 60 | 74 |
| 9 | 41.5 | 9.5 | 7.75 | 33.75 | 49 | 35.5 | 17.25 | 8.5 | 53.5 | 66.75 |
| 10 | 43 | 11 | 7.5 | 38.75 | 50.5 | 37.25 | 15 | 4.75 | 39.75 | 42 |
| 11 | 38.25 | 26 | 6 | 32 | 45.75 | 38 | 10 | 5.5 | 52.75 | 61.25 |
| 12 | 58.25 | 24.25 | 7.75 | 46 | 70.25 | 90 | 14.25 | 7.5 | 56 | 118.75 |
| 13 | 47 | 21.5 | 7.25 | 30.25 | 56 | 35.5 | 16 | 7.25 | 55.5 | 63.25 |
| 14 | 34.5 | 32.5 | 4.25 | 40.25 | 43.25 | 32.25 | 15.25 | 5 | 50.25 | 58.5 |
| 15 | 37 | 21.25 | 6 | 24.75 | 60.25 | 30.25 | 17 | 6 | 54.25 | 63.5 |
| 16 | 24.75 | 14 | 3.25 | 21.75 | 24.75 | 34.75 | 14 | 5.75 | 56.5 | 69.75 |
| 17 | 22.75 | 13 | 5.25 | 22.25 | 22.75 | 62.25 | 18.25 | 8.25 | 34.5 | 84.5 |
| 18 | 0 | 9.25 | 4 | 18.75 | 0 | 38 | 17.75 | 6.5 | 35.75 | 101.25 |
| 19 | 32.5 | 18.25 | 9 | 29.75 | 42.5 | 53.75 | 24 | 9.75 | 50.5 | 84 |
| 20 | 42.5 | 18.5 | 9.75 | 31.75 | 49 | 88.5 | 16.5 | 7.75 | 55.25 | 106.25 |
| 21 | 30 | 20.5 | 12.25 | 40.5 | 46.75 | 41.75 | 18.25 | 7.75 | 32 | 87.5 |
| 22 | 39.25 | 14.5 | 4.25 | 21 | 39.25 | 44.75 | 11 | 8.25 | 54 | 108 |
| 23 | 32.25 | 15.5 | 7 | 33.25 | 32.25 | 33 | 14 | 9.75 | 55 | 105.25 |
| 24 | 10 | 4.25 | 0.75 | 10 | 10 | 44.5 | 11.25 | 9.75 | 31.75 | 83.25 |
| 25 | 22.5 | 21.5 | 1.25 | 17 | 26.5 | 36.75 | 13.5 | 10.75 | 55.25 | 86.25 |
| 26 | 9.75 | 4.5 | 1.75 | 27.5 | 9.75 | 40 | 10.25 | 9.25 | 33 | 85 |
| 27 | 33.5 | 17 | 3 | 20.5 | 33.5 | 41.25 | 13.75 | 8.25 | 51.5 | 86.25 |
| 28 | 12 | 5 | 1 | 5.75 | 12 | 31 | 13 | 8.5 | 41 | 50.75 |
| 29 | 12.75 | 4.5 | 1.5 | 19.25 | 12.75 | 43.75 | 12 | 6 | 47 | 72.75 |
| 30 | 51.25 | 19.75 | 6 | 27.75 | 59.5 | 39.75 | 14.25 | 8.75 | 49.5 | 90 |

**Source**: https://app.cpcbccr.com/AQI_India/

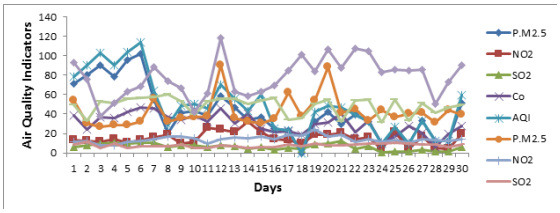



**Figure 5: Air Quality in Chennai City -Fifth Phase**

Considering the fifth phase of lockdown, many relaxation was made by the Government in sectors like industry, transportation and other sectors started running. It would elevate the air quality indicator values not only P.M. 2.5 all other values like SO2, NO2 and CO also have an increasing trend. The zig-jag of the P.M. 2.5 values are very erotic two times in the same month.

**Table 6: Air Qualities in Chennai City – Sixth Phase**

| Date | July 1 to July 31 2019(31 DAYS) | | | | | July 1 to July 31 2020(31 DAYS) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | P.M2.5 | NO2 | SO2 | Co | AQI | P.M2.5 | NO2 | SO2 | Co | AQI |
| 1 | 12.75 | 15.75 | 3 | 40 | 23.5 | 34.5 | 17.25 | 12.75 | 24.5 | 75.25 |
| 2 | 29 | 10.5 | 2.75 | 15 | 29 | 31.5 | 21.5 | 7 | 44.75 | 48.5 |
| 3 | 74.5 | 11.25 | 2.25 | 25.5 | 74.5 | 22.5 | 13.75 | 4.25 | 44 | 47 |
| 4 | 63.5 | 16.25 | 5 | 27.75 | 63.5 | 19.5 | 17.5 | 11.5 | 44.5 | 40 |
| 5 | 62.75 | 12 | 1.75 | 34.25 | 62.75 | 22.5 | 14.25 | 6.5 | 52.5 | 57 |
| 6 | 12 | 13.75 | 1.75 | 35.5 | 12 | 24 | 16.75 | 5.75 | 53.25 | 54.75 |
| 7 | 15 | 13.75 | 1.75 | 25.5 | 15 | 35.75 | 21 | 5.75 | 46 | 69 |
| 8 | 47.25 | 16.5 | 4.5 | 27.75 | 47.25 | 24 | 11.5 | 2.75 | 36.75 | 39.75 |
| 9 | 48.5 | 16 | 4 | 28 | 48.5 | 29 | 17 | 5.75 | 38 | 63 |
| 10 | 32.25 | 16.25 | 3.75 | 37.5 | 33 | 30.25 | 17 | 5 | 44.25 | 56.5 |
| 11 | 45.25 | 21 | 4.5 | 39 | 47.5 | 22 | 18 | 6.75 | 39.25 | 45.75 |
| 12 | 31.75 | 19.5 | 3.75 | 30.75 | 31.75 | 29 | 18 | 5 | 36.75 | 49.5 |
| 13 | 37.75 | 16 | 6.25 | 36.75 | 37.75 | 25.5 | 20.25 | 5.25 | 40.75 | 62 |
| 14 | 32.75 | 12.75 | 4.5 | 33.5 | 32.75 | 43.5 | 12.75 | 4 | 42.75 | 48.5 |
| 15 | 42.5 | 13.75 | 4.5 | 36 | 42.5 | 47 | 25.25 | 5.25 | 44 | 67 |
| 16 | 57 | 18.25 | 4.5 | 32.5 | 57.5 | 47.25 | 5.5 | 3 | 42.25 | 74.25 |
| 17 | 52 | 21.5 | 4.5 | 40 | 51.5 | 53.5 | 21.25 | 5 | 60.5 | 78 |
| 18 | 65 | 21 | 4 | 30 | 65 | 49.5 | 21.25 | 9 | 43.5 | 46.25 |
| 19 | 47 | 19 | 5.25 | 41.75 | 49.5 | 53.5 | 14.75 | 5 | 40.5 | 68.5 |
| 20 | 49.25 | 19.5 | 5.5 | 38.75 | 52.25 | 44 | 12.75 | 4.5 | 42.5 | 69.75 |
| 21 | 29 | 17 | 4.5 | 39.25 | 29 | 51.25 | 11.25 | 5.25 | 19.5 | 60.75 |
| 22 | 30.5 | 12.75 | 6.25 | 44 | 33.75 | 43.75 | 12.25 | 3.75 | 23.25 | 40.5 |
| 23 | 35.25 | 24.75 | 9.75 | 33 | 35.75 | 60.75 | 10 | 4.25 | 39.25 | 66.75 |
| 24 | 46 | 24.75 | 15.25 | 41.75 | 46 | 65 | 10 | 6 | 44.25 | 82 |
| 25 | 39.5 | 16.5 | 7 | 55.75 | 43.25 | 79.75 | 11.25 | 3 | 44.5 | 98.5 |
| 26 | 34.75 | 24 | 8.75 | 44 | 47.25 | 73 | 10.5 | 3.75 | 38.25 | 91.75 |
| 27 | 43 | 24.75 | 8.5 | 41 | 48.5 | 86.5 | 10 | 5.25 | 44.5 | 97.25 |
| 28 | 51.5 | 23.5 | 7.75 | 30.75 | 60.5 | 65.5 | 14.75 | 7.25 | 40.75 | 74.75 |
| 29 | 53.75 | 20.75 | 8.25 | 26 | 65.25 | 55.25 | 15 | 4.75 | 52.5 | 66.75 |
| 30 | 37.25 | 8.5 | 4.5 | 32 | 37.75 | 60.25 | 11.5 | 4.75 | 50.75 | 80.25 |
| 31 | 55.75 | 26 | 4.25 | 43.75 | 64 | 37.25 | 11 | 4.5 | 50.5 | 55.25 |

**Source**: https://app.cpcbccr.com/AQI_India/

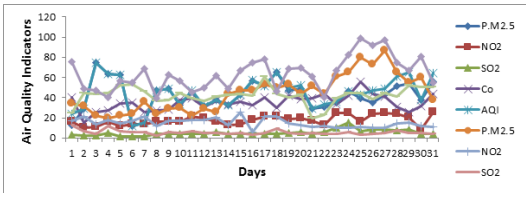



**Figure 6: Air Quality in Chennai City -Sixth Phase**

Figure 6 clearly explains that all the air quality indicator values gallop in nature compared to the first five phases. The relaxation on the side of the Government and movement of people, movement of vehicles, running of industries etc., cause the galloping rate of all four indicators. Considering the P.M. 2.5 values, it is very much higher compared to the previous year period. At the beginning of the month, this value is lower and it was gradually increased and attained peak at the end of the month.

**Table 7: Air Qualities in Chennai City – Seventh Phase**

| Date | August 1 to 31,2019 (31 days) | | | | | August 1 to 31,2020 (31 days) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | P.M2.5 | NO2 | SO2 | Co | AQI | P.M2.5 | NO2 | SO2 | Co | AQI |
| 1 | 52.5 | 15 | 6.75 | 24.25 | 71.75 | 39.75 | 11 | 5 | 41.75 | 62.75 |
| 2 | 56.75 | 15.5 | 6.75 | 33.75 | 95 | 43.5 | 11.25 | 4.25 | 42.5 | 63 |
| 3 | 34.75 | 22.25 | 5.5 | 32 | 34.75 | 35.75 | 10.25 | 8.25 | 37 | 52 |
| 4 | 45 | 34.25 | 6.75 | 25.5 | 76.75 | 63.5 | 13.5 | 9.5 | 28 | 80.25 |
| 5 | 28.75 | 18.25 | 3 | 25.25 | 28.75 | 48.25 | 14.5 | 5.5 | 42.25 | 57.25 |
| 6 | 54.5 | 26.25 | 6.75 | 29 | 80.25 | 36.5 | 9.5 | 4.25 | 61 | 38.5 |
| 7 | 26.75 | 16.75 | 8 | 21.75 | 55.75 | 31.75 | 9.5 | 3.25 | 47.5 | 59.75 |
| 8 | 32.75 | 16 | 7.75 | 23.5 | 40.75 | 36.75 | 11.5 | 3.5 | 43.25 | 58.5 |
| 9 | 32 | 17.75 | 5 | 23.5 | 49.75 | 43.25 | 12.75 | 4.75 | 37.75 | 60.75 |
| 10 | 35.25 | 17 | 9.5 | 20.5 | 27.75 | 29 | 11 | 3.75 | 45.5 | 57.25 |
| 11 | 8.75 | 8 | 4.25 | 12.5 | 8.75 | 44.25 | 10.5 | 4 | 37 | 53.25 |
| 12 | 8.75 | 7.25 | 2.5 | 17.25 | 12.5 | 44.25 | 11 | 4.5 | 43.25 | 44.25 |
| 13 | 10 | 3.75 | 2.25 | 16.5 | 40 | 66.75 | 12.25 | 3.25 | 39.25 | 78 |
| 14 | 21.75 | 7.5 | 6 | 35.25 | 50.75 | 53.25 | 11 | 4.75 | 43 | 59.5 |
| 15 | 31.75 | 18.75 | 14.5 | 36 | 50.25 | 51.75 | 11.5 | 3.5 | 41.25 | 60.25 |
| 16 | 29.5 | 18.75 | 10.25 | 41 | 36.75 | 54 | 9.75 | 4 | 35.25 | 62 |
| 17 | 11.25 | 12.5 | 7.25 | 28.75 | 24.5 | 46.75 | 10 | 4 | 36 | 57 |
| 18 | 19.5 | 13 | 7.25 | 14.25 | 31.5 | 60.75 | 12.5 | 3.75 | 35.5 | 63 |
| 19 | 38.5 | 21.75 | 8.5 | 40.25 | 45.5 | 51.75 | 11.5 | 3.5 | 38 | 62.75 |
| 20 | 32 | 17.5 | 6.25 | 21.5 | 37.25 | 49 | 12.5 | 5.5 | 38 | 61 |
| 21 | 35.75 | 19 | 18.25 | 26.5 | 39 | 47.25 | 11 | 6.75 | 43.25 | 68.25 |
| 22 | 65 | 22.75 | 8.25 | 37.5 | 74.75 | 38.5 | 9.5 | 25.5 | 20 | 47.5 |
| 23 | 20.25 | 10 | 1 | 17 | 23 | 46.5 | 10 | 5.75 | 40.75 | 71 |
| 24 | 24 | 12.25 | 4.25 | 26 | 32.25 | 35.75 | 10 | 5.5 | 38.75 | 67.5 |
| 25 | 17.25 | 9.25 | 3 | 23.25 | 20.75 | 38.25 | 9.5 | 7.75 | 35.25 | 64.5 |
| 26 | 26.5 | 13.25 | 5.5 | 23.5 | 36.25 | 70.75 | 30.5 | 5.25 | 41.25 | 81.75 |
| 27 | 17.5 | 15.25 | 2.75 | 22.25 | 22 | 16.25 | 11 | 2.75 | 47 | 34.75 |
| 28 | 25 | 13.5 | 5.75 | 24.5 | 59.25 | 51.5 | 11.25 | 4.75 | 42 | 73 |
| 29 | 19.75 | 10.5 | 3 | 25.75 | 21.5 | 57.75 | 10.25 | 12 | 30 | 70 |
| 30 | 29.5 | 14 | 6 | 25.5 | 51.75 | 54.5 | 10 | 7.25 | 36.75 | 71.75 |
| 31 | 20.75 | 9 | 4.75 | 27 | 53.25 | 45.75 | 9.75 | 7.5 | 35.75 | 64.25 |

**Source**: https://app.cpcbccr.com/AQI_India/

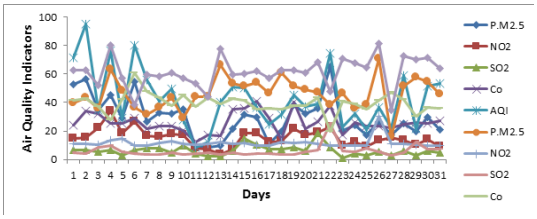
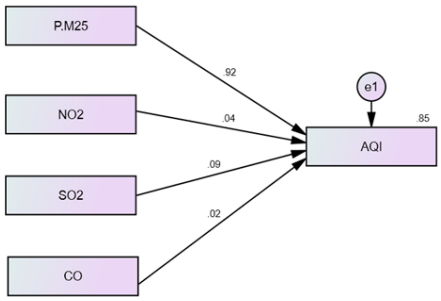


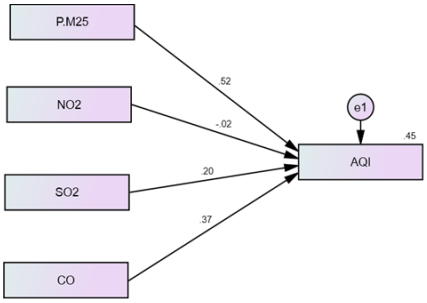

**Figure 7: Air Quality in Chennai City -Seventh Phase**

Considering the Seventh phase, P.M. 2.5 and SO2 values have increased tremendously compared to NO2 and CO. There is a greater up and down movement in P.M. 2.5 compared to SO2. With the help of AMOS the regression analysis was made and the results are given in a flow chart. This flow chart explains the regression results for 2019.




**Flow Chart 1: Regression Values for 2019**

In 2019, the impact of the air quality index concerning the variables of selected pollutants regressed. The results of the R2 value is 0.85. It explains that 85 percent of the air quality index is explained by selected four variables. 0.92 percent was influenced by P.M. 2.5 and the remaining variables NO2, SO2, and CO values represent .by 0.04.0.09, 0.02 respectively explanatory nature of air quality index. Hence, it is said that P.M. 2.5 plays a pivotal role in determining the air quality index of the region in 2019.




**Flow Chart 2: Regression Values for 2020**

Flow chart 2 inferred that the P.M. 2.5 value explains the air quality index by 0. 52 percent. But the real inference from this regression analysis is that due to lockdown made by the Government, the P.M. 2.5 value has a lower trend and the air quality has increased.

## Testing of Hypothesis

All four hypotheses were tested with the help of regression results and all four null hypotheses were rejected and accepted the alternative hypotheses.

- There is a change in the Air Quality Index during Lockdown Period in Chennai City.
- There is significant improvement in the Air Pollutants during Lockdown Period in Chennai City.
- Between the 7 phases there is a waste difference in the Air Quality in Chennai City. At the same time relaxation made by the Government leads to again a sharp increase in the pollutants.
- Between the two years (2019 &2020) there is difference in the Air Quality in Chennai City.

## Findings

- To improve the air quality index, periodic restriction on different sectors are advisable.
- The comparison result of the air quality indicators for the years 2019 and 2020 reveals that, during the lockdown period all the indicator values are lowered.
- Relaxation made by the Government leads to again increase the values of all air quality indicators.

## Suggestions

- Periodic and systematic lockdown in different sectors will be performed to avoid the concentration of air pollution and improve the air quality and better environment for sustainable development of an economy.
- Industrialists and others no need to expect the imposition of laws or rules and regulation in the form of compulsion by the Government and self-interest to initiate the shutdown of units with periodic intervals to avoid air pollution.
- At least once a month public transportation should be stopped by the Government and also Government should follow a complete lockdown once a month. It will reduce the air pollution caused by the transport sector.

- People should come forward to adopt all sorts of activities and precautions followed during the lockdown period even after relaxation and normalization to avoid health problems.

## Conclusion

The Lockdown is expected to contain the spread of the virus to masses and thus bring the situation in control. While the effective uses of Lockdown in controlling the spread of COVID-19 are yet to be determined, it has yielded sustainable improvement in the environmental conditions across the world. In Chennai city also the unprecedented halt in the anthropogenic activities during the Lockdown has resulted in a significant improvement in the environmental conditions. Crisis. After Tamil Nadu Government implemented strict lock down the streets of Chennai City are deserted,the strict travel restrictions are in place, the malla and theatres have been closed and people have been asked to stay in their homes, Worldwide flights are being canceled or turning around in mid-air as the aviation industry buckles. People are forced to stay at home practicing social distancing and working remotely. It is all aimed at controlling the spread of Covid-19 and hopefully reducing the death toll. But all this change has also led to some unexpected consequences. One among them is pollution levels and the natural environment. As industries, transport networks and businesses have closed down; it has brought a sudden drop in carbon emission.It is ironical that the health emergency caused by the COVID-19 pandemic has indirectly catalyzed a solution in another health crisis i.e., pollution. This Lockdown is unprecedented but has given us a rare opportunity to understand the impact of anthropogenic activities on the environment.

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