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# LOCKDOWN AND UNLOCK PERIOD HAS DRASTICALLY REDUCED POLLUTANT PARTICLES IN THE AIR: A STUDY OF KOLKATA ATMOSPHERE DURING COVID-19 PANDEMIC

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**ABSTRACT**
In the recent past, rapid urbanization in Kolkata induced environmental contamination especially in the air with several particulate matters has posed a severe challenge to the urban populace. However, owing to the Corona virus induced global pandemic and the concomitant lockdown in nearly all parts of the World, the situation has changed significantly. No one imagined that world is going to be at a stand-still as it is today. The world of automation has come to a halt. The best of economies has suffered terrible losses. The present study is a time series analysis of the particulate matter in the air of Kolkata in different corners of the city at a specific time before lockdown, during lockdown and after lockdown, i.e. unlocks periods. A significant spatial difference was observed and it was found that there was an abrupt decrease in PM values during the COVID-19. The lockdown phase associated with COVID-19 pandemic started in full swing on and from 25th March, 2020 with the aim to retard the spreading of the virus. The in-depth study with the data available from central pollution control board and West Bengal pollution control board of the surface atmospheric PM 2.5, PM 10, CO, SO2, NH3, NO2 level at seven different sites in the city of Kolkata before and during the lockdown phase from 20.03.2020 to 25.08.2020. A significant decrease in the levels of particulate matters were observed and analyzed.

**KEYWORDS:**
Covid, Corona, Kolkata, environment, particulate matters, pollution, lockdown

## BACKGROUND AND INTRODUCTION

If timeline development of Covid-19 in India and globally is considered, it is found that, on (i) 11th March, 2020 World Health Organization (WHO) declared this epidemic as pandemic (ii) On that very day, under the direction of Prime Minister of India, high level ministry group was constituted to close monitor of this outbreak iii) On 14th March, 2020 totally 84 positive cases were confirmed in India including 2 deaths. On that day, 13 states have already been reported with Covid-19 cases. On that day, globally, 1 lakh 32 thousand 758 cases were become positive with 4955 deaths. (iii) Janata Curfew was already called for and on 22nd March,2020 i.e. just before the national lockdown declaration in the history of India, total figure of India was raised to 360 in total with 7 deaths and 23 states were already been affected. iv) For the 1st time in Indian history, National Lockdown-1 was declared for 21 days under section 6(2) (i) of Disaster Management Act, 2005. On that day, India had 909 active cases with 19 deaths in 27 states and union territories. On that very day, globally, 20, 834 death figure was confirmed along with 4,46, 684 positive cases v) After video conferencing and consultation with all chief ministers of every state of this country, Prime Minister declared the extension of National Lockdown-1 to National Lockdown-2, till 3rd May, 2020. vi) Phase-2 lockdown occurred from 15th April 2020 to 3rd May, 2020 for 19 days vii) 3rd phase lockdown declared from 4th May 2020 to 17th May, 2020, for 14 days and lastly, for 4th phase, from 18th May, 2020 to 31st May 2020 i.e. for 14 days again viii) Consecutive 3 unlock period nation has faced from 1st June to 30th June, 1st July to 31st July and 1st August to 31st August 2020. Under National Disaster Management Act, during lockdown period, all the transport system of rail-air-roadways were closed except emergency services. In fact, night curfew were started and it continued till July 2020, ie. 3rd

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lockdown. Transportation were opened for essential goods, fire services, law, police and army, LPG and essential food products, movement of medical personnel, relief and cargo movements etc. People were more or less confined and hence a more open air started prevailing in the city of joy, Kolkata.

## OBJECTIVE OF THE STUDY AND RESEARCH METHODOLOGY

Main objective of this research work is to find what was the air pollution level and percentage of different pollution creating particulate matters of different corners of city of joy, Kolkata. For that reason, time period was taken from 20th March,2020 to 25th August, 2020 and for primary source of information, data were taken from Central Pollution Control Board (CPCB) and West Bengal Pollution Control Board (WBPCB). The data were taken from 7 corners of the city viz. Ballygung, Bidhannagar, Fort William, Jadavpur University, Rabindra Bharati University, Rabindra Sarobar and Victoria Memorial. For selection of dates, for before lockdown, data of 20th March 2020 was considered. 24th March 2020 was considered as on the starting date of 1st lockdown in March. Consecutively 31st March, 6th April, 15th April,21st April, 28th April, 7th May, 14th May, 21st May, 28th May, 5th June, 12th June, 19th June, 26th June, 3rd July, 10th July, 17th July, 24th July, 31st July, 4th August, 11th August, 18th August and lastly 25th August i.e. 24 days in total were considered for collection of data regarding percentage of different particulate matters in air of Kolkata. Data for collection was taken as 12 noon on those selected days.

## NATIONAL AIR QUALITY INDEX AND ITS 6 CATEGORIES

National Air Quality Index (AQI) transforms complex air quality data of eight pollutants into a single number (index value), nomenclature and colour. It may be noted that ambient air quality standards are specified separately in India for around 12 pollutants including the 8 that constitute the Air Quality Index.The measurement of air quality is based on eight pollutants, namely,

**●Particulate Matter (size less than 10 µm) or ($PM_{10}$) ●Particulate Matter (size less than 2.5 µm) or ($PM_{2.5}$) ●Nitrogen Dioxide ($NO_2$) ●Sulphur Dioxide ($SO_2$) ●Carbon Monoxide (CO) ●Ozone ($O_3$) ●Ammonia ($NH_3$) ●Lead (Pb)**

AQI has six categories of air quality. These are: Good, Satisfactory, Moderately Polluted, Poor, Very Poor and Severe. The AQI values and corresponding ambient concentrations (health breakpoints) for the identified eight pollutants are as follows:

| AQI Category | AQI | Concentration range* | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $PM_{10}$ | $PM_{2.5}$ | $NO_2$ | $O_3$ | CO | $SO_2$ | $NH_3$ | Pb |
| Good | 0 - 50 | 0 - 50 | 0 - 30 | 0 - 40 | 0 - 50 | 0 - 1.0 | 0 - 40 | 0 - 200 | 0 - 0.5 |
| Satisfactory | 51 - 100 | 51 - 100 | 31 - 60 | 41 - 80 | 51 - 100 | 1.1 - 2.0 | 41 - 80 | 201 - 400 | 0.5 - 1.0 |
| Moderately polluted | 101 - 200 | 101 - 250 | 61 - 90 | 81 - 180 | 101 - 168 | 2.1 - 10 | 81 - 380 | 401 - 800 | 1.1 - 2.0 |
| Poor | 201 - 300 | 251 - 350 | 91 - 120 | 181 - 280 | 169 - 208 | 10 - 17 | 381 - 800 | 801 - 1200 | 2.1 - 3.0 |
| Very poor | 301 – 400 | 351 - 430 | 121 - 250 | 281 - 400 | 209 - 748* | 17 - 34 | 801 - 1600 | 1200 -1800 | 3.1 - 3.5 |
| Severe | 401 - 500 | 430 + | 250+ | 400+ | 748+* | 34+ | 1600+ | 1800+ | 3.5+ |

* CO in $mg/m^3$ and other pollutants in $\mu g/m^3$; 2h-hourly average values for $PM_{10}$, $PM_{2.5}$, $NO_2$, $SO_2$, $NH_3$, and Pb, and 8-hourly values for CO and $O_3$.

The AQI Index values and their associated health impacts are as follows:

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| AQI | Associated Health Impacts |
|---|---|
| **Good (0–50)** | Minimal Impact |
| **Satisfactory (51–100)** | May cause minor breathing discomfort to sensitive people. |
| **Moderately polluted (101–200)** | May cause breathing discomfort to people with lung disease such as asthma, and discomfort to people with heart disease, children and older adults. |
| **Poor (201–300)** | May cause breathing discomfort to people on prolonged exposure, and discomfort to people with heart disease |
| **Very Poor (301–400)** | May cause respiratory illness to the people on prolonged exposure. Effect may be more pronounced in people with lung and heart diseases. |
| **Severe (401-500)** | May cause respiratory impact even on healthy people, and serious health impacts on people with lung/heart disease. The health impacts may be experienced even during light physical activity. |

### PARTICULATE MATTER 2.5 (PM2.5) AND ITS EFFECT ON HEALTH

The term fine particles, or particulate matter 2.5 ($PM_{2.5}$), refers to tiny particles or droplets in the air that are two and one half microns or less in width. Like inches, meters and miles, a micron is a unit of measurement for distance. There are about 25,000 microns in an inch. The widths of the larger particles in the $PM_{2.5}$ size range would be about thirty times smaller than that of a human hair. The smaller particles are so small that several thousand of them could fit on the period at the end of this sentence. Particles in the $PM_{2.5}$ size range are able to travel deeply into the respiratory tract, reaching the lungs. Exposure to fine particles can cause short-term health effects such as eye, nose, throat and lung irritation, coughing, sneezing, runny nose and shortness of breath. Exposure to fine particles can also affect lung function and worsen medical conditions such as asthma and heart disease. Scientific studies have linked increases in daily $PM_{2.5}$ exposure with increased respiratory and cardiovascular hospital admissions, emergency department visits and deaths. Studies also suggest that long term exposure to fine particulate matter may be associated with increased rates of chronic bronchitis, reduced lung function and increased mortality from lung cancer and heart disease. People with breathing and heart problems, children and the elderly may be particularly sensitive to $PM_{2.5}$.

### PARTICULATE MATTER 10 (PM10) AND ITS EFFECT ON HEALTH

PM10 particles are so small that they effectively act as a gas. When breathed in the penetrate deep into the lungs. Exposure to high concentrations of PM10 can result in a number of health impacts ranging from coughing and wheezing to asthma attacks and bronchitis to high blood pressure, heart attack, strokes and premature death.

### NITROGEN DIOXIDE (NO2) AND ITS EFFECT ON HEALTH

Nitrogen dioxide, or $NO_2$, is a gaseous air pollutant composed of nitrogen and oxygen and is one of a group of related gases called nitrogen oxides, or NOx. $NO_2$ forms when fossil fuels such as coal, oil, gas or diesel are burned at high temperatures. $NO_2$ and other nitrogen oxides in the outdoor air contribute to particle pollution and to the chemical reactions that make ozone. It is one of six widespread air pollutants that have national air quality standards to limit them in the outdoor air. $NO_2$ can also form indoors when fossil fuels like wood or natural gas are burned. Nitrogen dioxide causes a range of harmful effects on the lungs, including: Increased inflammation of the airways; Worsened cough and wheezing; Reduced lung function; Increased asthma attacks; and Greater likelihood of emergency department and hospital admissions. A large new study found evidence that people with lung cancer faced greater risk from $NO_2$, ozone, and other outdoor air pollutants. The 2016

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study tracked the air pollution levels from 1988 to 2011 experienced by more than 350,000 cancer patients in California. The researchers found that exposure to these air pollutants shortened their survival.

### AMMONIA (NH3) AND ITS EFFECT ON HEALTH

Ammonia is one of the most widely produced chemicals in the United States. In pure form, it is known as anhydrous ammonia. Ammonia is also produced in the human body and is commonly found in nature. It is essential in the body as a building block for making proteins and other complex molecules. Ammonia is a colorless highly irritating gas with a sharp suffocating odor. It dissolves easily in water to form ammonium hydroxide solution which can cause irritation and burns. Ammonia gas is easily compressed and forms a clear, colorless liquid under pressure. It is usually shipped as a compressed liquid in steel cylinders. Ammonia is not highly flammable, but containers of ammonia may explode when exposed to high heat. When ammonia enters the body as a result of breathing, swallowing or skin contact, it reacts with water to produce ammonium hydroxide. This chemical is very corrosive and damages cells in the body on contact.

### SULFUR DIOXIDE AND ITS EFFECT ON HEALTH

Sulfur dioxide ($SO_2$) is a gaseous air pollutant composed of sulfur and oxygen. $SO_2$ forms when sulfur-containing fuel such as coal, oil, or diesel is burned. Sulfur dioxide also converts in the atmosphere to sulfates, a major part of fine particle pollution. The largest sources of sulfur dioxide emissions are electricity generation, industrial boilers, and other industrial processes such as petroleum refining and metal processing. Diesel engines are another major source, including old buses and trucks, locomotives, ships, and off-road diesel equipment. Sulfur dioxide causes a range of harmful effects on the lungs, as the EPA's most recent review of the science concluded: Wheezing; shortness of breath and chest tightness and other problems, especially during exercise or physical activity; Continued exposure at high levels increases respiratory symptoms and reduces the ability of the lungs to function; Short exposures to peak levels of $SO_2$ in the air can make it difficult for people with asthma to breathe when they are active outdoors; Rapid breathing during exercise helps $SO_2$ reach the lower respiratory tract, as does breathing through the mouth; Increased risk of hospital admissions or emergency room visits, especially among children, older adults and people with asthma.

### CARBON MONOXIDE AND ITS EFFECT ON HEALTH

Carbon monoxide (CO) is an odorless, colorless, and tasteless but dangerous gas. Carbon monoxide is produced when fuels are burned such as gasoline, natural gas, oil, kerosene, wood or charcoal. Breathing CO reduces the blood's ability to carry oxygen. It can reach dangerous levels indoors or outdoors. Sources include: Gas appliances (furnaces, ranges, ovens, water heaters, clothes dryers, etc.), Fireplaces, wood stoves, Coal or oil furnaces, Space heaters or oil or kerosene heaters, Charcoal grills, camp stoves, Gas-powered lawn mowers and power tools, Automobile exhaust fumes etc. Once inhaled, CO attaches to the hemoglobin in the red blood cells. Hemoglobin normally carries oxygen throughout the body. When CO attaches, it blocks the oxygen the body must have, creating a wide range of health problems. Breathing low levels of CO can cause: Headache, nausea, dizziness, weakness, confusion and disorientation. Many of these symptoms are similar to the flu, food poisoning or other illnesses. So you may not suspect CO poisoning. If symptoms persist, and especially if they get better after you leave the building, CO may be the cause. Breathing high levels of CO also can cause: Sleepiness, nausea, anxiety or depression, vomiting, confusion, impaired vision and impaired coordination

### OZONE AND ITS EFFECT ON HEALTH

Ozone ($O_3$) is a gas molecule composed of three oxygen atoms. Often called "smog," ozone is harmful to breathe. Ozone aggressively attacks lung tissue by reacting chemically with it. When ozone is present, there are other harmful pollutants created by the same processes that make ozone. Breathing in ozone is like getting a sunburn on your lungs. Four groups of people are especially vulnerable to the effects of breathing ozone: children and teens; anyone 65 and older; people with existing lung diseases, such as asthma and chronic obstructive pulmonary disease (also known as COPD, which includes emphysema and chronic bronchitis and people who work or exercise outdoors. Breathing ozone can shorten your life. Strong evidence exists of the deadly impact of ozone. Researchers repeatedly found that the risk of premature death increased with higher

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levels of ozone. Newer research has confirmed that ozone increased the risk of premature death even when other pollutants also are present. Immediate problems—in addition to increased risk of premature death—include: shortness of breath, wheezing and coughing; asthma attacks; increased risk of respiratory infections; increased susceptibility to pulmonary inflammation; and increased need for people with lung diseases, like asthma or chronic obstructive pulmonary disease (COPD), to receive medical treatment and to go to the hospital. Breathing other pollutants in the air may make lungs more responsive to ozone—and breathing ozone may increase body's response to other pollutants.

## CONTENT ANALYSIS WITH GRAPHICAL REPRESENTATION

**Table-1**

| 20th March 2020 | Avr | Min | Max |
|---|---|---|---|
| PM 2.5 | 114 | 43 | 312 |
| PM 10 | 103 | 65 | 186 |
| $NO_2$ | 59 | 37 | 152 |
| $NH_3$ | 9 | 4 | 11 |
| $SO_2$ | 21 | 9 | 33 |
| CO | 14 | 4 | 67 |
| $O_3$ | 27 | 12 | 112 |

**Table-2**

| 24th March 2020 | Avr | Min | Max |
|---|---|---|---|
| PM 2.5 | 62 | 52 | 83 |
| PM 10 | 62 | 52 | 73 |
| $NO_2$ | 33 | 25 | 51 |
| $NH_3$ | 10 | 9 | 11 |
| $SO_2$ | 17 | 15 | 19 |
| CO | 15 | 9 | 19 |
| $O_3$ | 25 | 16 | 90 |

**Table-3**

| 31st March 2020 | Avr | Min | Max |
|---|---|---|---|
| PM 2.5 | 79 | 41 | 115 |
| PM 10 | 89 | 66 | 107 |
| $NO_2$ | 33 | 22 | 53 |
| $NH_3$ | 8 | 7 | 9 |
| $SO_2$ | 19 | 16 | 23 |
| CO | 14 | 3 | 35 |
| $O_3$ | 31 | 18 | 67 |

**Table-4**

| 6th April 2020 | Avr | Min | Max |
|---|---|---|---|
| PM 2.5 | 73 | 41 | 103 |
| PM 10 | 87 | 66 | 104 |
| $NO_2$ | 34 | 25 | 51 |
| $NH_3$ | 10 | 9 | 11 |
| $SO_2$ | 16 | 11 | 19 |
| CO | 16 | 9 | 19 |
| $O_3$ | 16 | 16 | 90 |

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**Table-5**

| 15th April 2020 | Avr | Min | Max |
|---|---|---|---|
| PM 2.5 | 42 | 18 | 74 |
| PM 10 | 59 | 41 | 90 |
| $NO_2$ | 9 | 8 | 12 |
| $NH_3$ | 2 | 2 | 2 |
| $SO_2$ | 8 | 5 | 18 |
| CO | 19 | 17 | 30 |
| $O_3$ | 34 | 24 | 76 |

**Table-6**

| 21st April 2020 | Avr | Min | Max |
|---|---|---|---|
| PM 2.5 | 23 | 11 | 38 |
| PM 10 | 26 | 15 | 41 |
| $NO_2$ | 23 | 15 | 66 |
| $NH_3$ | 7 | 6 | 8 |
| $SO_2$ | 15 | 14 | 17 |
| CO | 8 | 5 | 15 |
| $O_3$ | 65 | 36 | 80 |

**Table-7**

| 28th April 2020 | Avr | Min | Max |
|---|---|---|---|
| PM 2.5 | 11 | 5 | 21 |
| PM 10 | 19 | 11 | 29 |
| $NO_2$ | 10 | 9 | 12 |
| $NH_3$ | 2 | 1 | 2 |
| $SO_2$ | 6 | 5 | 7 |
| CO | 19 | 16 | 22 |
| $O_3$ | 21 | 12 | 45 |

**Table-8**

| 7th May 2020 | Avr | Min | Max |
|---|---|---|---|
| PM 2.5 | 34 | 12 | 50 |
| PM 10 | 35 | 20 | 46 |
| $NO_2$ | 8 | 6 | 12 |
| $NH_3$ | 3 | 3 | 4 |
| $SO_2$ | 11 | 6 | 19 |
| CO | 16 | 13 | 32 |
| $O_3$ | 30 | 13 | 98 |

**Table-9**

| 14th May 2020 | Avr | Min | Max |
|---|---|---|---|
| PM 2.5 | 35 | 18 | 58 |
| PM 10 | 39 | 26 | 59 |
| $NO_2$ | 7 | 6 | 10 |
| $NH_3$ | 3 | 3 | 3 |
| $SO_2$ | 12 | 5 | 38 |
| CO | 15 | 12 | 18 |
| $O_3$ | 24 | 15 | 75 |

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Table-10

| 21st May 2020 | Avr | Min | Max |
|---|---|---|---|
| PM 2.5 | 7 | 2 | 17 |
| PM 10 | 8 | 2 | 16 |
| $NO_2$ | 14 | 12 | 17 |
| $NH_3$ | 4 | 4 | 5 |
| $SO_2$ | 9 | 8 | 11 |
| CO | 12 | 3 | 14 |
| $O_3$ | 41 | 32 | 60 |

Table-11

| 28th May 2020 | Avr | Min | Max |
|---|---|---|---|
| PM 2.5 | 29 | 17 | 60 |
| PM 10 | 32 | 26 | 46 |
| $NO_2$ | 9 | 8 | 13 |
| $NH_3$ | 2 | 1 | 2 |
| $SO_2$ | 11 | 5 | 38 |
| CO | 17 | 15 | 23 |
| $O_3$ | 40 | 15 | 54 |

Table-12

| 5th June 2020 | Avr | Min | Max |
|---|---|---|---|
| PM 2.5 | 23 | 10 | 40 |
| PM 10 | 31 | 19 | 44 |
| $NO_2$ | 8 | 5 | 16 |
| $NH_3$ | 1 | 1 | 1 |
| $SO_2$ | 7 | 4 | 24 |
| CO | 19 | 16 | 26 |
| $O_3$ | 28 | 17 | 67 |

Table-13

| 12th June 2020 | Avr | Min | Max |
|---|---|---|---|
| PM 2.5 | 12 | 6 | 18 |
| PM 10 | 21 | 13 | 32 |
| $NO_2$ | 16 | 9 | 25 |
| $NH_3$ | 1 | 1 | 1 |
| $SO_2$ | 6 | 5 | 7 |
| CO | 21 | 16 | 26 |
| $O_3$ | 19 | 10 | 28 |

Table-14

| 19th June 2020 | Avr | Min | Max |
|---|---|---|---|
| PM 2.5 | 18 | 6 | 32 |
| PM 10 | 26 | 19 | 34 |
| $NO_2$ | 15 | 7 | 29 |
| $NH_3$ | 1 | 1 | 2 |
| $SO_2$ | 6 | 4 | 7 |
| CO | 22 | 17 | 32 |
| $O_3$ | 27 | 16 | 41 |

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**Table-15**

| 26th June 2020 | Avr | Min | Max |
|---|---|---|---|
| PM 2.5 | 25 | 11 | 36 |
| PM 10 | 44 | 32 | 58 |
| $NO_2$ | 17 | 6 | 43 |
| $NH_3$ | 5 | 3 | 6 |
| $SO_2$ | 10 | 5 | 12 |
| CO | 13 | 8 | 22 |
| $O_3$ | 44 | 24 | 85 |

**Table-16**

| 3rd July 2020 | Avr | Min | Max |
|---|---|---|---|
| PM 2.5 | 19 | 14 | 28 |
| PM 10 | 28 | 19 | 40 |
| $NO_2$ | 11 | 8 | 16 |
| $NH_3$ | 2 | 1 | 4 |
| $SO_2$ | 7 | 5 | 18 |
| CO | 17 | 14 | 20 |
| $O_3$ | 17 | 6 | 35 |

**Table-17**

| 10th July 2020 | Avr | Min | Max |
|---|---|---|---|
| PM 2.5 | 17 | 7 | 27 |
| PM 10 | 40 | 16 | 78 |
| $NO_2$ | 9 | 8 | 11 |
| $NH_3$ | 2 | 2 | 2 |
| $SO_2$ | 8 | 7 | 10 |
| CO | 12 | 9 | 21 |
| $O_3$ | 22 | 18 | 41 |

**Table-18**

| 17th July 2020 | Avr | Min | Max |
|---|---|---|---|
| PM 2.5 | 12 | 8 | 19 |
| PM 10 | 20 | 13 | 27 |
| $NO_2$ | 10 | 7 | 19 |
| $NH_3$ | 2 | 1 | 5 |
| $SO_2$ | 8 | 7 | 9 |
| CO | 22 | 18 | 26 |
| $O_3$ | 18 | 12 | 30 |

**Table-19**

| 24th July 2020 | Avr | Min | Max |
|---|---|---|---|
| PM 2.5 | 24 | 13 | 37 |
| PM 10 | 35 | 21 | 51 |
| $NO_2$ | 14 | 6 | 22 |
| $NH_3$ | 1 | 1 | 2 |
| $SO_2$ | 9 | 6 | 17 |
| CO | 26 | 23 | 33 |
| $O_3$ | 16 | 9 | 38 |

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Table-20

| 31st July 2020 | Avr | Min | Max |
|---|---|---|---|
| PM 2.5 | 10 | 6 | 16 |
| PM 10 | 17 | 9 | 25 |
| $NO_2$ | 10 | 5 | 17 |
| $NH_3$ | 2 | 1 | 7 |
| $SO_2$ | 8 | 6 | 19 |
| CO | 20 | 15 | 24 |
| $O_3$ | 12 | 4 | 38 |

Table-21

| 4th August 2020 | Avr | Min | Max |
|---|---|---|---|
| PM 2.5 | 103 | 51 | 192 |
| PM 10 | 85 | 57 | 113 |
| $NO_2$ | 21 | 15 | 40 |
| $NH_3$ | 4 | 2 | 4 |
| $SO_2$ | 10 | 8 | 11 |
| CO | 13 | 8 | 29 |
| $O_3$ | 47 | 36 | 56 |

Table-22

| 11th August 2020 | Avr | Min | Max |
|---|---|---|---|
| PM 2.5 | 33 | 24 | 51 |
| PM 10 | 44 | 36 | 58 |
| $NO_2$ | 17 | 7 | 34 |
| $NH_3$ | 4 | 3 | 4 |
| $SO_2$ | 11 | 9 | 12 |
| CO | 12 | 9 | 17 |
| $O_3$ | 36 | 25 | 72 |

Table-23

| 18th August 2020 | Avr | Min | Max |
|---|---|---|---|
| PM 2.5 | 43 | 27 | 64 |
| PM 10 | 54 | 42 | 73 |
| $NO_2$ | 20 | 15 | 26 |
| $NH_3$ | 4 | 3 | 5 |
| $SO_2$ | 9 | 7 | 10 |
| CO | 19 | 8 | 26 |
| $O_3$ | 39 | 25 | 75 |

Table-24

| 25h August 2020 | Avr | Min | Max |
|---|---|---|---|
| PM 2.5 | 83 | 64 | 106 |
| PM 10 | 86 | 74 | 99 |
| $NO_2$ | 29 | 16 | 45 |
| $NH_3$ | 3 | 1 | 4 |
| $SO_2$ | 7 | 3 | 8 |
| CO | 16 | 9 | 47 |
| $O_3$ | 16 | 11 | 57 |

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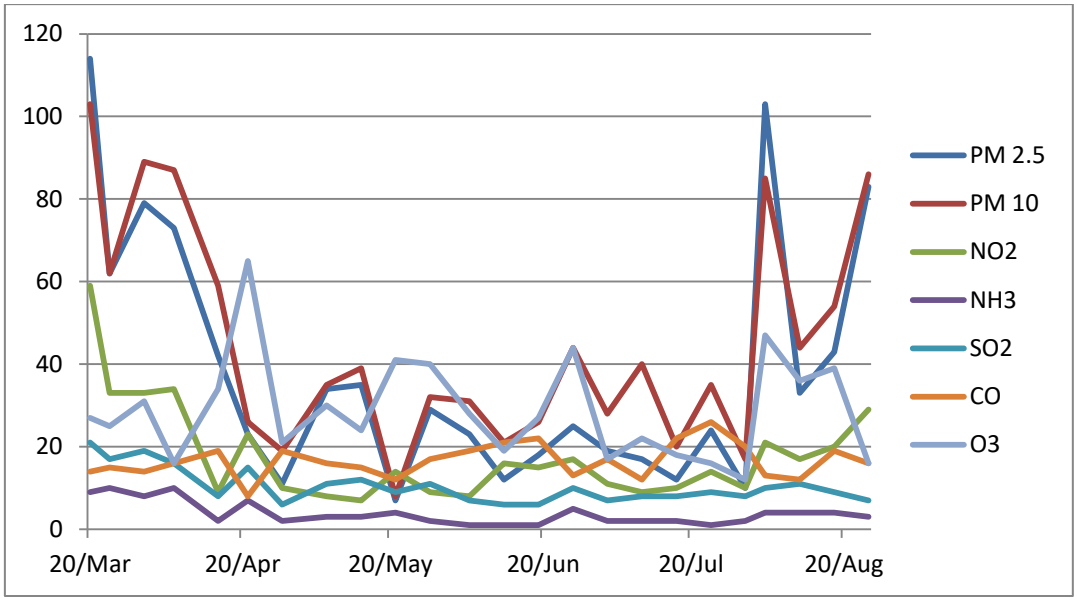


***Graph-1 Line graph showing gradual decreasing of PM10, PM 2.5, CO, SO2, NH3 during and after lockdown in Kolkata***

The charts and data below describes vividly the particulate matter position average of Kolkata at the time of lockdown and unlock period, datewise and time was taken 12 noon. From the table-1, it has been found that air of Kolkata was moderately polluted due to more presence of PM 2.5 particles and also more presence of PM 10 particle. According to data, presence of carbon monoxide was also very high and made the atmosphere of Kolkata as poor. Other parameters were either good or satisfactory. From the table-2, it has been found that, air of Kolkata has become good as presence of PM 2.5 and PM 10 were reduced to 62 and presence of NO2 was become lower than before lockdown. Quality of air has become satisfactory. Other parameters were either good or satisfactory. From the other tables and the line graph shows that after 24th April 2020, the portion of PM 2.5, PM 10, SO2, NH3, O3, NO2 etc has drastically pull down due to non movement of any type of cars. After that, since lockdown has started riving relief and unlock period started, again gradually the graph of carbon monoxide, ammonia, nitrogen di oxide, PM 2.5, PM 10, sulpher di oxide etc gases started increasing gradually. Even last 2 days of this sample survey, i.e. on 8th and 25th August 2020, the percentage of PM 2.5 and PM 10, along with carbon monoxide etc have already increased.

## RESULTS AND DISCUSSION

- For 20th March, 2020 the prominent pollutant is PM 2.5 (114) which implies poor quality.
- For 24th March, 2020 the prominent pollutant is PM 10 (62) which implies satisfactory quality.
- For 31st March, 2020 the prominent pollutant is PM 10 (89) which implies satisfactory quality.
- For 6th April, 2020 the prominent pollutant is PM 10 (87) which implies satisfactory quality.
- For 15th April, 2020 the prominent pollutant is PM 10 (59) which implies satisfactory quality.
- For 21st April, 2020 the prominent pollutant is Ozone (65) which implies satisfactory quality.
- For 28th April, 2020 the prominent pollutant is Ozone (21) which implies good quality.
- For 7th May, 2020 the prominent pollutant is PM 10 (35) which implies good quality.
- For 14th May, 2020 the prominent pollutant is PM 10 (39) which implies good quality.
- For 21st May, 2020 the prominent pollutant is Ozone (41) which implies good quality.
- For 28th May, 2020 the prominent pollutant is Ozone (40) which implies good quality.
- For 5th June, 2020 the prominent pollutant is PM 10 (31) which implies good quality.
- For 12th June, 2020 the prominent pollutant is PM 10 (21) which implies good quality.
- For 19th June, 2020 the prominent pollutant is Ozone (27) which implies good quality.
- For 26th June, 2020 the prominent pollutant is Ozone (44) which implies good quality.

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- For 3rd July, 2020 the prominent pollutant is PM 10 (28) which implies good quality.
- For 10th July, 2020 the prominent pollutant is PM 10 (10) which implies good quality.
- For 17th July, 2020 the prominent pollutant is CO (22) which implies very poor.
- For 24th July, 2020 the prominent pollutant is PM 10 (35) which implies moderately polluted.
- For 31st July, 2020 the prominent pollutant is CO (20) which implies very poor.
- For 4th August, 2020 the prominent pollutant is PM 2.5 (103) which implies moderately polluted.
- For 11th August, 2020 the prominent pollutant is PM 10 (44) which implies good quality.
- For 18th August, 2020 the prominent pollutant is PM 10 (54) which implies satisfactory quality.
- For 25th August, 2020 the prominent pollutant is PM 10 (86) which implies satisfactory quality
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