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DRAMATIC IMPACT OF AIR QUALITY DURING PANDEMIC: A BENEFIT OR INUTILE

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ABSTRACT: The COVID-19 is an infectious disease outbreak in December 2019 that started in Wuhan, China which is caused by the viral strain Coronavirus SARS-2 (COV SARS-2). The main effects which were observed due to COVID-19 were economic downfall and spillover of different sectors and industries which gave a halt to all the major activities worldwide. Though, this pandemic condition has brought massive effect on pollution level which has drastically decreased across the country and rest parts of the world in just a short span owing to very less anthropogenic activities which have shown an indication of a cleaner world and exceptional blue skies. India also faced the phase of total lockdown form 24th March till 30th May 2020 which started with a 21-day lockdown period and has reached to Unlock-3. COVID-19 has resulted in unprecedented decrease in the partial pollution in India and worldwide. The drop of concentration of pollutants in the atmosphere changes on the daily basis, so it becomes necessary to analyse the data in this lockdown period for the better assessment. The current study is based on the secondary data of Indian metro cities for the air pollutants (PM_{10}, $PM_{2.5}$, NO_2, O_3, SO_2, CO, andNH_3), which was recorded by NAQI (National Air Quality Index) through operating stations in the cities to show air quality during lockdown phases. The study will provide insight to understand the role of these pollutants in the environment.

KEYWORDS: National Air Quality Index, COVID-19, Lockdown, WHO, Health Hazards

I. INTRODUCTION

The novel corona virus (COVID-19) is spreading worldwide, challenging the health care personnel. Since the first case came into the limelight in Wuhan city, Hubei province of People's Republic of China in late December 2019 [1]. This newly strain was known to cause severe acute respiratory syndrome thus named as SARS-CoV-2, and disease caused by this as COVID-19. From that point this disease has been in complete swing with the quick transmission of infection through direct contact, respiratory secretions and droplets [2,3].
This virus infected thousands of individuals and resulted in number of deaths till the end of February 2020 and has spreaded over 54 countries [4]. Due to the massive rise in the infected cases, World Health Organization (WHO) declared the situation as pandemic.The Coronaviridae is the family of the SARS-CoV-2 including four genera (alpha, beta, gamma and delta) and all four are differentiated upon their genetic properties and this new identified virus belongs to beta corona virus [5]. The first case reported in India was from Kerala state in late month of January 2020 which had a travel history of China. After the emergence of this case, Kerala was the state with the highest number of infected cases of COVID-19 in India [6]. In the end of March and in the month of April 2020 there was a sudden increase in number of cases throughout the country covering 36 States and Union Territory [3].

India being second most populated country in the world with nearly 1.38 billion populations [7] and in which New Delhi, the Capital of India stands 2nd in terms of most populous city of the world [8]. As the numbers of cases were increasing, Prime Minister of India, Shri Narendra Modi took a major decision and announced "Janta Curfew" on 22nd March followed by 21 days lockdown from the midnight of 24th March to 14th April. China was first country to implement lockdown for 76 days and India followed the same strategy to prevent the country from the spread of virus. [9]. It was the major control measures step to halt the chain of COVID-19 by maintaining social distancing [3]. One of the investigation by the Oxford, COVID-19 Government Response Tracker (OXCGRT) expressed that out of 73 nations of the world the Indian government has adopted more draconian measures to manage this pandemic circumstance. [10].

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During these last 4 months there was massive increase in number of cases of COVID-19 which initiated a lot of research worldwide [11-15]. At the same time there were few more studies published online which showed a significant reduction of main pollutants and aerosol concentration in the atmosphere which lead to the improvement of air quality in the major cities [16-18].

The lockdown due to the outbreak of COVID-19 leads in the decrease of toxins or pollutants. The most prominent pollutants mainly found in the different parts of India majorly covering metro cities are particulate matter ($PM_{2.5}$ and PM_{10}) which is released from the vehicular and several anthropogenic activates including industry, residential, energy and dust [19,20]. The drastic increase in the air pollution, the five-year action plan was launched by National Clean air Programme (NCAP) in the year 2019 to reduce the major effects of Particulate matter by 30% [21]. On the hand due to unfavourable metrological conditions $PM_{2.5}$ did not reduced [22]. Likewise, the same study done by [23] assessed that there was ~33% diminution in nitrate in eastern US by emission control was offset by meteorology. The simulation study was done in China which clearly indicated that metrology plays a significant role in air pollution, whereas in the month of January and February 2020 which was the lockdown phase, showed severe air quality conditions. [24].

The main cities of the country New Delhi, Kolkata, Mumbai and Chennai which usually have moderate to poor or severe air quality index in the previous months before the lockdown showed a significant downfall in the pollutant concentration during this pandemic situation. The main impact in the pollutant concentration is due to the major sectors contributing which were industries, transportation, power plant, biomass burning, construction activities and residential activities. This paper will highlight the substantial impact of pollutants before and after lockdown in the major cities of India, New Delhi, Kolkata, Mumbai and Chennai.

II. DATA COLLECTION AND PRESENTATION

The present study was done on the basis of the changes in air quality before and after lockdown in major cities of India i.e. Delhi, Mumbai, Kolkata and Chennai covering north, west, east and south regions of the country. The data was collected to analyse the concentrations of the different pollutants for the time period of 1st February to 30th June 2020 mainly focusing the period pre and post lockdown. The day wise concentration of seven air pollutants PM_{10}, $PM_{2.5}$, SO_2, NO_2, CO and O_3 were taken for the study and all the data were collected from the website of National Air Quality Index, Central Pollution Control Board of India [25].

2.1. MEASURES OF POLLUTANTS AND THEIR EFFECTS

The air quality standards are the rudimentary that provide a main framework for the pollution control. And these air quality standards are according to the protocol of regulatory bodies. The main purpose of development of these standards is to provide protection to the public health from the adverse effects of the hazardous air pollutants. With these developments Central pollution control board [26] has set a new Indian National Air Quality Standards (INAQS) highlighting 12 parameters – particulate matter less than 2.5-micron size ($PM_{2.5}$), PM less than of 10 microns size PM_{10}, sulphur dioxide (SO2), nitrogen dioxide (NO2), Ammonia (NH_3), carbon monoxide (CO), Ozone (O_3), Nickel (Ni), Asenic (As), lead (Pb), Benzene (C_6 H_6) and Benzo(a) pyrene (BaP). Further, a new National air quality standard (AQI) launched in October 2014 to broadcast info on air quality in an easy comprehensible form the general public. For the Measurement of air quality is mainly based on eight standard parameters (i.e. PM_{10}, $PM_{2.5}$, SO_2, NO_2, CO, O_3 and Pb) which are used by the Indian AQI having short term standards which is around 24 hours average period but CO and O_3 are measured 8 hours average period [27].

The seven pollutants (PM_{10}, $PM_{2.5}$, SO_2, NO_2, CO and O_3) were taken in the present study as mentioned in the website of National Air Quality Index (AQI). These national quality standard are recommended and the pollutant having worst reading indicates the cities AQI. In the present scenario the air pollution is rising and posing a threat to human health as well as damaging the natural environment. These categories are classified for the various reading of the pollutants are constructed on the health breakpoints as shown in the Table 2.1. The AQI categories are arranged into the specific colour codes which visually express the level of severity that people can comprehend easily.

The WHO reported in 2018 shows that ambient outdoor air pollution effects both rural and urban areas which estimated to cause nearly 4.2 million premature deaths globally in the previous years. The air pollution is one of the major risk factor for the environment and public health. If countries worldwide can diminish the level of pollutants then they can also reduce the burden of its impact on the human body leading to various disease including heart disease, chronic and acute respiratory tract problem in adults as well as children below 5 years of age and lung cancer [28]. The below mentioned Table 2.2 clearly classifies the specific sources of the pollutants identifying their health breakpoint and fig.1 depicts the impact of pollutants on the different parts human body.

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Table 2.1. IND-AQI Category and Range

AQI Range	AQI Category
0 – 50	Good
51 – 100	Satisfactory
101 – 200	Moderate
201 – 300	Poor
301 – 400	Very Poor
401 - 500	Severe

*Source: National Quality Index (https://app.cpcbccr.com/AQI_India/)

Table 2.2. Pollutant components with its emission source showing its impact on Health and environment

S.No.	Pollutants	Components	Sources	Health effects	Environmental Impacts
1.	Particulate Matter (2.5 & 10)	Sulfate, nitrates, ammonia, sodium chloride, black carbon, mineral dust and water.	Its sources are combustion engines i.e. diesel and petrol, coal, lignite (solid-fuel), use of heavy oil and biomass burning for energy production in households as well as industry. Other industrial activities which emit the pollutants are manufacture of cement, ceramic and bricks, smelting and mining.	It can penetrate into the lungs and also enter the blood system. The chronic exposure to particles contribute to the risk of developing cardiovascular and respiratory disease as well as Lung Cancer.	Abridged visibility
2.	Ozone	Photochemical smog	It is mainly formed by NO_x and volatile organic compounds (VOCs). The photochemical reaction takes place reaction with sunlight and pollutants nitrogen oxides (NO_x) emitting from vehicle and volatile organic compounds (VOCs)from the industry	Too much amount of ozone in the air can effected on human health. It can lead to breathing problems, elicit asthma, decrease lung function and lung diseases	Ozone is present in the upper troposphere layer which produces greenhouse effect, and can cause harmful effects on plants by meddling in photosynthesis.

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			emissions. The large amount of ozone pollution is formed during periods of sunny weather.		
3.	NO_2	Mainly particulate matter and ozone	emitted by power generation, industrial and traffic sources	Symptoms of bronchitis and asthma, as well as lead to respiratory infections and reduced lung function and growth. Evidence also suggests that NO_2 may be responsible for a large disease burden, with exposure linked to premature mortality and morbidity from cardiovascular and respiratory diseases.	Precursor of ozone formation in the troposphere
4.	SO_2	Sulphuric Acid	One of the main sources of SO_2 is emissions from fossil fuel combustion as well as natural volcanic activity.	SO_2 generally irritates the skin and mucous membranes of the nose, eyes, throat, and lungs. If high content of SO_2 can cause inflammation and irritation in the respiratory system, specifically during heavy physical activity.	Acid rain
5.	CO	Carbon Monoxide	The sources of Carbon monoxide device Gas heater, Fuel fired furnaces, Gas stove and dryers and automobiles.	Breathing CO can cause headache, dizziness, vomiting, and nausea. If high level of CO is inhaled, then it may cause unconscious or die. If expose to moderate and high concentration of CO for the long periods of time, then it may cause heart disease.	Climate change and green- house effect
6.	NH_3	Ammonia	The main source of NH_3 releases is from the agriculture land (manures, slurries and fertiliser) applications which includes animal husbandry. the NH_3-based fertilizer as well as also from the applications. vehicular emissions,	If exposure to high concentration level of ammonia in air causes instant burning of the nose, throat and respiratory tract. This further also cause bronchiolar respiratory distress or failure	In the atmosphere ammonia reacts with acid pollutants (SO_2 and NO_X) releases to form ammonium (NH_4^+) which contain aerosol

			volatilization from soils and oceans.		

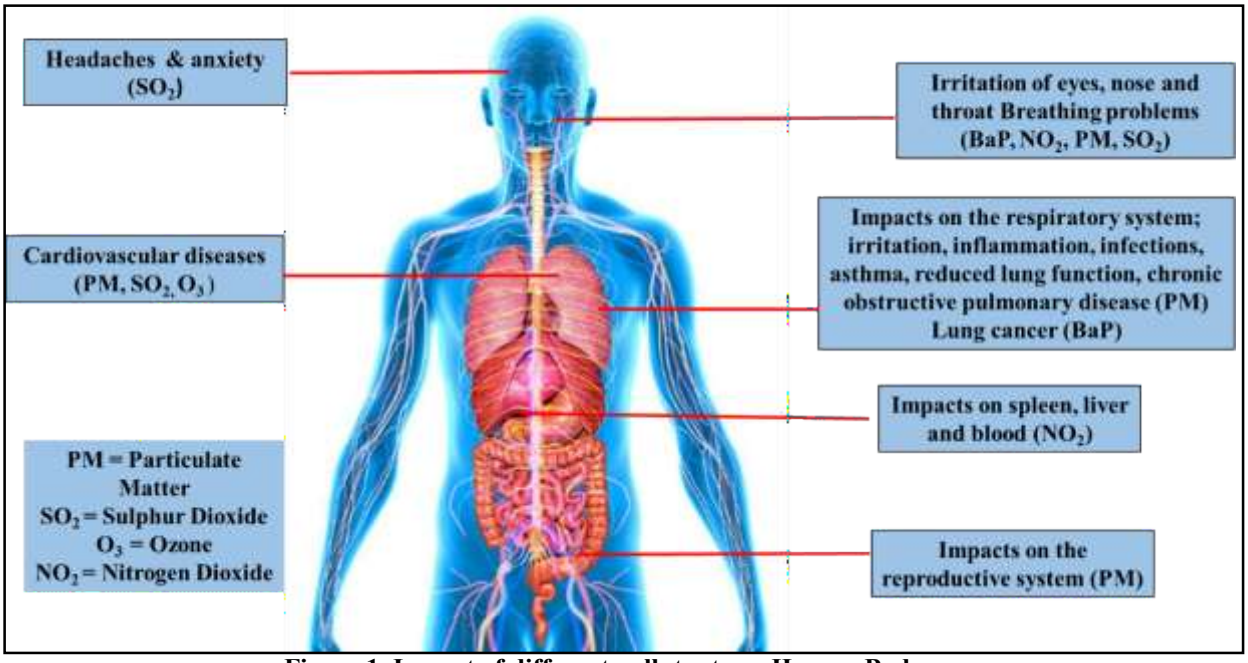

Figure 1. Impact of different pollutants on Human Body

III. AMBIENT AIR QUALITY DURING COVID-19 IN THE METROCITIES OF INDIA

Due to the fast emergent of industrialization, urbanization and increasing transport vehicles etc. are the main reason for causing air pollution. There are many reports published which shows that nearly, two third of world's most polluted cities are in India as compared to other Asian countries which remains unduly affected by the toxic gases mainly raises from the crowed cites, coal –fired plants, vehicular exhaust, industrial emanations and agricultural burning [29].The data of air quality parameters i.e. $PM_{2.5}$, PM_{10}, NO_2, NH_3 SO_2, CO and Ozone were taken for four metro cities including Delhi (Anand Vihar-DPCC and Dwarka Sector 8–DPCC); Mumbai (Chhatrapati Shivaji International Airport(T2)-MPCB); Chennai (Manali-CPCB);Kolkata (Ghusuri, Howrah-WBPCB) before and after lockdown (01/02/2020 to 30/6/2020) period.

3.1 NATIONAL CAPITAL NEW DELHI

The national capital is considered amongst one of the most polluted megacities of the globe based on environment performance index by WHO 2016 [30]. The WHO in April 2018 published the environmental monitoring database of the world's leading megacities encircling around 100 countries for the period of 2011 and 2016 and the data revealed that New Delhi is high in the list of PM_{10} pollution [31]. Last few years New Delhi has been recorded as one of the major cities for the $PM_{2.5}$ concentrations which showed high above tolerable limits according to National Ambient Air Quality Standards (NAAQS) [32,33]. The high concentration of these pollutants increase the intensity of air pollution which leads to major health problems to the people such as less oxygen level, acute asthma, pneumonia and chronic respiratory disorder [34,35].
In the year 2017, there was massive increase in the health issues due to which Indian council of Medical Research (ICMR) has to take an initiative regarding health threats and declared emergency for the public health in the Delhi region [36,37].
In continuation of the study executed by state level disease Burden Initiative Collaborators, Public Health Foundation of India (PHFI), Indian Council of medical Research (ICMR) and Institute for Health Metric and Evaluation (IHME) in the year 2017. It was also seen that one out of every eight deaths was due to the contamination of pollutants in India [38].
The present study focused on the air quality situation before and after lockdown period. The air quality data of seven pollutant parameters (PM_{10}, $PM_{2.5}$, SO_2, NO_2, CO, O_3 and NH_3) for Anand Vihar-DPCC and Dwarka Sector 8 –DPCC have been employed from National Air Quality Index (NAQI) to show the pattern of air quality in pre, during and after lockdown phases quite visible from the fig. 6a. New Delhi the Capital of India is mainly

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surrounded by other cities namely, Gautam Buddha Nagar, Greater Noida, Ghaziabad, Faridabad, Meerut and Gurugram which makes a huge constellation and releases large amount of gaseous content into the atmosphere due to anthropogenic activities. The data was taken for different weeks of the locations Anand vihar and Dwarka Sector 8 –DPCC between 01/02/2020 to 30/06/2020 which covers the period of pre, during and post lockdown phase.

The month of February, Anand Vihar showed that level of $PM_{2.5}$ in the all the four weeks was most protuberant pollutant varied from 163-290 µg/m^3 as compared to other pollutants. In month of March there was downfall in the level of all the pollutants and prominent pollutants were $PM_{2.5}$ and PM_{10} which showed moderate to poor conditions of air quality varied from 123- 183 µg/m^3 and 145-211µg/m^3. But CO was also one of the prominent pollutant at the end days of the month and showed satisfactory conditions as the lockdown stared. During the lockdown phase all the pollutants showed satisfactory conditions throughout the month of April. During 15th May to 30th June the most prominent pollutant was ozone and varied from average 98-255 µg/m^3. The another pollutant NO_2 also showed a decrease in its concentration level. The pollutant $PM_{2.5}$ showed a moderate condition during this phase which quit visible from the fig. 2.

Another station Dwarka sector -8 showed PM_{10} (120-340µg/m^3) and $PM_{2.5}$ (212-300 µg/m^3) in February which is much higher level as compared to pollutant content in Anand Vihar as the fig.2.1 depicted. In the month of March, the pollutant PM_{10} showed much higher values which varied from 90-200 µg/m^{3}and PM $_{2.5}$ 93-185µg/m^3. The PM_{10} indicated moderate to satisfactory level during the month and at very less time it showed poor quality of air. The month of April and May indicated that ozone concentration was seen at satisfactory condition during this period which varied from 41-103 µg/m^3 and simultaneously pollutant $PM_{2.5}$ and PM_{10} varied from average 75-116 µg/m^3 and 88-118 µg/m^3 in April and the other hand in May its average value varied from 73-148 µg/m^3 and 105-150 µg/m^3 respectively. The month of June, pollutant PM_{10} was one of the prominent pollutant which marked its increase in the concentration level as the lockdown phase started towards unlock conditions and its varied from average of 123-150 µg/m^3.

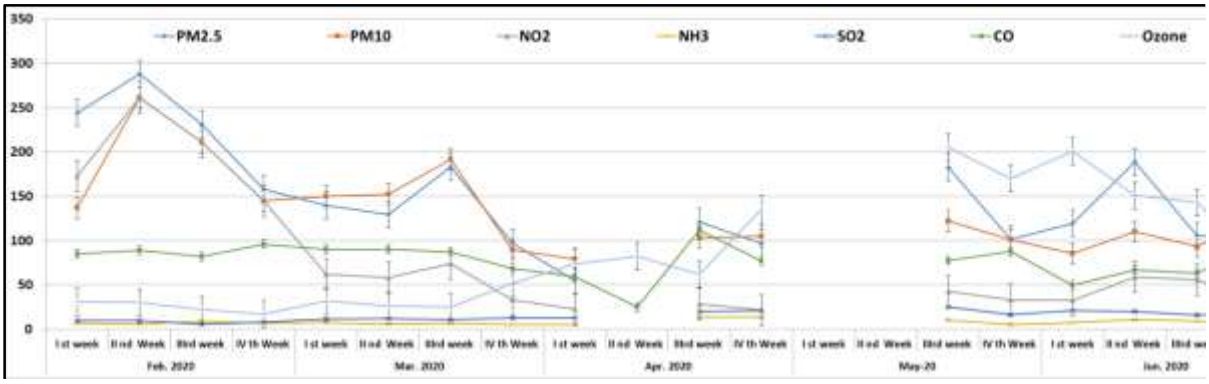

Figure 2. Graph represents the pollutant level in the different weeks in Delhi –Anand Vihar.

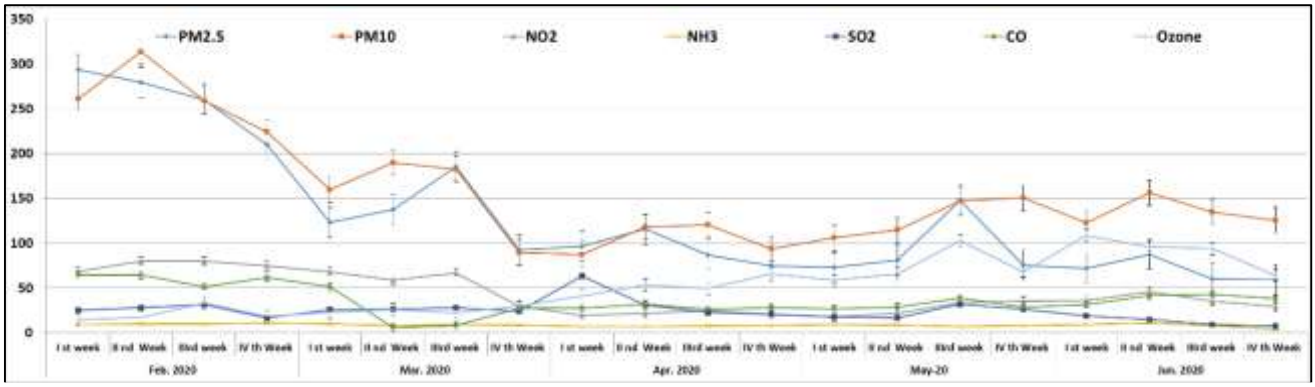

Figure 2.1. Graph represents the pollutants level in the different weeks at Delhi-Dwarka Sector-8.

3.2 WEST COAST OF INDIA – MUMBAI

Mumbai is one of the most populated city of India and stands seventh in position in the world known to be as highly populous metropolitan area stated by United Nations in 2018 [39]. Mumbai's air quality during 2017 and 2018 has increased in the annual average $PM_{2.5}$ concentration level on the other hand it recorded a downfall in the $PM_{2.5}$ level in the year 2019. World Air Quality Report ranked Mumbai 71 position in the 2018, but the city

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stands on 27 out of the 58 Indian cities in term of unhealthy air quality. The level of pollutant in the Mumbai city indicated that in the month of February the most noticeable pollutant was PM_{10} which varied from average 159-192 µg/m³ and PM $_{2.5}$ from average of 142-178 µg/m³. As we see the March 2020 air quality index it indicated that $PM_{2.5}$ and PM_{10} are decreased to lower level varying average from 66-122 µg/m³ and 90-162 µg/m³ respectively. In the April, May and June during this lockdown phase it was seen that there was greater decrease in the level of pollutants as the below mentioned fig.3 represents. During the Lockdown period the Mumbai city air quality index showed minimal impact of pollutants as there was total shut down of the mobility of personal and local vehicles as well as industries which lead to the clean air and environmental conditions in one of the busiest cities of India as fig. 6c represents.

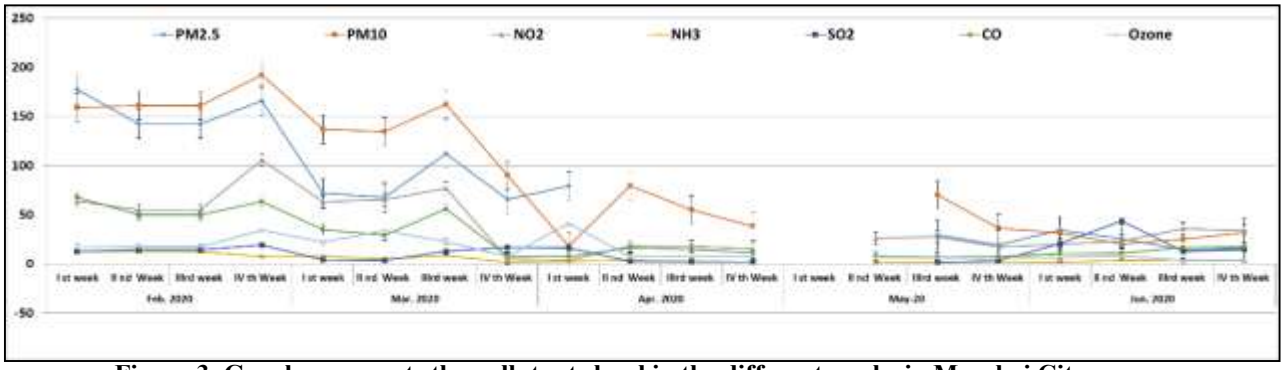

Figure 3. Graph represents the pollutants level in the different weeks in Mumbai City.

3.3 EASTERN PART OF INDIA-KOLKATA

The data collected by [40] showed that Kolkata along with national capital- Delhi were the worst affected Indian Cities when it comes for the air pollution. One of the data which was released by Scientific and environment research, 2009 stated that atmospheric SPM (suspended particulate matter) in Kolkata was nearly 511.With this instant peak in the concentration of PM made Kolkata one of the most polluted metro cites in the country and it surpass the other followed metro cites Delhi, Mumbai and Chennai respectively. The Chittaranajan National Cancer Institute (CNCI) found that near about 70% of the people of Kolkata are suffering from severe respiratory disease such as asthma, lung cancer and dyspnea [41]. The report given by Centre for Science and Environment revealed that between 2009 and 2011 there were number of cancer cases including lung cancer with 12% share [42]. One of the article published in *The Telegraph*, stated that Kolkata has been nicknamed as the "lung cancer capital of India" whereas, World Health Organization's (WHO) has placed Kolkata in the 25th position among the over-all of 1100 cities of the world [43-45]. The city shows higher content of the major pollutants including $PM_{2.5}$ and PM_{10} with an average variation of 223-302 µg/m^3 and 204-290 µg/m^3 in the month of February. If we see the fig. 4 it clearly shows that there was slight downfall in the level of these two pollutants which varied from average of $PM_{2.5}$ 61-175 µg/m^{3}and PM_{10} 95-170 µg/m^3. At the same time if we see the graph of March, the values of other pollutants evidently indicate that there was no sudden increase in the concentration level.

As we perceive the values of pollutants in the next months of the year 2020 (April, May and June) during this period the level of pollutants were reduced as compared to the previous months and slight increase in the level of ozone during the month of May and June 2020 which was observed an average of 35-75 µg/m^3. This decrease in the pollutant level during lockdown makes a clear picture of the atmosphere which can be seen in fig. 6d.

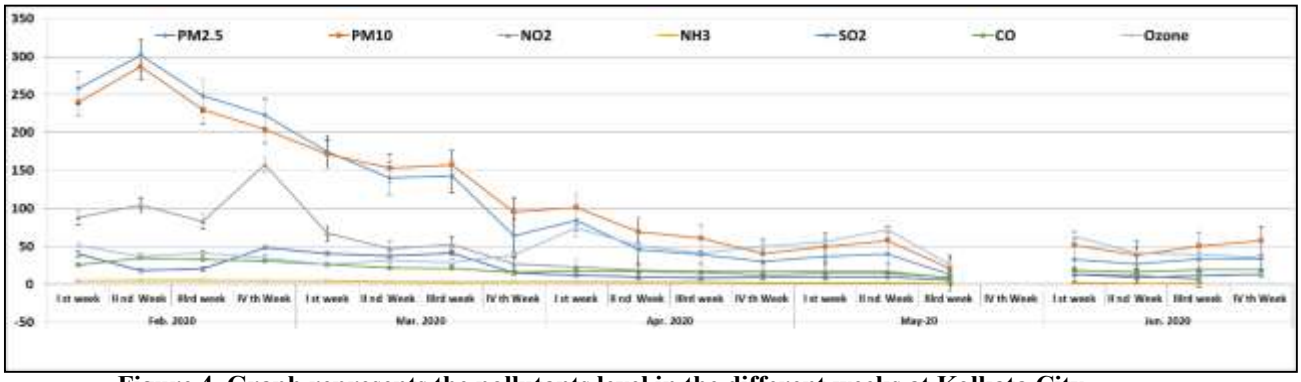

Figure 4. Graph represents the pollutants level in the different weeks at Kolkata City.

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3.4. SOUTHERN INDIA-CHENNAI

Chennai lies on the Coromandel Coast of the Bay of Bengal and the city is well known as the "Gateway to South India". But city also faced poor air last year and change the atmosphere into misty sky with increased pollutant content and led the people to think that Chennai is also becoming one of also pollution cities of India like other megacities. In November 2019, CPCB recorded particulate matter concentration hovered about 100 ug/m^3 and other stations also showed the increased level of $PM_{2.5}$ which was much than the guidelines given by CPCB and WHO [46-47].

The concentration level $PM_{2.5}$ showed moderate air quality conditions before the lockdown in the month of February till middle of the march which varied average of 73-143 ug/m^3. During the month of April, May and June, 2020 $PM_{2.5}$ measured good to satisfactory conditions most of the days and varied from 27-89 ug/m^3, 21-92 ug/m^3 for April and May respectively. After the unlock phase -1 varied from average of 64-85 ug/m^3. The pollutants during and post lockdown does not showed much variation in the level of concentration as the below graph evidently depicts in the fig. 5. The most prominent pollutant which gradually showed increase in the concentration level before and after lockdown CO which varied from average of 35-98 ug/m^3 throughout all these months. Whereas, NO_2 also was found to be decreased during this entire period. The ozone and PM_{10} were such pollutant which were found to be insignificant during this complete phase of time. The major change in the atmospheric conditions can be visible from the below given fig.6b.

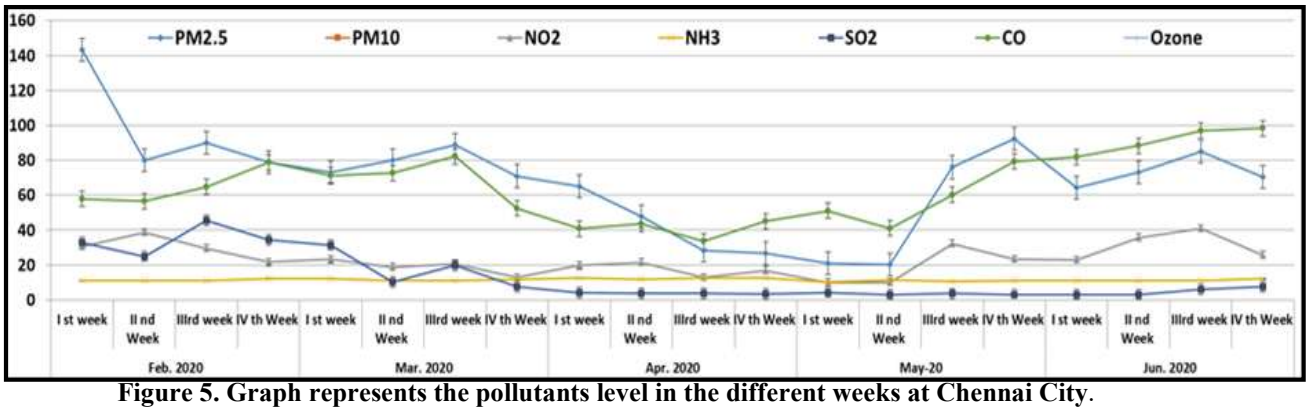

Figure 5. Graph represents the pollutants level in the different weeks at Chennai City.

Figure 6. Picture shows the variation in the air quality before and during the lockdown in the four megacities of India a- New Delhi; b- Chennai; c- Mumbai; d- Kolkata

IV. CONCLUSION

India is one of the most polluted counties of the world where air quality remains a major concern. From the past few months, world is suffering from a deadly disease COVID-19, that has resulted in increased mortality rate. Although this disease has very adverse effects on health but also have some positive impact especially on the environment. The two months long lockdown had reduced the level of pollutants resulting in the rise of air quality. During the lockdown period the mountains were clear and blue sky was seen after many decades. According to the National Air Quality Index of 2020, there was a drastic change in the pollutants level during the lockdown. The mega cities of India are generally listed in the world's top polluted cities in terms of poor air quality standards especially our national capital has always been in headlines. Due to COVID-19 there was restricted anthropogenic activities so the study was done to analyse the effect of concentration level of seven pollutants before and after lockdown (1st February to 30th June, 2020) period in four metro cities. Among all the pollutants, $PM_{2.5}$ showed the drastic reduction in the level in all the metro cities (New Delhi, Mumbai, Kolkata and Chennai). The result shows that there was an increase in pollutants (O_3 and CO), decrease in the $PM_{2.5}$, PM_{10} and NO_2. This was because of the effective reduction in the vehicular activities and electricity plants in these cities. The increase in the ozone level could be due to significant reduction in the level of NO_2. These results showed a substantial reduction in air quality index of 2020 as compared to previous years.

However, the take home message from the current scenario is that we should adopt such measures to protect our environment as it becomes our prime responsibility. From the results we recommend that there should be 2-3 days restrictions on the vehicular movement and people should avoid unnecessary movements and large gatherings. By implementing these measures, we can get clean and healthy air for the rest of our life's.

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