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STATUS OF AIR QUALITY IN INDIAN METROPOLITIAN CITIES – PRE COVID, COVID PANDEMIC AND POST COVID

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Abstract: Air Pollution and Air Quality are the major concerns due to rapid industrial growth and urbanization. Air Pollutants in indoor as well as outdoor causes significant threat to human health. Therefore, the monitoring of air pollutants in the atmosphere is most important for management of air quality. Air quality is the measurement of air pollutants that how clean or polluted the air is. It is the fundamental right of every citizen to know about the quality of air they breathe. The air quality levels in the atmosphere are not easily understood by all common people. To overcome this concern, the concept of Air Quality Index (AQI) has been developed. An AQI is defined as an overall scheme that transforms weighted values of individual air pollution related parameters into a single number or set of numbers. It is an effective tool for communication of air quality status to people in terms, which are easy to understand. It transforms complex air quality data of various pollutants into a single number (index value), nomenclature and colour.

The objective of this paper is to bring out the status of the air quality in the Indian metropolitan cities during pre COVID, at the time of COVID pandemic period and post COVID for major air pollutants such as PM_{10}, $PM_{2.5}$, SO_2 and NO_x. The data's are obtained from the Central Pollution Control Board. The results indicate that how the air quality had impacted the metropolitan cities due to sudden decline in the industrial activities and due to transportation. It also helps to understand the trends that can support the policy makers and the nodal agencies to identify mitigate measures to reduce the air pollution and preference to the hotspots.

Keywords: Air Pollution, Air Pollutants, Air Quality, Air Quality Index (AQI), COVID-19, Metropolitan cities

1. INTRODUCTION

In India, the first case of COVID-19 was reported on January 30, 2020 and many measures were proposed to prevent the spread of the virus [1]. To overcome the tough situation, the Indian Government has imposed a lockdown for 21 days on March 24, 2020. Since the COVID-19 cases did not decrease, the lockdown was extended followed by three more lockdowns of 19 days, 14 days and 14 days respectively [2]. Then, the Indian Government has announced three unlock phases except the containment zones.

The COVID-19 and their lockdowns drastically improved the quality of air due to halting of industrial operations and decrease in traffic [3]. This type of information shall help the nodal agencies and the policy makers to devise a scientific air quality management plan by directly

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targeting their hotspots which may lead to change in law and prevailing policies. India was the world's eighth most polluted country in 2022, dropping from the fifth spot the previous year. For such a most populous country like India, huge data's are required to plan and develop an effective management plan. The Central Pollution Control Board has been entrusted with the added responsibilities of Air Pollution Control since May, 1981 under the provisions of the Air (Prevention and Control of Pollution) Act, 1981. The enactment of the Environment (Protection) Act, 1986, which is the umbrella legislation for enforcement of measures for protection of environment, and several notifications of Rules under the Act widened the scope of activities of the Central Board [4].

Air pollution is responsible for 6.7 million premature deaths every year (WHO). Around 2.4 billion people cook and heat their homes with polluting fuels and every year 3.2 million people die prematurely from household air pollution. More than 99% of the population lives in areas where the air pollution is above WHO air quality guidelines and 4.2 million deaths are attributed to ambient air pollution each year[5]. Hence, it is most important to keep track the quality of the air as it may not only have short-term effects but can also have long-term effects on the health of the people, particularly for those who have cardiac or respiratory issues.

2. MATERIALS AND METHOD

Pollutants with the strongest evidence for public health concern include Particulate matter (PM_{10}), Particulate matter ($PM_{2.5}$), Nitrogen dioxide (NO_2) and Sulfur dioxide (SO_2). Health problems occur as a result of both short- and long-term exposure to these various pollutants. For some pollutants, there are no thresholds below which adverse effects do not occur.

Particulate matter (PM) refers to inhalable particles, composed of sulphate, nitrates, ammonia, sodium chloride, black carbon, mineral dust or water. PM can be of different size and is generally defined by their aerodynamic diameter, with PM2.5 and PM10 the most common in the regulatory framework and relevant for health. Sources of the largest particles called coarse particles (particles with diameter between 2.5 μm and 10 μm) will mainly consist of pollen, sea spray and wind-blown dust from erosion, agricultural spaces, roadways and mining operations. The finer particles (i.e., PM2.5) can be derived from primary sources (e.g., combustion of fuels in power generation facilities, industries or vehicles) and secondary sources (e.g., chemical reactions between gases). The main source of indoor pollution is due to particulate matter which generally occurs during the combustion of polluting fuels in open hearths or poorly vented, inefficient stoves or space heaters. In outdoor, the main sources are

site-specific and shall be from different origins but typically include traffic and transportation, industrial activities, power plants, construction sites, waste burning, fires or fields. The health risks associated with particulate matter of less than 10 and 2.5 microns in diameter (PM_{10} and $PM_{2.5}$). PM is capable of penetrating deep into the lung and enter the bloodstream causing cardiovascular (ischaemic heart disease), cerebrovascular (stroke) and respiratory impacts. Both long-term and short-term exposure to particulate matter is associated with morbidity and mortality from cardiovascular and respiratory diseases.

Ambient sources of NO_2 results from high temperature combustion of fuels in processes such as those used for heating, transportation, industry and power generation. Household sources of nitrogen oxides (NOx) include equipment that burn fuels such as furnaces, fireplaces and gas stoves and ovens. Exposure to nitrogen dioxide can irritate airways and aggravate respiratory diseases. Sulfur dioxide (SO_2) is predominantly a resultant from the combustion of fossil fuels for domestic heating, industries and power generation.

The data's are obtained from the Central Pollution Control Board for air pollutants such as PM_{10}, $PM_{2.5}$, SO_2 and NO_x to compare the Status of Air Quality in Indian Metropolitian Cities such as Mumbai, Pune, Delhi, Ahmedabad, Surat, Chennai, Kolkata, Bangalore, and Hyderabad during Pre COVID, COVID Pandemic period and Post COVID for the years 2019, 2020 and 2021. Accordingly, Air Quality Index was also computed for the years 2019, 2020 and 2021 for the Metropolitian Cities [6].

3. RESULTS AND DISCUSSION

The Particulate Matter (PM_{10}) showed a decline rate during the COVID pandemic period (2020) except Delhi when compared to the year 2019. The year 2021 also showed a decline rate except Mumbai when compared to the year 2021. The comparisons of the data are shown in Table 1 and Figure 1 respectively.

The Particulate Matter ($PM_{2.5}$) showed a decline rate during the COVID pandemic period (2020) except Delhi and Kolkata when compared to the year 2019. The year 2021 also showed a decline rate in all metropolitian cities when compared to the year 2021. The comparisons of the data are shown in Table 2 and Figure 2 respectively.

The pollutant Sulphur Dioxide (SO_2) showed a decline rate during the COVID pandemic period (2020) except Kolkata and Mumbai when compared to the year 2019. The year 2021 showed a decline rate in few metropolitian cities such as Chennai, Kolkata and Surat when compared to the year 2021. The comparisons of the data are shown in Table 3 and Figure 3 respectively.

The Nitrogen Dioxide (NO_2) showed a decline rate during the COVID pandemic period (2020) except Kolkata and Mumbai when compared to the year 2019. The year 2021 also showed a decline rate in all metropolitian cities except Ahmedabad when compared to the year 2021. The comparisons of the data are shown in Table 4 and Figure 4 respectively.

The Air Quality Index (AQI) during the year 2019 shows that except Delhi all metropolitian cities had the AQI of moderately polluted ranging between 101-154. As per National Air Quality Index, the range between 101-200 may cause breathing discomfort to the people with lung disease such as asthma and discomfort to people with heart disease, children and older adults. The AQI showed a decline rate during the COVID period i.e., 2020 except Delhi and Kolkata. The metropolitian cities such as Bangalore, Chennai and Mumbai had the AQI of Satisfactory ranging between 58-92. As per National Air Quality Index, the range between 51-100 may cause minor breathing discomfort to sensitive people. Except Delhi all other metropolitian cities had the AQI ranging between 109-145. Delhi's AQI observed to be very poor i.e., 319 which may cause respiratory illness to the people on prolonged exposure. Effect may be more pronounced in people with lung and heart diseases. During the year 2021, AQI showed satisfactory rate at Bangalore, Chennai and Hyderabad. The other metropolitian cities such as Ahmedabad, Kolkata, Mumbai, Pune and Surat showed the AQI category of moderately polluted. The AQI of Delhi observed to be Poor which may cause breathing discomfort to people on prolonged exposure and discomfort to people with heart disease. The comparisons of the data of AQI and trend in AQI are shown in Table 5 and Figure 5 respectively. The AQI category and associated health impacts are presented in Table 6.

4. CONCLUSION

The air pollutant data and trend in Air Quality Index (AQI) indicated that during the lockdown period the air quality improved. The trend in AQI provides valuable insights to the industries, nodal agencies and public to opt for environment friendly alternatives. Network of metro rails for public transport can be further enhanced and more cities shall be covered. Promotion of public transport and improvements in roads and building of more bridges to ease congestion on roads may improve the air quality. A country's growth needs to be sustainable and requires the participation of every citizens for sustainable growth. This data analysis showed that air pollutants can be curbed, and the general public should be more aware and switch over to eco friendly measures to maintain good air quality.

Tables

Table 1: Particulate Matter PM_{10}, $\mu g/m^3$ for Metropolitian Cities

S. No	Metropolitian Cities/Year	Particulate Matter PM_{10}, $\mu g/m^3$		
		2019	2020	2021
1	Ahmedabad	150	137	123
2	Bangalore	109	92	67
3	Chennai	101	58	58
4	Delhi	217	225	207
5	Hyderabad	148	114	89
6	Kolkata	151	133	107
7	Mumbai	136	56	106
8	Pune	181	125	108
9	Surat	151	114	100

Table 2: Particulate Matter $PM_{2.5}$, $\mu g/m^3$ for Metropolitian Cities

S. No	Metropolitian Cities/Year	Particulate Matter $PM_{2.5}$, $\mu g/m^3$		
		2019	2020	2021
1	Ahmedabad	44	NA*	46
2	Bangalore	46	35	31
3	Chennai	42	30	26
4	Delhi	128	145	107
5	Hyderabad	55	NA*	39
6	Kolkata	62	72	48
7	Mumbai	40	NA*	47
8	Pune	NA*	NA*	45
9	Surat	46	42	35
NA* – Data Not Available				

Table 3: Sulphur Dioxide (SO_2), $\mu g/m^3$ for Metropolitian Cities

S. No	Metropolitian Cities/Year	Sulphur Dioxide SO_2, $\mu g/m^3$		
		2019	2020	2021
1	Ahmedabad	22	15	17

2	Bangalore	7	3	5
3	Chennai	15	14	11
4	Delhi	6	NA*	10
5	Hyderabad	6	5	6
6	Kolkata	11	14	9
7	Mumbai	2	14	14
8	Pune	46	16	26
9	Surat	26	22	20
*NA – Data Not Available				

Table 4: Nitrogen Dioxide (NO_2), µg/m^3 for Metropolitian Cities

S. No	Metropolitian Cities/Year	Nitrogen Dioxide NO_2), µg/m^3		
		2019	2020	2021
1	Ahmedabad	28	19	34
2	Bangalore	30	26	21
3	Chennai	23	20	13
4	Delhi	117	71	42
5	Hyderabad	51	49	34
6	Kolkata	54	56	36
7	Mumbai	30	46	23
8	Pune	101	62	38
9	Surat	29	27	24
*NA – Data Not Available				

Table 5: Air Quality Index for Metropolitian Cities during Pre COVID, COVID Pandemic period and Post COVID

S. No	Metropolitian Cities/Year	Nitrogen Dioxide NO_2), µg/m^3		
		2019	2020	2021
1	Ahmedabad	133	125	115
2	Bangalore	106	92	67
3	Chennai	101	58	58
4	Delhi	306	319	257

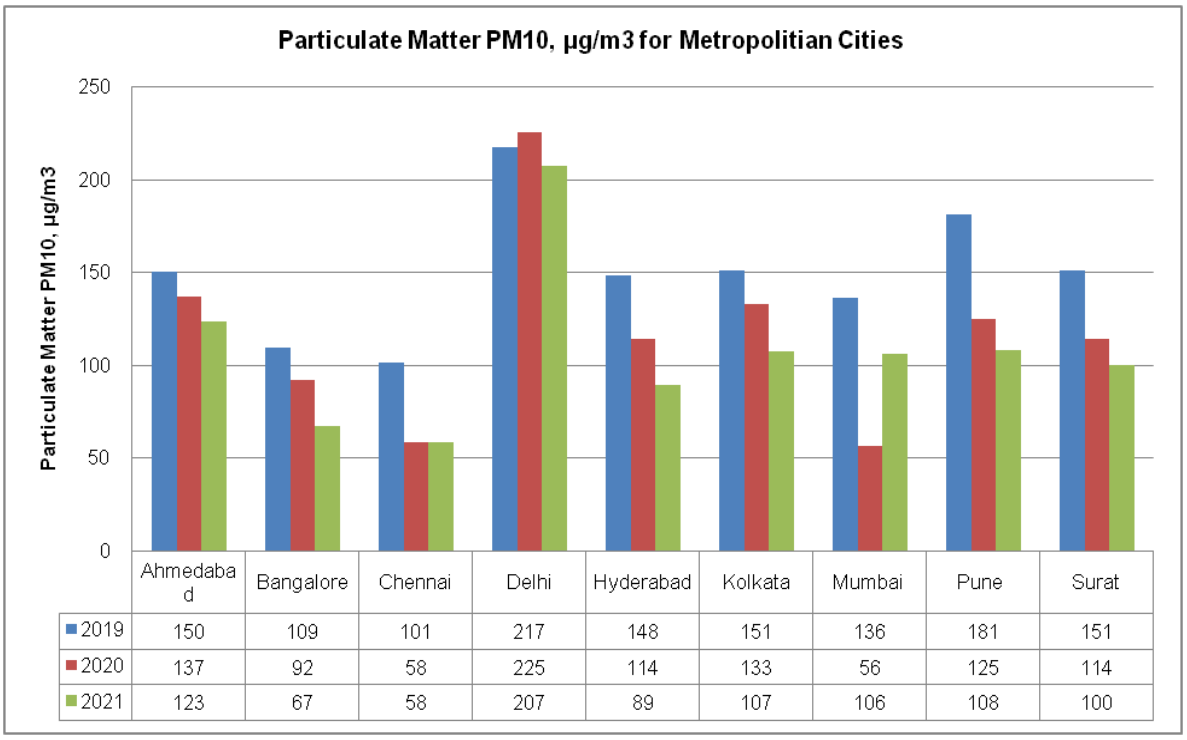
5	Hyderabad	132	109	89
6	Kolkata	130	145	105
7	Mumbai	124	58	104
8	Pune	154	117	105
9	Surat	134	109	100

Table 6: Air Quality Index (AQI)

AQI Category	Associated Health Impact
Good (0 to 50)	Minimal impact
Satisfactory (51 to 100)	May cause minor breathing discomfort to sensitive people
Moderately Polluted (101 to 200)	May cause breathing discomfort to the people with lung disease such as asthma and discomfort to people with heart disease, children and older adults
Poor (201 to 300)	May cause breathing discomfort to people on prolonged exposure and discomfort to people with heart disease
Very Poor (301 to 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 to 500)	May cause respiratory effects even on healthy people and serious health impacts on people with lung/heart diseases. The health impacts may be experienced even during light physical activity

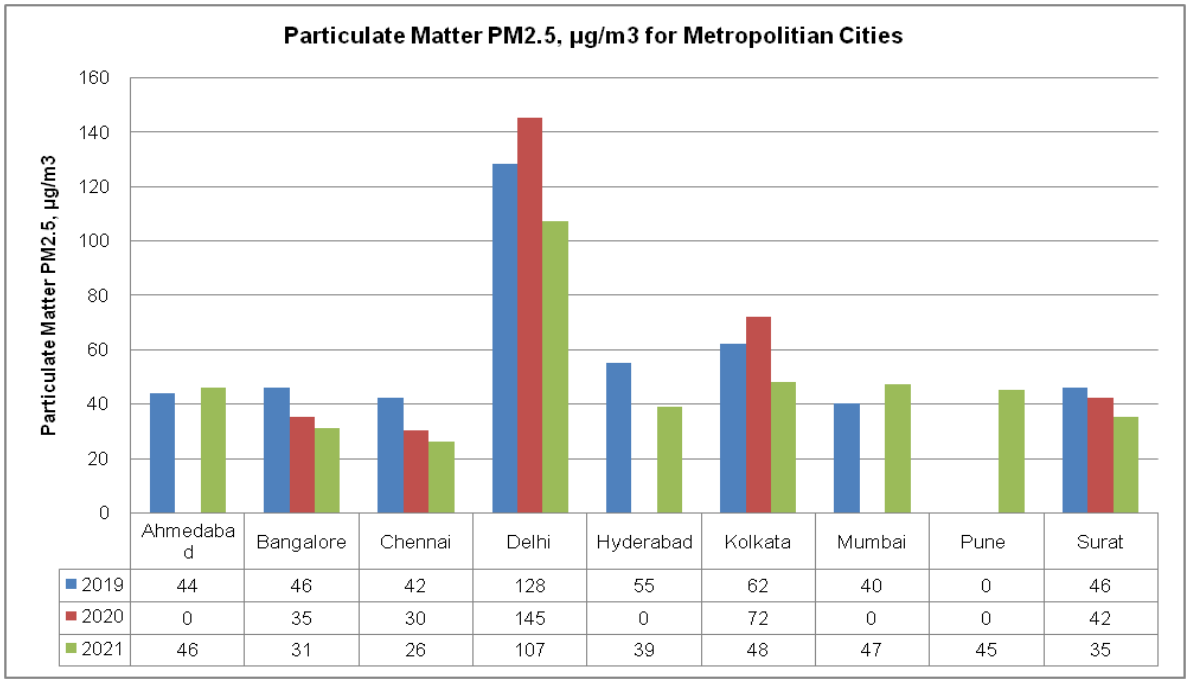
Source: Central Pollution Control Board

Figures



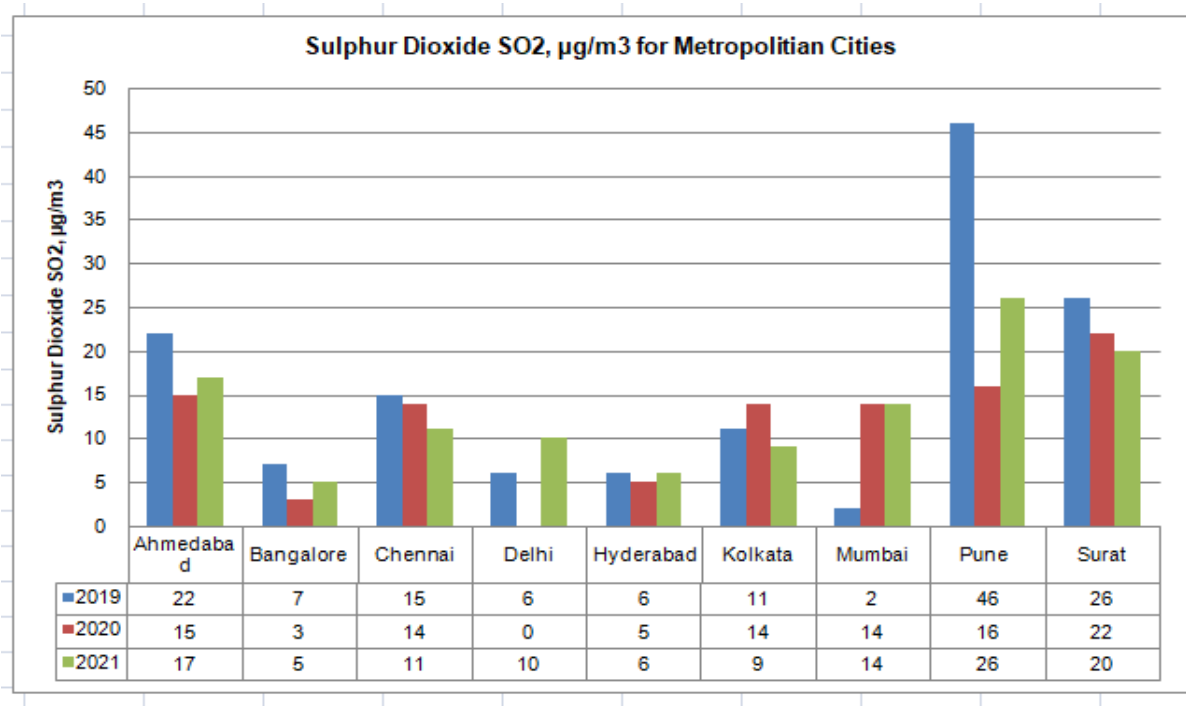
	Ahmedabad	Bangalore	Chennai	Delhi	Hyderabad	Kolkata	Mumbai	Pune	Surat
2019	150	109	101	217	148	151	136	181	151
2020	137	92	58	225	114	133	56	125	114
2021	123	67	58	207	89	107	106	108	100

Figure 1: Particulate Matter PM_{10}, µg/m^3 for Metropolitian Cities for the year 2019, 2020 & 2021 (Pre COVID, COVID Pandemic period and Post COVID)



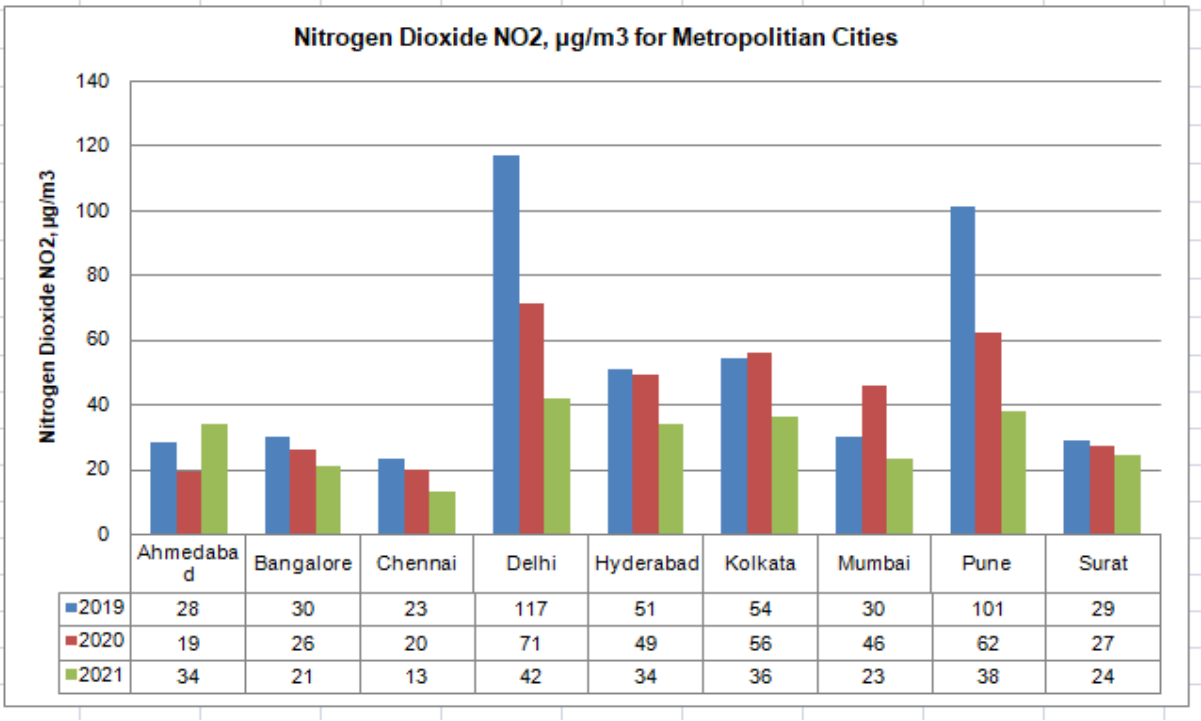
	Ahmedabad	Bangalore	Chennai	Delhi	Hyderabad	Kolkata	Mumbai	Pune	Surat
2019	44	46	42	128	55	62	40	0	46
2020	0	35	30	145	0	72	0	0	42
2021	46	31	26	107	39	48	47	45	35

Figure 2: Particulate Matter $PM_{2.5}$, µg/m^3 for Metropolitian Cities for the year 2019, 2020 & 2021 (Pre COVID, COVID Pandemic period and Post COVID)



	Ahmedabad	Bangalore	Chennai	Delhi	Hyderabad	Kolkata	Mumbai	Pune	Surat
2019	22	7	15	6	6	11	2	46	26
2020	15	3	14	0	5	14	14	16	22
2021	17	5	11	10	6	9	14	26	20

Figure 3: Sulphur Dioxide (SO2), µg/m^3 for Metropolitian Cities for the year 2019, 2020 & 2021 (Pre COVID, COVID Pandemic period and Post COVID)



	Ahmedabad	Bangalore	Chennai	Delhi	Hyderabad	Kolkata	Mumbai	Pune	Surat
2019	28	30	23	117	51	54	30	101	29
2020	19	26	20	71	49	56	46	62	27
2021	34	21	13	42	34	36	23	38	24

Figure 4: Nitrogen Dioxide (NO2), µg/m^3 for Metropolitian Cities for the year 2019, 2020 & 2021 (Pre COVID, COVID Pandemic period and Post COVID)

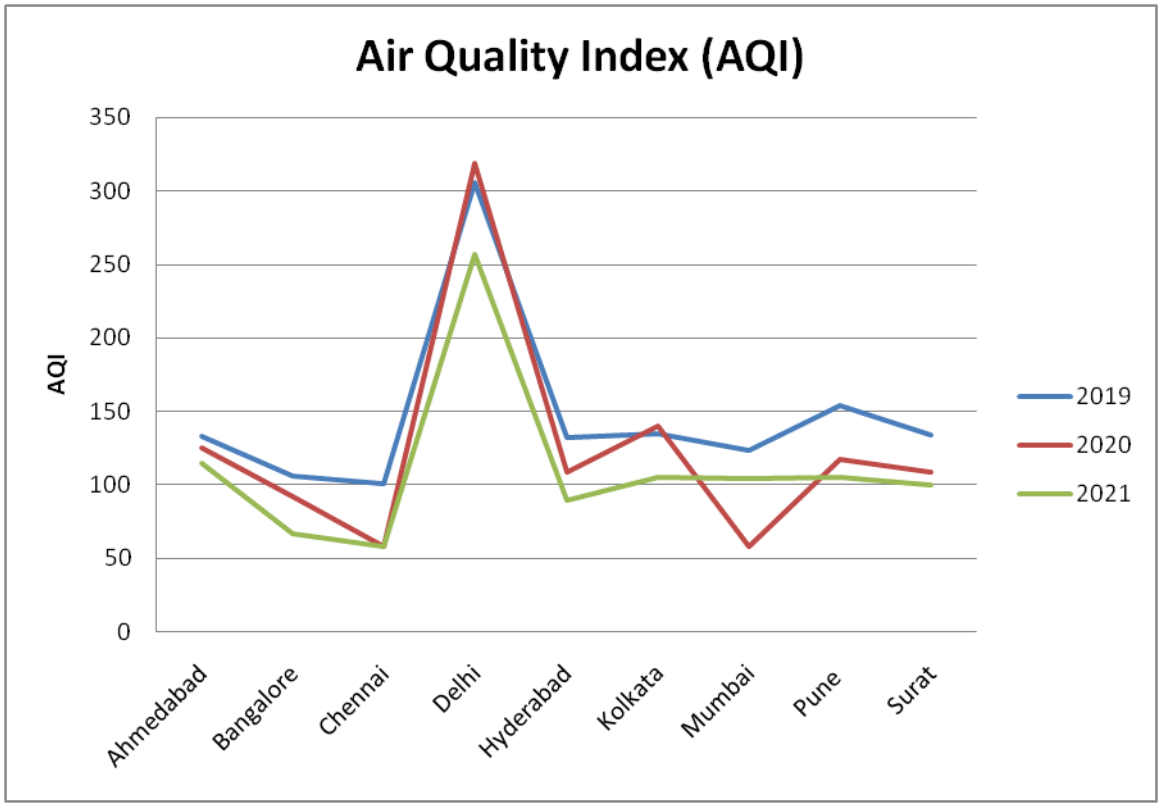


Figure 5: Air Quality Index (AQI)

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