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Status of Air Quality during, pre and post COVID Lockdown time

2019, 2020 & 2021

Gandhinagar, Gujarat

Introduction

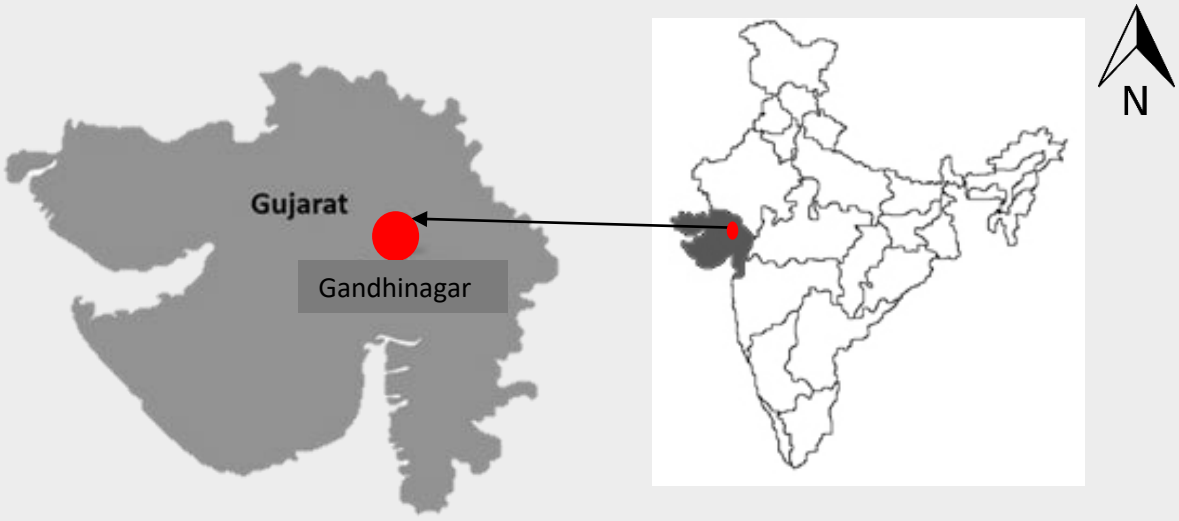
Being one of the crucial elements of life, air does not only impact the physical health of the people but also the overall wellbeing of human beings. It is an alarming fact which if not controlled will affect the overall health of the environment. The rapid urbanisation and population growth have worsen the situation. It has a long term effect on climate change as well.

The description of air quality is expressed through air quality standard which is regulated by an enforcing authority. The objective behind developing standards is to understand the variations in the level of concentration of pollutants and its impact on public health, so that the relevant authorities can take the necessary measures to improve the air quality.

This Newsletter is a detail discussion on the impact of lockdown on the air quality and the change from pre and post COVID situation of air quality. While the whole country was devastated by the impact of COVID 19, the effect of lockdown on the air quality was positive. India recorded its 1st COVID case in the year 2020 on 30th January and as the number of cases drastically increased consequently the nation prepared for lockdown and since 25th March till 31st May India went into nationwide lockdown.

Study area

To evaluate the change of air quality during, pre and post COVID time the city of Gandhinagar has been selected as the study area. Gandhinagar, the capital of Gujarat, is a planned city which is located approximately 23kms North of Ahmedabad with a population of 2.92 lakhs (2011 Census). The city has been developed in three phases following a sector-wise pattern. The

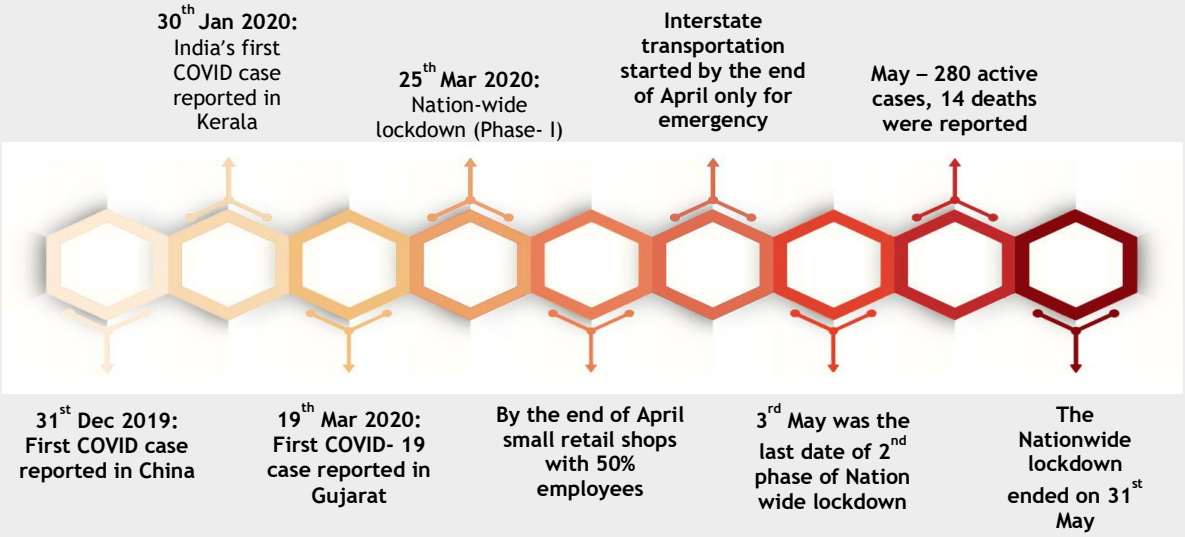


Map 1 Gandhinagar: Study Area

dominant landuse of Gandhinagar is residential, administrative and institutional, few sectors

are allotted as industrial areas in the outskirts of the city. Though the population in Gandhinagar is lower than that of Ahmedabad, the drastic increase in the population growth has attributed to overall pollution in the city. Being the administrative hub the number of daily commuters along with their vehicles have increased with time. The presence of industrial zones in sector 29 and 30 with major MNCs in the city might be one of the influential contributors of degradation of the air quality. Also, situation of burning of plastic and fossil fuel is quite common in this city like any other cities.

Methodology



Data from online portal of Central Pollution Control Board (CPCB) has been collected for seven pollutants i.e. $PM_{2.5}$, PM_{10}, NO_2, SO_2, CO, O_3 and NH_3 who are the major contributors of air pollution. For evaluation of air quality, three years have been considered: 2019, 2020 and 2021. The time period considered for the evaluation is from 23rd March to 31st May for each year, corresponding to the lockdown duration in 2020. There were four phases of lockdown maintained by the nation. The 1st phase started from 25th March, 2020 to 14th April, 2020. The second phase started from 14th April to 3rd May, 2020. The third phase started from 3rd May to 17th May, 2020. Even after 3rd May Gandhinagar was still in the red zone according to the report submitted by Health Ministry. The fourth phase started from 18th May to 31st May. After 31st May the unlock period started. The analysis is based on these four phases.

It has been assumed that level of air pollution in March, April, and May of 2019 is considered normal due to usual conditions, while the variation in air pollution level in March, April and May of 2020 is due to the country-wide lockdown imposed during the pandemic. The Air quality in 2021 has been considered that of the new normal.

The process of calculating the AQI is depicted in the figure below.

The formula used to calculate sub-indices of AQI is stated below (Indian air quality index – IND-AQI):

$$I_p = \left[\left\{\frac{(I_{HI} - I_{LO})}{(B_{HI} - B_{LO})}\right\} * (C_p - B_{LO})\right] + I_{LO}$$

where, I_p $= AQI$ for pollutant p

$B_{HI} =$ Breakpoint concentration greater or equal to given concentration.

$B_{LO} =$ Breakpoint concentration smaller or equal to given concentration.

$I_{HI} =$ AQI value corresponding to BHI

$I_{LO} =$ AQI value corresponding to BLO

$C_p =$ Pollutant concentration

The breakpoint concentrations for the pollutants have been considered as per the National Air Quality Index document and are shown in the table below:

Table 1Breakpoint concentration of various pollutants as per CPCB Regulation.

AQI Category	**Breakpoint concentration of different pollutants**						
	Carbon Monoxide, CO (mg/m^3)	**Nitrogen Dioxide, NO_2 ($\mu g/m^3$)**	**Particulate Matter**		**Ozone, O_3 ($\mu g/m^3$)**	**Sulphur Dioxide, SO_2 ($\mu g/m^3$)**	**Ammonia, NH_3 ($\mu g/m^3$)**
			PM_{10} ($\mu g/m^3$)	**$PM_{2.5}$ ($\mu g/m^3$)**			
Good	0-1	0-40	0-50	0-30	0-50	0-40	0-200
Satisfactory	1.1-2	41-80	50-100	31-60	51-100	41-80	201-400
Moderate	2.1-10	81-180	100-250	60-90	101-168	81-380	401-800
Poor	10.1-17	180-280	250-350	90-120	169-208	381-800	801-1200
Very Poor	17.1-34	280-400	350-430	120-250	208-748	801-1600	1201-1800
Severe	34+	400+	430+	250+	748+	1600+	1800+

Source: Report of National Air Quality Index, CPCB

Results

The concentration of air pollutants during lockdown period for COVID- 19 in 2020 and a similar period in 2019 and 2021 have been shown in the subsequent charts.

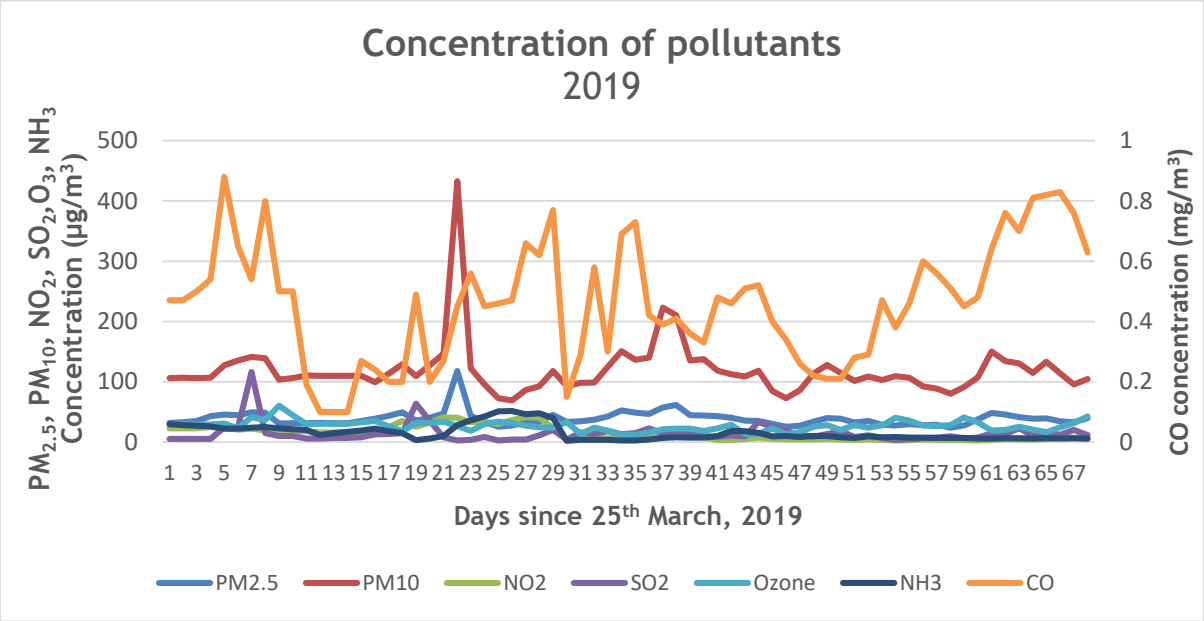
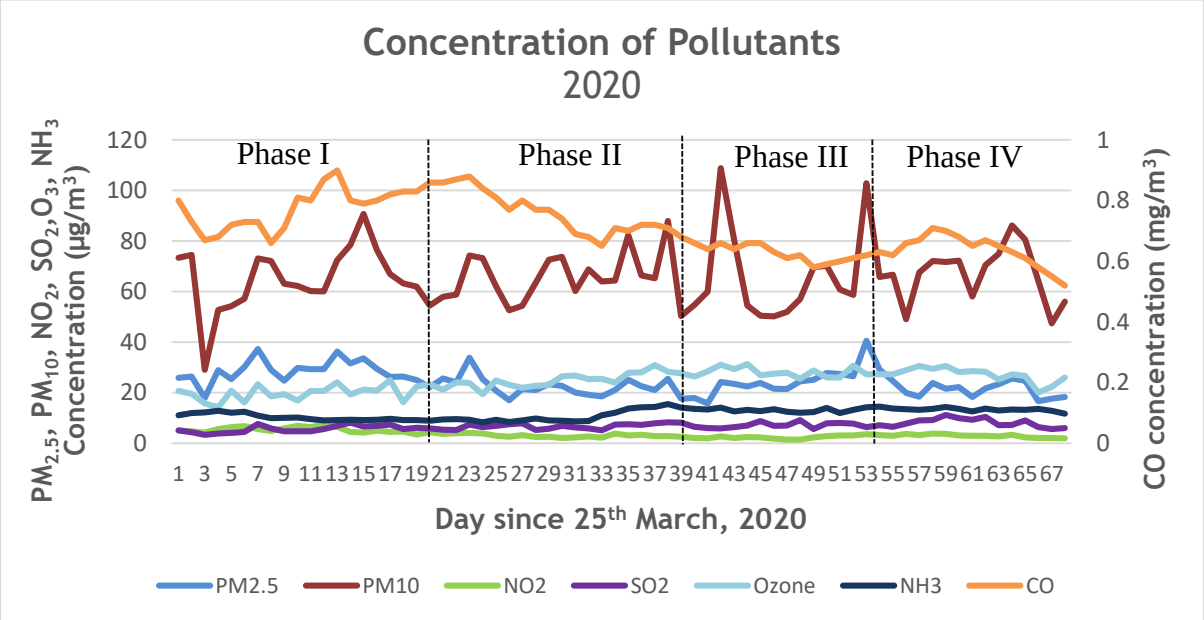


Figure 1Concentration of pollutants, 2019

Figure 2 Concentration of Pollutants, 2020 - During Lockdown



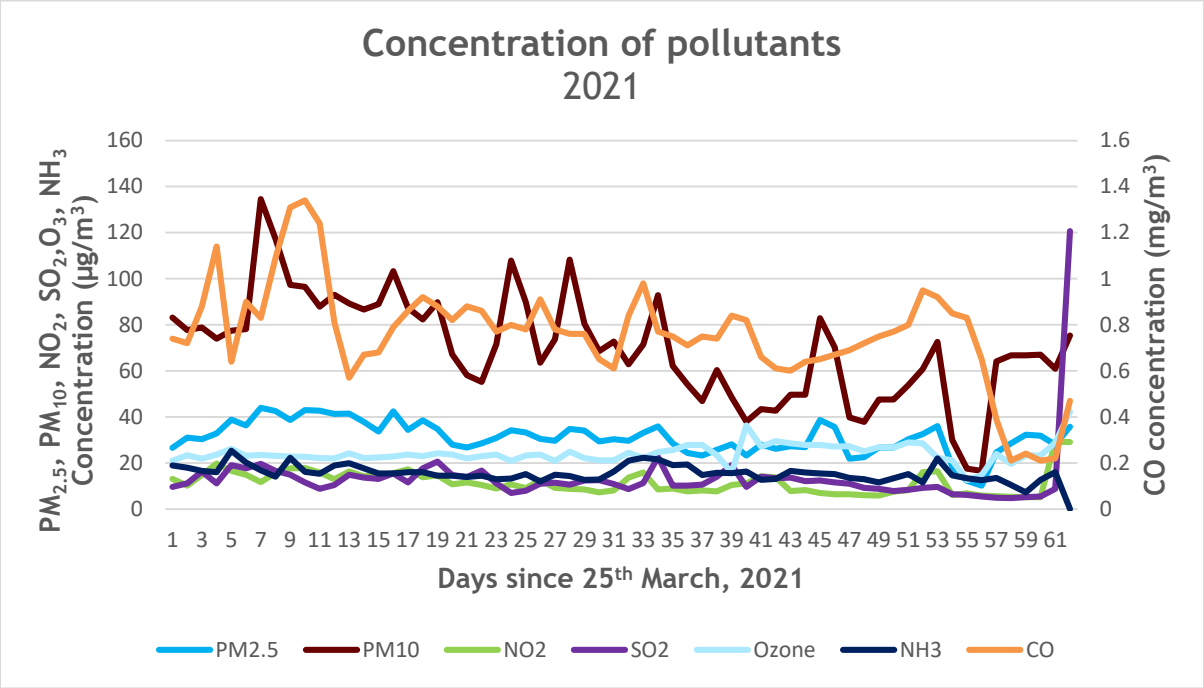


Figure 3 Concentration of Pollutants, 2021

Data source: https://app.cpcbccr.com/ccr/#/caaqm-dashboard-all/caaqm-landing/data

A notable reduction in the levels of pollutant concentration can be observed in 2020 as compared to that of 2019. Further, in 2021, the levels show an increment in comparison with 2020 levels. It can also be noted that the fluctuation in the levels has also reduced after the imposition of lockdown. From the graphical representation it is visible that the value of PM10 and NO2 who are the major contributors of high AQI level of Gandhinagar, have drastically reduced from 2019 to 2020 and then again in 2021 it shows an increasing trend.

The table below shows the mean value and standard deviation for different phases of lockdown in each year of analysis:

Table 2Mean and Standard Deviation of Pollutants in different phases in 2019, 2020 and 2021(for the same months)

Period	$PM_{2.5}$		PM_{10}		NO_2		SO_2		O_3		CO	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
2019												
Phase 1	38.43	6.84	116.80	13.83	22.49	6.59	19.06	25.56	32.46	8.30	0.39	0.22
Phase 2	45.45	19.45	138.83	79.79	19.62	13.66	11.28	6.08	22.58	6.63	0.48	0.16
Phase 3	33.43	5.25	105.80	14.04	4.11	1.11	12.79	7.61	23.91	7.69	0.37	0.11
Phase 4	35.78	7.12	110.46	20.53	4.59	1.64	12.04	5.07	27.34	7.67	0.66	0.13
2020												
Phase 1	28.12	4.32	64.50	12.27	5.25	1.06	5.59	1.29	20.02	2.83	0.78	0.07

Phase 2	22.02	3.77	65.77	9.68	2.91	0.62	6.81	0.99	25.29	2.64	0.75	0.07
Phase 3	25.24	5.14	67.20	17.17	2.48	0.64	7.08	1.02	28.09	1.77	0.62	0.02
Phase 4	20.95	2.83	66.95	11.16	2.93	0.62	8.33	1.68	27.09	2.97	0.64	0.06
2021												
Phase 1	36.45	5.51	88.03	16.09	14.74	2.41	14.38	3.30	23.02	1.06	0.89	0.21
Phase 2	29.85	3.73	69.95	18.79	9.75	2.17	11.98	3.72	23.81	3.94	0.78	0.08
Phase 3	27.32	6.68	49.71	16.21	9.13	3.74	10.22	2.48	25.81	4.20	0.74	0.11
Phase 4	27.28	7.75	59.62	18.04	12.18	10.71	22.19	40.23	25.13	8.07	0.34	0.16

Data source: https://app.cpcbccr.com/ccr/#/caaqm-dashboard-all/caaqm-landing/data

The data is from 25th March to 31st May for all the three years (2019, 2020 and 2021). It can be observed that both mean and standard deviation have reduced for $PM_{2.5}$, PM_{10}, NO_2 and SO_2. The reduction in mean indicates the overall reduction in the concentration of pollutants. Lower values of standard deviation depict consistency in pollution levels.

$PM_{2.5}$ There is a significant decline in the mean concentration of PM $_{2.5}$ from 2019 to 2020 in all the four phases of lockdown. In the 1st, 2nd, 3rd and 4th phase the percentage change in the mean concentration has decreased to 27%, 55%, 24% and 42% respectively. The maximum decline is seen in the 2nd and 4th phases. From 2020 to 2021 the percentage change have increased to 28.57%, 31%, 8%, and 35% respectively.

PM_{10} There is a significant decline in the mean concentration of PM $_{10}$ from 2019 to 2020 in all the four phases of lockdown. In the 1st, 2nd, 3rd and 4th phase the percentage change in the mean concentration has declined to 44%, 52%, 36% and 40% respectively. The maximum decline is seen in the 1st and 2nd phases. From 2020 to 2021 the percentage change have been recorded in the 1st two phases as 37%, 6% and it has declined in the last two phases as 26%, 10% respectively.

NO_2 There is a significant decline in the mean concentration of NO_2 from 2019 to 2020 in all the four phases of lockdown. In the 1st, 2nd, 3rd and 4th phase the percentage change in the mean concentration has declined to 77%, 89%, 50% and 49% respectively. The maximum decline is seen in the 1st and 2nd phases. From 2020 to 2021 the percentage change have been recorded as 180%, 350%, 349%, and 500% respectively. It has drastically increased in 2021.

SO_2 There is a significant decline in the mean concentration of SO_2 from 2019 to 2020 in all the four phases of lockdown. In the 1st, 2nd, 3rd and 4th phase the percentage change in the mean concentration has decreased to 68%, 38%, 41% and 33% respectively. The maximum decline is seen in the 1st and 3rd phases. From 2020 to 2021 the percentage change have been recorded as 180%, 100%, 42%, and 175% respectively.

O_3 There is a mixed trend in the mean concentration of O_3 from 2019 to 2020 in all the four phases of lockdown. In the 1st, 2nd, 3rd and 4th phase the percentage change in the mean concentration shows a mixed trend. The values have decreased to 37% in the 1st phase but in the next two phases the percentage change have increased to 13%, 21% respectively and in the last phase it has again declined to 17%. From 2020 to 2021 the percentage change in the 1st phase is recorded as 15% while in the second phase it has declined to 8% but in the third and fourth phases it have rose upto 10%, and 7% respectively.

CO There is a significant increase in the mean concentration of CO from 2019 to 2020 in the first three phases of lockdown. In the 1st, 2nd, 3rd phases the percentage change in the mean concentration are around 100%, 56%, 67% respectively but it has declined in the last phase i.e. 3%. From 2020 to 2021 the percentage change have increased and the levels have been recorded as 14%, 4%, 19%, and 46% respectively.

A similar pattern has been observed in the AQI levels as well. The AQI shows the air quality has been better during the duration of lockdown in 2020. The level in 2019 the level of air quality varies between **'moderate to poor'**, only for one day it had rose upto the level of **'very poor'**. In 2020 the level lies in the **'good'** category, whereas, in the year 2021 it is **'satisfactory'**. The chart below shows the AQI level in Gandhinagar for the selected time period.

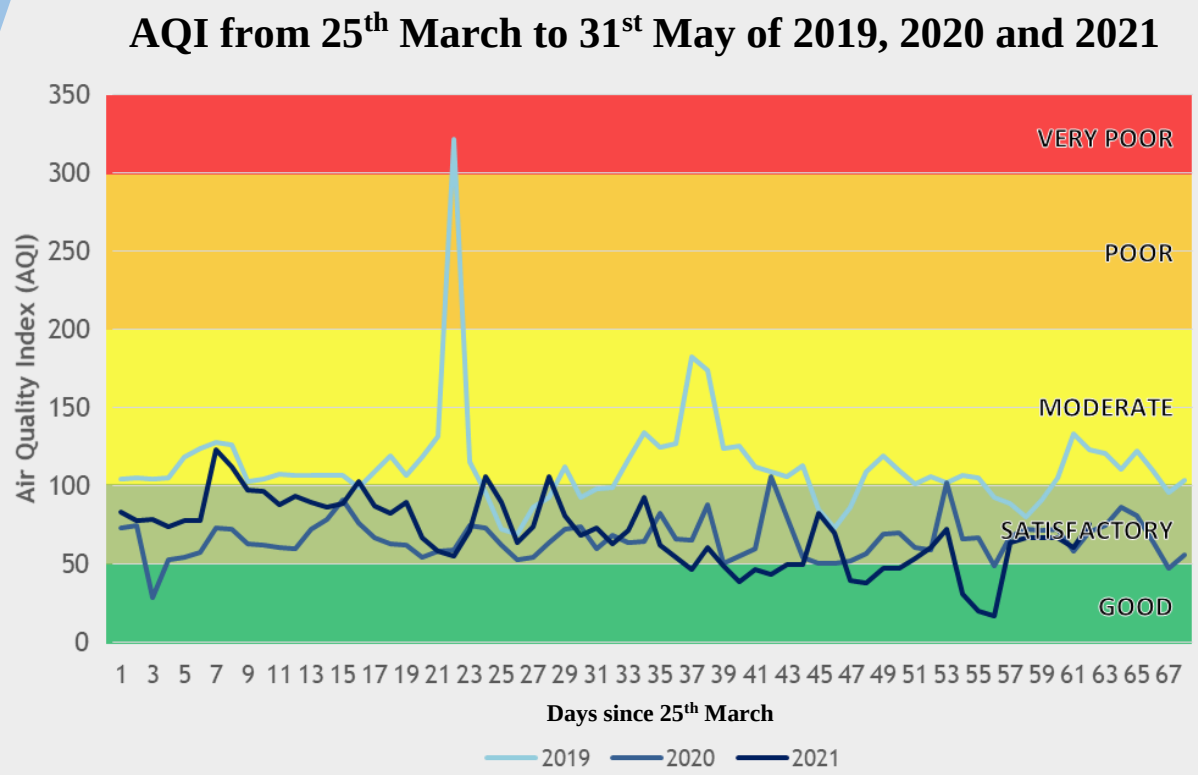


Figure 4Trend of AQI for the duration of lockdown, 2019, 2020 and 2021

Data source: https://app.cpcbccr.com/ccr/#/caaqm-dashboard-all/caaqm-landing/data

Discussion

According to the WHO report on World Air Quality Report, 2019 almost all the people of various cities across globe live in the air quality which exceeds the WHO guidelines limit. The severity is more in the developing countries like India. The cities face the impact of air pollution every day caused by vehicular and industrial emissions, construction activities etc. which contributes to the rising value of $PM_{2.5}$, PM_{10}, NO_2, CO, Ozone etc. It is an alarming fact that many people die in stroke, lung cancer, and respiratory diseases for which degradation of the air quality is one of the major reasons. But the nationwide lockdown during COVID 19 had changed the scenario last year.

The data representation states that the concentration of particulate matters and NO_2 are majorly responsible for air pollution in Gandhinagar. One of the reasons behind the significant reduction in the air pollutants is the decrease in the anthropogenic activities during nationwide lockdown. The halt in the industrial sectors as well as reduction in the vehicle transit had a positive effect on air quality. For the same reason the level of these pollutants started rising again in 2021, though the level of concentration is lesser than 2019 as even in 2021 some of the private officials worked from home and the Government officials had 50% attendance

system during the second wave of COVID and also many activities are done through virtual platforms. .

The change in the trend of concentration of SO_2 and O_3 shows a mixed nature for all the three consecutive years. The probable reasons behind it may be various coal based or thermal power plants, ash and few essential industrial activities were still in the active state after the 1^{st} phase of lockdown so it did not change the concentration significantly. Also, the concentration of CO has significantly increased from 2019 to 2020 and 2021 probably because the functioning of power plants.

The concentration of O_3 level shows a mixed trend. The increase in few phases during lockdown might be because of few reasons. The reduction in the vehicular and industrial emission with increased insolation and temperature during the months of March-April may increase the concentration of O_3. Being a secondary pollutant the level of O_3 depends on the levels of volatile organic compounds and NOx. The reduction in the emission of these precursors have increased the concentration. Also, NO consumes O_3 during titration process, but during lockdown as the emission of NO was reduced and controlled it affected the level of O_3 in the air.

Conclusion

From the above discussion it is evident that though the strict actions during lockdown had impacted the economy badly but it had a very positive effect on the air quality which is desirable at any point of time. Being the capital of Gujarat, Gandhinagar has experienced rapid growth of population, activities as well as vehicular movements which has impacted its air quality during the last decade. As shown in the graphical representation of the AQI value that the air quality has drastically improved during and post lockdown period compared to 2019. The scenario of lockdown can be used as a case study as well as model which can provide various insights regarding the level of pollutants and the ways to control it. The policy makers and planners can actually use this model to implement a better policy. Though the air quality level also depends on other meteorological factors, but controlling some of the major causes especially anthropogenic causes which result higher concentration of pollutants can bring a better air for humanity to inhale.

Limitation

There are few limitations of this study. There are listed below.

- Only one station (Sector 10, Gandhinagar, GPCB) was there in Gandhinagar which recorded the data of the pollutants. Recently from June, 2021 two more stations (IIPHG Lekawada, Gandhinagar – IITM; GIFT city, Gandhinagar, IITM) have been recording the data.
- The result of May 2021 is taken based on the available data upto 24th May.

Data source

https://app.cpcbccr.com/ccr/#/caaqm-dashboard-all/caaqm-landing/data

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