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Impact of Corona crisis on Environment

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Abstract- The novel Corona Virus disease pandemic (Covid-19) has brought the human life to complete standstill as most countries of the World have shut themselves off from the work. Covid-19, just few days back, was foreign to us and today it has indeed routed itself in our lives so much so that we are witnessing lot of things around us which we could not have imagined otherwise or perhaps for the first time in modern industrialized history. To be precise, shut down of all types of industries, drastically reduced plying of vehicle on the road and several activities of people affecting the environment in not so good ways. For a long time, it has been stated that the increased industrialization and anthropogenic activities in the last two decades polluted the atmosphere, hydrosphere, and biosphere. Therefore, the aim of this study is to understand the impact of Covid-19 on our environment viz., Air quality, Water quality, Carbon emission in longer run. Data available through various platforms have helped in this analysis on impact of Covid- 19 on environment. Cleaner atmosphere, hydrosphere and biosphere for a few months may be a tiny silver lining to Covid-19's dark clouds, but will do little in the long run to solve the problem of environmental pollution in all forms viz., air, water etc.

Key words: Corona Virus, environmental, Air quality, Water quality, Carbon emission

INTRODUCTION

The Covid-19 pandemic has impacted every aspect of human life and the global economy. As of May 25, 2020, the coronavirus (Covid-19) has infected over 1.31 lacs people and caused ~3867 deaths in India. (https://economictimes.indiatimes.com/coronavirus). From March 2020, India, the second-most populous country in the world with 1.3 billion people, went into lockdown. Nonetheless, the lockdown has halted quite significantly all forms of transport (flights, trains, automobiles), factories, shops, markets, and other economic and social activities.

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Despite the severe impacts of lockdown on people's social life, global mobility and economy, there are reports that lockdown has temporarily improved environmental conditions. For example, the lockdown improved the air quality of the 103 cities in India- the most polluted country in the world which has 21 out of the 30 world's most polluted cities (Singh and Chakraborty 2020)[1].

Air pollution is one of the largest environmental health risks in the world. 7 million people die prematurely every year globally as a result of exposure to air pollution, more than 91% of the world's population lives in places where air quality exceeds the World Health Organization's guidelines (WHO 2020)[2]. PM2.5 is a common cause for adverse health outcomes such as chronic obstructive

pulmonary disease (COPD) and lower respiratory infection (LRI) causing death of nearly three million people globally, according to a study. NO_2 is the leading source of childhood asthma in urban areas globally (Achakulwisut *et al.* 2019)[3]. Likewise, acute to chronic exposures to SO_2, CO, and O_3 can harm the human respiratory system, causing breathing problems including occasional death (Chen *et al.* 2007, Brown 2009)[4,5]. The coronavirus-triggered lockdown has led to a steep fall in global carbon emissions by 17 per cent in early April as compared to 2019 levels with India's emissions dropping by 26 per cent, according to a study.

Therefore, understanding this temporary improvement in air quality at the planetary scale provides a unique opportunity to study its implications in longer run.

MATERIALS & METHODS

Here, insight on air pollution by utilizing vast networks of ground-based air quality monitoring stations from major Indian cities is being provided. The air quality data is collected from 10 ground-based stations from 1st January 2020 till 25th May 2020 to compare periodical changes pre-covid and post-covid lockdown.

Selection of the major cities

10 major cities in India are selected to undergo this study for Air Pollution. Study is based on the following:

(i) The historical level of air pollution in these cities

(ii) Availability of air pollution data.

CPCB - India Central Pollution Control Board portal (https://cpcb.nic.in/) is used to download the above discussed periodical data on air pollution indicators. Selection was also based on the fact that these cities are affected heavily by anthropogenic emissions and a visible/ remarkable reduction in air pollution is expected in these cities as a result of lockdown.

Selection of air pollutants:

Normally, air quality is evaluated by measuring the atmospheric concentrations of six pollutants:

i) Fine particulate matter (PM2.5, mass concentration of particles with diameters d"2.5 um)

ii) Coarse particulate matter (PM10, mass concentration of particles with diameters d"10 um)

iii) Ground-level ozone (O_3)

iv) Nitrogen dioxide (NO_2)

v) Sulfur dioxide (SO_2)

vi) Carbon monoxide (CO)

All of them except O_3 have primary sources, such combustion sources as the automobiles and industries, while O_3 is formed in the atmospheric from precursor gaseous species, emitted mostly from primary sources, in presence of sunlight. Therefore, pollutants viz., PM2.5, PM10, NO_2, O_3, SO_2 & CO, to investigate the changes in air quality among cities before and during lockdowns and its future is selected.

Data and analysis:

Publicly available air quality data provided by the CPCB - India Central Pollution Control Board which curates air quality data collected from ground-based air quality monitoring stations situated in cities in India has been referred to.

Analysis Assumptions:

- It must be noted that the data from CPCB is from the stations managed by government agency and may not be always fully validated.
- Daily concentrations of air pollutants collected from multiple CPCB stations, which were available for further analysis.
- By 'lockdown', it is meant restrictions on vehicles, commercial flights except for cargo and charter, and prohibitions of commercial activities, except for essential services, resulting in a temporary shutdown of air pollution sources from these activities.
- It is assumed that air quality in January, February of 2020 was under the business as usual conditions and hence considered normal. Therefore, daily changes in concentrations of these air pollutants from January 1 to May 25 (146 days) was examined to investigate the effect of lockdown on their daily concentrations of air pollutants using lockdown as dummy variable, i.e., periodical concentration (on a given day) of the six air pollutants of January, February of 2020, (all pre-Covid) with March, April and May of 2020 (post Covid lockdown).

RESULTS & DISCUSSIONS

After analysing the data, it is seen, that there had been consistent decline in the PM2.5 levels in all the concerned cities throughout. Marginal spikes are visible post 17th May'20 and same is due to the ease in lockdown by the Govt. during Lockdown 4.0. It is worth mentioning here that in absolute term these cities already have cleaner air, i.e., PM2.5 concentrations are very low compared to heavily polluted earlier.

Table 1: PM2.5 concentration levels analysis: (unit: particle per million (ppm))

City	1st Jan 20	1st Feb	1st March	25th March	14th April	3rd May	17th May	25th May
Bhopal	100.74	35.45	55.92	23.57	44.21	19.69	19.8	17
Patna	144.22	62.48	71.4	54.08	49.09	20.03	43.76	47.9
Lucknow	388.95	139.37	54.43	96	98.66	43.83	83.86	95.7
Kolkata	115.14	46.13	68.19	51.52	27.67	19.58	8.27	14.25
Amravati	58.61	20.55	33.53	16.71	19.42	21.94	None	16.82
Delhi	367.38	130.43	61.67	42.55	None	None	96.64	69.01
Ahmedabad	78.79	88.63	52.56	34.65	31.44	23.85	26.89	23.59
Mumbai	54.93	None	24.37	21.26	20.33	42.29	59.18	47.33
Jaipur	51.64	35.2	28.47	24.36	32.08	29.65	33.14	42.31
Chennai	29.55	42.88	36.9	15.7	14.78	12.9	3.96	12.14

***Range:** Good (O -30); Satisfactory (31 -60); Moderately Polluted (61 -90); Poor (91 -120); Very Poor (121-250); Severe (250+)*

Data Source: CPCB - India Central Pollution Control Board portal (https://cpcb.nic.in/)

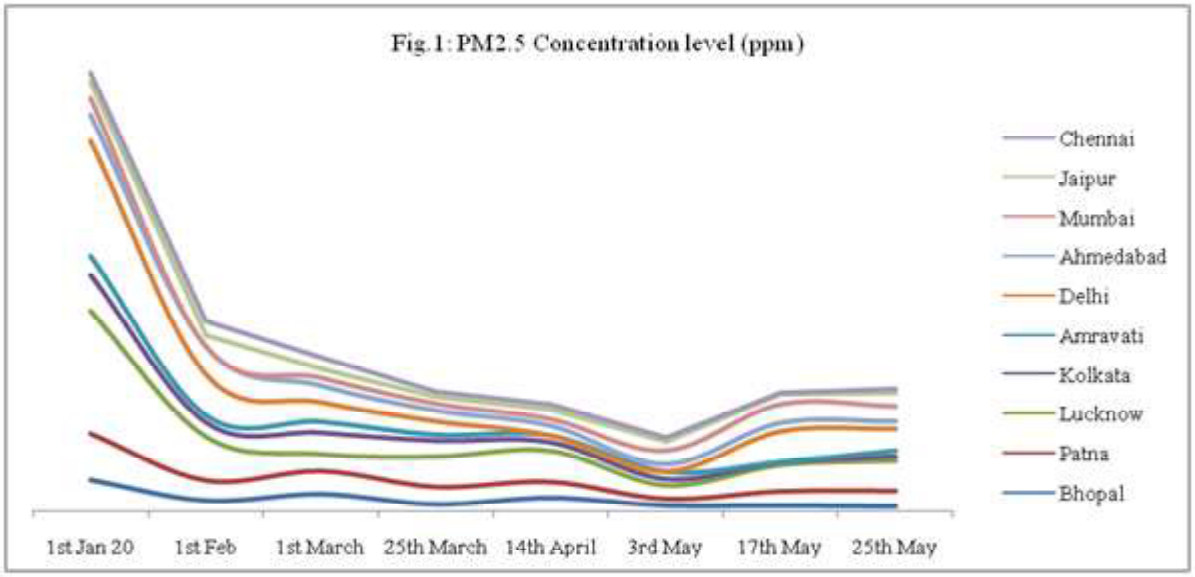


Table 2: PM10 concentration levels analysis: (unit: particle per million (ppm))

City	1st Jan 20	1st Feb	1st March	25th March	14th April	3rd May	17th May	25th May
Bhopal	146.59	95.66	153.83	67.92	122.27	84.34	67.02	40.19
Patna	263.65	154.05	160.75	100.07	79.52	46.89	117.48	129.93
Kolkata	185.33	81.35	150.87	76.69	53.19	31.59	22.44	45.89
Amravati	87.32	42.45	56.54	35.6	45.57	55.14	45.44	57.38
Delhi	460.72	269.45	190.19	72.58	NA	NA	165.23	104.76
Ahmedabad	131.51	125.72	122.71	92.68	71.5	63.16	62.76	66.46
Mumbai	129.59	NA	71.02	71.07	78.11	61.93	100.83	123.31
Jaipur	135.71	88.71	98.43	46.24	108.09	78.22	74.3	123.03
Note: Data for Lucknow and Chennai not available, hence excluded for PM 10 analysis								

***Range:** Good (O -50); Satisfactory (51 -100); Moderately Polluted (101 -250); Poor (251 -350); Very Poor (351-430); Severe (430+)*

Data Source: CPCB - India Central Pollution Control Board portal (https://cpcb.nic.in/)

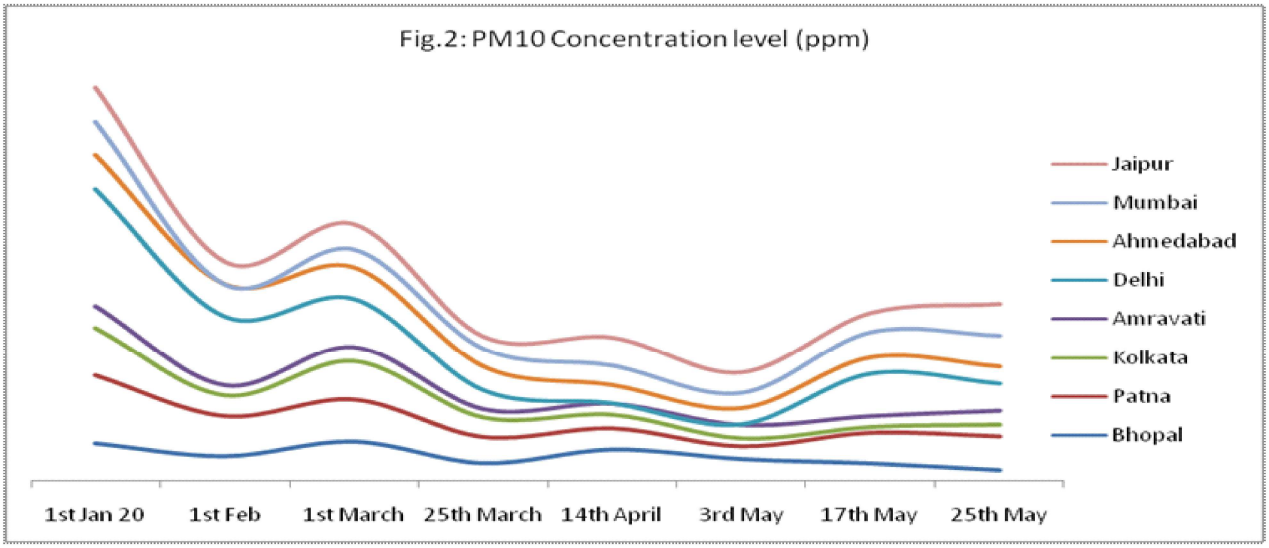


Table 3: NO_2 concentration levels analysis: (unit: particle per billion (ppb))

City	1st Jan 20	1st Feb	1st March	25th March	14th April	3rd May	17th May	25th May
Bhopal	42.23	36.69	34.67	9.64	10.85	6.34	9.95	4.21
Patna	77.55	80.61	84.04	None	None	None	79.75	None
Lucknow	26.99	35.76	33.66	14.34	49.62	9.89	14.3	26.99
Kolkata	49.37	34.62	39.78	9.87	4.84	5.07	4.94	4.37
Amravati	11.95	11.54	8.52	4.32	4.94	4.36	14.39	3.55
Delhi	54.65	68.57	75.51	20.65	None	None	28.25	27.79
Ahmedabad	12.56	53.05	58.4	35.7	23.07	15.77	18.69	14.13
Mumbai	33.99	3.3	33.89	23.11	4.36	None	None	16.96
Jaipur	23.44	42.57	20.46	10.73	15.34	7.77	21.55	14.3
Chennai	17.41	19.65	13.79	10.35	20.85	3.85	4.78	10.32

Range: ***Good (O -50); Satisfactory (51 -100); Moderately Polluted (101 -360); Poor (360 -650); Very Poor (650-1250); Severe (1250+)***

Data Source: CPCB - India Central Pollution Control Board portal (https://cpcb.nic.in/)

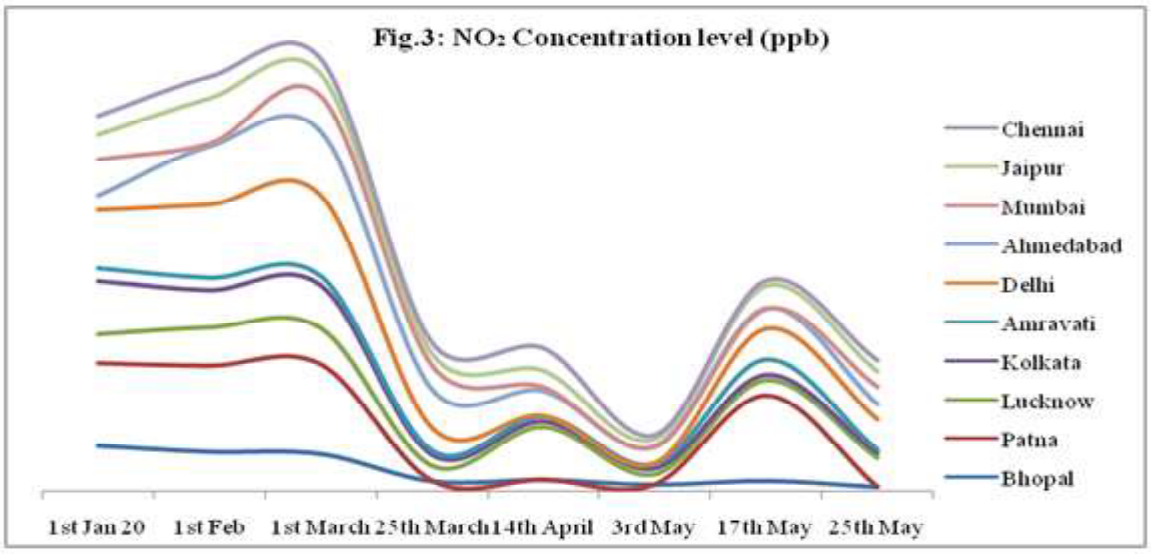


Table 4: CO concentration levels analysis: (unit: particle per million (ppm))

City	1st Jan 20	1st Feb	1st March	25th March	14th April	3rd May	17th May	25th May
Bhopal	1.15	0.75	0.97	0.37	0.68	0.36	0.38	0.31
Patna	2.52	1.25	1.45	0.67	0.49	0.39	0.68	0.72
Lucknow	2.25	1.42	0.99	0.96	1.01	0.99	0.66	0.97
Kolkata	1.3	0.55	0.86	0.45	0.4	0.4	0.3	0.31
Amravati	0.76	0.44	0.49	1.51	0	None	None	0.45
Delhi	3.67	2.1	2.18	1.24	None	None	2.94	1.04
Ahmedabad	0.88	0.99	1.23	1.24	0.37	0.65	0.67	0.51
Mumbai	2.54	3.41	1.9	1.05	0.93	0.96	0.62	0.53
Jaipur	0.92	0.86	0.57	0.58	0.91	0.82	0.67	0.74
Chennai	0.52	0.42	0.7	0.29	0.36	0.47	0.39	0.51

***Range:** Good (O -5); Satisfactory (5 -10); Moderately Polluted (10 -12); Poor (13 -16); Very Poor (17-30); Severe (30+)*

Data Source: CPCB - India Central Pollution Control Board portal (https://cpcb.nic.in/)

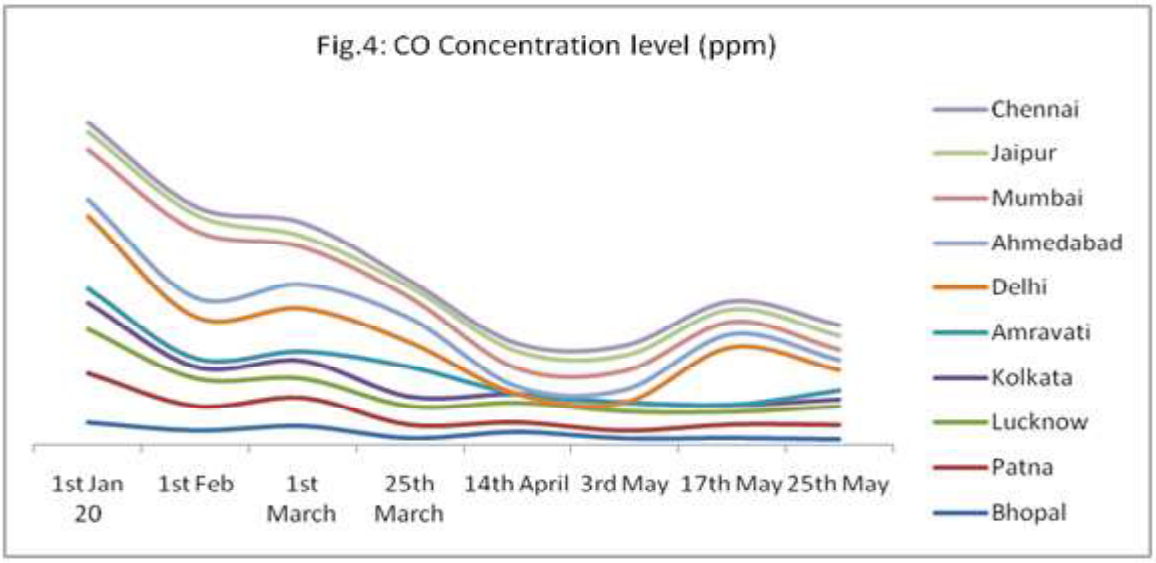


Table 5: O_3 concentration levels analysis: (unit: particle per billion (ppb))

City	1st Jan 20	1st Feb	1st March	25th March	14th April	3rd May	17th May	25th May
Bhopal	38.6	62.72	68.87	64.27	47.6	68.24	88.75	37.9
Patna	3.51	2.22	5.92	21.1	56.15	87.58	95.04	43.39
Lucknow	54.74	8.25	3.07	3.11	3.53	4.18	3.25	2.37
Kolkata	34	76.69	67.22	54.88	26.12	46	20.43	29.35
Amravati	56.9	32.13	51.55	27.85	27.18	31.91	30.3	42.57
Delhi	60.06	20.55	42.59	45.52	None	None	106.38	130.09
Ahmedabad	23.67	45.37	40.87	38.72	43.88	54.43	55.41	59.66
Mumbai	35.1	25.25	14.57	34.5	0.28	None	10.51	10.1
Jaipur	71.54	51.98	68.97	51.25	47.83	55.24	72.35	57.47
Chennai	19.19	34.04	50.34	11.52	16.34	20.28	19.86	21.81

***Range:** Good (O -50); Satisfactory (51 -70); Moderately Polluted (71 -85); Poor (86 -105); Very Poor (106-200); Severe (200+)*

Data Source: CPCB - India Central Pollution Control Board portal (https://cpcb.nic.in/)

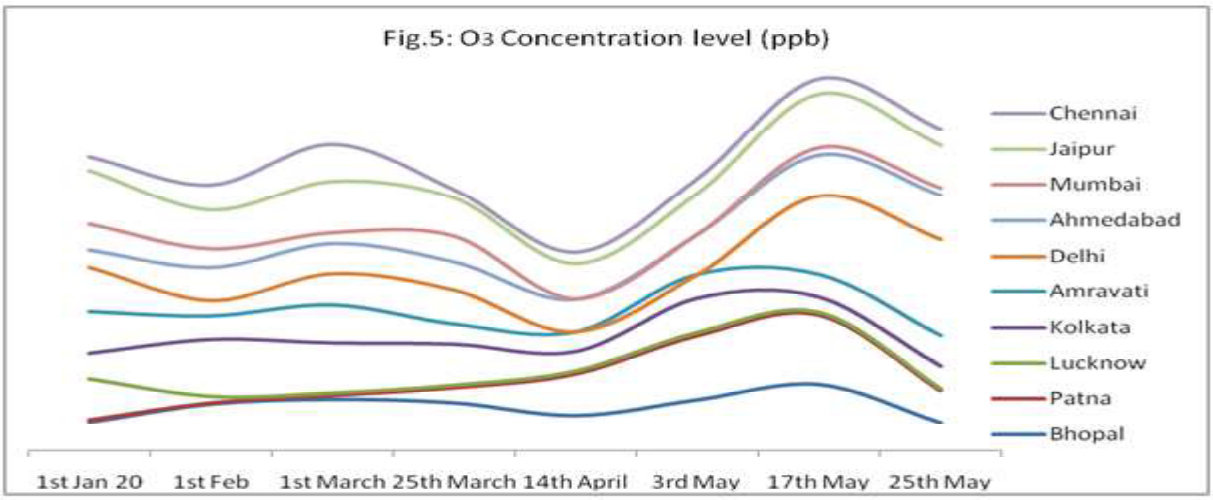
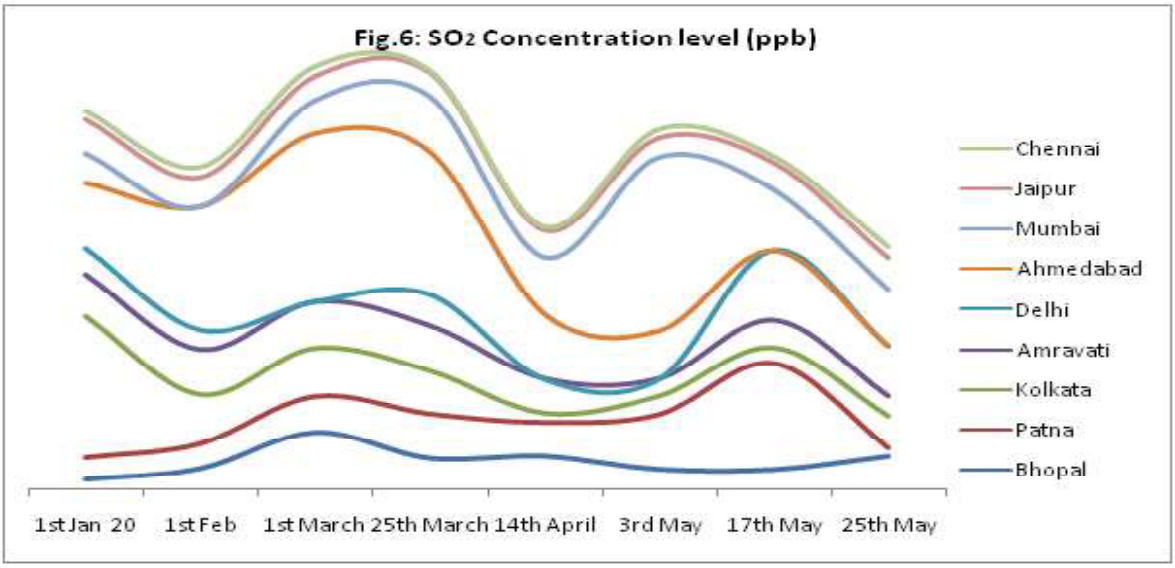


Table 6: SO_2 concentration levels analysis: (unit: particle per billion (ppb))

City	1st Jan 20	1st Feb	1st March	25th March	14th April	3rd May	17th May	25th May
Bhopal	3.82	8.22	22.91	12.48	13.26	7.9	7.77	13.22
Patna	9.35	10.57	15.06	18.36	14.09	22.66	43.75	3.87
Kolkata	57.78	19.78	19.67	17.56	3.43	7.33	6.33	12.52
Amravati	17.62	18.82	19.71	19.08	14.6	7.45	11.83	8.49
Delhi	10.66	8.28	None	12.83	None	None	28.71	20.89
Ahmedabad	27.07	51.16	69.35	58.95	26.97	19.89	None	None
Mumbai	12.32	0.04	13.91	23.15	23.48	71.79	25.4	23.45
Jaipur	13.89	11.78	9.46	9.4	11.32	7.84	10.87	13.16
Chennai	3.74	4.33	4.56	1.29	1.36	3.77	2.79	4.7
Lucknow	NA	NA	NA	NA	NA	NA	NA	NA

***Range:** Good (O -35); Satisfactory (36 -75); Moderately Polluted (76 -185); Poor (186 -300); Very Poor (300-600); Severe (600+)*
Data Source: CPCB - India Central Pollution Control Board portal (https://cpcb.nic.in/)



RESULTS

On the basis Time series of daily concentrations from January 1 to May 25, 2020 in 10 cities across India, following outcomes are noted:

i. PM2.5 concentration showed that after the lockdown, a statistically significant decrease in PM2.5 concentration was observed in almost all the cities. Delhi and Lucknow have witnessed highest reduction in PM2.5 concentration levels. Though the concentration in Mumbai & Jaipur is back to pre-Covid levels. For other cities, concentration of PM2.5 has commenced peaking towards pre-Covid levels gradually. It is construed that, concentration levels have begun peaking due ease down in lockdown and commencement of anthropogenic activities.

ii. PM10 concentration is available for 8 cities out of the 10 considered. Among 8 cities, despite reduction in PM10 concentration, 4 cities are still under moderately polluted range. Kolkata & Bhopal are under Good range. Delhi and Patna have witnessed considerable reduction. Mumbai is showing PM10 concentration around pre-Covid levels. It is evidenced by the data that PM 10 levels are gradually peaking towards pre-Covid levels.

iii. NO_2 concentration shows significant reduction in Kolkata and Bhopal post lockdown. Patna is showing consistency higher levels. Ahmedabad & Lucknow are back to pre-Covid levels. Others have seen slight improvement initially post lockdown, however, trends have gradually commenced to move upward.

iv. CO concentration shows that all the cities under study are within good range. Delhi, Patna, Lucknow and Mumbai have seen significant decline in carbon emission levels. Chennai though is back to pre-Covid levels with ease in lockdown.

v. Time series of daily O_3 concentrations shows mixed trends. Patna & Bhopal have seen increase in O_3 concentration post lockdown. Lucknow and Mumbai have seen drastic reductions, and other cities have shown stagnancy.

As O_3 is a secondary air pollutant, the local availability of precursor gases (nitrogen oxides and volatile organic compounds) and local meteorology (sunlight and temperature) influences the production and destruction of O_3 in air. These two factors, particularly more incoming sunlight in March than February, are expected to vary widely across the cities, and hence the O_3 concentrations too.

vi. SO_2 concentration has shown mixed trends. Kolkata having significant decline. Other cities have shown stagnancy and increasing trend.

CONCLUSION

Evidence based on ground level stations shows significant reduction in concentrations of four major air pollutants PM2.5, PM10, NO_2 and CO in majority of the cities. Lockdown introduced to contain the Covid-19 has led to a near-simultaneous shutdown of many sources of air pollutants at a global scale and has set a natural condition to examine the planetary scale reduction in air pollution albeit temporarily. Though the reduction is expected to be short-lived, it provides us encouraging evidence that a swift and widespread implementation of air pollution measures can result in immediate air quality benefits. Yet, there is nothing to celebrate as the Covid-19 pandemic has taken an enormous toll on humanity and nobody wanted air pollution reduction this way.

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