Impact of lockdown during COVID-19 on Air pollution

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Abstract

The year late 2019 has introduced rigorous conditions all around the world beginning from Wuhan, city of China. A novel as well as dreadful pneumonia flamed out in December 2019, pathogens were isolated and recognized and were originally named as Coronavirus or COVID-19 alike SARS (Severe Acute Respiratory Syndrome) and MERS (Middle East Respiratory Syndrome) coronavirus. The fast transmission of virus from one infected person to others created panic all over the world and therefore World Health Organization officially declared this virus as Global Pandemic on February 11, 2020. To prevent the spread of these pandemic stay-at-home instructions took start all over the nation which also led to improvement in the quality of air all over the world. As most of the air pollution occurs due to industries and motor vehicles in the urban areas. Whereas pollutants such as PM_{10}, $PM_{2.5}$, NO_2, CO, SO_2 increases in the atmosphere leading to certain respiratory disorders. Therefore, EPA (Environmental Protection Agency) has introduced a tool known as Air Quality Index (AQI) resembling the quality of air to the mankind. The outcome of analysis done by the researchers shows that number of metropolitan cities such as New Delhi, Bengaluru, Ahmedabad, Mumbai as well as Moscow, Paris, Beijing, Tehran have moderate to poor AQI but post lockdown the cities witnessed major decrease in AQI. Almost all the countries across the world witnessed major decrease in AQI due to lockdown. This paper covers studies about few Indian cities and few cities across globe that experienced major decrease in Air Quality Index Post Lockdown. Therefore, the positive impact has been shown post lockdown resulting in the cleaner air as well as good impact on human health.

Keywords: COVID-19, SARS, MERS, Particulate matter (PM_{10}, $PM_{2.5}$), Air quality index (AQI), Outdoor Air Pollution (OAP), Household Air Pollution (HAP).

1. Introduction

Coronavirus disease is Infectious disease that is cause by new strains of coronavirus which is now commonly called as COVID-19 [1].The name COVID-19 is given by World Health Organization while taxonomically it is termed as SARS-CoV-2 this is because the major source of Coronavirus disease 2019 is Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2). First case of Covid-19 emerged in late December 2019 in Wuhan, China [2, 3]. The fast transmission of virus from one infected person to

others created panic all over the world and therefore World Health Organization officially declared this virus as Global Pandemic on February 11, 2020 [4].

On January 30, 2020 first case of COVID-19 was reported in India. Soon after the cases of COVID-19 started reporting from different parts of India due to the international travel of Indians [5]. The Government of India imposed complete lockdown on 24th of March. Although complete lockdown was imposed but still the cases of COVID-19 kept on rising sharply specially in states like Maharashtra, Gujarat, Tamil Nadu, Delhi, Madhya Pradesh and few other states [6]. From the month of July lockdown was removed and a policy of unlock series started in India which let the people to return to their normal routines with some essential guidelines and though this result in rapid increase of COVID-19 cases and now the total number of cases are more than 47 lakhs where 39 lakhs recovered till now and many people died [7].

The most severe COVID-19 symptoms are fever, dry cough, difficulty in breathing and tiredness. Some of the less common symptoms that can affect certain patients include aches and pains, nasal congestion, fatigue, conjunctivitis, sore throat, diarrhea, loss of taste or scent, or a skin rash or finger or toe discoloration, typically these effects are mild, and eventually commences the disease [8].

Recent studies about the novel coronavirus revealed that it has 73 variants and this recent discovery was done by a team of Genomic researchers from CSIR-Institute of Genomics and Integrative Biology (IGIB), New Delhi and Institute of Medical Sciences and SUM Hospital, Bhubaneswar, India [9].

2. Components of Air pollution

Increase in the air pollution occurs due to massive growth in emissions of air pollutants in urban areas which has made air quality as one of the major environmental problem nationwide. Nitrogen dioxide, ozone, particulate matter, sulfur dioxide are some plentiful components of air pollution. In addition, Sulfur dioxide is mostly rich in industrial areas [10, 11].

2.1 Particulate matter

Overall number of different solids and liquid present in air seems as hazardous which may be both inorganic and organic like dust, pollen, smoke etc. Particles may be inhaled and respirable are made of sulfate, ammonia, sodium chloride, black carbon, dust, and water are some among the particulate matter [12, 13].

The specifications of the particulate matter are demonstrated below:-

Particulate matter	Specification
$PM_{2.5}$	• The diameter of pollutants is less than 2.5 micrometers [14]. • They can be easily inhaled and can go into the blood stream as they resembles 3% to the diameter of human hair [15]. • Pollutants are so small that they can be detected using electron microscope [16].
PM_{10}	• These pollutants are of 10 micrometer in diameter [17]. • They can enter through lower airways [17].
Nitrogen dioxide	• Nitrogen dioxide particularly obtained through power generation, industrial as well as traffic sources [18, 19]. • Prime cause of outdoor nitrogen dioxide is the automobile exhaust, found to be the forerunner of photochemical smog in outdoor air of urban and industrial regions [18, 19]. • Nitrogen dioxide is less reactive and less chances of inflammation in airways [18, 19].
Ozone	• Photochemical smog occurs via ozone causing health risk related to breathing issues, asthma, functioning of lung also decreases and respiratory diseases [20]. • Phytochemical reactions are involved such as nitrogen dioxide, hydrocarbons and UV radiations through which ozone is generated [20]. • Ozone reaches to be at highest level on increase in temperature [20].
Carbon monoxide	• WHO stated colorless and odorless gas as CO, when increased cause harm to humans and weakens the amount of oxygen conveyed in bloodstream to certain organs [21]. • High concentration of CO occurs from indoor and outdoor emissions especially in the developing urban areas [21]. • Symptoms leading to the dizziness, tiredness and unconsciousness when a person is contacted with CO [21].
Sulfur dioxide	• There are various fossil fuels (coal and oil) that contains sulphur dioxide, when these fuels are burnt they produces sulphur dioxide [21]. • High concentration of this component causes acidification and also causing severe harm to aquatic as we the ecosystem [22]. • In humans the excess amount of SO_2 causes respiratory issues and malfunctioning in lungs [22].

3. Air Pollution and the pandemic COVID-19

Air pollution is an emerging public health concern as there is growing evidence that due to the presence of various toxic pollutants, polluted air significantly affects our health. Around 6.3 million deaths have

been estimated are caused by polluted air 3.3 million of which are due to OAP (outdoor Air Pollution) and 3.5 million due to HAP (Household Air Pollution) [23].

The current COVID-19 pandemic has prompted many countries around the world to practice absolute shutdown requiring residents to live in their houses. India has fully also faced the 3-week complete lockdown period to prevent coronavirus transmission possible [24]. This shutdown has affected environmental pollution levels and increased air and water quality in the short term leading to much fewer human activities [25].

Lockdown step to tackle the COVID-19 pandemic have brought about a dramatic shift in environmental pollution worldwide. Researchers measured quantitative and diurnal shifts in the six air pollutants parameters, including particulate matter ($PM_{2.5}$ and PM_{10}) and gaseous contaminants (NO_2, O_3, CO and SO_2) during and after the lockdown [26].

4. Air quality index (AQI)

Air quality index one of the most widely used tool for measuring pollution level caused by air pollutant. It summarizes the measure of ambient quality of air and tells about health risk level to mankind. Tool is introduced by Environmental Protection Agency (EPA). AQI shows air quality report to the public that explains the clean or contaminated air [27, 28]. Therefore, table shows the range of air quality index standard range.

Table 4.1. AQI standard range

AQI Category (Range)	PM_{10}	$PM_{2.5}$	NO_2	SO_2
Good (0-50)	0-50	0-30	0-40	0-40
Satisfactory (51-100)	51-100	31-60	41-80	41-80
Moderately polluted (100-200)	101-250	61-90	81-180	81-380
Poor (201-300)	251-350	91-120	181-280	381-800
Very Poor (301-400)	351-430	121-250	281-400	801-1600
Severe (401-500)	430+	251+	400+	1600+

4.2 AQI for the year 2016

Place	Month	$PM_{2.5}$	PM_{10}	NO_2	SO_2	CO
New Delhi	January	358	-	31	9	27
	February	329	-	22	3	23
	March	196	-	26	10	31
	April	318	-	23	10	38
	May	315	-	25	8	35
	June	320	-	22	5	28
Lucknow	January	334	-	19	7	38
	February	157	-	18	6	43
	March	205	-	37	8	38
	April	198	-	80	9	35
	May	185	-	75	5	42
	June	192	-	51	6	36
Mumbai	January	97	95	14	11	36
	February	49	85	7	4	26
	March	62	102	6	3	29
	April	43	92	12	9	42
	May	60	103	8	5	38
	June	56	41	8	5	57
Bengaluru	January	186	-	15	2	23
	February	141	-	17	2	44
	March	114	-	17	2	34
	April	76	-	18	2	7
	May	65	-	18	2	41
	June	40	-	14	1	20
Beijing	January	151	95	11	8	11
	February	145	82	15	4	16
	March	151	66	12	11	25
	April	120	75	10	5	14
	May	110	55	8	16	14
	June	95	53	15	12	17
New York	January	96	-	8	7	15
	February	85	-	15	5	10
	March	85	-	11	4	12
	April	52	-	10	8	18
	May	65	-	12	2	19
	June	71	-	12	6	18
Moscow	January	101	-	5	19	7
	February	97	-	10	15	11
	March	105	-	12	16	15
	April	80	-	10	18	12
	May	121	-	9	11	17
	June	115	-	16	8	8
Tehran	January	121	-	5	15	16
	February	145	-	7	12	15
	March	117	-	2	16	15
	April	152	-	8	20	15
	May	115	-	10	12	12
	June	95	-	8	10	16

4.3 AQI for the year 2017

Place	Month	$PM_{2.5}$	PM_{10}	NO_2	SO_2	CO
New Delhi	January	202	102	44	-	-
	February	57	103	69	-	-
	March	240	166	62	-	-
	April	153	144	84	-	-
	May	117	220	52	-	-
	June	209	133	49	-	-
Lucknow	January	300	-	63	5	75
	February	276	-	32	7	72
	March	244	-	36	6	52
	April	302	-	21	6	68
	May	149	-	16	3	60
	June	157	-	14	5	20
Mumbai	January	237	215	19	24	86
	February	134	163	43	25	69
	March	52	77	32	11	26
	April	41	58	26	14	22
	May	38	40	26	12	25
	June	19	40	20	13	19
Bengaluru	January	42	-	28	8	22
	February	61	-	34	7	25
	March	51	-	25	7	21
	April	53	-	23	3	32
	May	40	-	23	8	40
	June	23	-	30	6	37
Beijing	January	131	85	7	18	10
	February	141	82	10	14	18
	March	145	68	12	15	12
	April	125	78	5	15	19
	May	115	65	8	18	12
	June	98	52	6	12	15
New York	January	98	-	8	7	14
	February	86	-	7	7	16
	March	85	-	11	2	10
	April	58	-	11	5	22
	May	75	-	9	2	20
	June	72	-	9	2	18
Moscow	January	105	-	5	17	7
	February	85	-	6	15	4
	March	110	-	7	12	5
	April	95	-	10	18	2
	May	100	-	9	11	7
	June	105	-	5	6	5
Tehran	January	131	-	15	8	17
	February	127	-	11	4	16
	March	110	-	18	4	20
	April	122	-	16	5	19
	May	105	-	12	2	19
	June	135	-	18	9	15

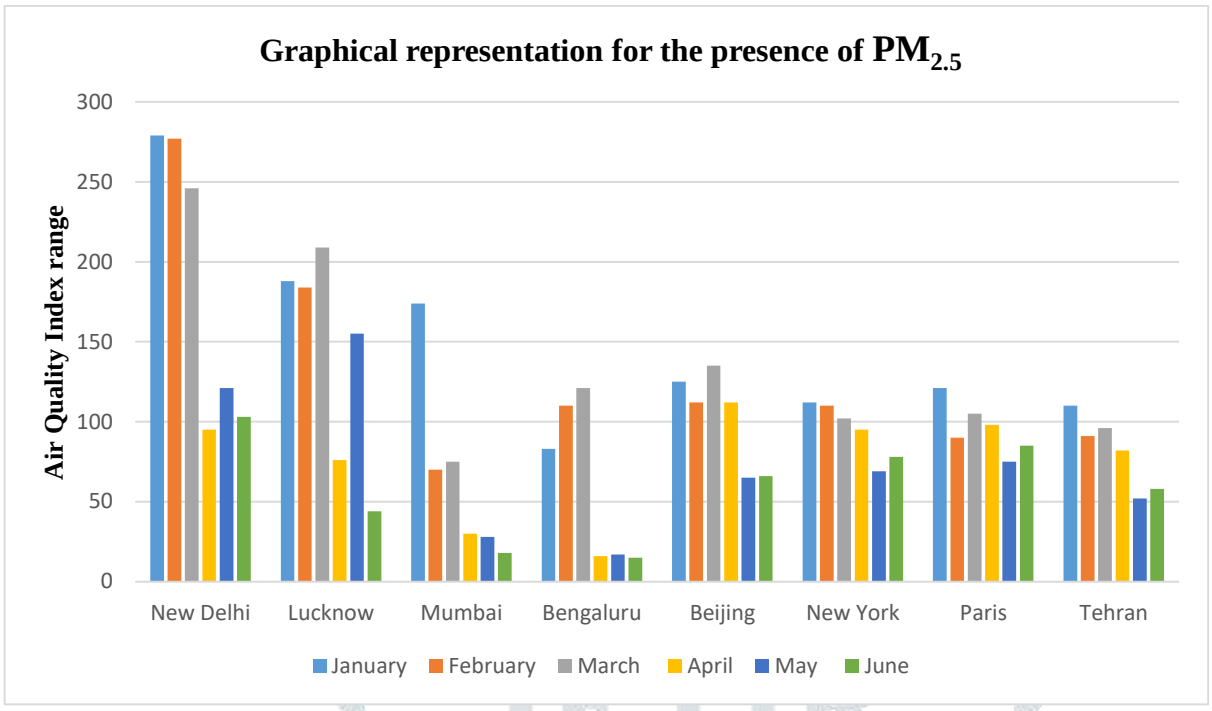
4.4 AQI for the year 2018

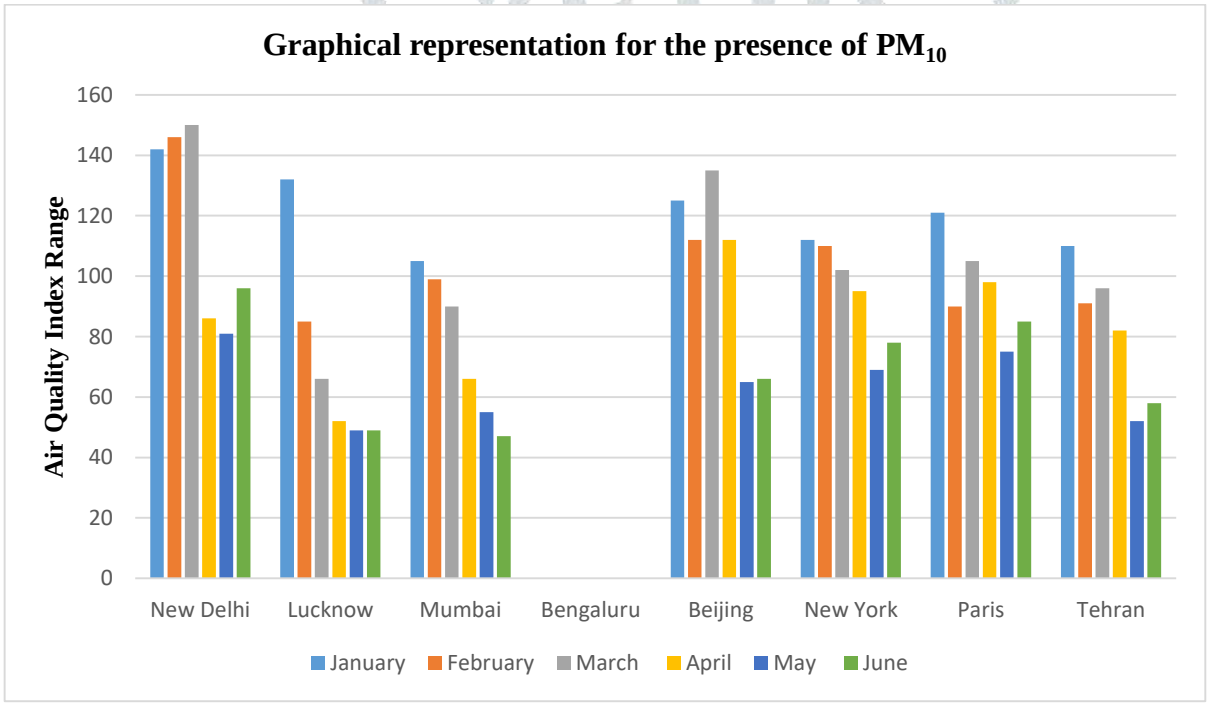
Place	Month	$PM_{2.5}$	PM_{10}	NO_2	SO_2	CO
New Delhi	January	347	257	95	-	-
	February	271	199	93	-	-
	March	192	141	100	-	-
	April	185	146	123	-	-
	May	170	145	131	-	-
	June	147	129	90	13	69
Lucknow	January	298	-	67	18	35
	February	209	-	18	10	43
	March	136	-	72	4	35
	April	287	-	72	2	38
	May	17	-	51	2	43
	June	131	-	55	2	28
Mumbai	January	104	114	37	26	58
	February	134	170	49	35	60
	March	57	90	28	29	73
	April	65	92	32	28	65
	May	38	-	30	28	64
	June	56	41	28	25	73
Bengaluru	January	51	-	82	3	71
	February	33	-	55	4	71
	March	68	-	39	4	134
	April	51	-	24	4	54
	May	68	-	16	4	48
	June	28	-	22	5	38
Beijing	January	146	115	16	8	41
	February	152	87	10	4	52
	March	135	110	12	1	45
	April	143	95	15	5	36
	May	110	75	18	6	58
	June	95	117	10	8	57
New York	January	196	-	18	6	-
	February	155	-	18	4	-
	March	145	-	16	4	-
	April	162	-	12	4	-
	May	156	-	12	7	-
	June	171	-	12	8	-
Moscow	January	151	112	15	-	7
	February	177	117	18	-	12
	March	135	93	18	-	5
	April	180	95	19	-	13
	May	151	125	10	-	10
	June	136	102	16	-	8
Tehran	January	95	-	17	15	-
	February	87	-	12	11	-
	March	112	-	15	16	-
	April	135	-	9	22	-
	May	115	-	13	10	-
	June	95	-	8	10	-

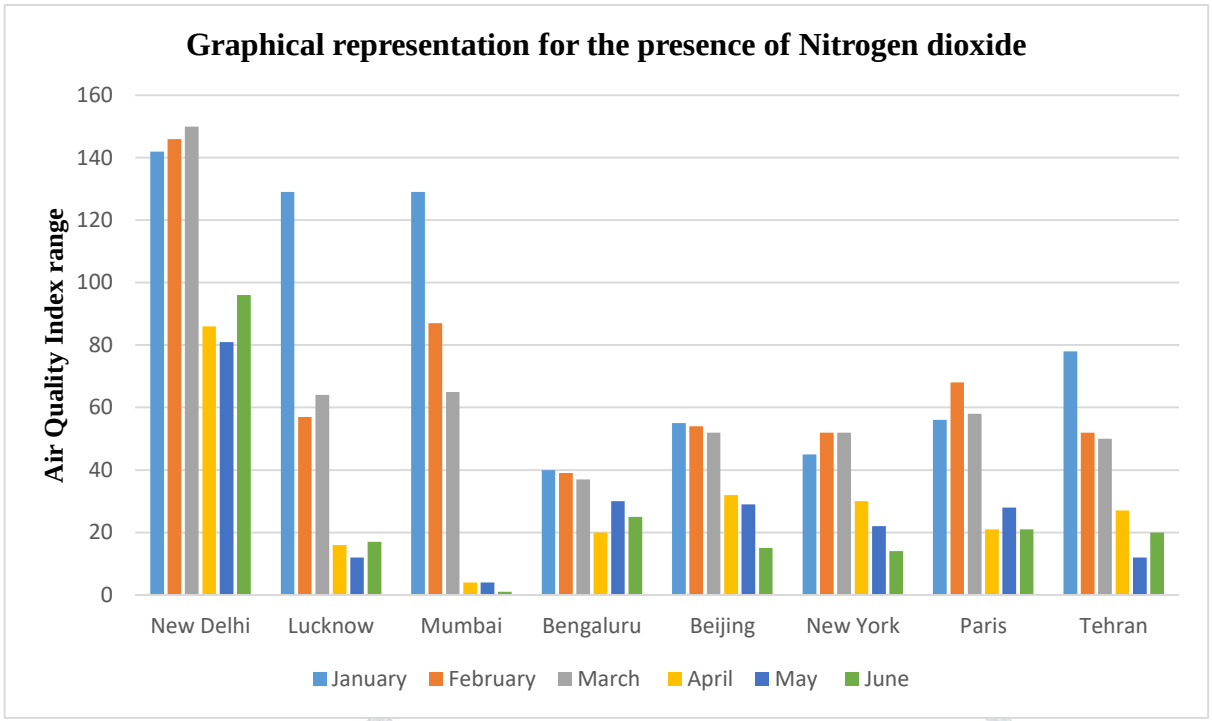
4.5 AQI for the year 2019

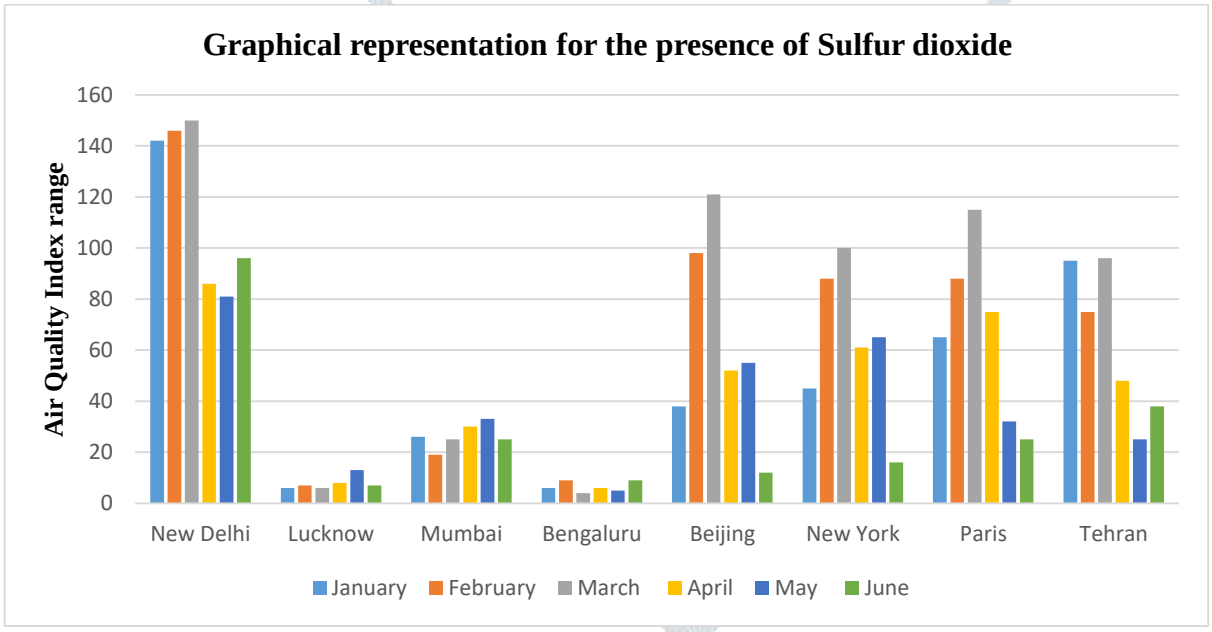
Place	Month	$PM_{2.5}$	PM_{10}	NO_2	SO_2	CO
New Delhi	January	445	419	234	24	90
	February	278	264	119	43	69
	March	302	246	106	26	105
	April	207	229	133	26	85
	May	216	203	166	19	93
	June	76	130	80	10	95
Lucknow	January	336	-	92	16	64
	February	147	-	59	11	24
	March	241	-	53	19	57
	April	170	-	96	4	56
	May	223	-	38	5	28
	June	64	-	21	4	31
Mumbai	January	211	250	40	44	113
	February	134	156	38	29	101
	March	42	88	14	5	81
	April	39	80	43	25	95
	May	18	54	21	26	84
	June	22	69	19	26	94
Bengaluru	January	72	81	49	5	16
	February	40	67	17	6	24
	March	61	84	43	7	30
	April	48	66	69	11	49
	May	85	114	70	11	49
	June	43	88	48	9	54
Beijing	January	159	98	19	10	19
	February	150	87	22	8	20
	March	157	69	17	17	28
	April	128	79	11	9	18
	May	120	60	10	19	17
	June	99	57	18	19	20
New York	January	100	-	15	10	18
	February	92	-	19	11	17
	March	88	-	16	8	18
	April	69	-	12	9	19
	May	75	-	18	7	22
	June	89	-	19	9	26
Moscow	January	120	-	10	22	9
	February	100	-	16	18	16
	March	106	-	15	19	18
	April	99	-	17	24	19
	May	131	-	11	14	17
	June	125	-	18	9	10
Tehran	January	131	-	8	19	22
	February	150	-	9	18	20
	March	119	-	7	17	21
	April	163	-	11	21	26
	May	125	-	15	18	18
	June	99	-	9	17	19

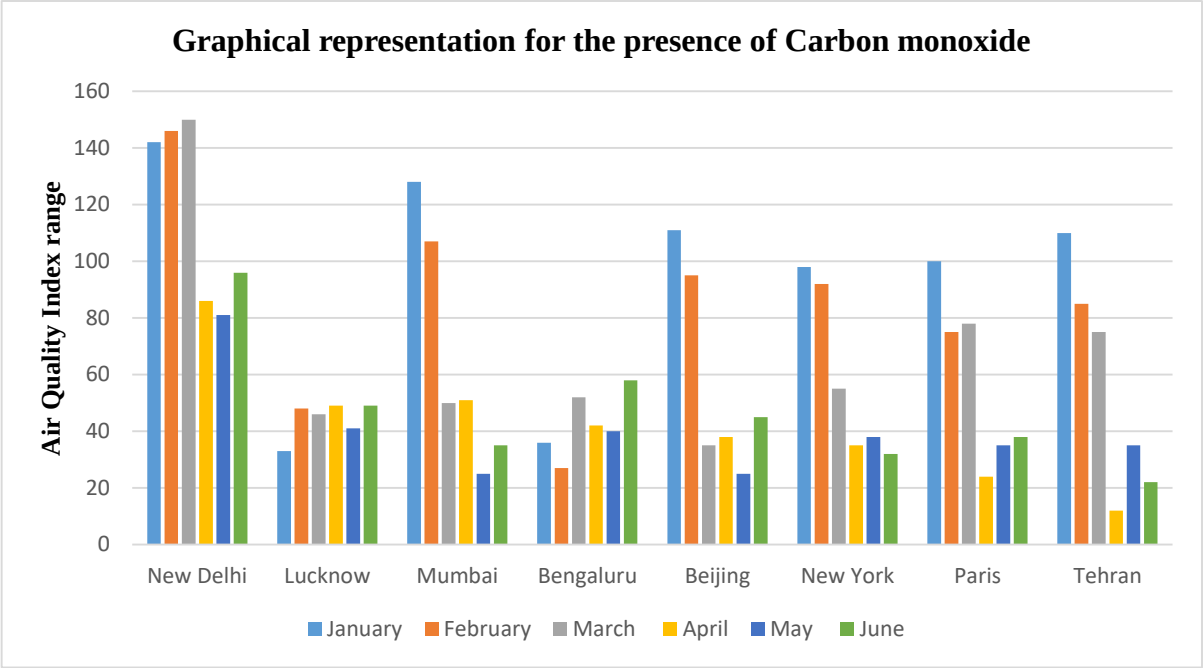
4.6 AQI for the year 2020






Graphical representation for the presence of Nitrogen dioxide
Air Quality Index range
160
140
120
100
80
60
40
20
0
New Delhi
Lucknow
Mumbai
Bengaluru
Beijing
New York
Paris
Tehran
January
February
March
April
May
June


Graphical representation for the presence of Sulfur dioxide
Air Quality Index range
160
140
120
100
80
60
40
20
0
New Delhi
Lucknow
Mumbai
Bengaluru
Beijing
New York
Paris
Tehran
January
February
March
April
May
June



Monitoring of air quality gives the information about the status for present air quality. In urban areas, leading cause of decrease in air quality is the motorized transport worldwide. As per the analysis, the results shows that year 2016, air quality index (AQI) in New Delhi reached at severe level for some days whereas in 2017 the AQI was found to be cleaner stated by Central Pollution Control Board (CPCB). In different cities the AQI was quite low when compared with period when there was no lockdown (January, February).

Therefore, AQI was found to be poor before the lockdown period but according to Indian Institute of Technology (IIT) Delhi analysis shows, decreasing in levels of $PM_{2.5}$, PM_{10}, CO, and NO_2 during the lockdown period compared to previous years. Analysis shows that the closing of regular traffic has led to extreme down fall of $PM_{2.5}$ level as it got decreased major folds in certain metropolitan cities post lockdown.

Conclusion

COVID-19 affected the whole world as well as it has created a great impact on environment. Now a days, the leading and main source of concern is air pollution mostly in the urban areas where most of the industries are being set up and motor vehicles are used hence several studies revealed that the concentration of pollutants is increasing at the regular intervals. Commercial areas and the areas with dense traffic has higher range of PM_{10} as compared to the $PM_{2.5}$, SO_2, and NO_2. Use of air quality index gives information about adverse effect of air pollution to the nation to protect themselves from the health implications due to air pollution try to reduce the pollution. As the nation is well aware of the pandemic and followed by the lockdown, because this novel coronavirus depicts the transmittable characteristics and has spread worldwide therefore the step of lockdown has been taken which gave major positive impact on the quality of air. In addition, the air quality index has been dropped major folds and the air quality seems to be clear post lockdown as compared to previous years. Therefore, the

air quality index before lockdown was found to moderate to poor but the air quality index post lockdown was found to be good

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