Air quality analysis during summer lockdown: Some highlights

1. The dataset for trend analysis

Centre for Science and Environment (CSE) has analysed trend in PM2.5, NO2, and ozone in 22 cities spread across 15 states and National Capital Territory of Delhi for the period 1 January 2019 to 31 May 2020. This also includes spatial trend analysis of ozone in selected cities. Most granular data (15-minute averages) has been sourced from the CPCB's official online portal Central Control Room for Air Quality Management - All India (https://app.cpcbccr.com/).

This has analysed over 23 million data points recorded by 116 air quality monitoring stations or about 50 per cent of the existing network under the Continuous Ambient Air Quality Monitoring System (CAAQMS) of CPCB. All cities with three or more CAAQMS stations are included in this analysis; more have been chosen to ensure geographical and demographical representation. However, this study does not include modeling to isolate the impact of lockdown or any other impact. This analytically presents the trends in key air pollutants.

2. Ozone

2.1. Number of days ozone exceeded 8-hour standard during the lockdown

For this analysis CSE has considered the maximum rolling 8 hour average during the day to compare with the 8 hour average standards. This is part of the global best practice which is different from the method of Central Pollution Control Board (CPCB) that considers a fixed time slot of 8AM to 4PM to assess the 8-hour average that may not be the worst part of the day and may underestimate the risk. Other regulators like the USEPA has adopted the approach of considering maximum 8 hour average.

Table : Number of days when daily maximum 8-hour average of ozone exceeded the 8-hour standard (100 µg/m^3) during the lockdown (25 March – 31 May, 2020)

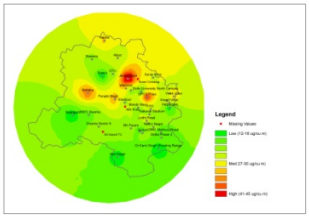
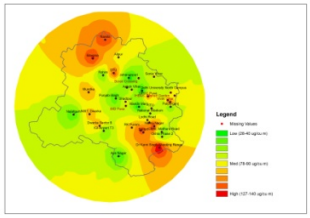
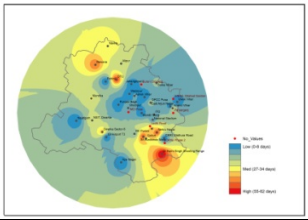
City	25 March – 31 May, 2019		25 March – 31 May, 2020	
	Exceedance – citywide	Exceedance – at least on one station	Exceedance – citywide	Exceedance – at least on one station
Bengaluru	8	50	0	2
Chennai	1	11	0	61
Delhi	21	68	4	67
Hyderabad	0	24	0	0
Kolkata	0	0	8	17
Mumbai	0	0	0	5
Amritsar	0	0	0	0
Gurugram	4	8	26	57
Faridabad	56	56	4	46
Noida	0	7	12	42
Ghaziabad	51	63	15	56
Lucknow	0	12	0	0
Patna	59	59	0	34
Howrah	0	0	3	10
Ahmedabad	12	-	43	-
Guwahati	1	-	0	-
Jaipur	13	27	3	9
Jodhpur	15	-	9	-
Kochi	-	-	0	-

Pune	0	-	0	-
Ujjain	43	-	38	-
Visakhapatnam	0	-	0	-
Source: CSE analysis based on CPCB data.				

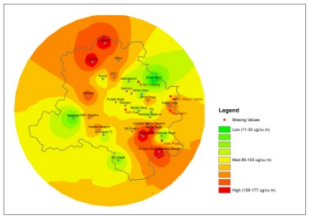
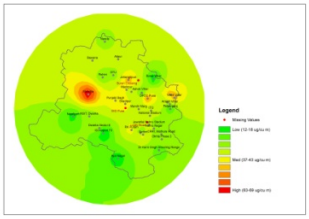
2.2. Spatial representation of NO2 and ozone build up during the lockdown

This analysis has been carried out to depict how NO2 and ozone pollution zones are different fro each other. Ozone is low in high NO2 areas and high in low NO2 areas. This reflects the complex chemistry. Ozone forms when NOx and volatile gases react under the influence of sunlight and temperature. But in the cyclical chemistry ozone again gets removed when it reacts with NOx. Therefore, even though ozone is formed in high NOx areas with other gases present, it does not build up. But the ozone that drifts to cleaner areas where NOx is absent or negligible, it has longer resident life and builds up. NO2 is a subset of NOx and is considered to be good representative for NOx concentration. These maps show the wide variation in the NO2 and ozone zones in cities despite the comparatively lower levels.

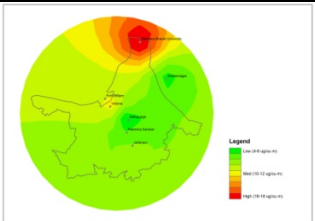
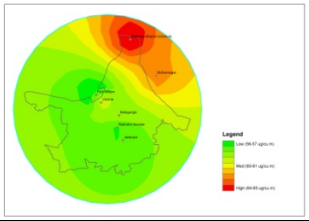
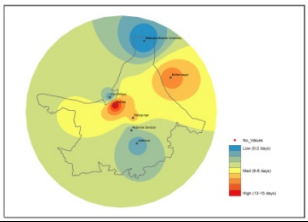
a. **Delhi**

NO2 (lockdown average)	**Ozone (lockdown average)**	**Ozone (lockdown exceedance)**
		
Source: CSE analysis based on CPCB data.		

b. Delhi Worst ozone pollution day: 17-May, 2020

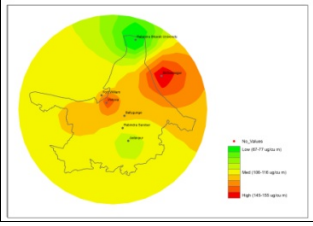
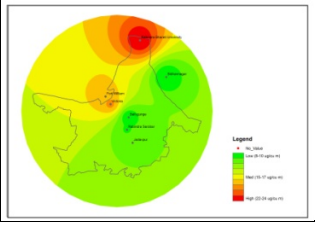
Ozone (max 8-hr average)	**NO2 (24-hr average)**
	
Source: CSE analysis based on CPCB data.	

c. Kolkata

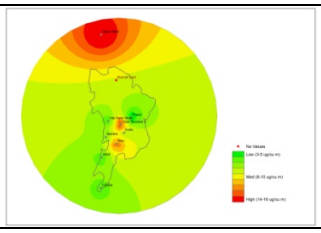
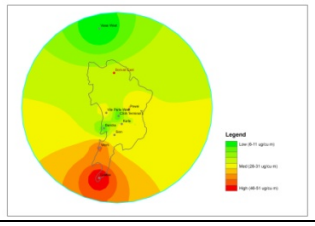
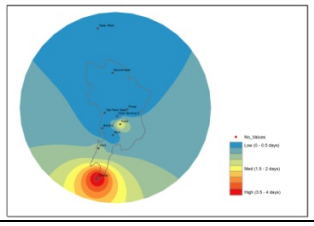
NO2 (lockdown average)	**Ozone (lockdown average)**	**Ozone (lockdown exceedance)**
		

Source: CSE analysis based on CPCB data.

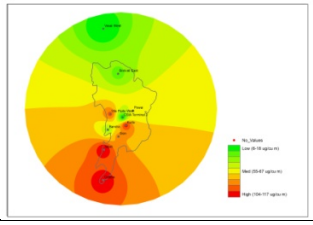
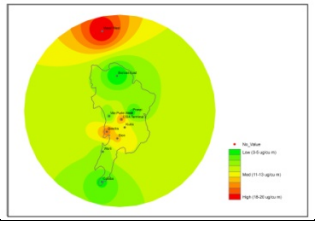
d. Kolkata Worst ozone pollution day: 04-Apr

Ozone (max 8-hr average)	NO2 (24-hr average)
	
Source: CSE analysis based on CPCB data.	

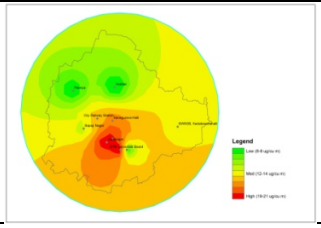
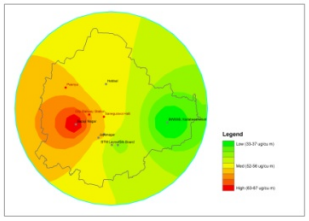
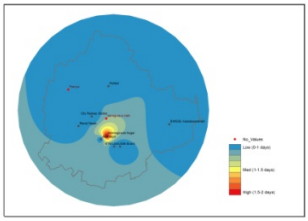
e. Mumbai

NO2 (lockdown average)	Ozone (lockdown average)	Ozone (lockdown exceedance)
		
Source: CSE analysis based on CPCB data.		

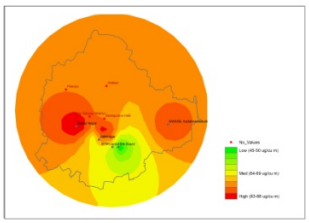
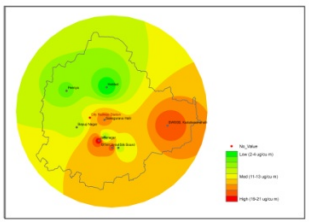
f. Mumbai Worst ozone pollution day: 29-March

Ozone (max 8-hr average)	NO2 (24-hr average)
	
Source: CSE analysis based on CPCB data.	

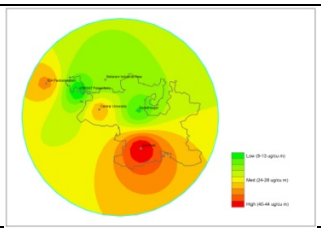
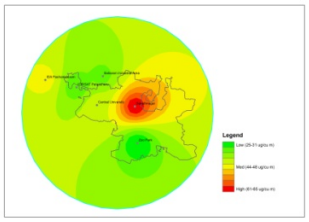
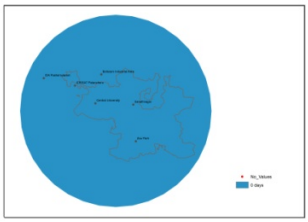
g. Bengaluru

NO2 (lockdown average)	Ozone (lockdown average)	Ozone (lockdown exceedance)
		
Source: CSE analysis based on CPCB data.		

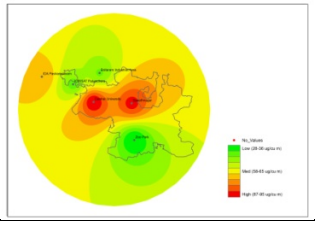
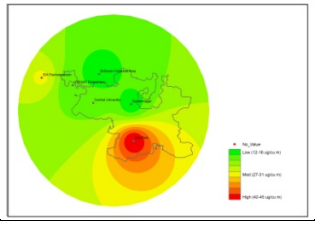
h. Bengaluru Worst Ozone pollution day: 09-Apr, 2020

Ozone (max 8-hr average)	NO2 (24-hr average)
	
Source: CSE analysis based on CPCB data.	

i. Hyderabad

NO2 (lockdown average)	Ozone (lockdown average)	Ozone (lockdown exceedance)
		
Source: CSE analysis based on CPCB data.		

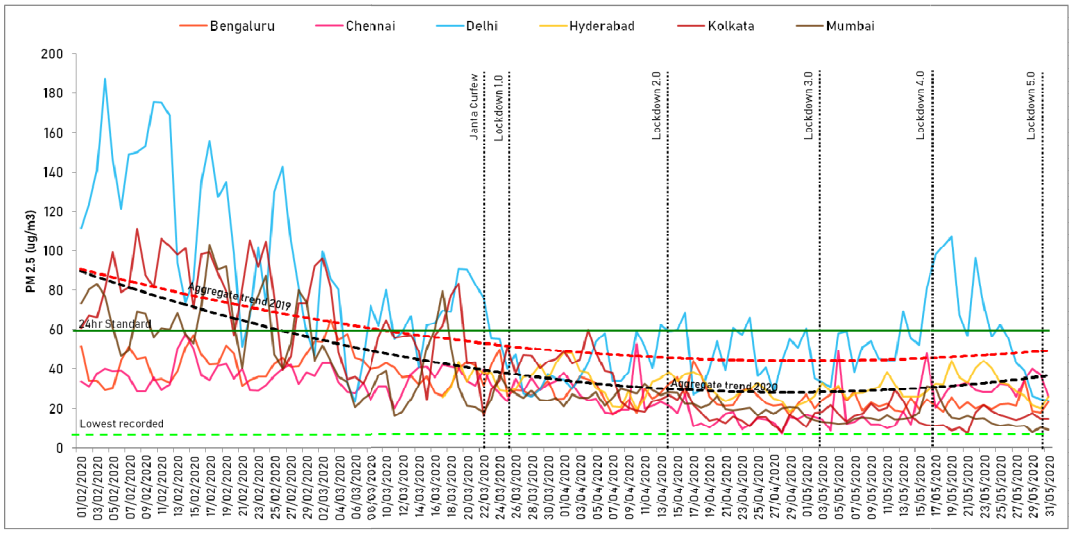
j. Hyderabad Worst ozone pollution day: 25-May, 2020

Ozone (max 8-hr average)	NO2 (24-hr average)
	
Source: CSE analysis based on CPCB data.	

2. PM2.5 and summer lockdown

2.1. Trend in mega cities

Graph: PM2.5 daily trends through lockdown – mega cities

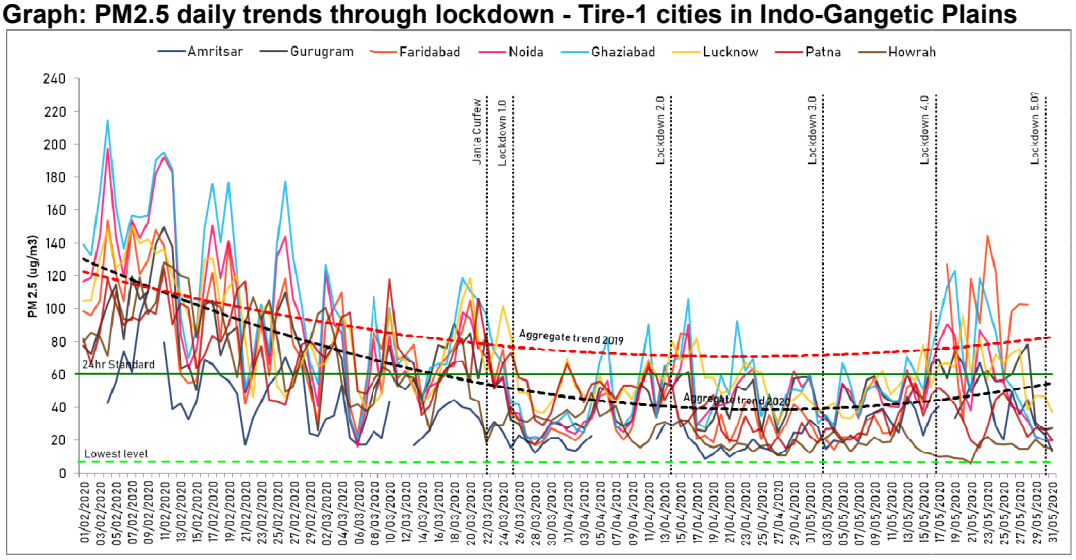


Note: Trendlines are based on the average of only those stations that have valid data for both years 2019 and 2020 across all cities.

Source: CSE analysis based on CPCB data.

2.2. Trend in daily PM2.5 levels in Tire-1 cities in Indo-Gangetic Plains

Graph: PM2.5 daily trends through lockdown - Tire-1 cities in Indo-Gangetic Plains

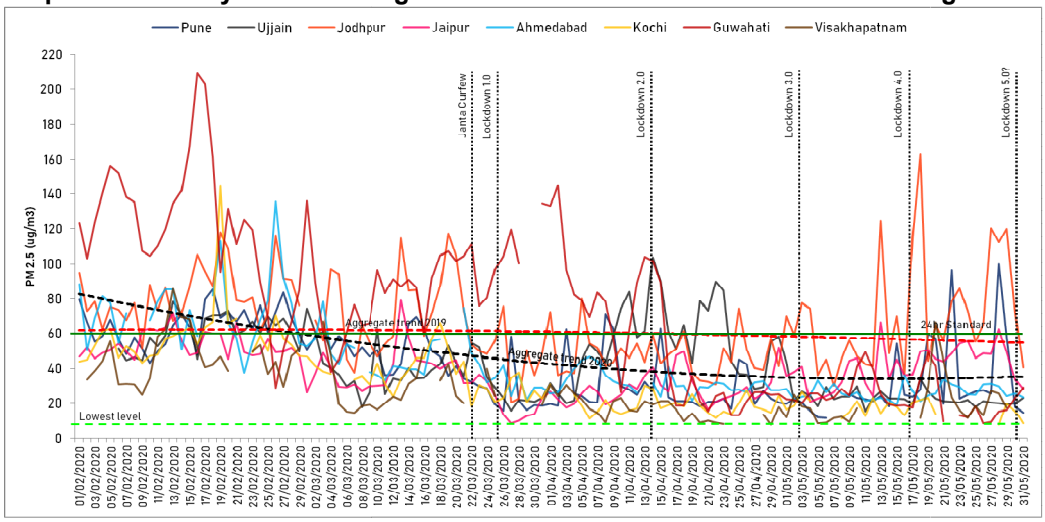


Note: Trendlines are based on the average of only those stations that have valid data for both years 2019 and 2020 across all cities.

Source: CSE analysis based on CPCB data.

2.3. PM2.5 trends in ire-1 cities outside Indo-Gangetic Plains

Graph: PM2.5 daily trends through lockdown - Tire-1 cities outside Indo-Gangetic Plains

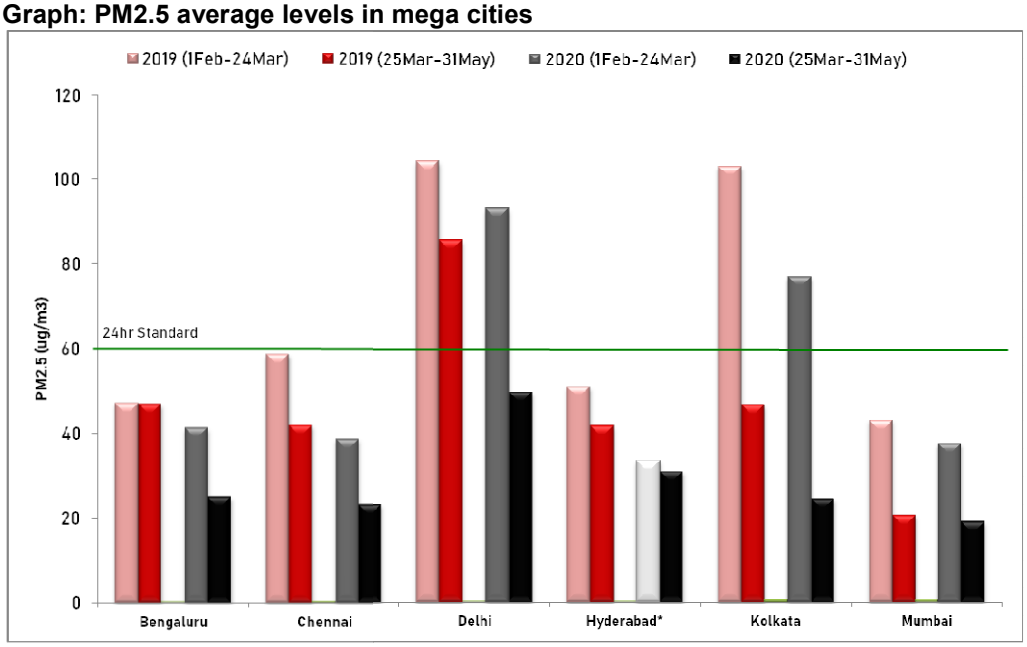


Note: Trendlines are based on the average of only those stations that have valid data for both years 2019 and 2020 across all cities.

Source: CSE analysis based on CPCB data.

2.4. PM2.5 level in mega cities: Comparing same period of 2019 and 2020

Graph: PM2.5 average levels in mega cities

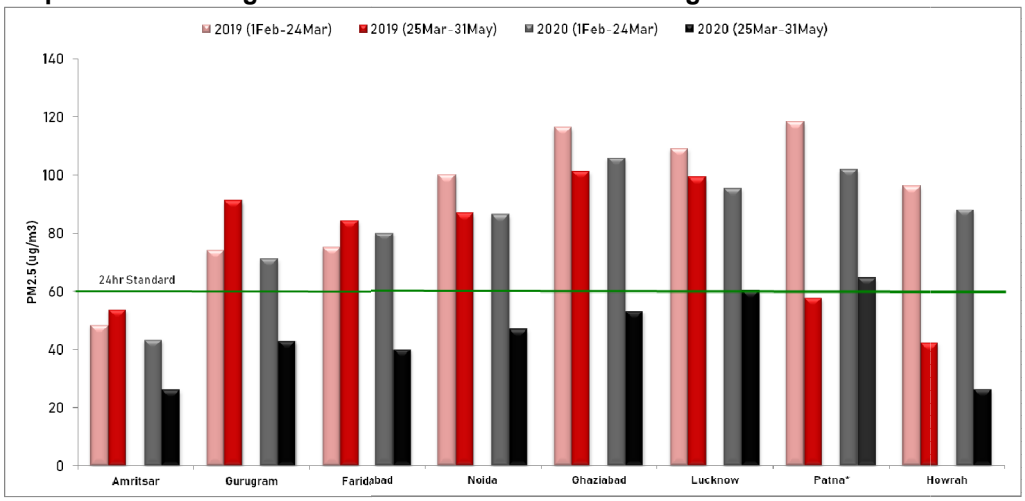


Note: Average of only those stations that have valid data for both years 2019 and 2020 have been used for each city.

Source: CSE analysis based on CPCB data.

2.5. PM2.5 level in Tire-1 cities in Indo-Gangetic Plains: Comparing same period of 2019 and 2020

Graph: PM2.5 average levels in Tire-1 cities in Indo-Gangetic Plains

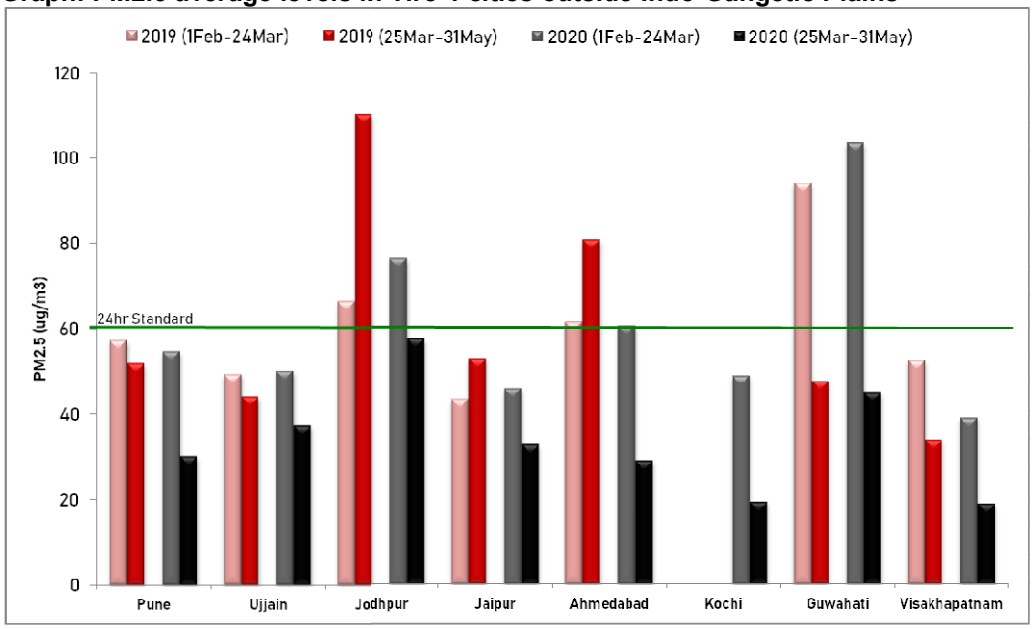


Note: Average of only those stations that have valid data for both years 2019 and 2020 have been used for each city.

Source: CSE analysis based on CPCB data.

2.6. PM2.5 level in Tire-1 cities outside Indo-Gangetic Plains: Comparing same period of 2019 and 2020

Graph: PM2.5 average levels in Tire-1 cities outside Indo-Gangetic Plains



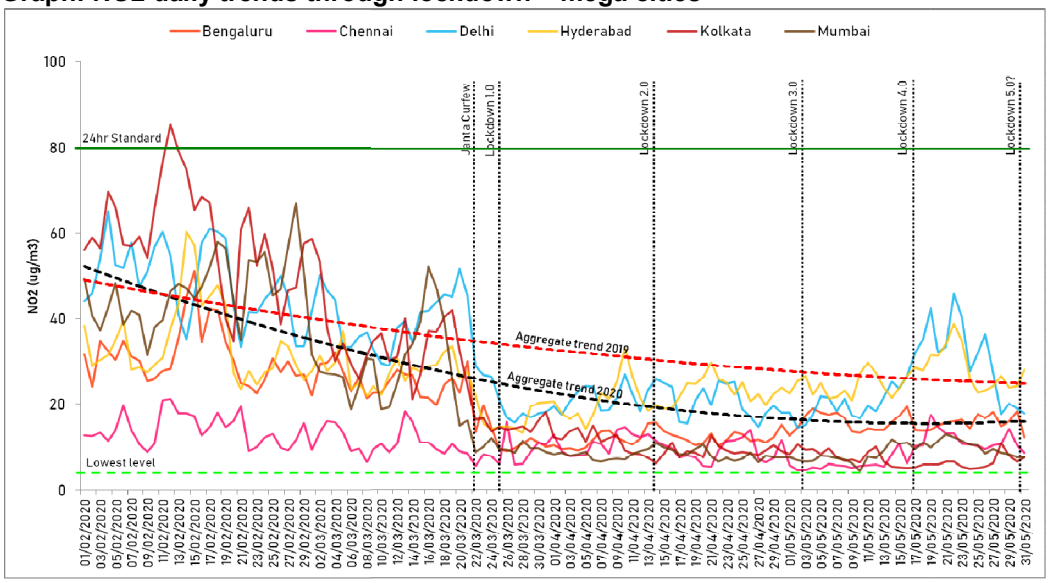
Note: Average of only those stations that have valid data for both years 2019 and 2020 have been used for each city.

Source: CSE analysis based on CPCB data.

3. NO2 trend during summer lockdown

3.1. Mega cities: Trend during lockdown

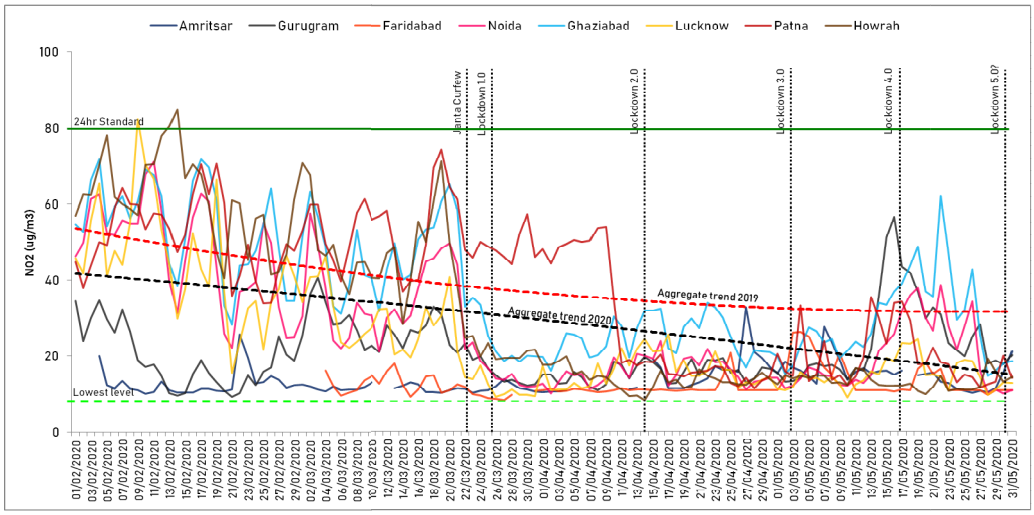
Graph: NO2 daily trends through lockdown – mega cities



Note: Trendlines are based on the average of only those stations that have valid data for both years 2019 and 2020 across all cities.
Source: CSE analysis based on CPCB data.

3.2. Tire-1 cities in Indo-Gangetic Plains: Trend during lockdown

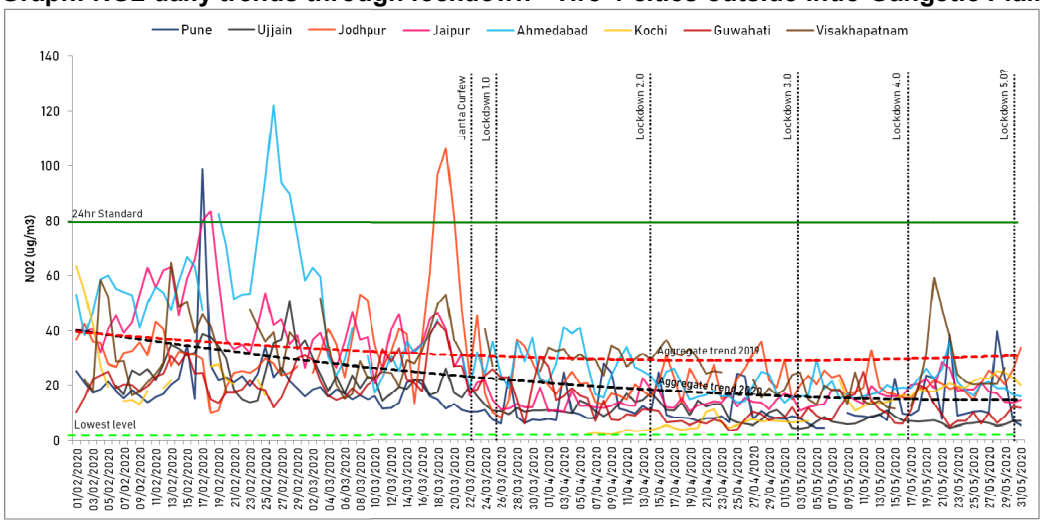
Graph: NO2 daily trends through lockdown - Tire-1 cities in Indo-Gangetic Plains



Note: Trendlines are based on the average of only those stations that have valid data for both years 2019 and 2020 across all cities.
Source: CSE analysis based on CPCB data.

3.2. Tire-1 cities outside Indo-Gangetic Plains: Trend during lockdown

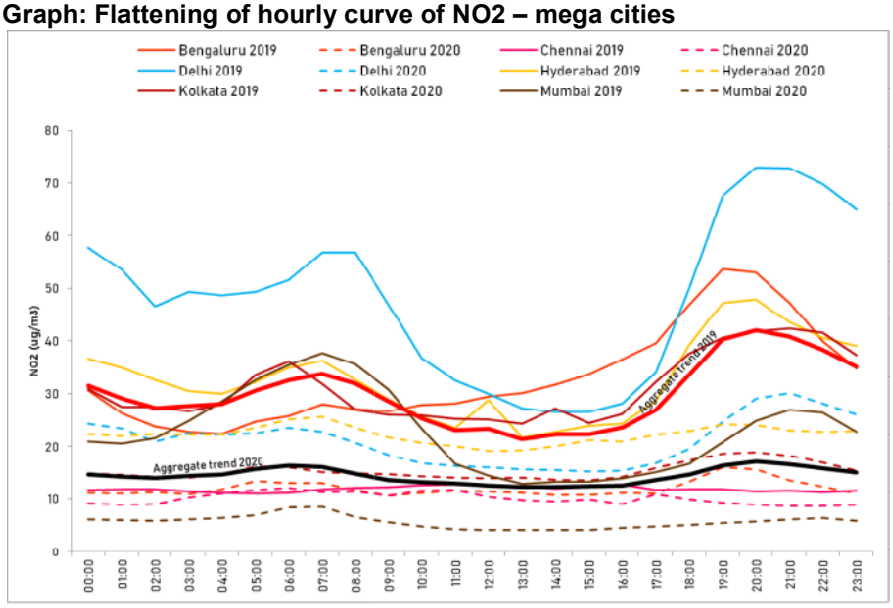
Graph: NO2 daily trends through lockdown - Tire-1 cities outside Indo-Gangetic Plains



Note: Trendlines are based on the average of only those stations that have valid data for both years 2019 and 2020 across all cities.
Source: CSE analysis based on CPCB data.

3.4. Hourly NO2 curve flattens in mega cities

Graph: Flattening of hourly curve of NO2 – mega cities

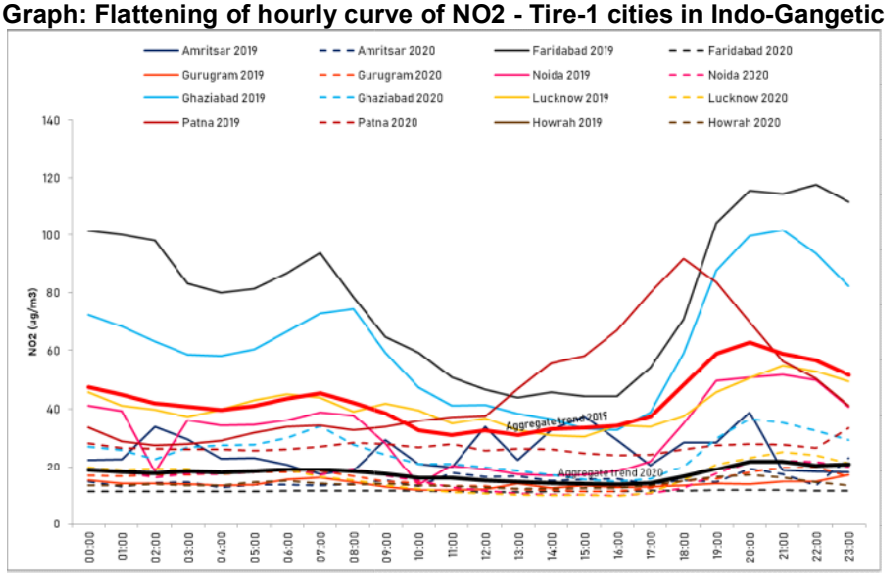


Note: Average of only those stations that have valid data for both years 2019 and 2020 have been used for each city.

Source: CSE analysis based on CPCB data.

3.5. Hourly NO2 curve flattens in Tire-1 cities in Indo-Gangetic Plains

Graph: Flattening of hourly curve of NO2 - Tire-1 cities in Indo-Gangetic Plains

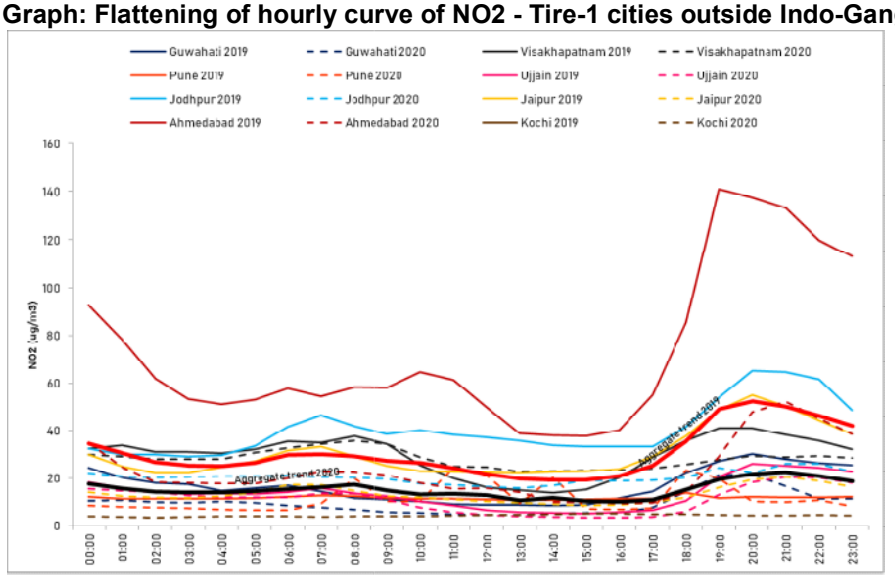


Note: Average of only those stations that have valid data for both years 2019 and 2020 have been used for each city.

Source: CSE analysis based on CPCB data.

3.6. Hourly NO2 curve flattens in Tire-1 cities outside Indo-Gangetic Plains

Graph: Flattening of hourly curve of NO2 - Tire-1 cities outside Indo-Gangetic Plains



Note: Average of only those stations that have valid data for both years 2019 and 2020 have been used for each city.
Source: CSE analysis based on CPCB data.