Ground-level ozone – Delhi-NCR: An invisible threat

Anumita Roychowdhury and Sharanjeet Kaur

Lead Research and analysis: Sharanjeet Kaur

Centre for Science and Environment, New Delhi, June, 2025

New Delhi June 13, 2025: New analysis of Centre for Science and Environment (CSE) finds higher number of days exceeding the standard for ozone and also wider geographical spread of the problem in Delhi and the National Capital Region (NCR) this summer. CSE issues the alert on the multi-pollutant crisis in in the region.

This summer, several days have recorded ozone as the lead pollutant in the daily Air Quality Index (AQI) instead of particulate matter. Out of 18 days between May 25-June 11, ozone has been the lead pollutant on 12 days. But there is no system to address this problem under the current Graded Response Action Plan for emergency action to reduce exposures or to address its sustained mitigation with longer term clean air action plan. While the policy attention are nearly fully drawn towards particulate pollution, co-control of the toxic gases from vehicles, industry and combustion sources that contribute to ozone formation in the air, are neglected. If unchecked this can become a serious public health crisis as ozone is a highly reactive gas.

Inadequate monitoring, limited data and inadequate methods of trend analysis have weakened the understanding of this growing public health hazard across cities of India. Instead of only averaging out the levels for the city – which is the standard practice to estimate AQI, It is also important to capture adequately the high levels of localized exposures in the hotspots and to design mitigation strategies accordingly. Managing short term exposures are critical to protect public health.

Why ozone needs special attention? The complex chemistry of ground-level ozone makes it one of the most challenging pollutants to monitor and control. Unlike primary pollutants, ozone is not emitted directly from any source. It forms through intricate chemical reactions involving nitrogen oxides (NOx), volatile organic compounds (VOCs), and carbon monoxide—pollutants released by vehicles, power plants, factories, and other combustion sources. In the presence of sunlight, these substances undergo a series of cyclic reactions that result in the formation of ozone near the ground. VOCs also have natural sources, such as vegetation, adding to the complexity.

Ground-level ozone accumulates not only in urban environments but can also travel long distances, turning into a regional pollutant. This means that effective control requires both local and broader regional interventions. Beyond its harmful effects on human health, ozone also impacts agricultural productivity, threatening food security.

As a highly reactive gas, ground-level ozone poses serious health risks. It can inflame and damage the airways, increase susceptibility to infections, and worsen respiratory conditions such as asthma, chronic bronchitis, and emphysema. Children with underdeveloped lungs, older adults, and individuals with existing respiratory conditions are particularly vulnerable. Ozone exposure increases the frequency and severity of asthma attacks, often leading to higher rates of hospitalization.

The investigation method: This assessment has traced trends during summer (March-May) between 2021 to 2025 May (up to May 31st). The analysis is based on publicly available granular real time data (15-minute averages) from the CPCB's official online portal Central Control Room for Air Quality Management. The data has been captured from 57 official stations under the Continuous Ambient Air Quality Monitoring System (CAAQMS) spread across Delhi-NCR. Delhi (39), Gurugram (4), Faridabad (4), Noida (4), Ghaziabad (4), and Greater Noida (2).

Given the volatile and highly localized nature of ground-level ozone pollution build-up and its variability across space, and consistent with the global good practice, this analysis has considered station level trends in terms of number of days exceeding the 8-hour standard over time. As ozone formation depends on complex atmospheric chemistry and on photochemical reaction its level varies across time and space horizon. Meteorological parameters such as sunny and warm weather, stagnant wind patterns etc. have bearing on its formation. This analysis tracks exceedances at each station in core NCR. Breach of the standard by even one station is

considered exceedance by the core NCR. Days with multiple stations exceeding the standard indicates the severity of the spatial spread and number of people exposed.

The study has considered global good practice and taken on board the USEPA approach of computing eight-hour averages for a day and then checking for the maximum value among them to capture the daily ozone pollution level. USEPA assesses city-wide or regional AQI based on the highest value recorded among all stations of the city or the region. Thus, trends have been calculated in terms of number of days when the daily level has exceeded the 8-hr standard (referred as exceedance days hereafter).

The investigation: This assessment has traced trends during summer (March-May) between 2021 to 2025 May (up to May 31st). The analysis is based on publicly available granular real time data (15-minute averages) from the CPCB's official online portal Central Control Room for Air Quality Management. The data has been captured from 57 official stations under the Continuous Ambient Air Quality Monitoring System (CAAQMS) spread across Delhi-NCR. Delhi (39), Gurugram (4), Faridabad (4), Noida (4), Ghaziabad (4), and Greater Noida (2).

Given the volatile and highly localized nature of ground-level ozone pollution build-up and its variability across space, and consistent with the global good practice, this analysis has considered station level trends in terms of number of days exceeding the 8-hour standard over time. As ozone formation depends on complex atmospheric chemistry and on photochemical reaction its level varies across time and space horizon. Meteorological parameters such as sunny and warm weather, stagnant wind patterns etc. have bearing on its formation. This analysis tracks exceedances at each station in core NCR. Breach of the standard by even one station is considered exceedance by the core NCR. Days with multiple stations exceeding the standard indicates the severity of the spatial spread and number of people exposed.

The study has considered global good practice and taken on board the USEPA approach of computing eight-hour averages for a day and then checking for the maximum value among them to capture the daily ozone pollution level. USEPA assesses city-wide or regional AQI based on the highest value recorded among all stations of the city or the region. Thus, trends have been calculated in terms of number of days when the daily level has exceeded the 8-hr standard (referred as exceedance days hereafter).

Key highlights

Ground-level ozone exceedance is reported on nearly all days of summer:

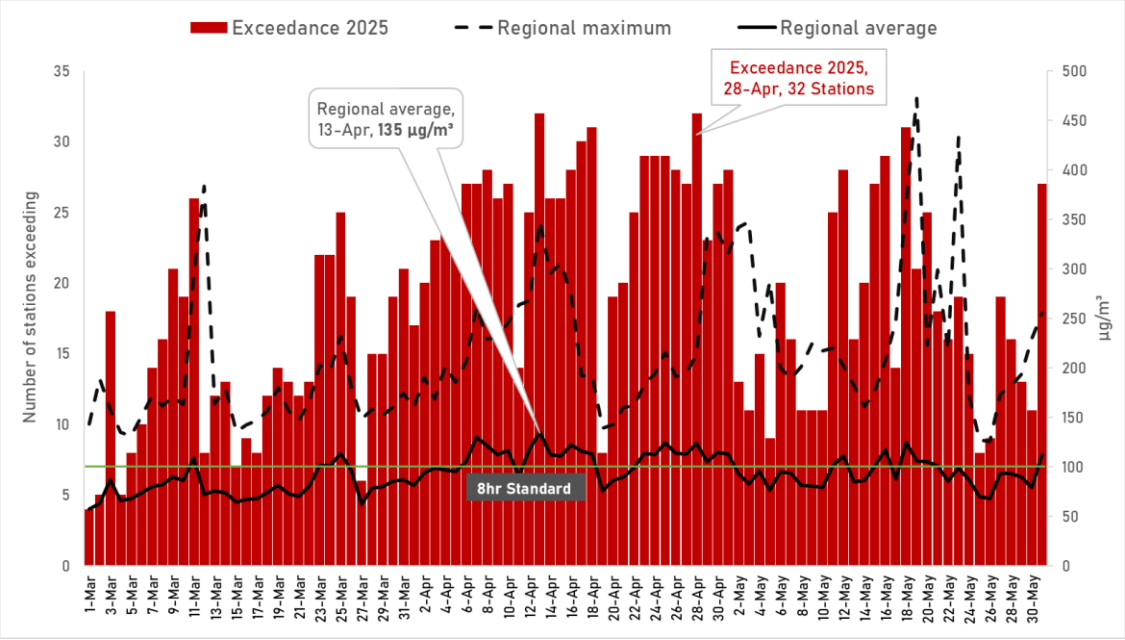
This summer, ground-level ozone pollution remained consistently high across the region (Delhi and the cities of Gurugram, Faridabad, Gaziabad, Noida and Greater Noida), with the maximum concentration exceeding 100 µg/m³ on each of the 92 days between 1 March and 31 May, highlighting the persistent and widespread nature of the problem. The worst day in terms of spatial spread was April 28, when 32 out of 58 monitoring stations across the region reported ozone levels above the safe limit. The highest regional intensity was recorded on April 13, with the Delhi-NCR average reaching 135 µg/m³.

However, when looking at the individual cities, distinct local trends and variations in ozone levels begin to emerge.

Delhi: Ground-level ozone ` on 92 days between 1 March and 31 May. The highest intensity of pollution in the city was observed on 13th April, when the average ozone level stood at 135 µg/m³, with 25 out of 39 monitoring stations reporting exceedance.

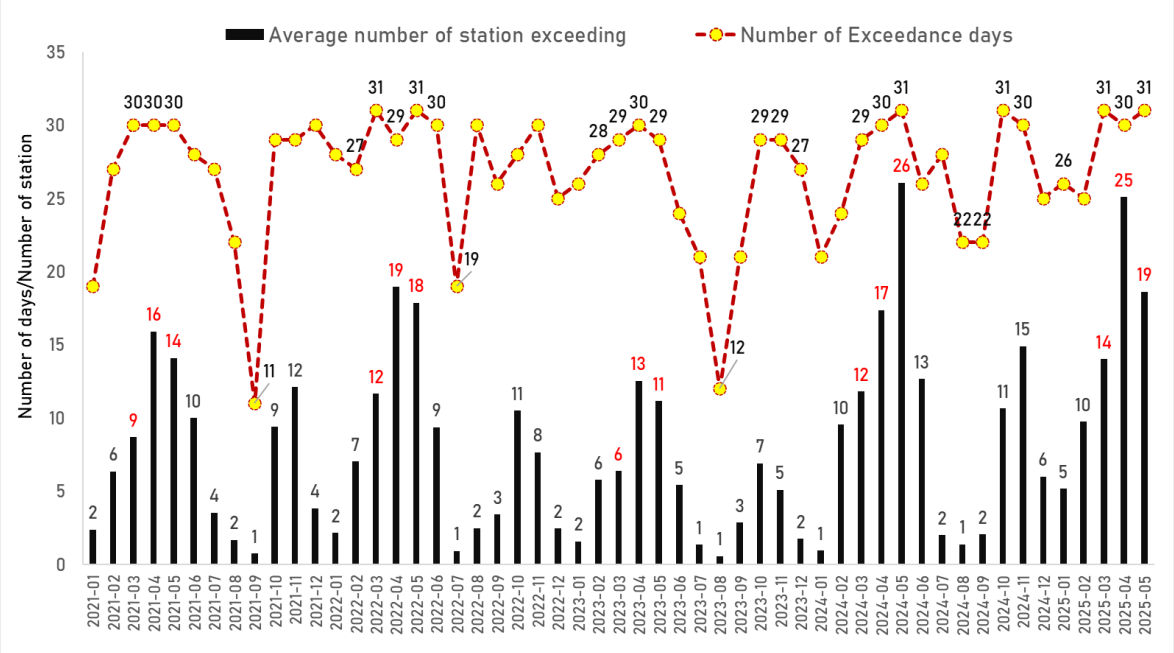
NCR outside Delhi: In the surrounding NCR areas, exceedances were reported on 83 days during the same period. The NCR average peaked slightly higher at 139 µg/m³ on 25 April. However, the maximum number of stations in NCR reporting exceedance were 9 – out of ten stations with sufficient data for this period. This has been observed on both 18 and 28 April. Among NCR towns, the highest exceedance was observed in Ghaziabad, followed by Noida. Over the last five years it has been noted that ground-level ozone has been all season problem but it is exceptionally high during the months of April and May with hot and sunny weather conditions. (see Graph 1: Daily variation in ground-level ozone exceedances in Delhi-NCR and Graph 2: Monthly variation in ground-level ozone in Delhi-NCR (2021-25)**.**

Graph 1: Daily variation in ground-level ozone exceedances in Delhi-NCR



Note: Based on exceedances recorded at the monitoring stations at Delhi, Gurugram, Faridabad, Ghaziabad, Noida and Greater Noida. Exceedance is computed as daily maximum 8-hr average crossing the ground-level ozone 8-hr standard, i.e. 100 µg/m3.
Period of study is 1 March to 31 May 2025. Faridabad does not have adequate data for the given period.
Source: CSE analysis of CPCB real-time data.

Graph 2: Monthly variation in ground-level ozone in Delhi-NCR (2021-25)



Note: Based on exceedances recorded at the monitoring stations at Delhi, Gurugram, Faridabad, Ghaziabad, Noida and Greater Noida. Exceedance is computed as daily maximum 8-hr average crossing the ground-level ozone 8-hr standard, i.e. 100 µg/m^3.
Summer is defined as March to May. Data till 31 May 2025.
Source: CSE analysis of CPCB real-time data.

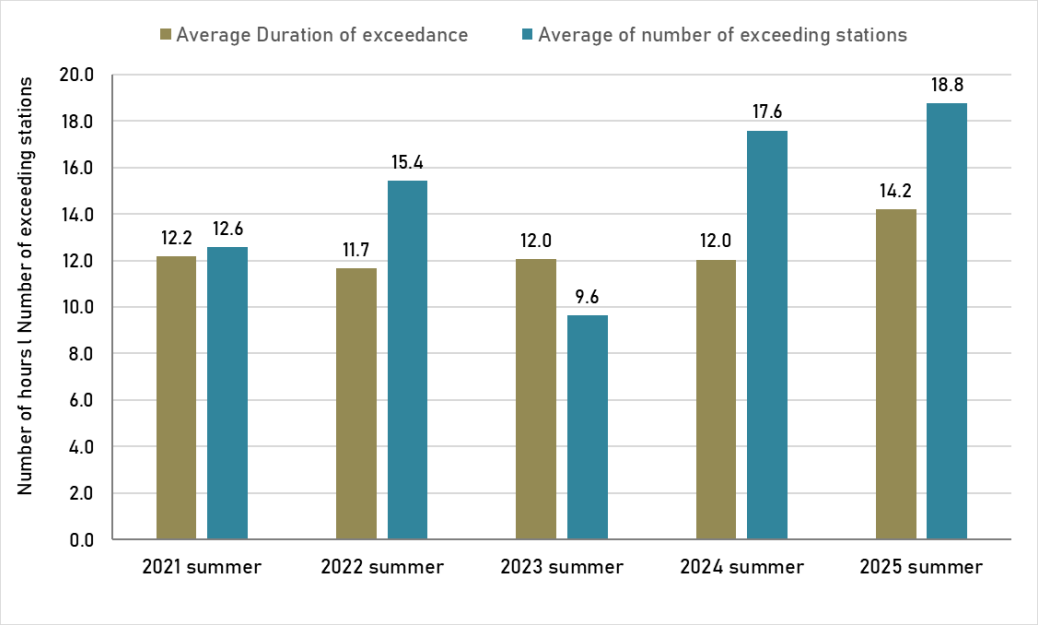
Geographical spread of ground-level ozone pollution in Delhi-NCR during March-May is highest in past 5 years: Ground-level ozone usually exceeds the safety standard on all days of summer in some location in Delhi-NCR every year. This summer, the regional spatial spread (number of stations exceeding the standard across the core NCR) averaged 18.8 stations which is the highest in last five years. In comparison, the daily average was 12.6 stations during the summer of 2021 and 17.6 stations last summer, marking a 6.8 percent increase this year. (See *Graph 3: Variation in average duration and spatial spread of daily exceedance during summer in the core Delhi-NCR*).

Not just the spatial spread of ground-level ozone has increased this summer, but also its duration has increased. This summer, at the stations which reported exceedance the rolling 8-hr average stayed above standard for 14.2 hours on average, which is up from 12.0 hours observed the last summer.

Delhi: Delhi has recorded a notable rise in the spatial spread of ozone exceedance, averaging 15.1 stations this summer, compared to 13.2 last year. The average duration of exceedance also increased to 12 hours.

NCR cities: The NCR cities have recorded a decline in spatial spread, which dropped to 3.6 stations from 4.4 last summer. However, this trend should be interpreted with caution, as Faridabad lacks complete data from all its monitoring stations this summer. Despite this limitation, available data also shows that the average duration of exceedance in NCR rose sharply to 15 hours, surpassing even the average for Delhi. The highest average duration was reported in Gwal Pahari in Gurugram.

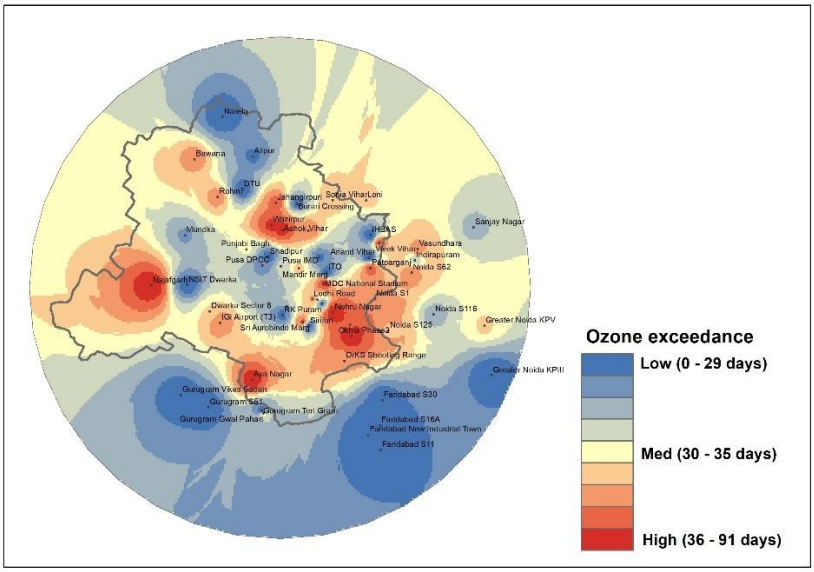
Graph 3: Variation in average duration and spatial spread of daily exceedance during summer in the core Delhi-NCR



Note: Based on exceedances recorded at the monitoring stations at Delhi, Gurugram, Faridabad, Ghaziabad, Noida and Greater Noida. Exceedance is computed as daily maximum 8-hr average crossing the ground-level ozone 8-hr standard, i.e. 100 µg/m^3. Duration of exceedance is computed as number of hours the rolling 8-hr average was exceeded at a station on a day. Summer is defined as March to May. Data till 31 May 2025.
Source: CSE analysis of CPCB real-time data.

North-west and South Delhi neighborhoods are worst affected by ground-level ozone pollution: Nehru Nagar in South Delhi is the most chronically affected in the core Delhi. It has exceeded the standard in this location for all 92 days this March-May. It is followed by Najafgarh, Okhla Phase II, Ashok Vihar, AyaNagar and Wazirpur as the worst polluted (See *Map 1: Hotspots of ground-level ozone exceedance in the core Delhi-NCR & Table 1: Locations with most ground-level ozone exceedance in the core Delhi-NCR*).

Map 1: Hotspots of ground-level ozone exceedance in the core Delhi-NCR



Note: Based on exceedances recorded at the monitoring stations at Delhi, Gurugram, Faridabad, Ghaziabad, Noida and Greater Noida. Exceedance is computed as daily maximum 8-hr average crossing the ground-level ozone 8-hr standard, i.e. 100 µg/m^3. Summer is defined as March to May. Data till 31 May 2025.
Source: CSE analysis of CPCB realtime data.

NCR: Ghaziabad, Noida, Gurugram and Greater Noida are also seriously affected by the ground-level ozone pollution. Vasundhara in Ghaziabad is the most affected in the region where ground level ozone exceeds by 48 days, followed by Sector 125 in Noida with such 43 days. Faridabad does not have adequate data of ground-level ozone. (See *Table 2: Locations with the lowest ground-level ozone pollution in the core Delhi-NCR*).

Table 1: Locations with most ground-level ozone exceedance in the core Delhi-NCR

S.No.	Station	Number of exceedance days
1	Nehru Nagar, Delhi	92
2	Najafgarh, Delhi	82
3	Okhla phase II, Delhi	81
4	Ashok Vihar, Delhi	77
5	AyaNagar, Delhi	77
6	Wazirpur, Delhi	72
7	Major Dhyan Chand National Stadium, Delhi	68
8	Patparganj, Delhi	64
9	CRRI Mathura Road, Delhi	62
10	Sri Aurobindo Marg, Delhi	60

Note: Exceedance is computed as daily maximum 8-hr average crossing the ground-level ozone 8-hr standard, i.e. 100 µg/m^3. Summer is defined as March to May. Data till 31 May 2025.
Source: CSE analysis of CPCB real-time data.

Table 2: Locations with the lowest ground-level ozone pollution in the core Delhi-NCR

S.No.	Station	Number of exceedance days
5	Anand Vihar, Delhi	0
6	IHBAS, Delhi	0
7	ITO, Delhi	0
8	Shadipur, Delhi	0
9	Narela, Delhi	0
10	Knowledge Park III, Greater Noida	0

Note: No exceedance was recorded among these stations. Ranking is based on daily maximum 8-hr average. Summer is defined as March to May. Data till 31 May 2025.
Source: CSE analysis of CPCB real-time data.

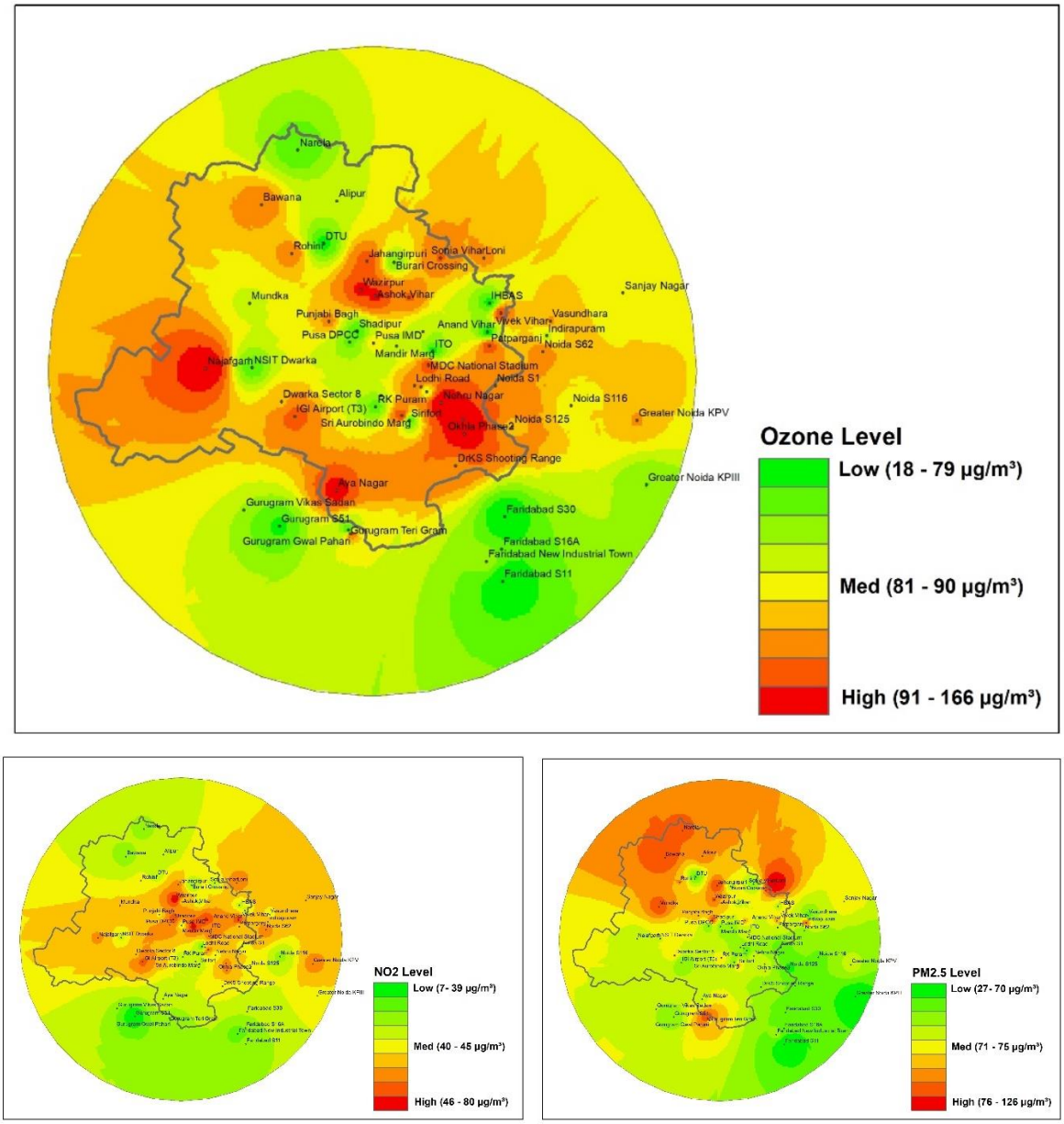
Ground-level ozone hotspots are located in the areas with low levels of NO2 and PM2.5:

Delhi: The spatial distribution of ground-level ozone is inverse of the NO2 and PM2.5 (see *Map 2: Spatial relationship among hotspots for key pollutants in the core Delhi-NCR*). However, Wazirpur stands out as a notable exception, recording high levels of both NO_2 and ground-level ozone (See *Table 5: Locations with the highest NO2 pollution in the core Delhi- NCR*). Hotspots for PM2.5 are completely distinct from the hotspots for ground-level ozone (See *Table 6: Locations with the highest PM2.5 pollution in the core Delhi-NCR*).

This bears out the fact that while ozone is created in polluted areas with nitrogen oxide being the catalyst, it also gets mopped up in high NO2 areas as it further reacts. But the ozone that escapes to cleaner areas with less NO2 builds up faster as unavailability of NO2 hampers its dissipation.

NCR: In the NCR, a similar trend is observed, but with exceptions. Loni in Ghaziabad records high levels of both NO_2 and ground-level ozone. It also shows elevated PM2.5 levels, followed by Teri Gram in Gurugram *(See Map 2: Spatial relationship among hotspots for key pollutants in Delhi-NCR).* These exceptions suggest complex local dynamics that may involve high precursor emissions, limited dispersion, and other meteorological factors contributing to elevated ozone levels despite the presence of NO_2 and PM2.5.

Map 2: Spatial relationship among hotspots for key pollutants in Delhi-NCR



Note: Seasonal average computed as mean of monthly averages based on daily 24-hr average for PM2.5 and NO2, while daily maximum 8-hr average is used for ground-level ozone. Summer is defined as March to May. Data till 31 May 2025.

Source: CSE analysis of CPCB real-time data.

Table 5: Locations with the highest NO2 pollution in the core Delhi-NCR

S.No.	Station	Summer NO2 average in µg/m³
1	Wazirpur, Delhi	81
2	Mandir Marg, Delhi	75
3	Anand Vihar, Delhi	71
4	Shadipur	67
5	IGI Airport (T3), Delhi	63
6	Loni, Ghaziabad	60
7	JLN Stadium, Delhi	60
8	Sector 116, Noida	59

9	Pusa DPCC, Delhi	58
10	Knowledge Park V, Greater Noida	56

Note: Summer average computed as mean of monthly averages based on daily 24-hr average. Summer is defined as March to May. Data till 31 May 2025.
Source: CSE analysis of CPCB real-time data.

Table 6: Locations with the highest PM2.5 pollution in the core Delhi-NCR

S.No.	Station	Summer PM2.5 average in µg/m³
1	Loni, Ghaziabad	127
2	Teri Gram, Gurugram	105
3	Bawana, Delhi	97
4	Jahangirpuri, Delhi	96
5	Shadipur, Delhi	92
6	Mundka, Delhi	92
7	Narela, Delhi	89
8	Wazirpur, Delhi	88
9	Indirapuram, Ghaziabad	88
10	Alipur, Delhi	86

Note: Seasonal average computed as mean of monthly averages based on daily 24-hr average. Summer is defined as March to May. Data till 31 May 2025.
Source: CSE analysis of CPCB real-time data.

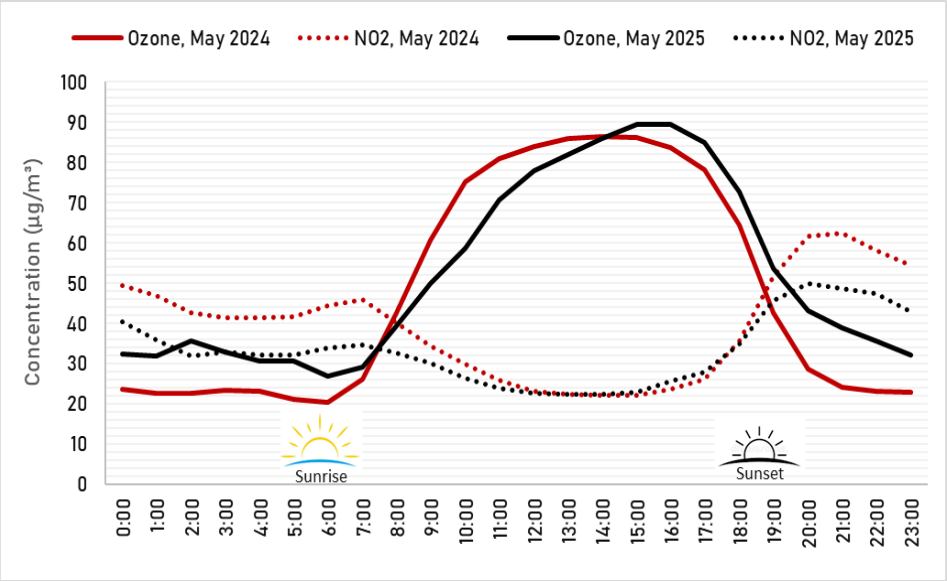
Regional hourly ozone peak level is up by 9 per cent compared to lockdown times: An indicative analysis of hourly ground-level ozone data, averaged across all monitoring stations and days during May, shows significant changes in pollution patterns this summer. Compared to May 2024, ozone concentrations are no longer lingering in the air after sunset. However, the regional average hourly peak has risen by 9 per cent, highlighting an overall intensification of the ozone problem. (See *Graph 4: Hourly cycle of ground level ozone and NO2 in the core Delhi-NCR – May 2024 v/s May 2025*). The resurgence of morning and evening rush-hour traffic is contributing to a temporary reduction in ozone levels around sunrise and sunset, as higher nitrogen dioxide (NO_2) concentrations from vehicle emissions react with and suppress ozone formation during these periods.

Notably, this year, unlike previous years, CPCB did not apply the 200 µg/m³ capping on ground level ozone data. As a result, 8-hourly daily averages have been recorded exceeding 450 µg/m³, levels previously unreported due to earlier data truncation.

Delhi: On 19 May 2025, the CRRI Mathura Road station in Delhi recorded a maximum 8-hour average of 472 µg/m³, the highest level ever observed at this location and the highest this summer across the core NCR network. In previous summers, the threshold of 190 µg/m³ was breached by several stations including Alipur, Rohini, Ashok Vihar, and Dr KS Shooting Range. This summer, Alipur and Ashok Vihar recorded new highs of 383 µg/m³ and 241 µg/m³, respectively.

NCR: Gwal Pahari in Gurugram emerged as a peak hotspot with 8-hour average of 315 µg/m³. It is followed by Sector 62 in Noida with 8-hour average of 223 µg/m³ (See *Table 7: Locations with the highest daily peak ground-level ozone pollution in the core Delhi-NCR*).

Graph 4: Hourly cycle of ground-level ozone and NO2 in the core Delhi-NCR – May 2024 v/s May 2025



Note: 24-hr profile is based on mean hourly concentration of ground-level ozone and NO2 recorded at the monitoring stations at Delhi, Gurugram, Faridabad, Ghaziabad, Noida and Greater Noida for month of May in 2024 and 2025. Data till 31 May 2025.
Source: CSE analysis of CPCB realtime data.

Table 7: Locations with highest daily peak ground-level ozone pollution in the core Delhi-NCR

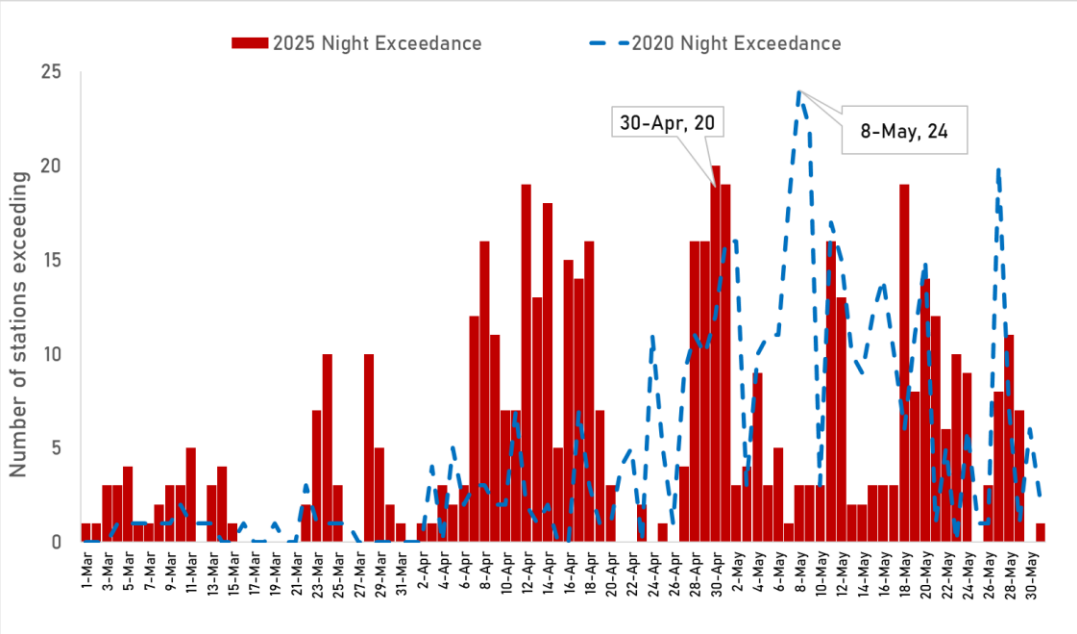
S.No.	Station	Highest daily 8-hr average in µg/m³
1	CRRI Mathura Road, Delhi	472
2	Lodhi Road, Delhi	432
3	Alipur, Delhi	383
4	AyaNagar, Delhi	348
5	IGI Airport (T3), Delhi	348
6	Gwal Pahari, Gurugram	315
7	Mandir Marg, Delhi	299
8	Punjabi Bagh, Delhi	299
9	Najafgarh, Delhi	263
10	Nehru Nagar, Delhi	257

Note: Based on daily maximum 8-hr average. Summer is defined as March to May. Data till 31 May 2025.
Source: CSE analysis of CPCB real-time data.

Night-time ground-level ozone continues to persist: Ground-level ozone should ideally become negligible in the night air but Delhi-NCR has been witnessing a phenomenon where ozone levels remain elevated hours after sunset. This summer regional night-time ozone was noted at 6 stations on average every night (See *Graph 5: Variation in occurrence of high night-time ground-level ozone pollution*). It was 5 stations per night during the 2020 summer.

Night-time ozone has been considered when hourly concentration has exceeded the level 100 µg/m^3 between 10PM and 2AM at any station.
Delhi: Night-time ozone is most frequently in Najafgarh in South West Delhi where it was reported on 55 nights this summer.
NCR: Outside Delhi, the most nighttime ozone is reported in Gwal Pahari in Gurugram where it was reported on 28 nights this summer.
(See *Table 8: Locations with most night-time ground-level ozone pollution instances*).

Graph 5: Monthly variation in occurrence of high night-time ground-level ozone pollution



Note: Based on high hourly concentration of ground-level ozone recorded at the monitoring stations at Delhi, Gurugram, Faridabad, Ghaziabad, Noida and Greater Noida during night-time. High hourly concentration is taken as 100 µg/m^3 or more. Night-time is taken as 10PM to 2AM. Summer is defined as March to May. Data till 31 May 2025.
Source: CSE analysis of CPCB real-time data.

Table 8: Locations with most night-time ground-level ozone pollution instances

S.No.	Station	Number of night-time exceedances
1	Najafgarh, Delhi	55
2	AyaNagar, Delhi	41
3	CRRI Mathura Road	39
4	Nehru Nagar, Delhi	37
5	Okhla Phase II, Delhi	31
6	Gwal Pahari, Gurugram	28
7	Wazirpur, Delhi	20
8	Ashok Vihar, Delhi	18
9	Punjabi Bagh, Delhi	16
10	IGI Airport (T3), Delhi	15

Note: Based on high hourly concentration of ground-level ozone recorded during night-time. High hourly concentration is taken as 100 µg/m^3 or more. Night-time is taken as 10PM to 2AM. Summer is defined as March to May. Data till 31 May 2025.
Source: CSE analysis of CPCB real-time data.

Way forward

Clean air action plan in Delhi and NCR need to address the multi-pollutant crisis urgently. It is important learn from the advanced economies that after controlling particulate pollution have fallen into the grip of rising NOx and ozone crisis. India should prevent this trap.

Integrate ozone in the Graded Response Action Plan to take emergency action to target the emitter of precursor gases like vehicles and industry that form ozone and to reduce short term exposures.

Clean air action plan for the city needs to integrate ozone mitigation to implement stringent measures to upscale zero emissions vehicles, clean industrial processes and fuels, eliminate waste burning with hundred percent remediation of legacy waste, collection, segregation and material recovery, and replace solid fuels with clean fuels in households.

Develop regional action plan on ozone: Ground-level ozone gets created in polluted areas but drifts and accumulates in cleaner urban environments, urban peripheries and surrounding rural areas affecting agricultural productivity and food security. While in polluted areas ozone further reacts with pollutants to dissipate, in cleaner environment it lives longer. Ozone is thus a regional pollutant that requires effective control at both local and regional level.