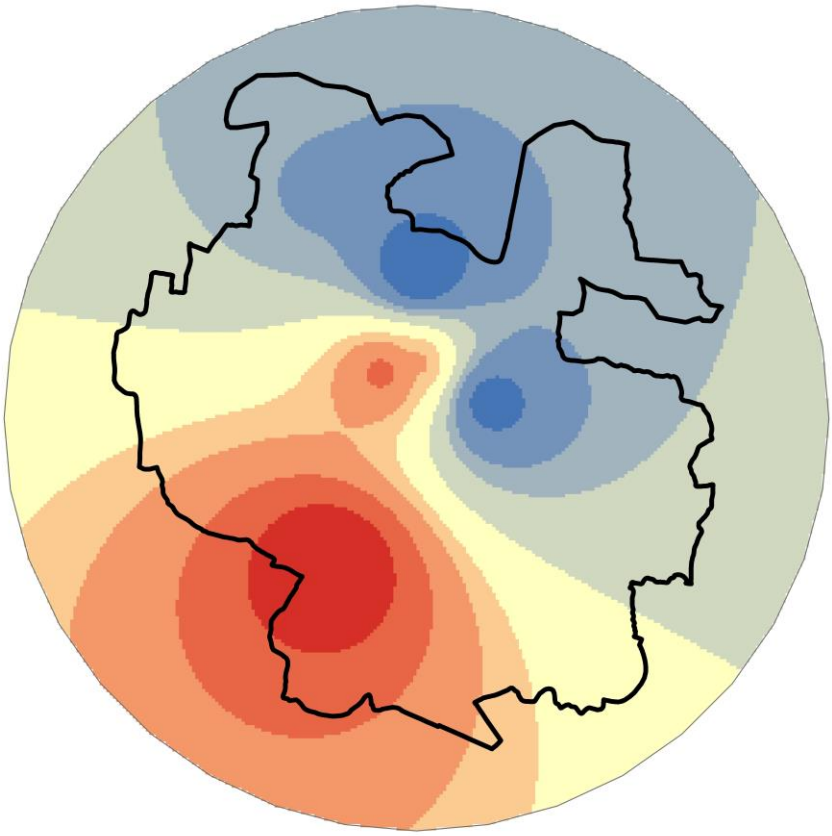
Air Quality Tracker

Ground-level Ozone



Greater Jaipur

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Citation: Avikal Somvanshi and Sharanjeet Kaur 2024, Air Quality Tracker Ground-level Ozone: Greater Jaipur, Centre for Science and Environment, New Delhi.

Published by
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Overview

Centre for Science and Environment (CSE) has alerted from time to time about the growing problem of ground-level ozone in Indian cities. While policy and public attention is nearly fully drawn towards very high level of particulate pollution, the challenge of this highly toxic gas has not attracted adequate policy attention for mitigation and prevention. Inadequate monitoring, limited data and inappropriate methods of trend analysis have weakened the understanding of this growing public health hazard. This requires early action.

The summer of 2024 has witnessed widespread ground-level ozone exceedance making the air of Greater Jaipur even more toxic. This summer the geographical spread of the problem is even more wide spread as compared to previous summers. The toxic built up is not lasting as long at locations where it is happening this summer compared to previous summers.

Health evidence is also growing stronger. The 2020 State of Global Air report states that age-standardized rates of death attributable to ground-level ozone is among the highest in India and the seasonal 8-hour daily maximum concentrations have recorded one of the highest increases in India between 2010 and 2017– about 17 per cent. This requires deeper understanding of what is going on in different cities and regions to inform mitigation.

Due to the very toxic nature of ground-level ozone, the national ambient air quality standard for ozone has been set for only short-term exposures (one-hour and eight-hour averages), and compliance is measured by the number of days that exceed the standards. Compliance requires that the standards are met for 98 per cent of the time of the year. It may exceed the limits on two per cent of the days in a year, but not on two consecutive days of monitoring. In other words, there should not be more than eight days in a year when the ozone standard is breeched, and none of those allowed exceedances can be on two consecutive days.

The standard practice of Central Pollution Control Board to average out the data of all stations in the city to determine daily AQI does not work for ground-level ozone as it is a short-lived and hyper-localised pollutant. A citywide average concentration level over an extended time frame does not indicate the severity of the problem and health implication from local build up and exposure for people living in hotspots.

Global experience shows that there is usually a trade-off. As particulate pollution is reduced the problem of NOx and ground-level ozone increase. Globally, regulators are tightening the regulatory benchmark for ozone to address the toxic threat which – given its complex chemistry, is difficult to address. India should prevent this trap.

Why ozone needs special attention? Complex chemistry of ground-level ozone makes it a difficult pollutant to track and mitigate. Ground-level ozone is not directly emitted from any source. It is produced from complex interaction between nitrogen oxides (NOx) and volatile organic compounds (VOCs) that are emitted from vehicles, power plants, factories, and other combustion sources and undergo cyclic reactions in the presence of sunlight to generate ground-level ozone. VOCs can also be emitted from natural sources, such as plants. Ozone not only builds up in cities but also drifts long distances to form a regional pollutant that makes both local and regional action necessary.

This highly reactive gas has serious health consequences. Those with respiratory conditions, asthma, chronic obstructive pulmonary disease, and particularly children with premature lungs and older adults are at serious risk. This can inflame and damage airways, make lungs susceptible to infection, aggravate asthma, emphysema, and chronic bronchitis and increase the frequency of asthma attacks leading to increased hospitalisation.

The investigation: This assessment has traced trends in ground-level ozone data from 2020 to 2024. 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 9 official stations under the Continuous Ambient Air Quality Monitoring System (CAAQMS) spread across Greater Jaipur.

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. Given that the data is capped at 200 $\mu g/m^3$ by CPCB, it is not possible to determine how high the concentration really goes.

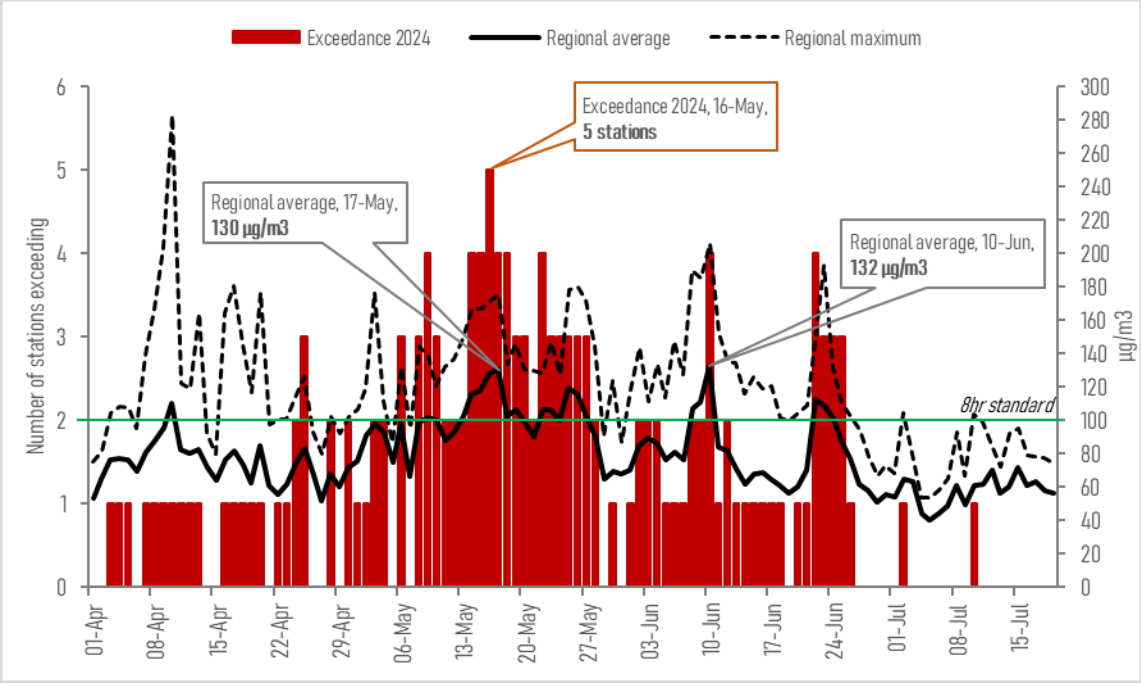
The study has considered global good practice and taken on board the USEPA approach of computing eight-hour averages for a day and then checking for the maximum value among them to capture the daily ozone pollution level. USEPA assesses city-wide or regional AQI based on the highest value recorded among 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).

While analysing the data it has also been noted that the ozone data available on CPCB portal never exceeds 200 $\mu g/m^3$, while data for the corresponding time on Delhi Pollution Control Committee may show higher levels. Therefore, due to this capping of data it is not possible to understand the nature of peaking in the city. This needs to be addressed as there are two sets of standard for ozone – 8-hourly standard of 100 $\mu g/m^3$ and one hourly standard at 180 $\mu g/m^3$. Capping makes assessment of one-hourly standard challenging.

Key findings

Ground-level ozone exceedance is reported on 75 days of this summer: This summer ground-level ozone exceedances were reported on 75 days between 1 April and 18 July. The worst day from spatial spread of ground ozone was the 16th of May when 5 stations out of 6 stations of Greater Jaipur reported exceedance (See *Graph 1: Daily variation in ground-level ozone exceedance in Greater Jaipur*). Nevertheless intensity of pollution was highest on 10th Jun when the regional average stood at 132 µg/m3

Graph 1: Daily variation in ground-level ozone in Greater Jaipur

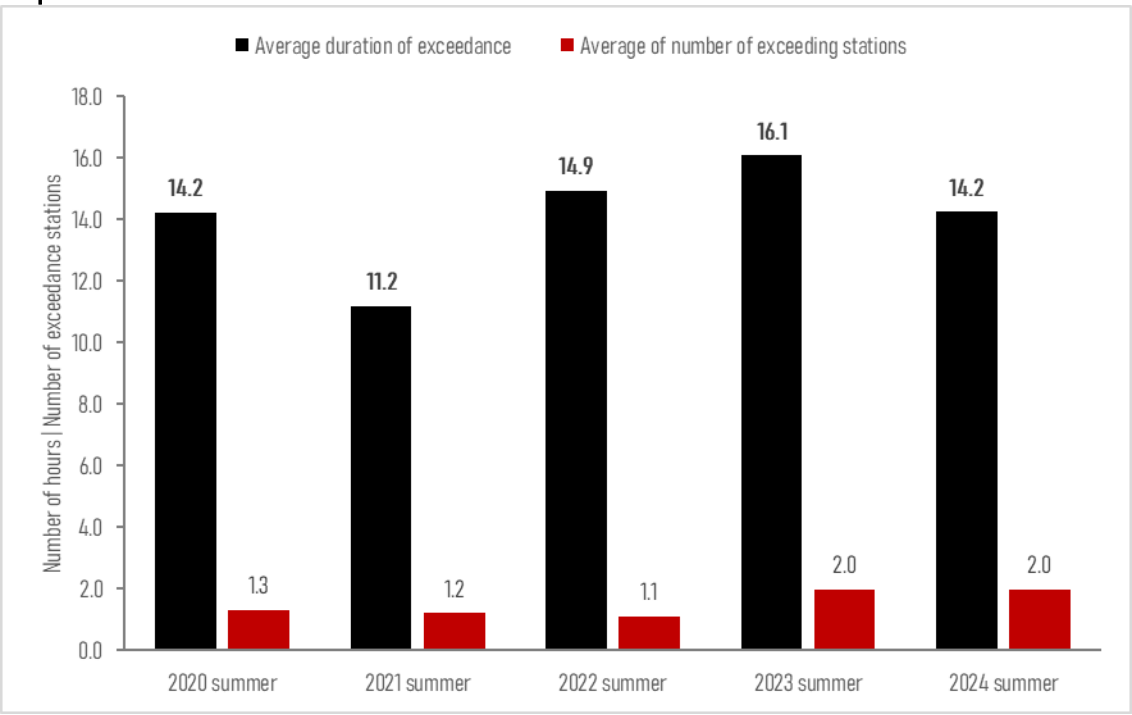


Note: Based on exceedances recorded at the monitoring stations at Greater Jaipur. Exceedance is computed as daily maximum 8-hr average crossing the ground-level ozone 8-hr standard, i.e. 100 µg/m³. Period of study is 1 April to 18 July 2024.
Source: CSE analysis of CPCB realtime data.

Geographical spread of ground-level ozone pollution in Greater Jaipur is relatively same as last summer: Ground-level ozone usually exceeds the safety standard on all days of summer in some location in Greater Jaipur every year. This year the spatial spread (number of stations exceeding the standard across Greater Jaipur) has been 2 station per day for period 1 April to 18 July. On an average 1.3 stations used to exceed the standard daily during the 2020 summers (See *Graph 2: Variation in average duration and spatial spread of daily exceedance in Greater Jaipur*). It must be noted that there were only three stations in Jaipur in 2020.

Average duration of exceedance this year has been similar to the 2020 pandemic. This year so far, at the stations which reported exceedance it lasted on average 14.2 hours, it was 14,2 hours in the 2020 pandemic.

Graph 2: Variation in average duration and spatial spread of daily exceedance in Greater Jaipur



Note: Based on exceedances recorded at the monitoring stations in Greater Jaipur. Exceedance is computed as daily maximum 8-hr average crossing the ground-level ozone 8-hr standard, i.e. 100 µg/m³. Duration of exceedance is computed as number of hours the rolling 8-hr average was exceeded at a station on a day. Period of the study is 1 January to 30 June.
Source: CSE analysis of CPCB realtime data.

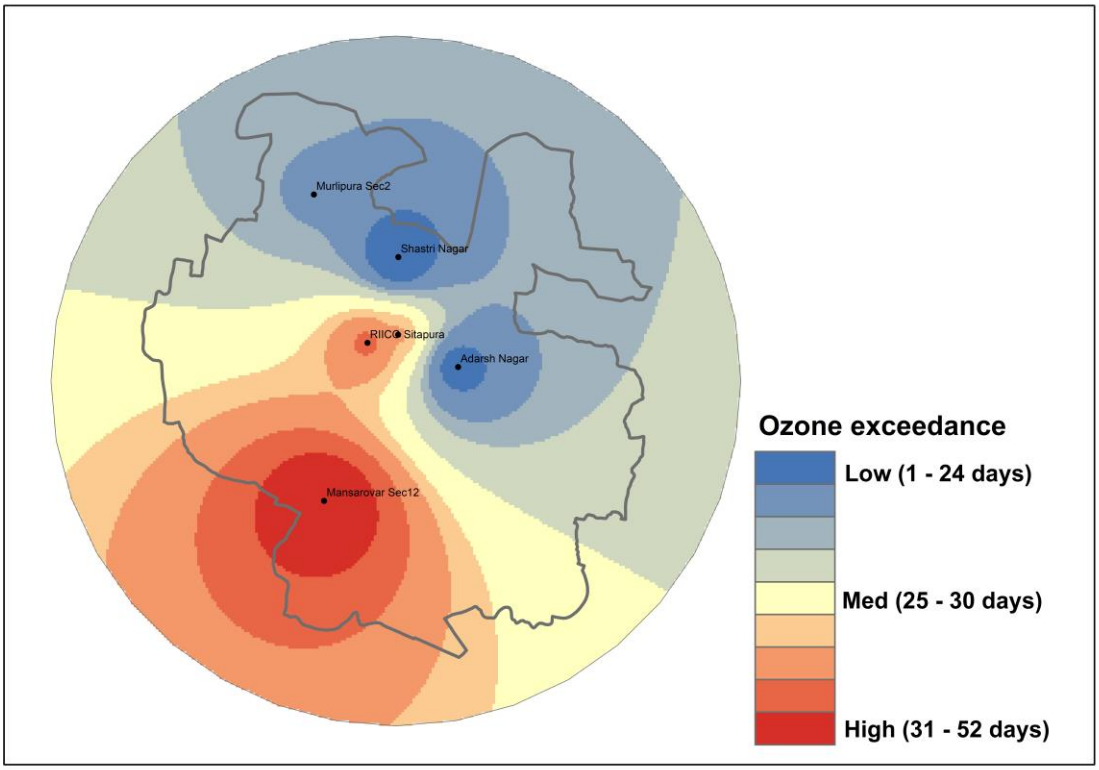
Outer Jaipur neighbourhoods are the worst affected by ground-level ozone pollution in Jaipur: Murlipura in the outer Jaipur is the most chronically affected by ground ozone pollution in Greater Jaipur. It has exceeded the standard in this location for 62 days this year so far. It is followed by Mansarovar and Sitapura as the worst polluted (See *Map 1: Hotspots of ground-level ozone exceedance in Greater Jaipur & Table 1: Locations with most ground-level ozone exceedance in Greater Jaipur*). Adarsh Nagar has the least instances of ground-level ozone exceedances in the region.

Table 1: Locations with most ground-level ozone exceedance in Greater Jaipur

S.No.	Station	Number of exceedance days
1	Murlipura Sector 2, Jaipur	62
2	Mansarovar Sector 12, Jaipur	57
3	Sitapura, Jaipur	55
4	Police Commissionerate, Jaipur	42
5	Shastri Nagar, Jaipur	17
6	Adarsh Nagar, Jaipur	6

Note: 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 January to 18 July 2024.
Source: CSE analysis of CPCB realtime data.

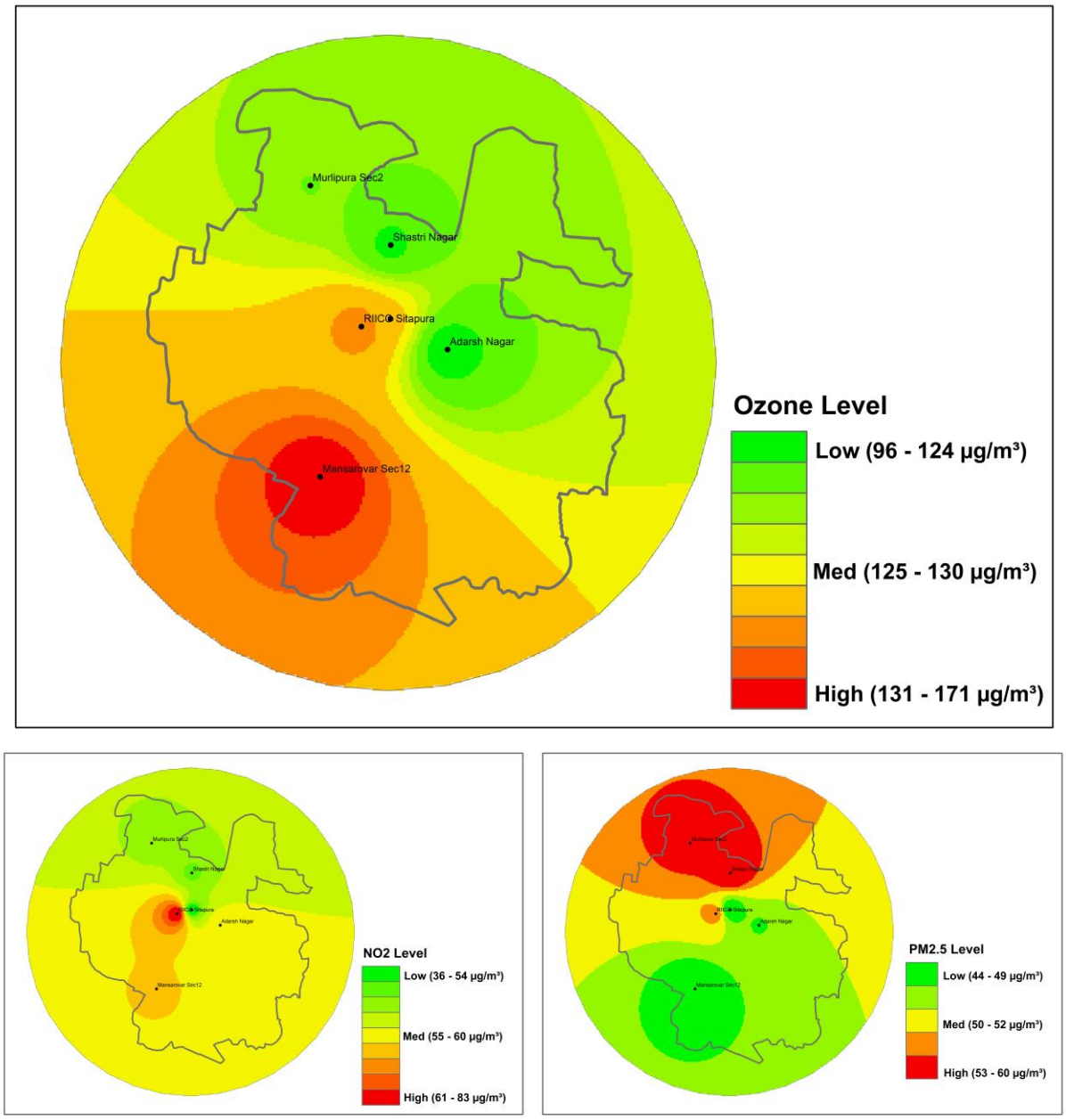
Map 1: Hotspots of ground-level ozone exceedance in Greater Jaipur



Note: Based on exceedances recorded at the monitoring stations in Greater Jaipur. Exceedance is computed as daily maximum 8-hr average crossing the ground-level ozone 8-hr standard, i.e. 100 µg/m^3. Period of study is 1 April to 18 July 2024.
Source: CSE analysis of CPCB realtime data.

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

Map 2: Spatial relationship among hotspots for key pollutants in Greater Jaipur



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. Period of study is 1 April to 18 July 2024.
Source: CSE analysis of CPCB realtime data.

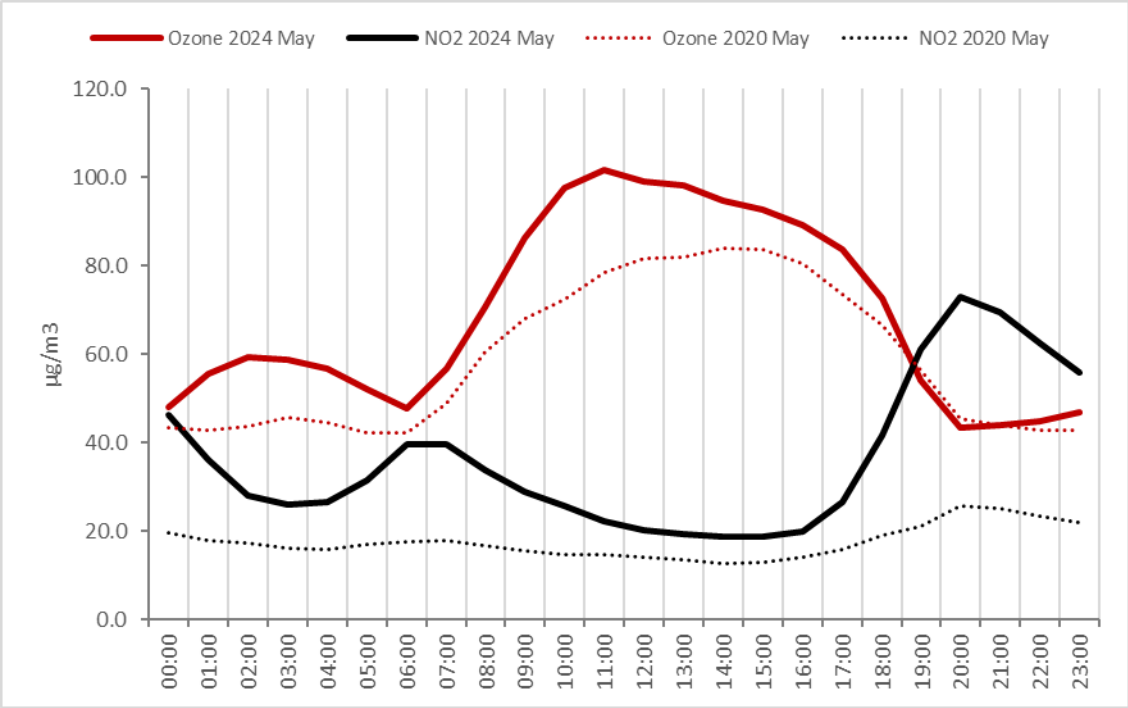
Regional hourly ozone peak level is up by 21 per cent compared to lockdown times: Since CPCB caps the data at 200 µg/m^3 it is not possible to access precisely how high the ground-level ozone concentration can go up to, but for to get a relative understanding in this study hourly data averaged across all station and all days of May has been analysed. This indicative analysis shows that compared to May of 2020 ground-level ozone hourly peak on an average has gone down up by 21 per cent (See *Graph 3: Hourly cycle of ground level ozone and NO2 in Greater Jaipur – May 2020 v/s May 2024*). Generally morning and evening rush-hour traffic is helping in neutralising ground-level ozone at sunrise and sunset as increased NO2 levels

cannibalise it and it happens in Jaipur as well but there is a strange uptick in ozone levels in the city around 2-3 AM.

The maximum 8-hour average was recorded at Velachery, Jaipur when level hit 282.8 µg/m^3 on 10 April 2024. It was followed by Sitapura. Every station in Jaipur has exceeded the standard at least once this year so far (See *Table 2: Locations with the highest daily peak ground-level ozone pollution in Greater Jaipur*).

Given the data cap of 200 µg/m^3 enforced by CPCB at the 15-minute granularity, this underscores the magnitude of the pollution.

Graph 3: Hourly cycle of ground-level ozone and NO2 in Greater Jaipur – May 2020 v/s May 2024



Note: 24-hr profile is based on mean hourly concentration of ground-level ozone and NO2 recorded at the monitoring stations in Greater Jaipur for month of May in 2020 and 2023. Period of study is 1 April to 18 July 2024.
Source: CSE analysis of CPCB realtime data.

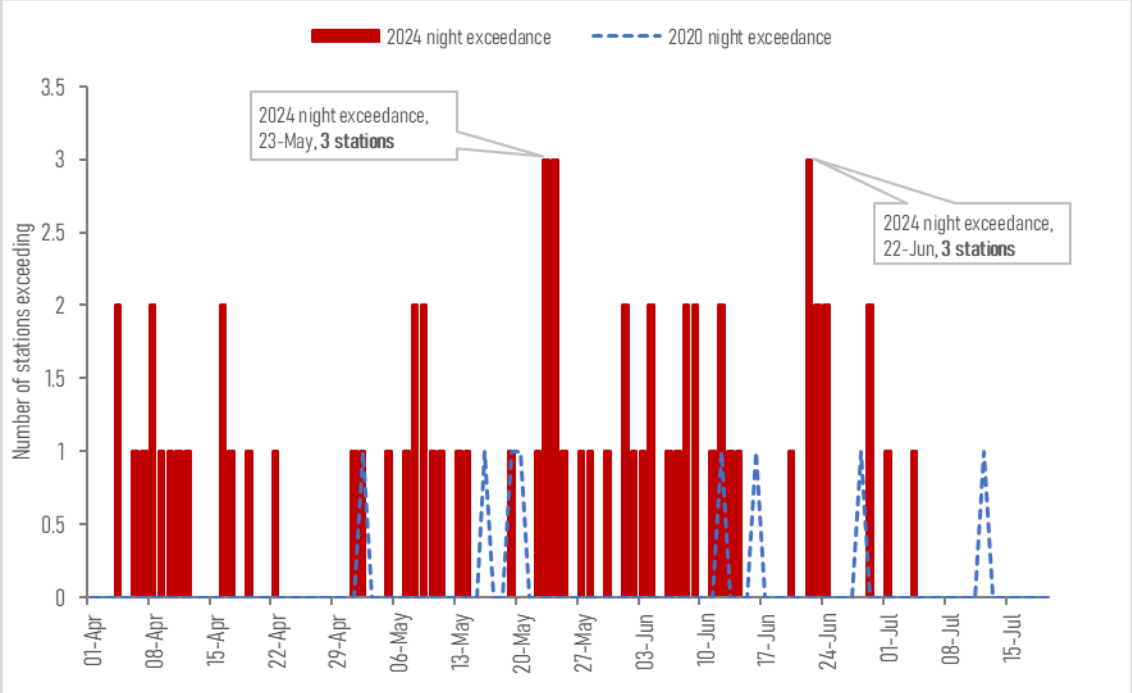
Table 2: Locations with highest daily peak ground-level ozone pollution in Greater Jaipur

S.No.	Station	Highest daily 8-hr average in µg/m^3
1	Mansarovar Sector 12, Jaipur	282.8
2	Sitapura, Jaipur	192.8
3	Police Commissionerate, Jaipur	146.5
4	Murlipura Sector 2, Jaipur	136.8
5	Adarsh Nagar, Jaipur	112.4
6	Shastri Nagar, Jaipur	101.9

Note: Based on daily maximum 8-hr average. Period of study is 1 April to 18 July 2024.
Source: CSE analysis of CPCB realtime data.

Night-time ground-level ozone continues to persist but is not as bad as it used to be during the lockdowns: Ground-level ozone should ideally become negligible in the night air but Greater Jaipur has been witnessing a rare phenomenon where ozone levels remain elevated hours after sunset. This was found to be very wide-spread in Delhi during the lockdowns of 2020 summers but it is also noted in Jaipur at a lower scale. This night-time ozone was noted at 0.7 stations on average every night (See *Graph 4: Daily variation in occurrence of high night-time ground-level ozone pollution*). It was 0.1 stations per night during the 2020 summer. Night-time ozone has been considered when hourly concentration has exceeded the level 100 µg/m³ between 10PM and 2AM at any station. Night-time ozone is most frequently in Mansarovar where it was reported on 24 nights (See *Table 5: Locations with most night-time ground-level ozone pollution instances*).

Graph 4: Daily 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 in Greater Jaipur during night-time. High hourly concentration is taken as 100 µg/m3 or more. Night-time is taken as 10PM to 2AM. Period of study is 1 April to 18 July 2024.
Source: CSE analysis of CPCB realtime data.

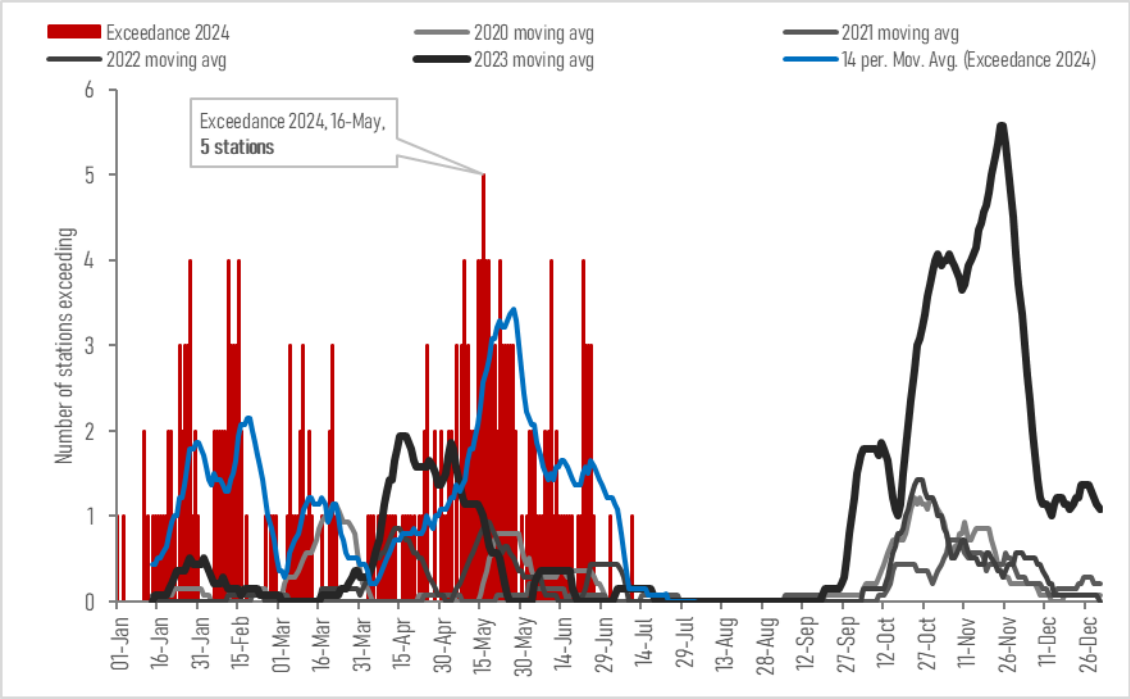
Table 5: Locations with most night-time ground-level ozone pollution instances

S.No.	Station	Number of night-time exceedance
1	Mansarovar Sector 12, Jaipur	24
2	Sitapura, Jaipur	22
3	Police Commissionerate, Jaipur	11
4	Murlipura Sector 2, Jaipur	5
5	Shastri Nagar, Jaipur	2
6	Adarsh Nagar, Jaipur	1

Note: Based on high hourly concentration of ground-level ozone recorded during night-time. High hourly concentration is taken as 100 µg/m³ or more. Night-time is taken as 10PM to 2AM. Period of study is 1 April to 18 July 2024.
Source: CSE analysis of CPCB realtime data.

Ground-level ozone has become a yearlong problem and in Jaipur there is no specific seasonal pattern: Even though the ground-level ozone exceedance is the worst during summer months, it remains a year-long problem as at least few locations continue to record exceedance throughout the year. The dangerous build-up of ground-level ozone can happen anytime during the year, but it is usually in small pockets during non-summer months. For it to have wider spatial spread hot and sunny weather conditions are needed which are generally present in summer – especially during April-May. The worst month is May for Jaipur. There is a considerable uptick in ozone pollution after monsoon – especially September-November (See *Graph 5: Trend in ground-level ozone over years -2020-24*). On the annual scale, last year exceedance were reported on 136 days, they were 70 days in 2022, 34 days in 2021, and 64 days in 2020. This year so far 126 days of exceedance have been recorded in Greater Jaipur already.

Graph 5: Trend in ground-level ozone over years -2020-24



Note: Based on exceedances recorded at the monitoring stations in Greater Jaipur. 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. Period of the study is 1 April to 18 July.
Source: CSE analysis of CPCB realtime data.

Act now

Ozone mitigation demands stringent control of gases from all combustion sources including vehicles, industry, power plants and open burning in the entire region. It is therefore necessary that while designing mitigation of particulate matter the key focus of action strategy today, is also calibrated for reduction of ozone precursor gases.

Immediately, refine the action strategy for combined control of particulate pollution, ozone and its precursor gases like NOx to maximise the co-benefits of the action plan.

Simultaneously develop a robust public information and dissemination system to alert public about ozone exceedance wherever ozone build up is happening for exposure management.