Winter pollution crisis in megacities of India: Going beyond Delhi

Delhi-NCR

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The new analysis by the Urban Lab at the Centre for Science and Environment (CSE) underscores the persistent challenge of winter air pollution in Delhi-NCR. While Delhi saw a slight increase in its seasonal PM2.5 levels this winter, the wider NCR region recorded a notable decline in pollution levels.

Delhi's average winter PM2.5 concentration stood at 174 µg/m³, a marginal 1 per cent rise from the previous three winters. In contrast, NCR cities experienced a significant improvement, with seasonal PM2.5 levels dropping to 109 µg/m³—marking a 24 per cent reduction compared to previous winters. Despite this seasonal variation, pollution peaks remained a concern, with Gwal Pahari in Gurugram recording the highest daily PM2.5 peak at 592 µg/m³.

The geographical diversity of Delhi-NCR—ranging from the floodplains of the Yamuna to the Aravalli foothills—contributes to complex air quality dynamics. While Delhi, located in a landlocked region, struggles with pollutant entrapment during winter due to low wind speeds and temperature inversions, parts of NCR benefit from slightly better dispersion conditions. However, pollution levels across the entire region remain well above safe limits, exacerbating public health risks.

Anand Vihar emerged as the most polluted monitoring location, recording a winter average PM2.5 level of 227 µg/m³—far exceeding its annual average of 136 µg/m³. Other high-pollution hotspots included Wazirpur, Jahangirpuri, and Bawana. The region also recorded a high number of 'very poor' and 'severe' air quality days, with Bawana witnessing the worst conditions (77 days), followed by Dwarka Sector 8 (75 days) and Jahangirpuri (72 days).

Adding to the pollution burden, nitrogen dioxide (NO_2) levels surged sharply during November and December due to intensified vehicular emissions and industrial activity. ITO in Delhi recorded the highest NO_2 concentration at 167 µg/m³ in December—a 37 per cent rise from November. Anand Vihar saw an even sharper spike, with NO_2 levels jumping by 71 per cent from October to December.

Winter pollution in Delhi-NCR typically worsens in late November and early December, as cooler temperatures and stagnant atmospheric conditions trap local emissions.

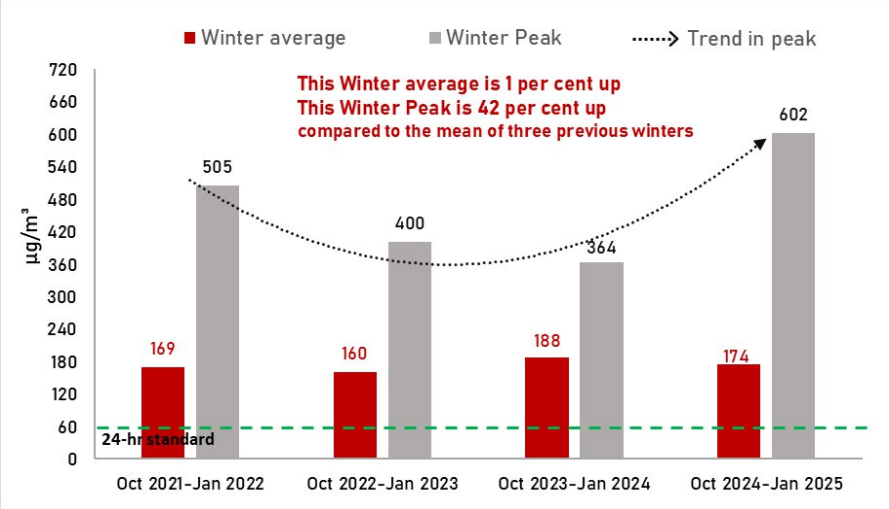
This analysis covers data from 55 continuous ambient air quality monitoring stations (CAAQMS) across Delhi-NCR—37 in Delhi, 4 in Gurugram, 4 in Faridabad, 4 in Noida, 2 in Greater Noida, and 4 in Ghaziabad. A robust dataset was processed using the USEPA methodology to ensure accuracy and address data gaps, providing a comprehensive understanding of air quality trends.

With Delhi-NCR's air quality challenges intensifying every winter, the findings highlight the urgent need for strengthened emission control policies, improved traffic management, and cleaner energy transitions to mitigate the seasonal pollution crisis.

Key Findings

Winter PM2.5 trends show slight increase in Delhi and improvement in NCR: This winter, Delhi experienced a slight increase in seasonal PM2.5 levels, with the city's average concentration reaching 174 µg/m³—1 per cent higher than the average of the previous three winter seasons (October to January) *(See Graph 1: Trend in winter average and winter peak in cities of Delhi).* While the seasonal average saw only a marginal rise, peak pollution levels surged significantly. The highest daily PM2.5 concentration was recorded on November 18, 2024, at 602 µg/m³, marking a 42 per cent increase from the mean of the past three winter peaks. RK Puram registered the highest daily peak among all monitoring locations, with a staggering 732 µg/m³ on the same day.

Graph 1: Trend in winter average and winter peak in cities of Delhi (1 Oct 2024 – 31 Jan 2025)

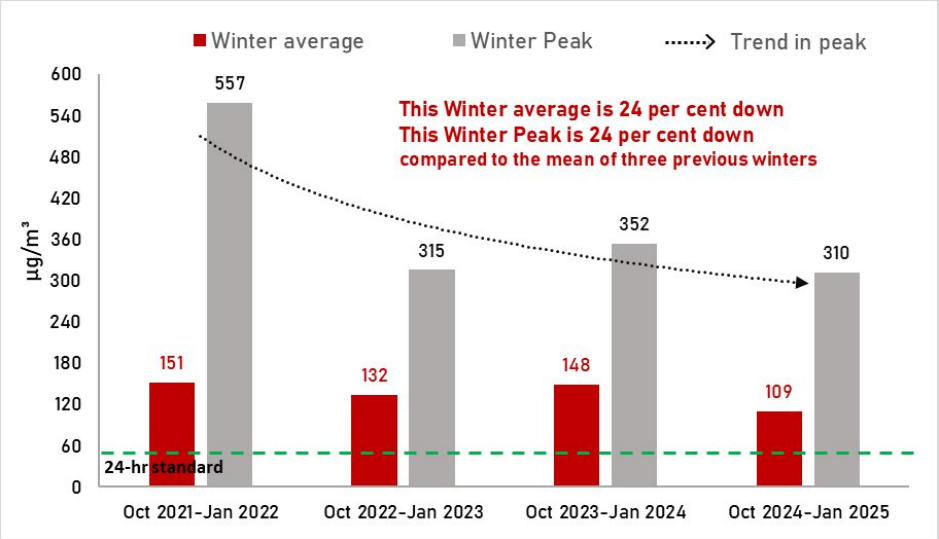


Source: CSE analysis of CPCB real-time data.

In contrast, the NCR region witnessed a notable improvement, with the seasonal average PM2.5 concentration dropping to 109 µg/m³—a 24 per cent decline compared to the average of the previous three winters *(See Graph 2: Trend in winter average and winter peak in cities of the NCR region).* However, despite this overall improvement, pollution peaks remained a concern. The highest daily PM2.5 level this winter was recorded on November 18, 2024, at 310 µg/m³, which is 24 per cent lower than the mean of the past three winter peaks. Among NCR locations, Gwal Pahari recorded the highest daily peak at 592 µg/m³ on the same day.

This analysis is based on data from 37 monitoring stations across Delhi and 18 stations in the NCR, including 4 in Gurugram, 4 in Faridabad, 4 in Noida, 2 in Greater Noida, and 4 in Ghaziabad. The winter period is defined as October 1 to January 31, with average and peak values derived from continuous daily data available since 2021.

Graph 2: Trend in winter average and winter peak in cities of the NCR region (1 Oct 2024 – 31 Jan 2025)



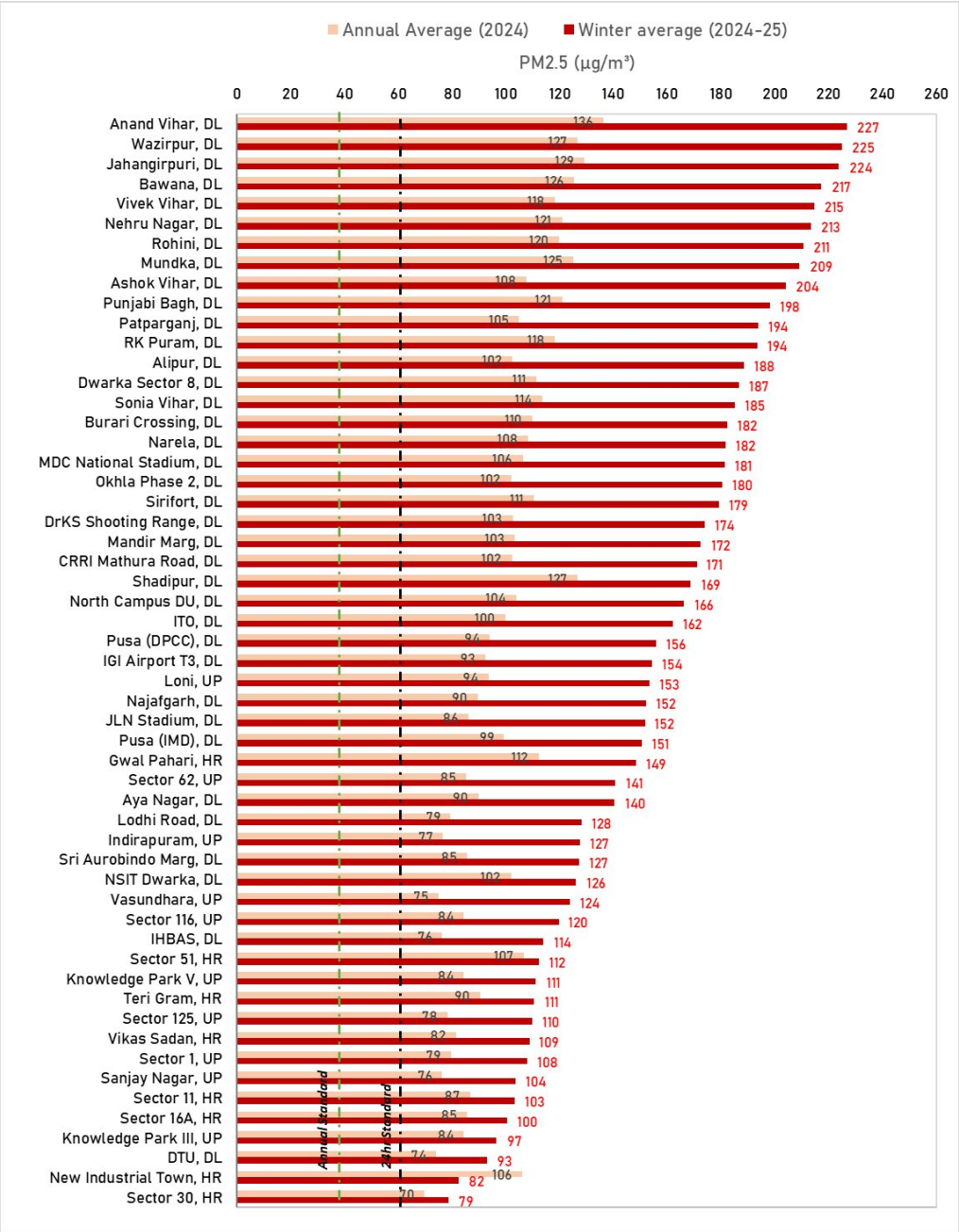
Source: CSE analysis of CPCB real-time data.

Rising winter PM2.5 levels disrupt annual air quality trends: Air quality in Delhi-NCR deteriorates significantly during winter, with PM2.5 concentrations in the 2024-25 season soaring well above the annual average recorded across monitoring stations. Anand Vihar reported the highest winter average at 227 µg/m³, a sharp increase from its annual average of 136 µg/m³. Similarly, Wazirpur and Jahangirpuri saw notable spikes, with winter averages of 225 µg/m³ and 224 µg/m³, compared to their annual averages of 127 µg/m³ and 129 µg/m³, respectively.

Across most locations, winter pollution levels exceeded the annual average by 5–47 per cent, highlighting the pronounced seasonal impact. Even in Faridabad's Sector 30, which had the lowest annual average of 70 µg/m³, winter levels still rose by 11 per cent to 79 µg/m³ *(See Graph 3: Station wise winter and annual PM2.5 levels in cities of DelhiNCR).* The sharp increase in winter pollution is likely driven by a combination of heightened emissions, stagnant atmospheric conditions, and reduced pollutant dispersion.

Notably, New Industrial Town in Faridabad was the only location where the annual average exceeded the winter average, with seasonal levels dropping by 29 per cent to 82 µg/m³ from an annual average of 106 µg/m³.

Graph 3: Station wise winter and annual PM2.5 levels in cities of DelhiNCR



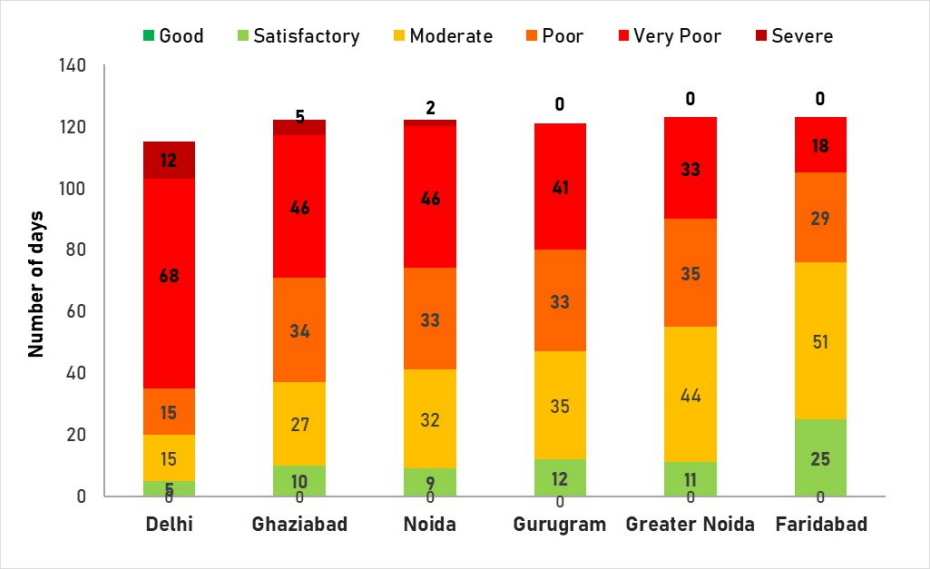
Source: CSE analysis of CPCB real-time data

Delhi-NCR records a high number of days with poor to severe air quality: Bawana recorded the highest number of such days, with 77 days falling under the 'very poor' and 'severe' AQI categories. It was followed by Dwarka Sector 8 and Jahangirpuri, which reported 75 and 72 days, respectively, of air quality in these critical ranges.

Jahangirpuri led the city in the number of 'severe' and 'severe plus' AQI days, recording 41 such days, followed by Anand Vihar and Wazirpur, each with 40 days. All 55 monitoring stations across Delhi-NCR recorded 'very poor' and 'severe' air quality days, ranging from 5 to 83 days.

Among the monitoring locations in Delhi, only Sri Aurobindo Marg (3 days), IHBAS (2 days), and Najafgarh (1 day) recorded any 'good' air quality days. Delhi saw the highest number of 'very poor' and 'severe' AQI days, with 68 days in the 'very poor' category and 12 days in the 'severe' category. It is followed by Ghaziabad and Noida each with 46 very poor days *(See Graph 4: PM2.5 based AQI categorization of days for DelhiNCR).*

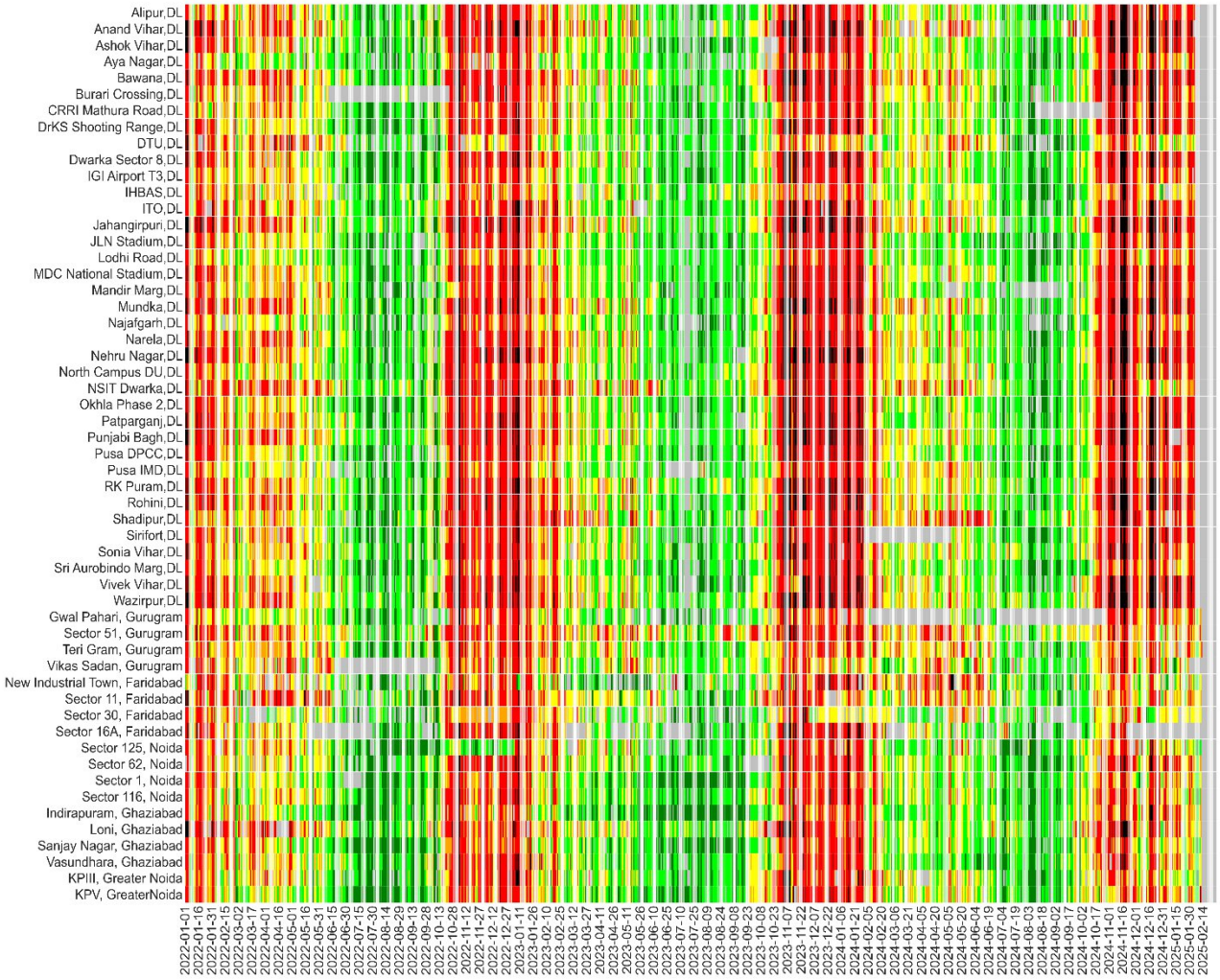
Graph 4: PM2.5 based AQI categorization of days for DelhiNCR



Note: PM2.5 values for cities that have continuous and adequate data for the complete assessment period. Data from 1 Oct 2024 – 31 Jan 2025.
Source: CSE analysis of real-time data from the CPCB website

Bad air days begin to build up around the same time in the cities of DelhiNCR during mid-October and persists till the end of January, as weather starts to cool down and winds slow down. Cities in the DelhiNCR show more pronounced impact of winter pollution. *(See Graph 5: Heat map based on days classified as per PM2.5 air quality index for DelhiNCR).*

Graph 5: Heat map based on days classified as per PM2.5 air quality index for cities of DelhiNCR



Note: Cell colors are based on the official AQI category colors. Data up till 31 January 2025.
Source: CSE analysis of real-time data from the CPCB portal.

The Pollution hotspots and cleaner cities: Anand Vihar emerging as the most polluted location, recording a staggering winter average PM2.5 level of 227 µg/m³. It is followed by Wazirpur with seasonal average at 225 µg/m³, Jahangirpuri at 224 µg/m³ *(See Graph 6: Winter average PM2.5 level in cities of DelhiNCR).*

Several other locations also reported alarmingly high pollution levels, with Bawana (217 µg/m³), Vivek Vihar (215 µg/m³), and Nehru Nagar (213 µg/m³) ranking among the most polluted sites in the region. Even areas like RK Puram, which typically see slightly lower pollution levels compared to industrial zones, recorded winter averages of 194 µg/m³.

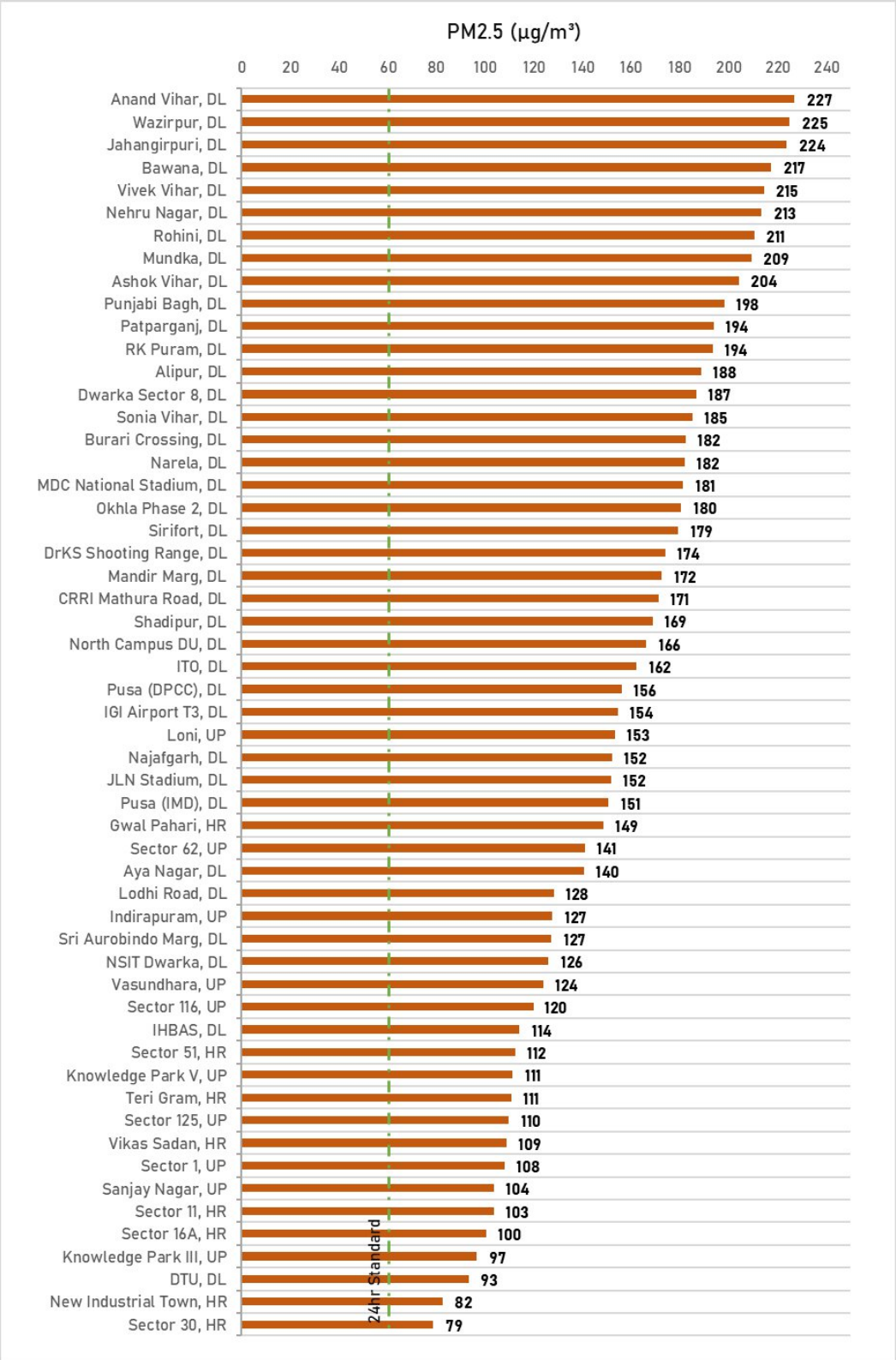
However, Sector 30 in Faridabad emerged as the least polluted location in Delhi-NCR, with a winter average PM2.5 level of 79 µg/m³, followed by New Industrial Town in Faridabad at 82 µg/m³. *(See Graph 6: Winter average PM2.5 level in cities of DelhiNCR).* A few other locations, such as DTU (93 µg/m³) and Knowledge Park III (97 µg/m³), managed to maintain PM2.5 levels below 100 µg/m³, though still significantly above the safe air quality standard.

CRRI Mathura Road followed by Ashok Vihar registered the highest increase in winter pollution: CRRI Mathura Road in Delhi was the worst performer and registered an increase of 20 per cent compared to the preceding winter. It was followed by Ashok Vihar with an increase of 13 per cent, Vivek Vihar and Gwal Pahari each with an increase of 11 per cent *(See Graph 7: Change in Winter average PM2.5 level in cities of DelhiNCR (2023-24 vs 2024-25)*

However, this winter many cities have shown improvement, with the most improvement was shown by New Industrial Town in Faridabad with 52 per cent compared to the corresponding period during previous year. It is

followed by Sector 16A in Faridabad with 46 per cent, Knowledge Park III in Greater Noida with 41 per cent, Knowledge Park V in Greater Noida with 36 per cent and NSIT Dwarka with 31 per cent *(See Graph 7: Change in Winter average PM2.5 level in cities of DelhiNCR (2023-24 vs 2024-25).*

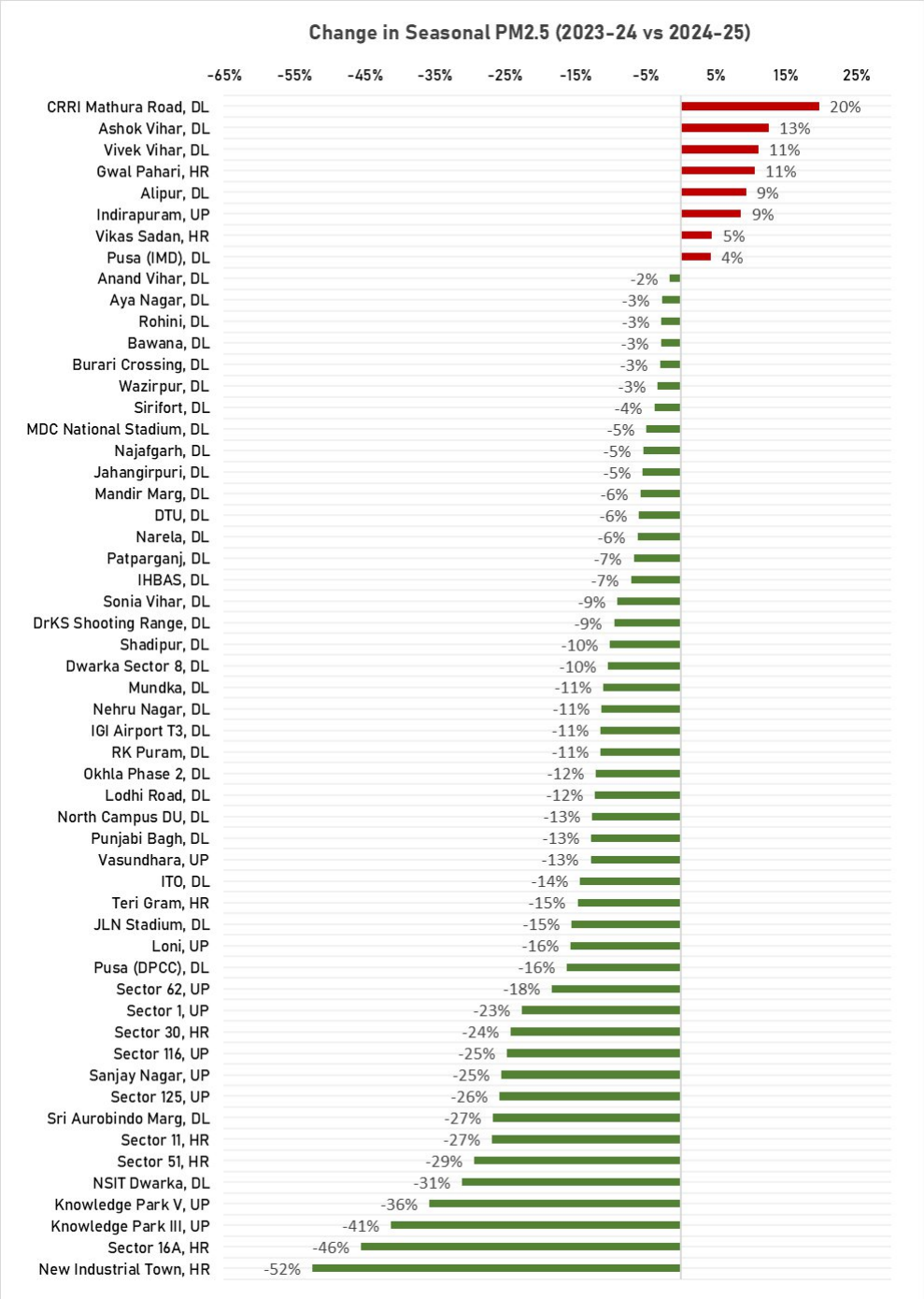
Graph 6: Winter average PM2.5 level in cities of DelhiNCR *(1 October 2024-31 January 2025)*



Note: 1 October 2024 – 31 January 2025 average is based on mean of daily averages.
Source: CSE analysis of CPCB real-time data

There is also wide variation in pollution concentration among the monitoring locations in cities of DelhiNCR. Anand Vihar, is the most polluting area with winter PM2.5 averaging at 227 µg/m³. Delhi's monitoring station at Anand Vihar, Wazirpur and Jahangpuri, Bawana, Vivek Vihar, Nehru Nagar, Rohini, Mundka, Ashok Vihar and Punjabi Bagh makeup the ten most polluted city in Delhi. Among NCR region, Loni in Ghaziabad is the most polluted with winter PM2.5 averaging at 153 µg/m³ , followed by Gwal Pahari in Gurugarm at 149 µg/m³ (*See Annex 1: PM2.5 level at station levels 1 Oct 2024-31 Jan 2025).*

Graph 7: Change in winter average PM2.5 level in cities of DelhiNCR *(2023-24 vs 2024-25)*



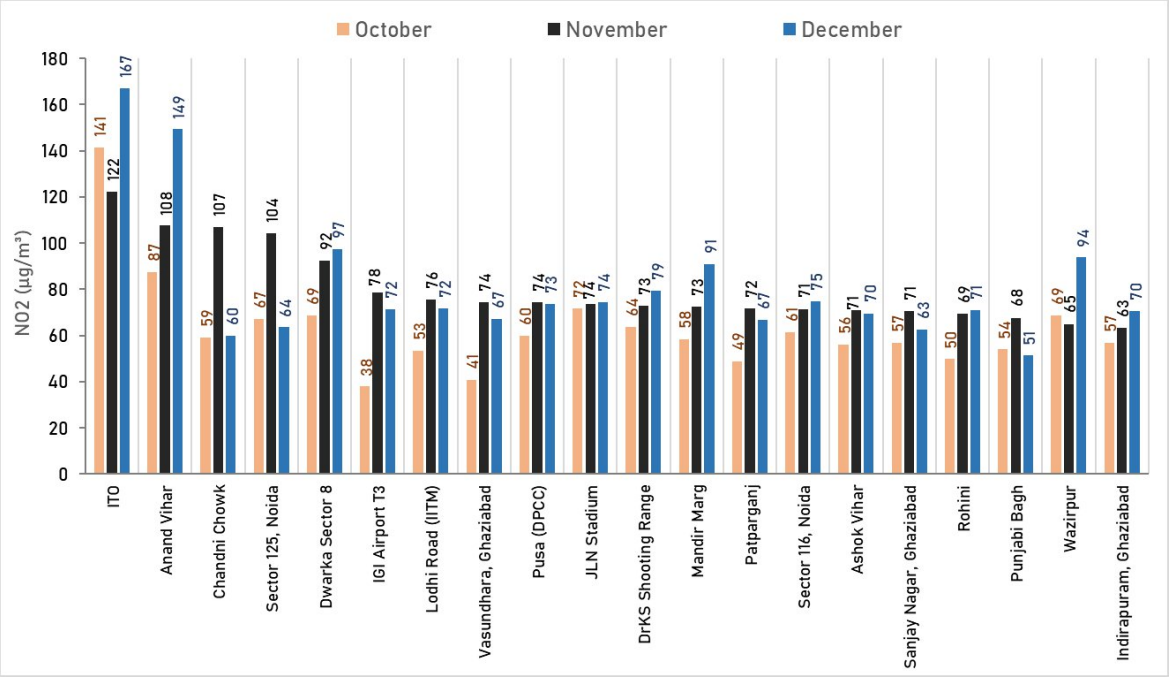
Note: 1 October-31 January 2023-24 and 2024-25 average is based on mean of daily averages. Cities with data in both 2023 and 2024 are compared.
Source: CSE analysis of CPCB real-time data

Multi-pollutant challenge - increasing levels of Nitrogen dioxide (NO2) during November, and December: There has been a significant surge in nitrogen dioxide (NO_2) concentrations across Delhi-NCR from October to December 2024. NO_2, primarily emitted from vehicular traffic and industrial combustion, has shown a sharp increase at major traffic hotspots, exacerbating winter air pollution.

Among all monitoring stations, ITO in Delhi recorded the highest NO_2 levels, averaging 167 µg/m³ in December, up from 122 µg/m³ in November, marking 1.37 times jump in just one month. Anand Vihar witnessed an even steeper rise, surging from 87 µg/m³ in October to 149 µg/m³ in December, 1.71 times increase. Other locations, including Wazirpur, Indirapuram (Ghaziabad), and Mandir Marg, also reported consistently high levels, with December being the peak month. *(See Graph 8: Trend in NO2 levels in the cities of DelhiNCR).*

This sharp buildup underscores the combined impact of winter inversion, increased vehicular emissions, and stagnant atmospheric conditions, which trap pollutants closer to the surface.

Graph 8: Trend in NO2 levels in the cities of DelhiNCR



Note: NO2 values for sub-regions are based on the average of citywide values of all the cities in that region. NO2 values is based on average of all stations that have continuous and adequate data for complete assessment period. Data up till 31 Jan 2025.
Source: CSE analysis of real-time data from CPCB portal

Annex 1: PM2.5 levels at station level 1 Oct 2024 – 31 Jan 2025

Station	State	1 Oct 2023 - 31 Jan 2024	1 Oct 2024 - 31 Jan 2025
Delhi			
AnandVihar	Delhi	230.6	227.0
Wazirpur	Delhi	232.5	224.9
Jahangirpuri	Delhi	236.4	223.7
Bawana	Delhi	223.4	217.3
VivekVihar	Delhi	193.2	214.7
NehruNagar	Delhi	240.6	213.4
Rohini	Delhi	216.4	210.6
Mundka	Delhi	235.2	209.2
AshokVihar	Delhi	181.4	204.2
PunjabiBagh	Delhi	227.3	198.3
Patparganj	Delhi	207.5	193.7
RKPuram	Delhi	218.5	193.6
Alipur	Delhi	172.4	188.5
DwarkaSector8	Delhi	208.4	186.8
SoniaVihar	Delhi	203.3	185.1

BurariCrossing	Delhi	187.8	182.3
Narela	Delhi	193.6	181.7
MDC_NationalStadium	Delhi	190.5	181.3
OkhlaPhase2	Delhi	205.2	180.4
Sirifort	Delhi	186.1	179.2
DrKS_ShootingRange	Delhi	191.9	173.9
MandirMarg	Delhi	182.9	172.4
CRRI_MathuraRoad	Delhi	142.8	171.0
Shadipur	Delhi	187.5	168.7
NorthCampus_DU	Delhi	190.1	166.2
ITO	Delhi	189.2	162.1
Pusa_DPCC	Delhi	186.2	156.0
IGIAirportT3	Delhi	174.2	154.4
Najafgarh	Delhi	160.7	152.2
JLN_Stadium	Delhi	179.5	151.8
Pusa_IMD	Delhi	144.5	150.6
AyaNagar	Delhi	144.2	140.4
LodhiRoad	Delhi	145.9	128.2
SriAurobindoMarg	Delhi	173.5	127.2
NSIT_Dwarka	Delhi	182.8	126.0
IHBAS	Delhi	122.6	114.0
DTU	Delhi	99.0	93.2
NCR			
Ghaziabad_Loni	Uttar Pradesh	181.9	153.4
Gurugram_GwalPahari	Haryana	134.3	148.5
Noida_S62	Uttar Pradesh	172.3	140.7
Ghaziabad_Indirapuram	Uttar Pradesh	117.3	127.4
Ghaziabad_Vasundhara	Uttar Pradesh	142.1	123.9
Noida_S116	Uttar Pradesh	159.0	119.7
Gurugram_S51	Haryana	159.1	112.4
GreaterNoida_KPV	Uttar Pradesh	172.9	111.1
Gurugram_TeriGram	Haryana	129.5	110.5
Noida_S125	Uttar Pradesh	147.7	109.7
Gurugram_VikasSadan	Haryana	104.1	108.7
Noida_S1	Uttar Pradesh	139.4	107.9
Ghaziabad_SanjayNagar	Uttar Pradesh	138.9	103.5
Faridabad_S11	Haryana	141.2	103.4
Faridabad_S16A	Haryana	184.3	100.4
GreaterNoida_KPIII	Uttar Pradesh	164.3	96.6
Faridabad_NewIndustrialTown	Haryana	173.0	82.4
Faridabad_S30	Haryana	103.6	78.6

Note: Oct- Jan average is based on mean of daily averages that have continuous and adequate data for both years. All values are in $\mu g/m^3$.
Source: CSE analysis of CPCB real-time data