Toxic cocktail of pollution during early winter in Delhi-NCR

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The new assessment of the early winter trends (October-November) and annual air quality trends in Delhi by the Centre for Science and Environment (CSE), exposes the growing toxicity of the air, stubborn and elevated trends during early winter, worsening of air quality in smaller towns of the National Capital region (NCR), and the risk of reversal of long term air quality gains in the city.

“Delhi and NCR cannot hide behind the smokescreen of farm fires any more as even with much lesser contribution to local air quality this time, air quality has turned very poor to severe exposing the imapct of local sources. But more worrying is the daily synchronised rise of PM2.5 and other toxic gases of nitrogen dioxide (NO2) and carbon monoxide (CO) largely from vehicles and combustion sources, creating a toxic cocktail that has gone unnoticed. The longer term air quality trend in Delhi has also plateaeued without showing improvement. This signals urgent need for deep rooted shifts in infrastructure and systems to upscale action to cut emissions from vehicles, industry, power plants, waste, construction and household energy,” says Anumita Roychowdhury, executive director at CSE.

“What further stands out is the stubborn stability and the vast spread of the pollution levels across the NCR region as well as the worsening and proliferation of more pollution hotspots in the city. The tinier towns in the region display more intense and longer smog build up. Even though the peak pollution spikes are lower this winter due to lesser contribution of farm fires, the airshed is getting increasingly more saturated”, says Sharanjeet Kaur, deputy programme manager, Urban Lab, Clean Air unit, in CSE.

This CSE analysis is based on the air quality data accessed from the portal of the Central Pollution Control Board.

The key highlights

Toxic cocktail of particulates and gases during early winter

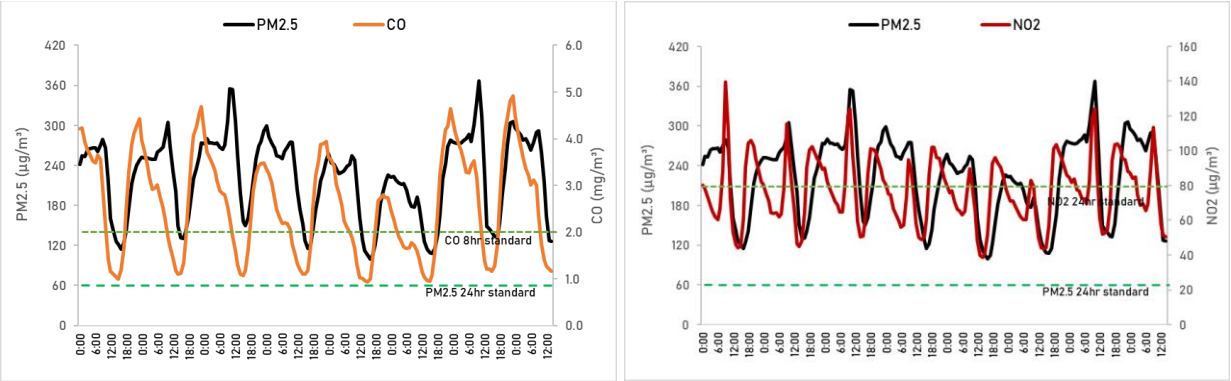
While all eyes are fixated on the daily peaks of tiny harmful particles or PM2.5 during the early winter, the parallel trends in toxic and extremely harmful gases – nitrogen dioxide (NO2) and Carbon monoxide (CO), - has gone unnoticed.

PM2.5 has risen and fallen almost in tandem with NO2 during morning (7–10 am) and evening (6–9 pm) hours, as both pollutants surge with traffic emissions and get trapped under shallow winter boundary layers. While NO2 shows sharper, more immediate peaks linked to vehicular plumes, PM2.5 displays broader peaks as fine particles accumulate and disperse more slowly *(see Graph 1: Correlation of PM2.5 with NO2 and CO (21 Nov – 28 Nov)).*

Carbon monoxide (CO), yet another highly toxic pollutant that curdles the blood and asphyxiates, and is predominantly emitted by vehicles, has shown widespread exceedances across Delhi this winter. Nearly 22 monitoring stations recorded CO levels above the 8-hour standard on more than 30 of the 59 days, indicating persistent traffic-linked emissions. Dwarka Sector 8 was the worst affected, with 55 exceedance days, followed by Jahangirpuri and North Campus DU, each reporting 50 days of violations.

This synchronized pattern clearly demonstrates that daily particulate pollution spikes are closely reinforced by traffic-related emissions of both NO2 and CO, especially under low-dispersion winter conditions. “This cocktail of pollutants also make the air more toxic to breathe. Yet, every winter pollution control efforts is dominated by the dust control measures with feeble action on vehicles, industry, waste and solid fuel burning,” says Roychowdhury.

Graph 1: Correlation of PM2.5 with NO2 and CO (21 Nov – 28 Nov)



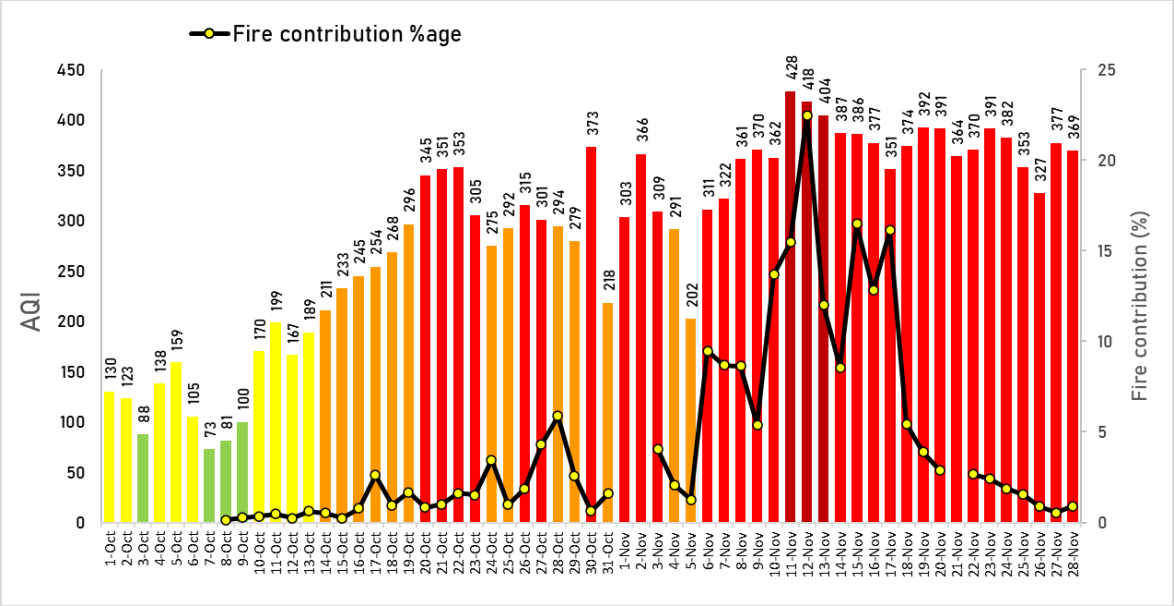
Note: Based on exceedances recorded at the monitoring stations. Exceedance is computed as daily maximum 8-hr average crossing the carbon monoxide 8-hr standard, i.e. 2 mg/m^3.
Source: CSE analysis of CPCB real-time data

Lesser contribution of farmfires expose high impacts of local sources

The crop burning season is now nearly over. Oficial data shows that that the crop burning incidence has reduced substatially in Punjab and Haryana this year partly due to the disrupton of massive floods in Punjab during monsoon. For most part of the early winter, the daily contribution of farm fires to the daily pollution levels have remained below 5 per cent, a few days between 5 to 15 per cent and peaked to 22 per cent only on Novembr 12-13.

The dip in fires prevented extreme spikes, but it did nothing to clean the daily average. In October–November, PM2.5 remained the dominant driver of AQI, emerging as the prominent pollutant on 34 days, followed by PM10 on 25 days, ozone on 13 days and CO on 2 days. AQI stayed in the Very Poor to Severe range for almost the entire month of November *(See Graph 2: Delhi’s AQI vs contribution of Farm fires)*. This indicates the significance of Delhi’s local, year-round sources.

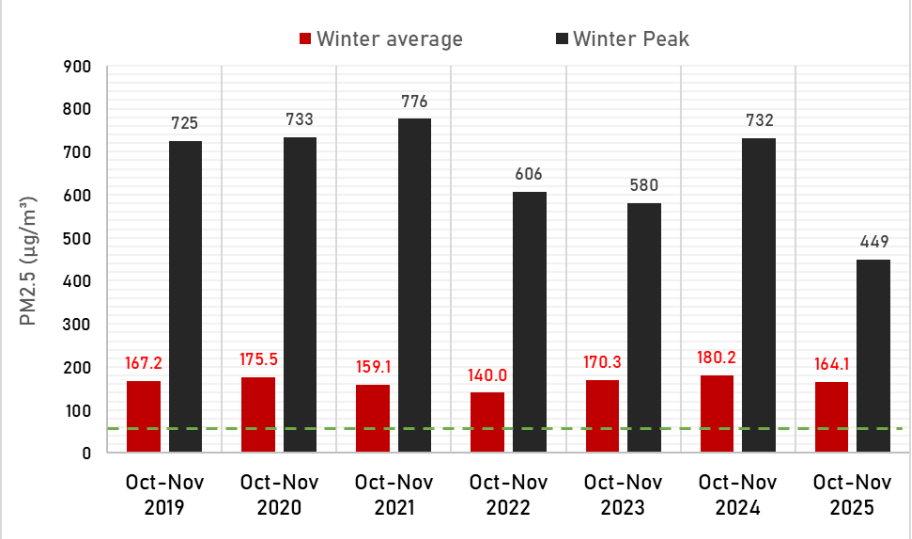
Graph 2: Delhi’s AQI vs contribution of Farm fires



Source: CSE analysis of CPCB'S AQI data and Farm fire contribution is based on data from SAFAR.

Even though the overall pollution levels have remained elevated at dangerous levels, the peak pollution during this early winter has reduced due to the lesser impacts of farm fires. Both the average and the peak levels is less compared to previous three winters. The Oct–Nov PM2.5 average is about 9 per cent lower than the previous year, and even the worst peaks appear slightly decliend. But when compared to the three-year baseline for early winter, the average hasn't changed at all, it has plateaued at the same unhealthy level *(see Graph 3: Trend in Winter Average and Peak Pollution in Delhi (2019 – 2025).* Winter looks better only when compared to last year's extreme; in real terms, pollution remains consistently high.

Graph 3: Trend in Winter Average and Peak Pollution in Delhi (2019 – 2025)



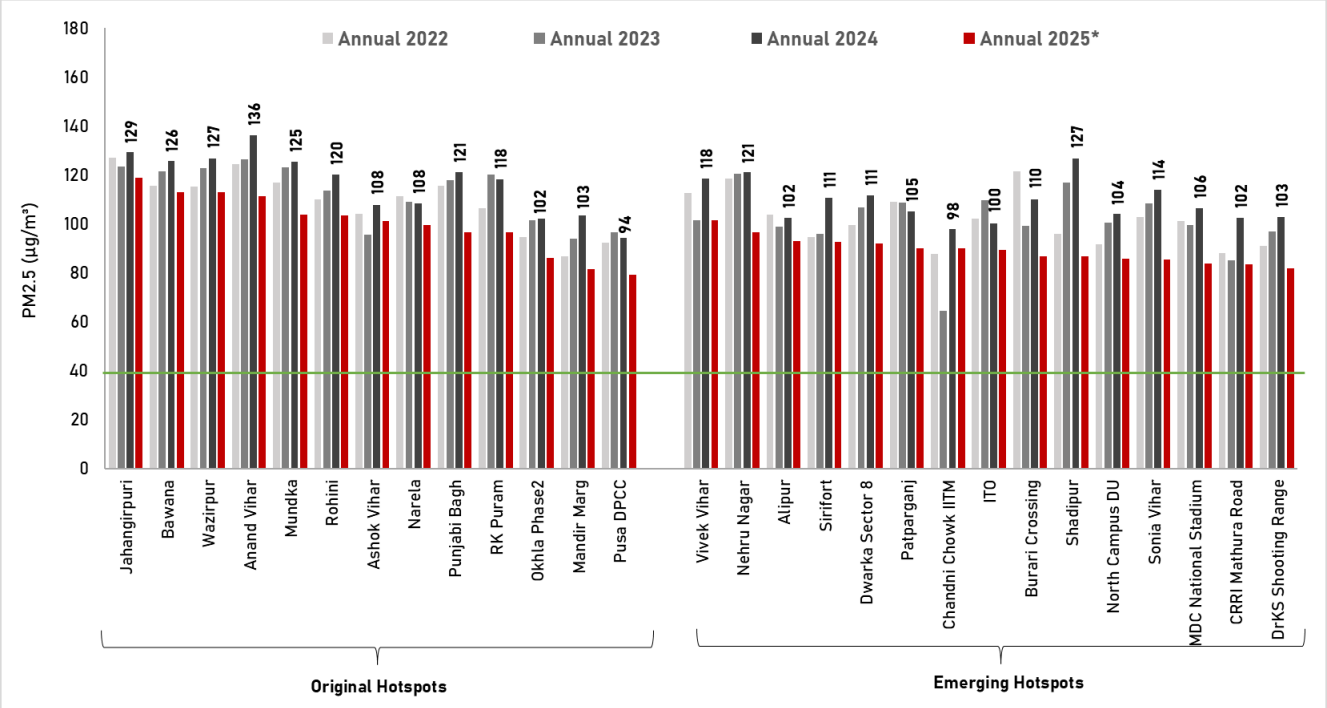
Note: Delhi citywide average is based on 37 stations, average includes all the Delhi stations except Lodhi Road IITM, Chandni Chowk IITM and East Arjun Nagar. October- mid-November average is based on mean of daily averages.
Source: CSE analysis of CPCB real-time data

Proliferation of more hotspots

In 2018, about 13 hotspots were officially identified based on their pollution levels that not only exceeded the standards but also the city average levels. These in any case have continued to remain extremely problematic, with North and East Delhi recording the highest concentrations. Jahangirpuri is the most polluted hotspot with an annual (Jan–Nov) PM2.5 average of 119 µg/m³, followed by Bawana and Wazirpur at 113 µg/m³, Anand Vihar at 111 µg/m³, and Mundka, Rohini, and Ashok Vihar ranging between 101–103 µg/m³. *(see Graph 4: Trend in annual PM2.5 level among official and emerging hotspots in Delhi).*

However, over the years, several more hotspots have emerged based on the same criteria. Vivek Vihar recorded 101 µg/m³, similar to Ashok Vihar. Other emerging locations are Nehru Nagar, Alipur, Sirifort, Dwarka Sector 8, and Patparganj, also crossed 90 µg/m³, with Vivek Vihar and Nehru Nagar remaining persistent hotspots for four consecutive years, and Dwarka Sector 8 and Sirifort featuring among the city's most polluted locations for the second year in a row.

Graph 4: Trend in annual PM2.5 level among official and emerging hotspots in Delhi



Note: Station wise annual average is based on mean of daily averages. Annual is from January – December.
***Data for year 2025 is till 28 Nov 2025.**
Source: CSE analysis of CPCB real-time data

Even smaller towns in NCR have experienced more intense smog

Several NCR cities remained just as polluted as Delhi, and often worse, with towns like Bahadurgarh recording significantly higher smog intensities during this period. A region-wide smog episode affected NCR towns, but it was Bahadurgarh that endured the most persistent conditions, with the episode lasting a full 10 days, from 9 to 18 November. *(See Graph 5: Air quality calendar of NCR cities and towns).* The town's average smog intensity reached 343 µg/m³, nearly 1.2 times higher than Delhi's *(see Table 1: NCR cities showing smog day from Oct–Nov).* This clearly demonstrates that the entire region now behaves as

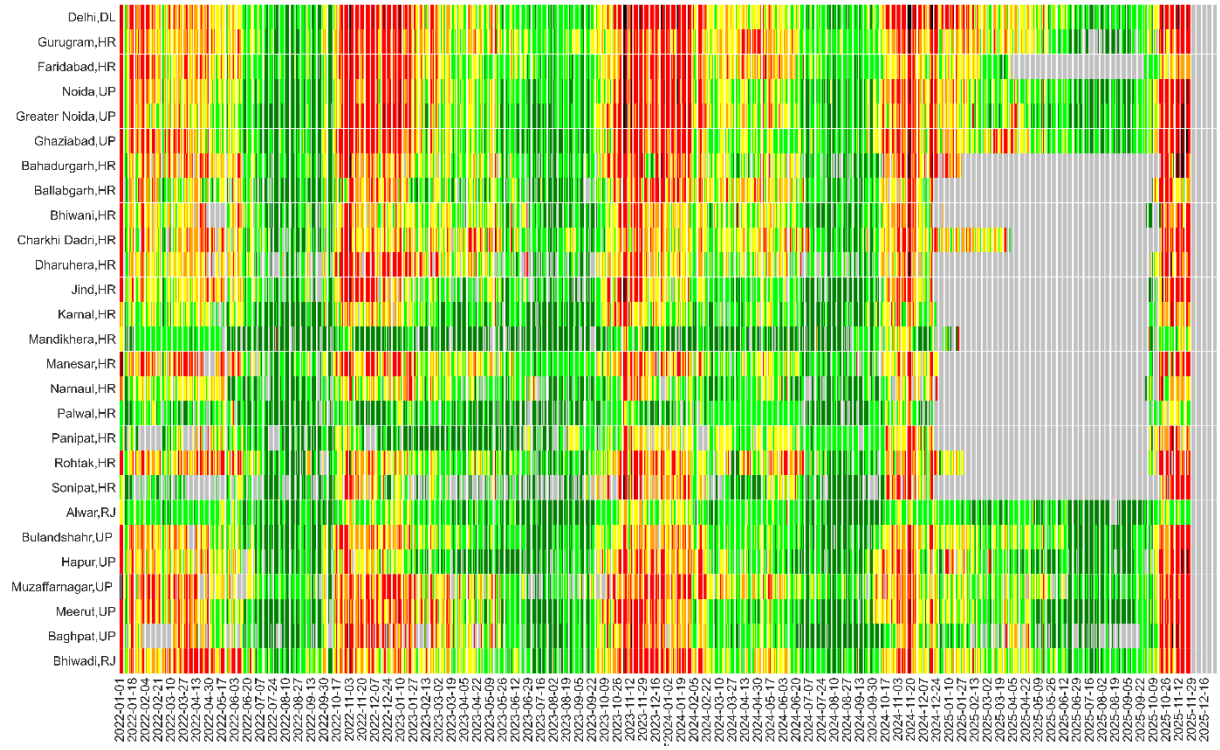
a single air-shed, where smaller towns are no longer cleaner gaps but hotspots facing equal or even greater pollution pressure.

Table 1: NCR cities showing smog period from Oct- Nov

Stations	Dates	Smog Intensity (µg/m³)
Bahadurgarh, HR	9-18 Nov	343.0
Ghaziabad, UP	15 -23 Nov	297.4
Delhi, DL	10-13 Nov	290.5
Hapur, UP	15-17 Nov	270.6
Greater Noida, UP	15-20 Nov	270.0
Noida, UP	18-24 Nov	266.3

Note: stations exceeding 250 µg/m³ for three consecutive days considered as smog period.

Graph 5: Air quality calendar of NCR cities and towns

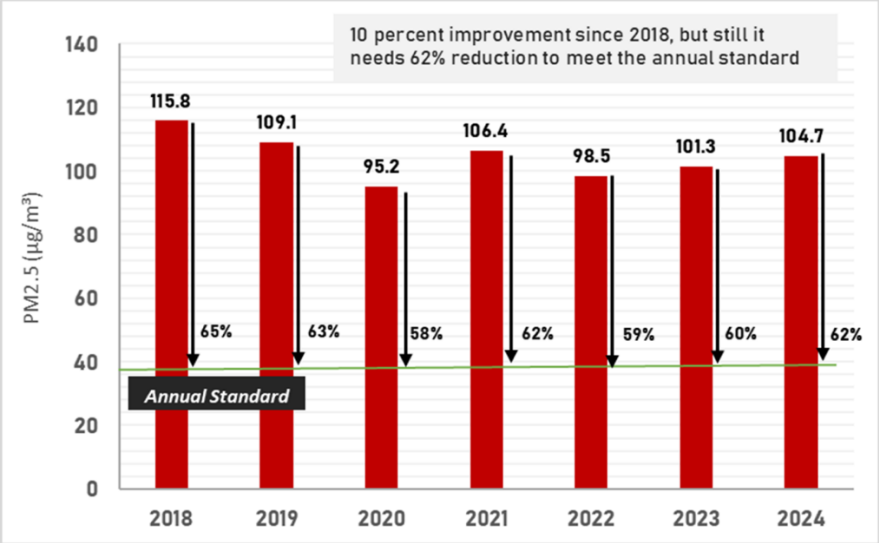


Note: Average PM2.5 concentration is based on mean of daily values recorded at all CAAQM stations in the city that have adequate data for the winter. Cell color is based on the official color-scheme of AQI sub-categories.
Source: CSE analysis of CPCB's real time air quality data

Is Delhi on the verge of losing its air quality gains

Since 2022, the annual trend in PM2.5 levels have plateaued and even took an upward turn showing plateauing of pollution at an elevated level. Between 2018 and 2020 (which was also the Pandemic year), there was a streadily decline in year-on-year PM2.5 levels in Delhi. But since 2021-22, the levels have remained largely elevated and stable with a slight variation. In fact, the annual average level took a sharp upward curve, touching 104.7 µg/m³ in 2024. Delhi continues to breathe extremely polluted air throughout the year, with no sustained downward trend. *(see Graph 6: Long term trend in annual average PM2.5).*

Graph 6: Long term trend in annual average PM2.5



Note: Delhi citywide average is based on 37 stations, average includes all the Delhi stations except Lodhi Road IITM, Chandni Chowk IITM and East Arjun Nagar.
Source: CSE analysis of CPCB real-time data

Action agenda

Small incremental steps cannot help to meet the clean air benchmarks. Pollution level in the region has plateaued at dangerously high levels. This is the inflexion point. Either a leapfrog strategy across the key sectors of pollution can bend the curve again or the pollution trend can take dangerous upward curve once again.

- **Meet ambitious electrification targets for all segments of vehicles in a time bound manner for zero tailpipe emissions; scrap and replace older vehicles·**
- **Upscale integrated public transport with last mile connectivity and walking and cycling infrastructure to increase ridership and active commuting**
- **Restrain the usage of personal vehicles with parking caps and pricing and congestion tax**
- **Industry to switch over to affordable cleaner fuels and stringent emissions control; lower the taxes on natural gas; electrify industrial processes**
- **Close the waste loop to stop burning: segregate waste, remediate legacy waste and promote recycling.**
- **Power plants to meet emissions standards**
- **Recycle construction waste, enforce dust-control Smart monitoring for enforcement throughout the year**
- **Ensure access to clean fuels for all households for cooking and heating**
- **Decompose or plough straw back into the soil to increase soil carbon. Bio-methanation of straw for ethanol and natural gas to increase income of farmers.**