Winter pollution crisis in megacities of India: Going beyond Delhi

Chennai

Anumita Roychowdhury and Sharanjeet Kaur

Lead research and analysis: Sharanjeet Kaur

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The winter air quality in Chennai has remained largely stable compared to previous years, according to a new analysis by the Urban Lab at the Centre for Science and Environment (CSE). The city's seasonal average PM2.5 concentration for winter (October 1, 2024 – January 31, 2025) was recorded at 36 µg/m³—just 1.2 per cent higher than the average of the past three winters. The highest daily PM2.5 level this season was observed on October 31, 2024, at 119 µg/m³, reflecting a 19 per cent decline compared to past winter peaks. However, individual monitoring stations saw significant variations, with Velachery recording the highest daily peak of 193 µg/m³.

Despite the relatively low seasonal average, winter pollution levels across Chennai's monitoring stations surged well above annual averages, with increases of 3–40 per cent. Arumbakkam, Royapuram, and Perungudi saw the sharpest seasonal rise of over 35 per cent compared to their annual levels. The impact of winter pollution was evident in the number of poor air quality days—Alandur experienced the highest with 14 days classified under 'poor' and 'very poor' AQI categories.

Chennai is also grappling with a multi-pollutant challenge, as nitrogen dioxide (NO2) levels spiked significantly in November and December. Manali recorded the highest NO2 build-up, increasing by 3.8 times from October to December. Chennai's winter pollution trends highlight the growing impact of seasonal variations on air quality. While overall PM2.5 levels have remained stable, localized pollution hotspots and increasing NO2 levels indicate the need for targeted mitigation strategies. The combination of stagnant winter conditions, reduced pollutant dispersion, and rising vehicular emissions continues to influence the city's air quality, necessitating sustained efforts for cleaner air.

This analysis covers 8 continuous ambient air quality monitoring stations (CAAQMS) across Chennai. A substantial dataset was processed using the USEPA methodology to ensure accuracy, addressing data gaps to provide a comprehensive understanding of air quality trends.

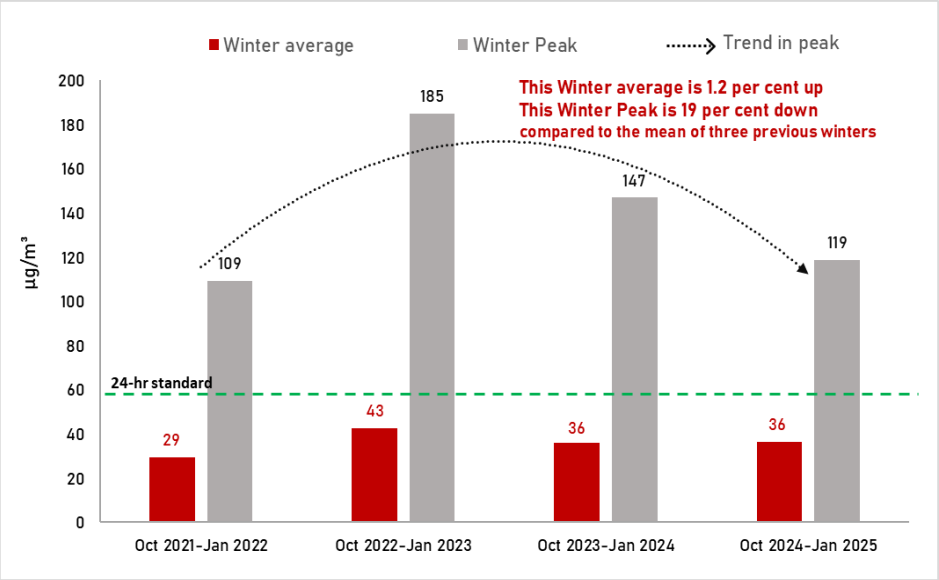
Key Findings

Chennai's winter PM2.5 level remain stable compared to previous year winter level: Chennai's air quality remained relatively stable this winter, with the city's average PM2.5 concentration recorded at 36 µg/m³—just 1.2 per cent higher than the average of the past three winter seasons (October to January) *(See Graph 1: Trend in winter average and winter peak in cities of Chennai*).

The highest daily PM2.5 level this winter was observed on October 31, 2024, at 119 µg/m³, reflecting a 19 per cent decline compared to the average of the past three winter peaks. However, among individual monitoring stations, Velachery recorded the highest daily peak on January 7, 2025, with a PM2.5 level of 193 µg/m³.

The analysis is based on data from eight monitoring stations across Chennai, assessing winter trends and peak pollution levels. The winter period is defined as October 1 to January 31, with average and peak values derived from daily mean concentrations recorded continuously since 2021.

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

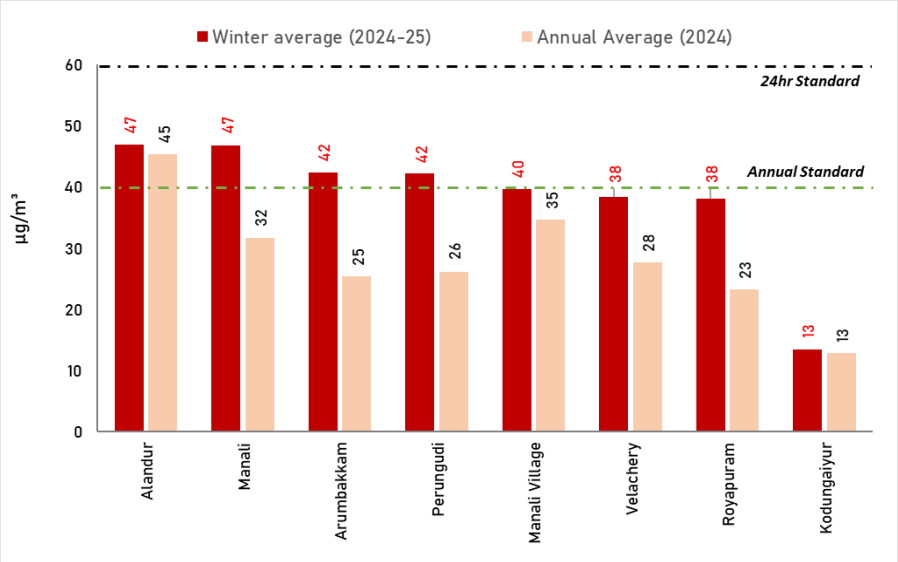


Source: CSE analysis of CPCB real-time data.

Rising winter PM2.5 levels disrupt annual air quality trends: Chennai's air quality deteriorates significantly during winter, with PM concentrations in the 2024-25 winter season rising well above the annual average of 2024 across monitoring stations. The highest winter average was recorded at Alandur, reaching 47 µg/m³, compared to its annual average of 45 µg/m³. The highest increase of above 35 per cent in winter averages was seen among Arumbakkam, Royapuram and Perungudi with winter levels at 42 µg/m³, 38 µg/m³ and 42 µg/m³, compared to their annual averages of 25 µg/m³, 23 µg/m³ and 26 µg/m³, respectively.

Across monitoring stations, winter pollution levels surged by 3 – 40 per cent above the annual average, indicating a significant seasonal impact. *(See Graph 2: Station wise winter and annual PM2.5 levels in cities of Chennai).* The sharp winter spike is likely attributed to a combination of increased emissions, stagnant atmospheric conditions, and reduced pollutant dispersion.

Graph 2: Station wise winter and annual PM2.5 levels in cities of Chennai

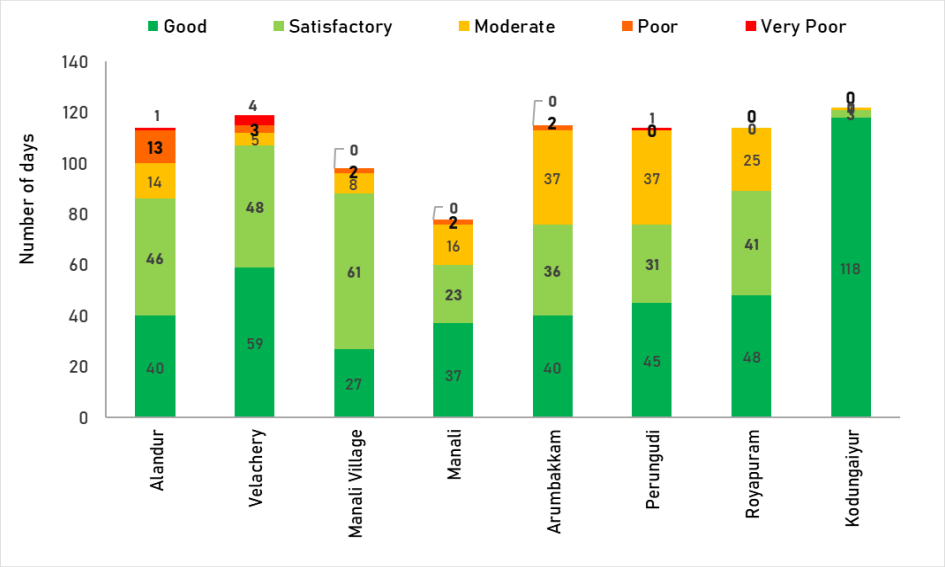


Source: CSE analysis of CPCB real-time data

Despite low winter average PM2.5 levels, cities in Chennai experienced a significant number of days with 'poor' AQI: Despite relatively stable winter average PM2.5 levels, Chennai experienced a significant number of days with poor air quality. Alandur recorded the highest number of such days, with 14 days classified under the 'poor' and 'very poor' AQI categories.

Velachery followed with 7 days of poor and very poor air quality, while Manali Village, Manali, and Arumbakkam each experienced 2 days of poor air quality *(See Graph 3: PM2.5 based AQI categorization of days for cities in Chennai).*

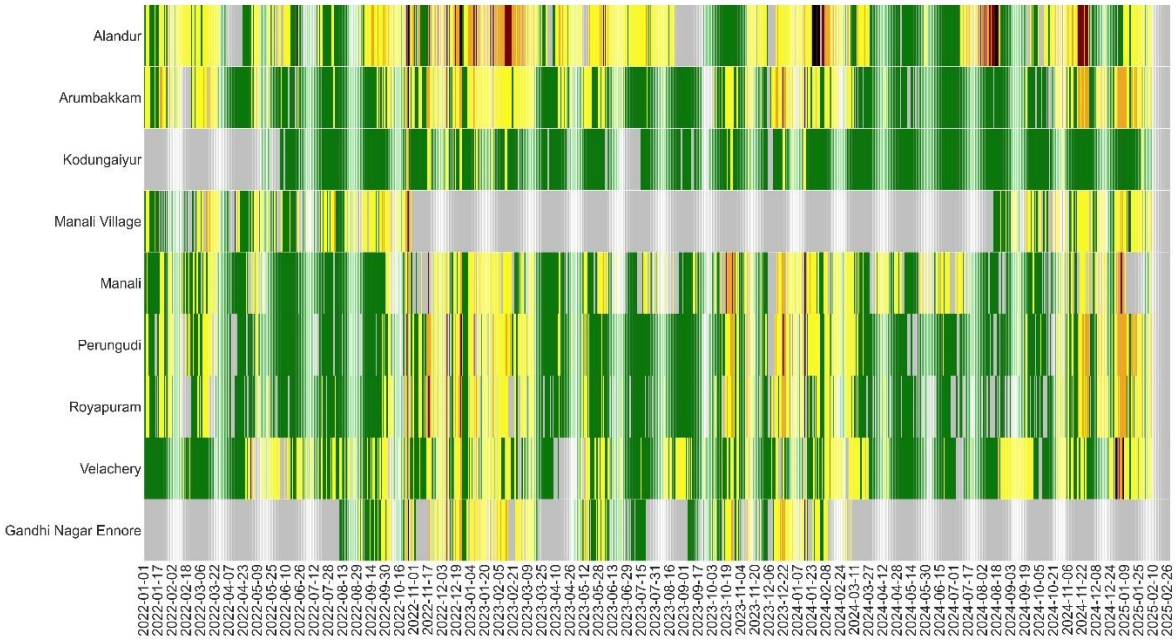
Graph 3: PM2.5 based AQI categorization of days for cities in Chennai



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 Chennai during mid of November and persists till the end of January, as weather starts to cool down and winds slow down. Cities in the Chennai show more pronounced impact of winter pollution. *(See Graph 4: Heat map based on days classified as per PM2.5 air quality index for cities of Chennai).*

Graph 4: Heat map based on days classified as per PM2.5 air quality index for cities of Chennai

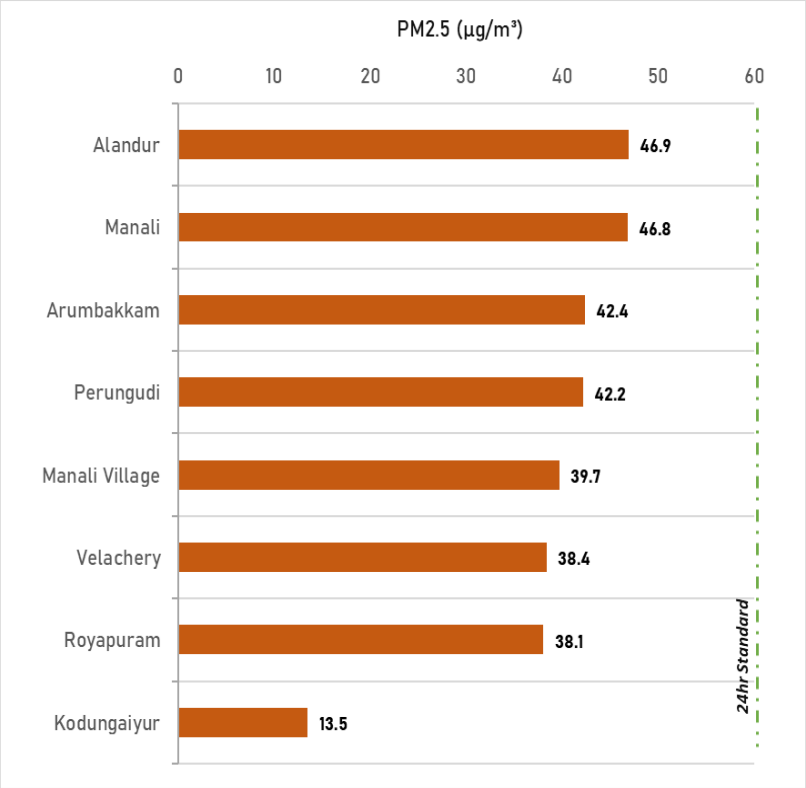


Note: Cell colors are based on the official AQI category colors. Data up till 31 January 2025.
Source: CSE analysis of real-time data from the CPCB portal.

The Pollution hotspots and cleaner cities: Alandur and Manali emerged as the most polluted areas in Chennai this winter, with an average PM2.5 concentration of 47 µg/m³. They were followed by Arumbakkam and Perungudi, both recording a seasonal average of 42 µg/m³ *(See Graph 5: Winter average PM2.5 level in cities of Chennai).*

In contrast, Kodungaiyur registered the lowest pollution levels, with a seasonal average of just 14 µg/m³, making it the cleanest area in the city. Royapuram followed, recording a winter average PM2.5 level of 38 µg/m³.

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



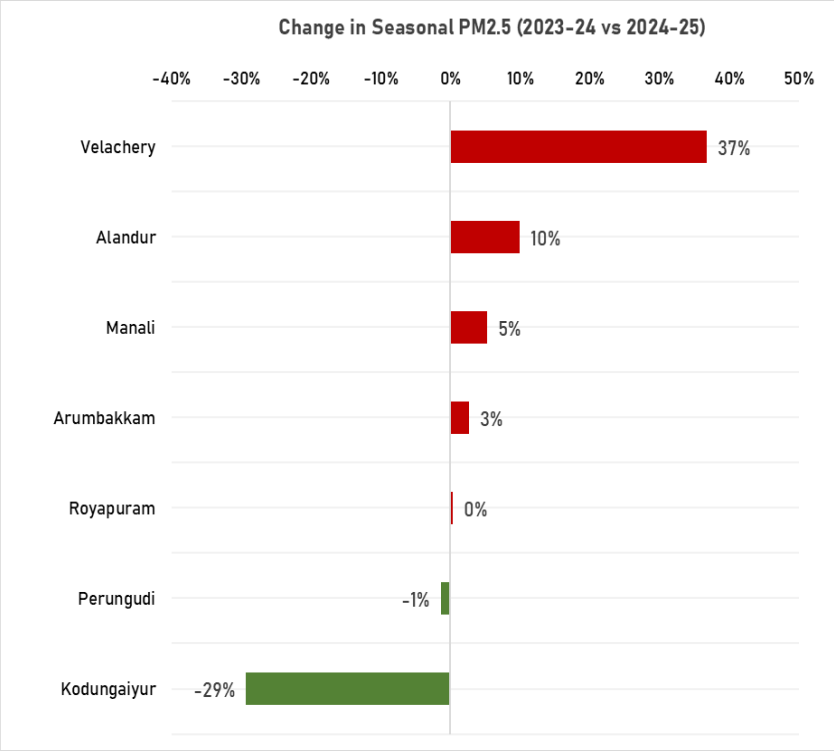
Note: 1 October 2024 – 31 January 2025 average is based on mean of daily averages.
Source: CSE analysis of CPCB real-time data

Velachery sees the sharpest rise in winter pollution, while kodungaiyur shows the most improvement: Velachery recorded the highest increase in winter pollution among Chennai's monitoring stations, with PM2.5 levels rising by 37 per cent compared to the previous winter. Alandur and Manali followed, with increases of 10 per cent and 5 per cent, respectively *(See Graph 6: Change in Winter average PM2.5 level in cities of Chennai (2023-24 vs 2024-25)*

However, city with the most improvement was shown by Kodungaiyur with 29 per cent compared to the corresponding period during previous year. Perungudi also saw a marginal decline of 1%, indicating slight progress in air quality. *(See Graph 6: Change in Winter average PM2.5 level in cities of Chennai (2023-24 vs 2024-25).*

In terms of absolute concentrations, Alandur emerged as the most polluted location, with a winter PM2.5 average of 46.9 µg/m³, followed by Manali (*See Annex 1: PM2.5 level at station levels 1 Oct 2024-31 Jan 2025).*

Graph 6: Change in Winter average PM2.5 level in cities of Chennai *(2023-24 vs 2024-25)*

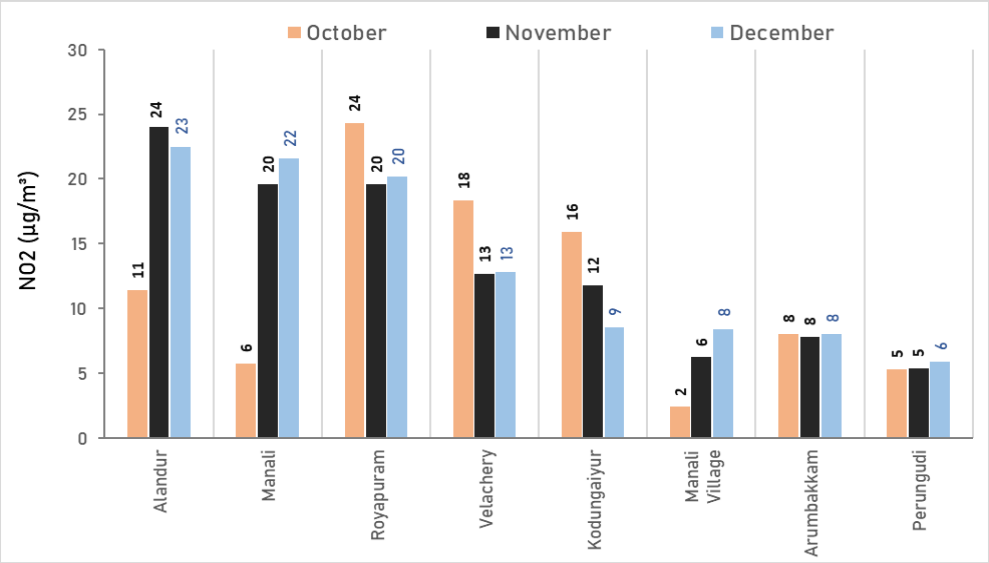


Note: 1 October-31 January 2023-24 and 2024-25 average is based on mean of daily averages. Cities with data in both 2023 and 2024 are compared.
Source: CSE analysis of CPCB real-time data

Multi-pollutant challenge - increasing levels of Nitrogen dioxide (NO2) during November and December: There is significant increase in amount of NO2 concentration during November to December compared to October, 2024. However, some stations even record higher NO2 levels in October. NO2 comes entirely from combustion sources and significantly from vehicles. Manali in Chennai have registered greatest increase of 3.8 times maximum build-up of NO2 between October and December. Alandur registered 2 times increase in NO2.

In absolute concentration, Alandur registered the highest NO2 average of 24 µg/m³ in November and 23 µg/m³ in December *(See Graph 7: Trend in NO2 levels in the cities of Chennai).* The lowest NO2 level was recorded by Perungudi with 6 µg/m³.

Graph 7: Trend in NO2 levels in the cities of Chennai



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
Chennai_Alandur	Chennai	42.7	46.9
Chennai_Manali	Chennai	44.5	46.8
Chennai_Arumbakkam	Chennai	41.3	42.4
Chennai_Perungudi	Chennai	42.7	42.2
Chennai_ManaliVillage	Chennai		39.7
Chennai_Velachery	Chennai	28.1	38.4
Chennai_Royapuram	Chennai	37.9	38.1
Chennai_Kodungaiyur	Chennai	19.1	13.5

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