Winter pollution crisis in megacities of India: Going beyond Delhi

Bangaluru

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Bengaluru recorded its lowest winter PM2.5 levels in four years, with an average concentration of 37 µg/m³ during the 2024-25 winter season—marking a 7 per cent decline compared to the previous three winter seasons, according to a new analysis by the Urban Lab at the Centre for Science and Environment (CSE). Despite this improvement, seasonal pollution spikes and localized hotspots remain a concern across the city.

The highest daily PM2.5 level this winter was recorded on November 1, 2024, at 67 µg/m³, reflecting a 40 per cent drop from previous winter peaks. However, certain locations experienced significantly higher pollution surges—RVCE recorded the highest daily peak at 141 µg/m³.

Winter pollution levels continue to exceed annual averages across most monitoring stations, with RVCE emerging as the most polluted location, registering a winter average PM2.5 level of 56 µg/m³. Five out of eleven stations saw an increase in PM2.5 levels compared to the previous winter, with RVCE witnessing the sharpest rise of 45 per cent.

Despite these challenges, Bengaluru's air quality saw notable improvements in some areas—Silk Board reported the largest decline in winter PM2.5 levels, dropping by 34 per cent compared to the previous year. However, poor air quality days persisted, with RVCE experiencing six days of 'poor' or 'very poor' AQI.

Additionally, Bengaluru is facing a growing multi-pollutant challenge with Hebbal saw the sharpest increase in NO2 levels, reaching 50 µg/m³—1.6 times higher in January than November levels. Other areas, including Kasturi Nagar and RVCE, also recorded elevated NO_2 levels, underscoring the need for comprehensive air quality management strategies.

Winter pollution in Bengaluru intensifies from mid-November and persists until January due to cooler temperatures, low wind speeds, and increased emissions, particularly in the metropolitan areas. The findings highlight the need for targeted pollution control measures, improved monitoring, and enhanced mitigation strategies to sustain air quality improvements and address persistent pollution hotspots.Bottom of Form

This analysis covers 8 older continuous ambient air quality monitoring stations (CAAQMS) across city. Although several new real-time monitors have been installed in some cities, they were not included in the long-term assessment due to data consistency requirements. A substantial dataset was processed using the USEPA methodology to ensure accuracy, addressing data gaps to provide a comprehensive understanding of air quality trends.

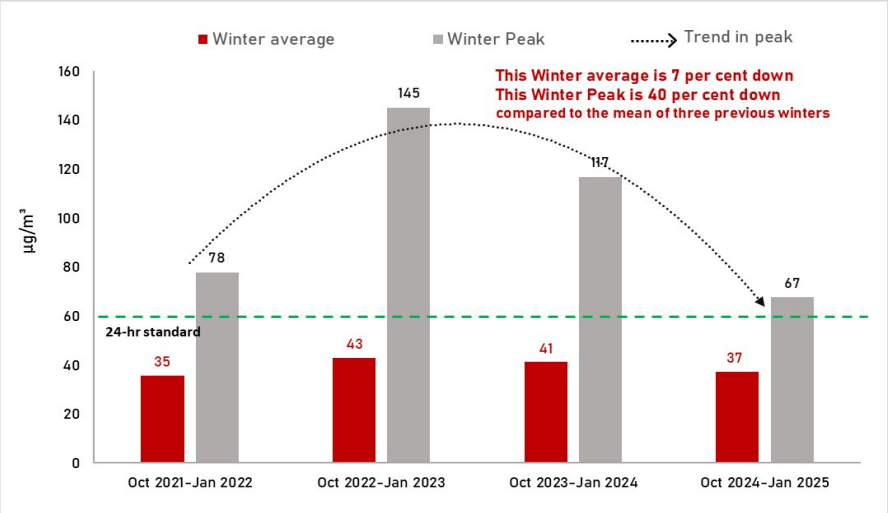
Key Findings

Bengaluru records lowest Winter PM2.5 levels in four years: Bengaluru's winter air quality has improved, with the average PM2.5 concentration dropping to 37 µg/m³ this winter (October 2024 – January 2025), marking the second-lowest level in the past four years. This reflects a 7 per cent decline compared to the average of the previous three winter seasons. *(See Graph 1: Trend in winter average and winter peak in cities of Bengaluru)*.

The highest daily PM2.5 level this winter was recorded on November 1, 2024, at 67 µg/m³, showing a 40 per cent decrease from the average of the past three winter peaks. Among the oldest monitoring stations, Hebbal recorded the highest daily peak of 108 µg/m³ on November 1, 2024— a day after Diwali—highlighting the impact of festival-related emissions. Meanwhile, among newly added monitoring stations, RVCE recorded the highest daily peak of 141 µg/m³ on October 26, 2024.

The analysis is based on data from 8 monitoring stations across Bengaluru, with winter trends and peaks assessed for the period of October 1 to January 31. The average and peak values are calculated from the daily mean of available continuous data since 2021.

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

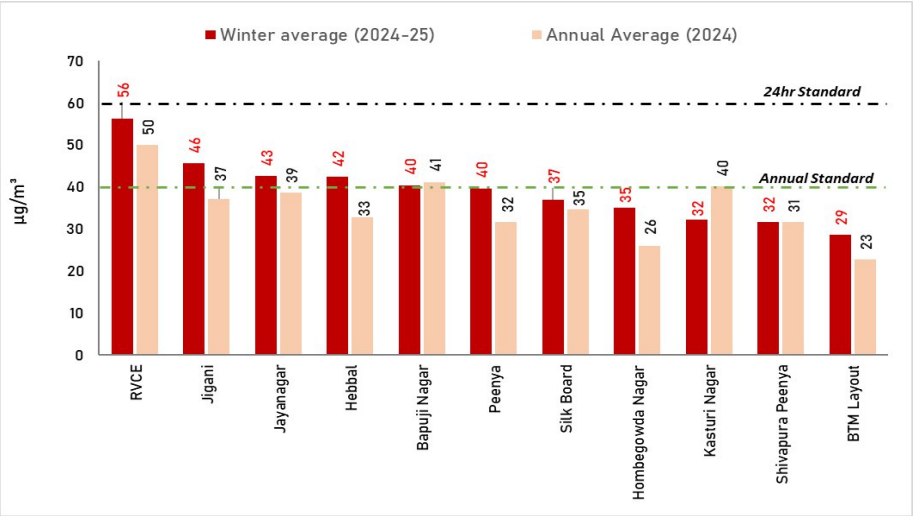


Source: CSE analysis of CPCB real-time data.

Rising winter PM2.5 levels disrupt annual air quality trends: Bengaluru's air quality worsens significantly during winter, with PM2.5 concentrations in the 2024-25 winter season rising above the annual average across most monitoring stations. The only exception is Kasturi Nagar, where the annual average remains higher than the winter average.

RVCE recorded the highest winter average at 56 µg/m³, exceeding its annual average of 50 µg/m³. This was followed by Jigani and Jayanagar, where winter levels reached 46 µg/m³ and 43 µg/m³, compared to their respective annual averages of 37 µg/m³ and 39 µg/m³ *(See Graph 2: Station wise winter and annual PM2.5 levels in cities of Bengaluru).* Across stations, winter pollution levels surged by 6-26 per cent above the annual average, indicating a significant seasonal impact.

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

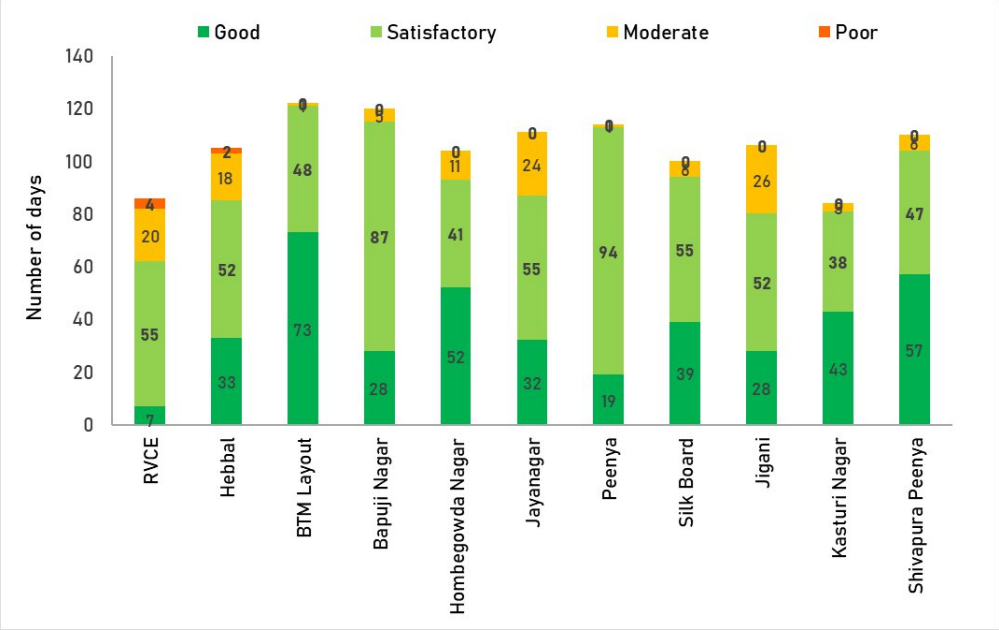


Source: CSE analysis of CPCB real-time data

Despite low winter average PM2.5 levels, few cities in Bengaluru even experienced a number of days with 'poor' AQI: While Bengaluru witnessed its lowest winter average PM2.5 levels in four years, a number of days still fell under the 'poor' and 'very poor' air quality index (AQI) categories. Among the monitoring locations, RVCE had the highest number of such days, with 4 days categorized as 'poor' and 2 days as 'very poor' AQI, highlighting persistent pollution hotspots in the city.

It was followed by Hebbal with 2 days of poor AQI. *(See Graph 3: PM2.5 based AQI categorization of days for cities in Bengaluru).*

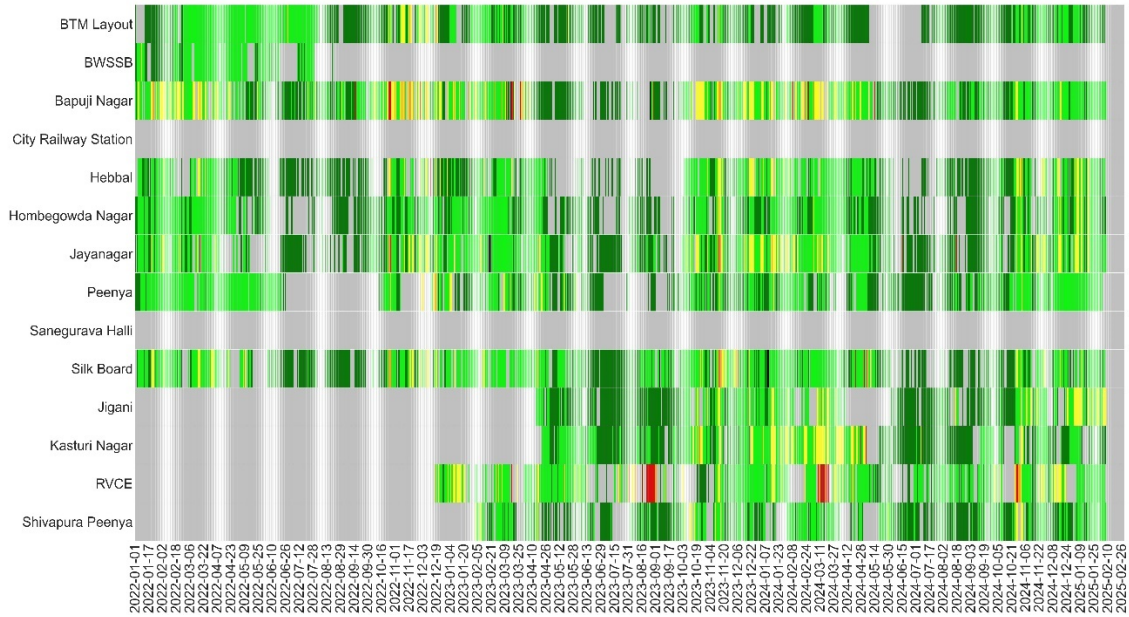
Graph 3: PM2.5 based AQI categorization of days for cities in Bengaluru



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 Bengaluru during mid of November and persists till the end of January. Cities in Bengaluruf metropolitan area show more pronounced impact of winter pollution. The combination of cooler temperatures, lower wind speeds, and increased emissions leads to the accumulation of pollutants, resulting in a higher number of poor air quality days. *(See Graph 4: Heat map based on days classified as per PM2.5 air quality index for cities of Bengaluru).*

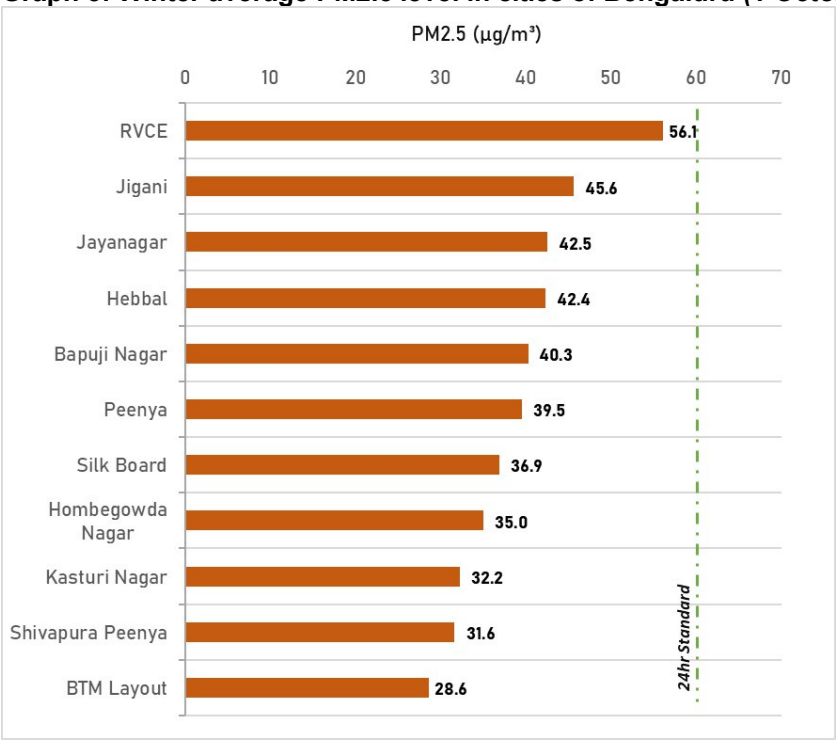
Graph 4: Heat map based on days classified as per PM2.5 air quality index for cities of Bengaluru



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: RVCE is the most polluted among the cities of Bengaluru with winter average PM2.5 level at 56 µg/m³. It is followed by Jigani with seasonal average at 46 µg/m³, and Jayanagar at 43 µg/m³ *(See Graph 5: Winter average PM2.5 level in cities of Bengaluru).* BTM layout station is the least polluted city with seasonal average of 29 µg/m³. However, all the stations remain well below the 24-hour national standard.

Graph 5: Winter average PM2.5 level in cities of Bengaluru *(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

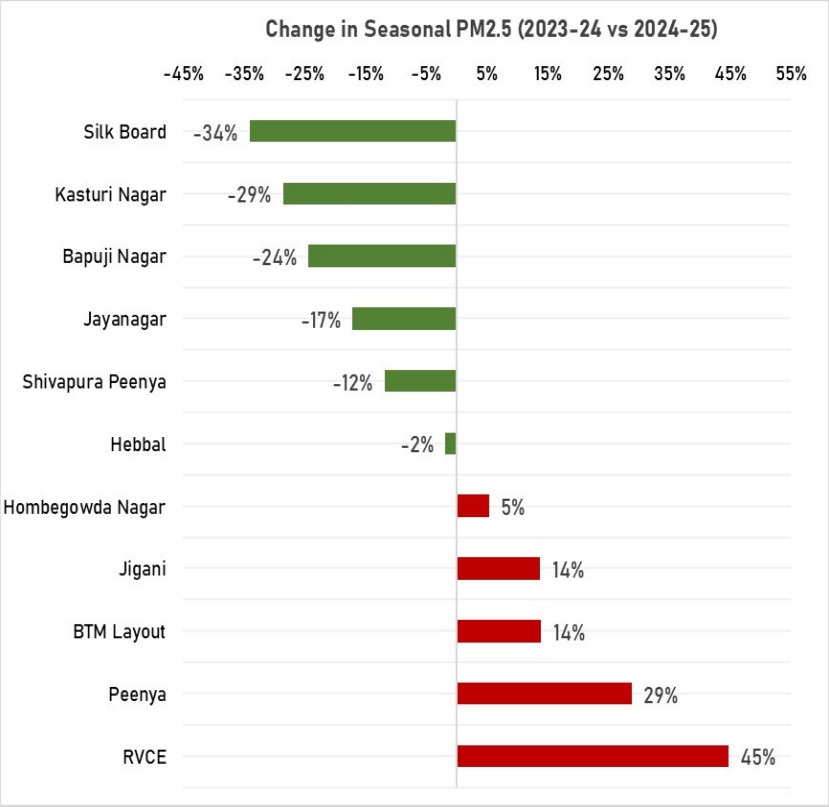
Despite winter average levels are below the 24hr standard, this winter levels are higher compared to the preceding winter PM2.5 levels: Despite an overall decline in winter average PM2.5 levels, five out of eleven station has recorded higher pollution levels this winter compared to the previous season. RVCE station in Bengaluru was the worst performer and registered an increase of 45 per cent compared to the preceding winter. It

was followed by Peenya with an increase of 29 per cent, BTM layout and Jigani each with an increase of 14 per cent.

Notably, Silk Board showed the most significant improvement, with a 34 per cent decline in PM2.5 levels compared to the preceding winter. It was followed by Kasturi Nagar and Bapuji Nagar with substantial reductions of 29 per cent and 24 per cent, respectively *(See Graph 6: Change in Winter average PM2.5 level in cities of Bengaluru (2023-24 vs 2024-25).*

There is a wide variation in pollution concentration among the monitoring locations in cities of Bengaluru. RVCE was the most polluted location with winter PM2.5 averaging at 56.1 µg/m³. Jigani was the second most polluted location. (*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 Bengaluru *(2023-24 vs 2024-25)*

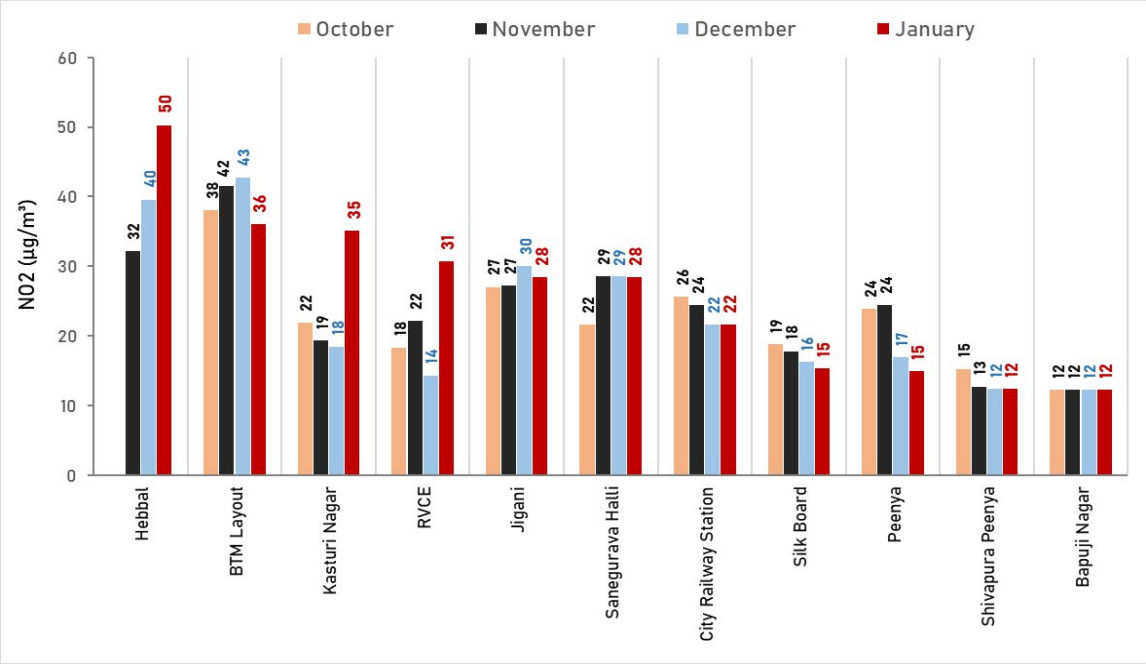


Note: 1 October-31 January 2023-24 and 2024-25 average is based on mean of daily averages. Cities with data in both 2023 and 2024 are compared.
Source: CSE analysis of CPCB real-time data

Multi-pollutant challenge - increasing levels of Nitrogen dioxide (NO2) during November, December and January: Nitrogen dioxide (NO_2) levels across various locations in Bengaluru exhibited noticeable monthly variations, with January recording the highest concentrations at several sites. Hebbal saw the most significant NO_2 rise, reaching 50 µg/m³ in January, registered greatest increase of 1.6 times maximum build-up of NO2 between November and January *(See Graph 7: Trend in NO2 levels in the cities of Bengaluru).* Other locations such as Kasturi Nagar (35 µg/m³) and RVCE (31 µg/m³) also recorded increased levels in January compared to the previous months.

In contrast, December generally reported the lowest NO_2 concentrations, with multiple stations, including Silk Board, Peenya, and Shivapura Peenya, showing a decline in comparison to October and November *(See Graph 7: Trend in NO2 levels in the cities of Bengaluru).*

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



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
Bengaluru_RVCE	Bengaluru	38.8	56.1
Bengaluru_Jigani	Bengaluru	40.1	45.6
Bengaluru_Jayanagar	Bengaluru	51.3	42.5
Bengaluru_Hebbal	Bengaluru	43.2	42.4
Bengaluru_BapujiNagar	Bengaluru	53.3	40.3
Bengaluru_Peenya	Bengaluru	30.7	39.5
Bengaluru_SilkBoard	Bengaluru	55.9	36.9
Bengaluru_HombegowdaNagar	Bengaluru	33.2	35.0
Bengaluru_KasturiNagar	Bengaluru	45.1	32.2
Bengaluru_ShivapuraPeenya	Bengaluru	35.9	31.6
Bengaluru_BTMLayout	Bengaluru	25.1	28.6

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