Winter pollution crisis in megacities of India: Going beyond Delhi

Kolkata

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The growing challenge of particulate pollution in Kolkata remains a concern despite improvements in winter air quality. According to a new analysis by the Urban Lab at the Centre for Science and Environment (CSE), Kolkata recorded its lowest winter average PM2.5 level in four years, with a seasonal average of 65 µg/m³—a 19 per cent decline compared to the previous three winters. This assessment, based on winter PM2.5 trends from October 1, 2024, to January 31, 2025, highlights both progress and ongoing pollution hotspots across the city.

While the overall seasonal average has improved, pollution spikes continue to be a challenge. The highest daily PM2.5 level this winter was recorded at 135 µg/m³ on November 2, marking a 6 per cent decrease from past winter peaks. However, localized pollution surges remain significant—Ballygunge recorded the highest daily spike at 195 µg/m³.

Despite seasonal improvements, winter pollution levels in Kolkata surged well above annual averages across monitoring locations. Ballygunge remained the most polluted area, with a winter average PM2.5 level of 80 µg/m³, followed by Fort William (71 µg/m³) and Bidhannagar (67 µg/m³). Even Rabindra Sarobar, the least polluted location, saw a 29 per cent increase in winter PM2.5 levels compared to its annual average.

Kolkata also faces a multi-pollutant challenge, with nitrogen dioxide (NO2) levels rising sharply between November and January. Victoria witnessed the steepest increase, with NO2 levels surging 6.4 times from October to January.

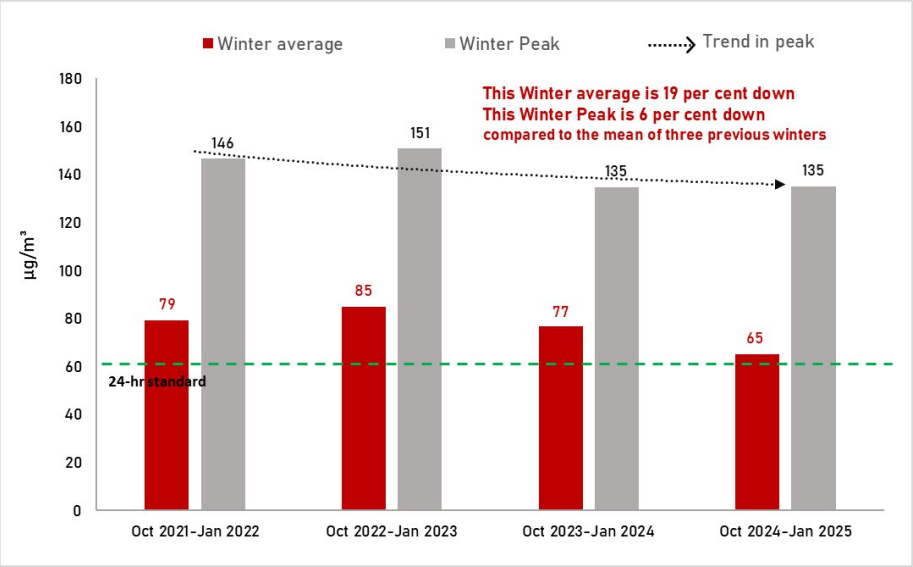
Winter pollution typically sets in by mid-November and persists until the end of January. This analysis, based on data from seven continuous ambient air quality monitoring stations (CAAQMS) across Kolkata, was processed using the USEPA methodology to ensure accuracy, addressing data gaps to provide a comprehensive understanding of air quality trends. These findings underscore the urgent need for a focused strategy to control pollution from key sources and mitigate the winter air quality crisis in Kolkata.

Key Findings

Kolkata records lowest Winter PM2.5 levels in four years, but localized peaks persist: Kolkata's winter air quality has shown improvement, with the average PM2.5 concentration this winter (October 2024 to January 2025) dropping to 65 µg/m³, the lowest in the past four years. This marks a 19 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 Kolkata)*.

Despite this overall improvement, pollution spikes continue to be a concern. The highest daily PM2.5 level this winter was recorded on November 2, 2024, at 135 µg/m³, reflecting a 6 per cent decrease from the average of the past three winter peaks. However, compared to the previous winter, the peak level remains stable. Among monitoring stations, Ballygunge recorded the highest daily peak of 195 µg/m³ on November 2, 2024. The total of 7 monitoring stations across Kolkata were used to assess the winter trends and peaks. The winter period is defined as October 1 to January 31, with the average and peak values calculated from the daily mean of available continuous data since 2021.

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

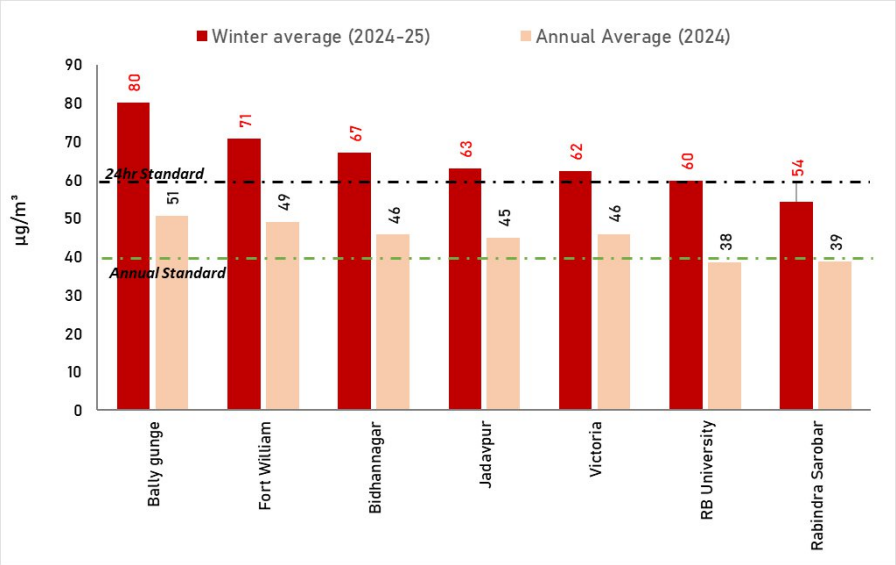


Source: CSE analysis of CPCB real-time data.

Rising winter PM2.5 levels disrupt annual air quality trends: Winter averages cannot be directly compared with either the annual or 24hr daily standards. But indicatively, Kolkata'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 Ballygunge, reaching 80 µg/m³, compared to its annual average of 51 µg/m³. Similarly, Fort William and Bidhannagar saw sharp increases, with winter levels at 71 µg/m³ and 67 µg/m³, compared to their annual averages of 49 µg/m³ and 46 µg/m³, respectively *(See Graph 2: Station wise winter and annual PM2.5 levels in cities of Kolkata).* Across stations, winter pollution levels surged by 29 – 37 per cent above the annual average, indicating a significant seasonal impact.

Even at Rabindra Sarobar, which had the lowest annual average of 39 µg/m³, winter levels still increased by 29 per cent to 54 µg/m³ *(See Graph 2: Station wise winter and annual PM2.5 levels in cities of Kolkata).* 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 Kolkata

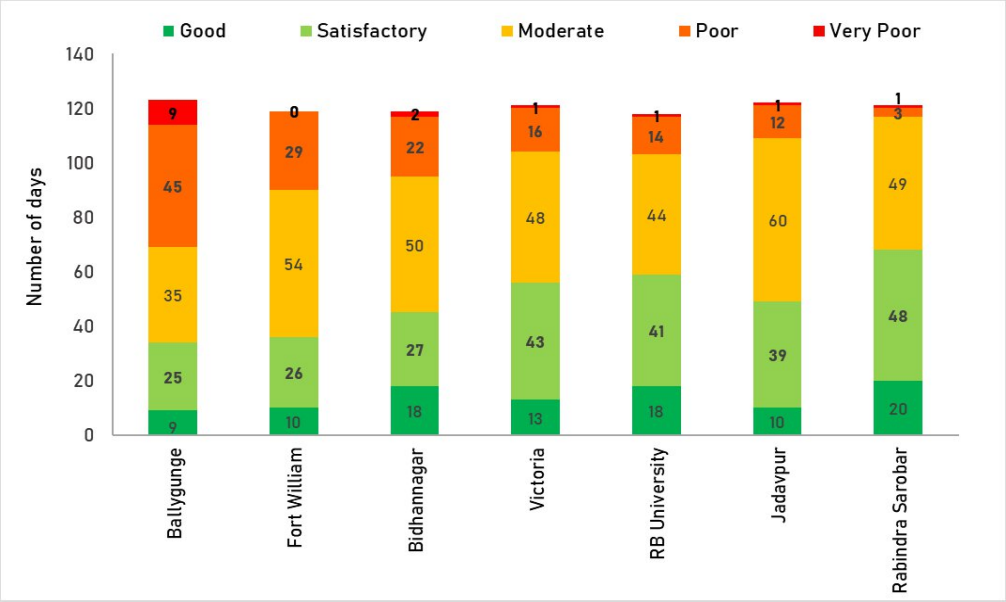


Source: CSE analysis of CPCB real-time data

Despite low winter average PM2.5 levels, cities in Kolkata experienced a significant number of days with 'poor' and 'very poor' AQI: While Kolkata witnessed its lowest winter average PM2.5 levels in four years, a concerning number of days still fell under the 'poor' and 'very poor' air quality index (AQI) categories, with Ballygunge recorded the highest number of such days, with 54 days of poor and very poor AQI, highlighting persistent pollution hotspots in the city.

Other locations also faced substantial air quality challenges. Fort William experienced 29 days of poor and very poor AQI, followed by Bidhannagar (24 days), Victoria (17 days), RB University (15 days), and Jadavpur (13 days) *(See Graph 3: PM2.5 based AQI categorization of days for cities in Kolkata).*

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

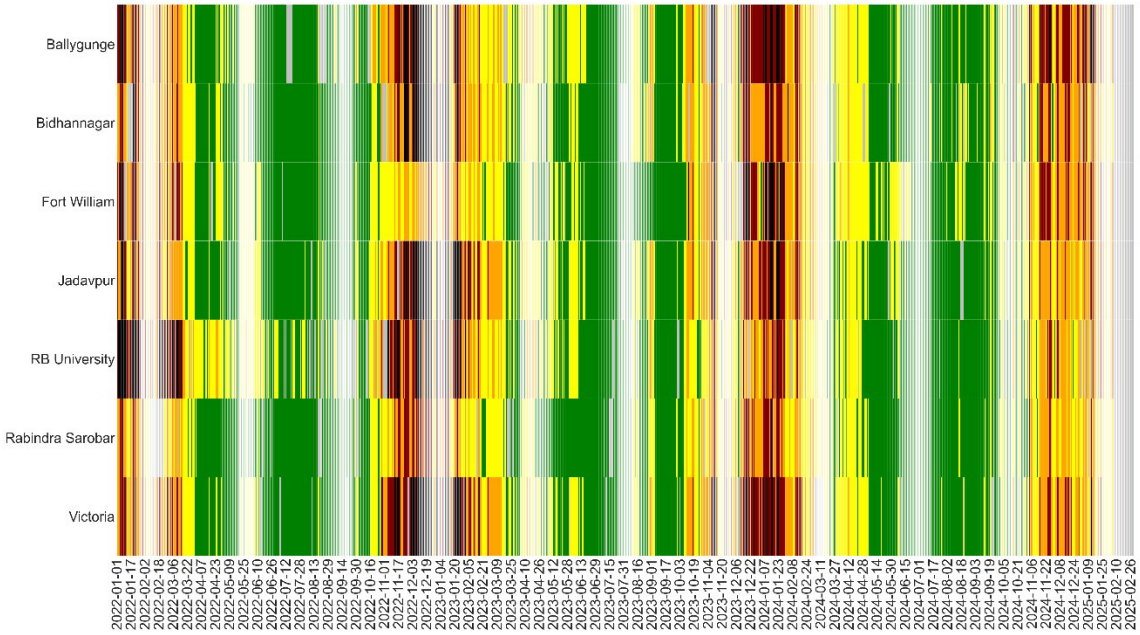


Note: PM2.5 values for cities that have continuous and adequate data for the complete assessment period. Data from 1 Oct 2024 – 31 Jan 2025.
Source: CSE analysis of real-time data from the CPCB website

Bad air days begin to build up around the same time in the cities of Kolkata during mid of November and persists till the end of January. Cities in Kolkata 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 and very poor air quality days. *(See Graph 4: Heat map based on days classified as per PM2.5 air quality index for cities of Kolkata).*

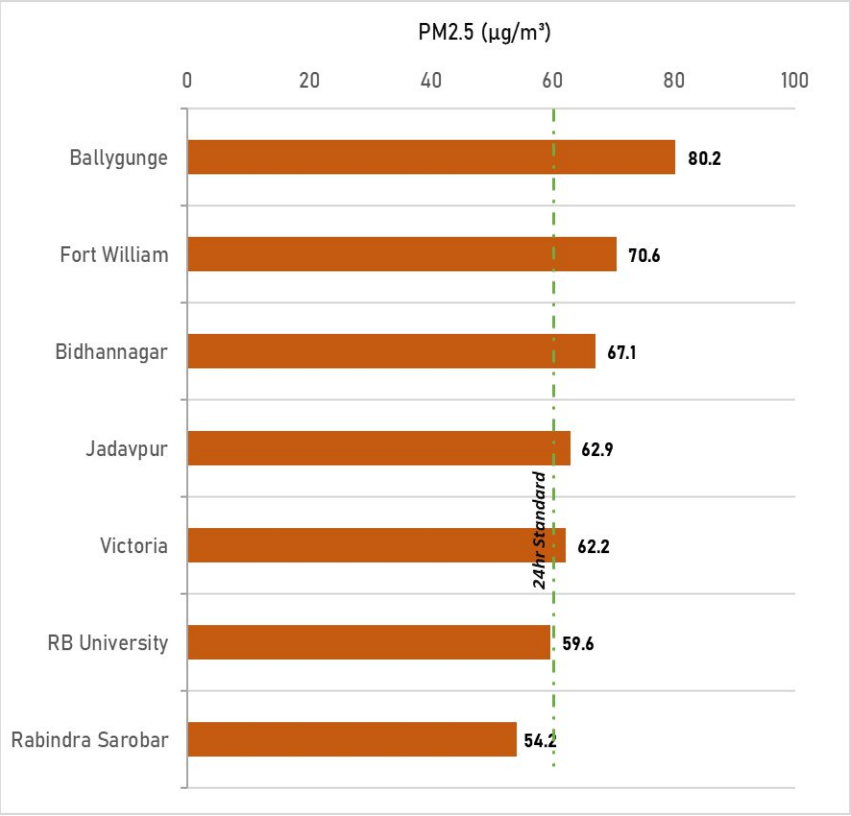
Graph 4: Heat map based on days classified as per PM2.5 air quality index for cities of Kolkata



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: Ballygunge is the most polluted among the cities of Kolkata with winter average PM2.5 level at 80 µg/m³. It is followed by Fort William with seasonal average at 71 µg/m³, and Bidhannagar at 67 µg/m³ *(See Graph 5: Winter average PM2.5 level in cities of Kolkata).* Rabindra Sarobar is the least polluted city with seasonal average of 54 µg/m³.

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

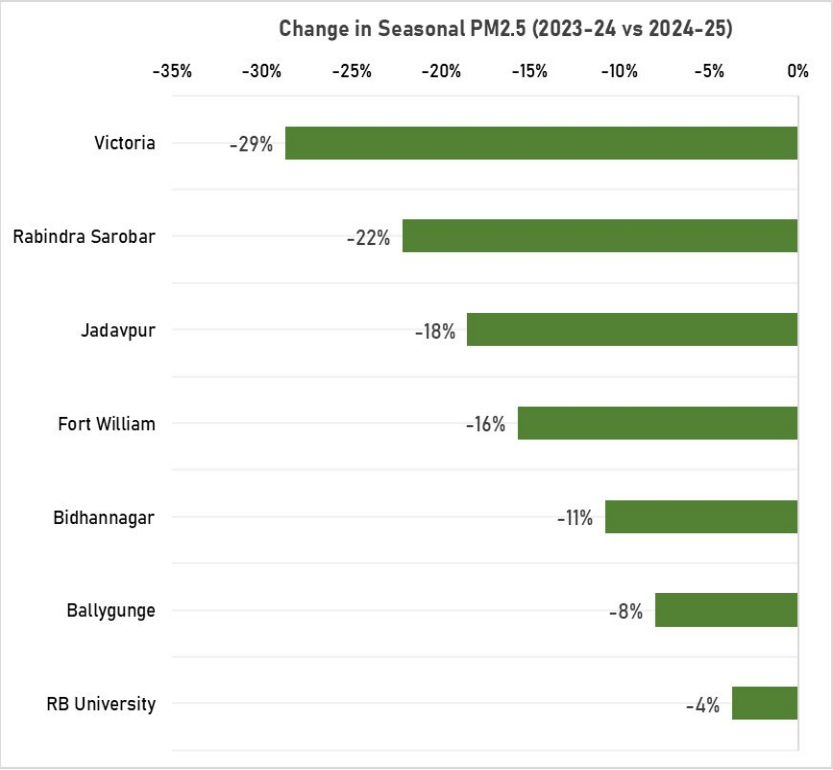


Note: 1 October 2024 – 31 January 2025 average is based on mean of daily averages.
Source: CSE analysis of CPCB real-time data

Interestingly, despite increase in the levels of winter average, this winter levels are lower compared to the preceding winter PM2.5 levels: Despite an overall increase in winter average PM2.5 levels, this winter has recorded lower pollution levels compared to the previous season. Notably, Victoria showed the most significant improvement, with a 29 per cent decline in PM2.5 levels compared to the preceding winter. It was followed by Rabindra Sarobar and Jadavpur with substantial reductions of 22 per cent and 18 per cent, respectively *(See Graph 6: Change in Winter average PM2.5 level in cities of Kolkata (2023-24 vs 2024-25).*

There is a wide variation in pollution concentration among the monitoring locations in cities of Kolkata. Ballygunge was the most polluted location with winter PM2.5 averaging at 80.2 µg/m³. Fort William 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 Kolkata *(2023-24 vs 2024-25)*

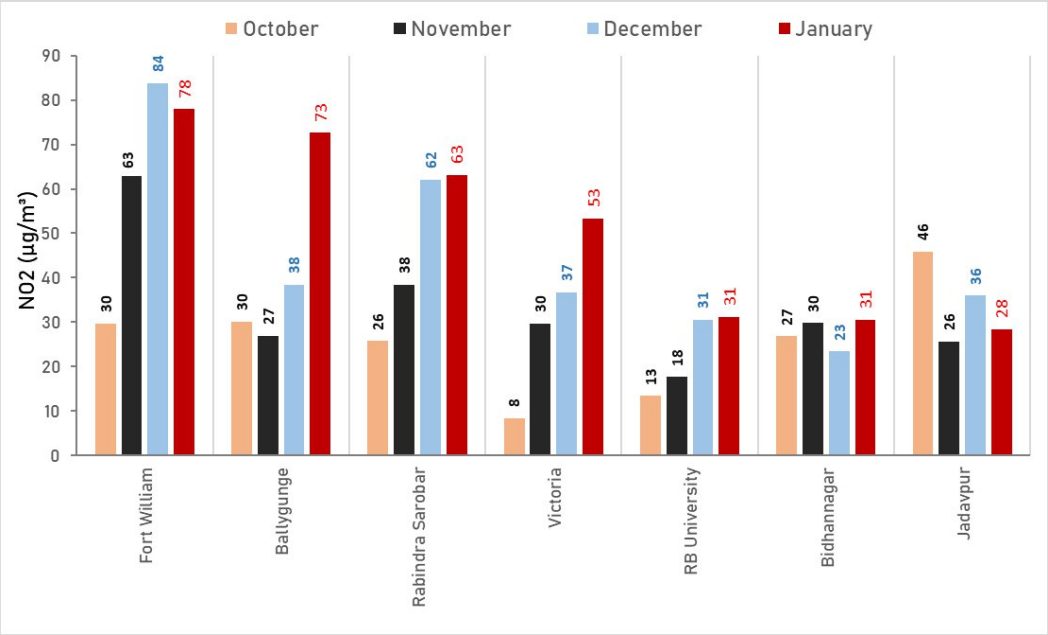


Note: 1 October-31 January 2023-24 and 2024-25 average is based on mean of daily averages. Cities with data in both 2023 and 2024 are compared.
Source: CSE analysis of CPCB real-time data

Multi-pollutant challenge - increasing levels of Nitrogen dioxide (NO2) during November, December and January: There is significant increase in amount of NO2 concentration during November to January compared to October, 2024. NO2 comes entirely from combustion sources and significantly from vehicles. Victoria in Kolkata have registered greatest increase of 6.4 times maximum build-up of NO2 between October and January. Fort-William registered 2.6 times increase in NO2.

In absolute concentration, Fort William registered the highest NO2 average of 84 µg/m³ in December and 78 µg/m³ in January *(See Graph 7: Trend in NO2 levels in the cities of Kolkata).* It is followed by Ballygunge with 73 µg/m³ and Rabindra Sarobar with 63 µg/m³. The lowest NO2 level was recorded by Jadavpur with 28 µg/m³.

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



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
Kolkata_Ballygunge	Kolkata	87.2	80.2
Kolkata_FortWilliam	Kolkata	83.8	70.6
Kolkata_Bidhannagar	Kolkata	75.2	67.1
Kolkata_Jadavpur	Kolkata	77.2	62.9
Kolkata_Victoria	Kolkata	87.3	62.2
Kolkata_RBUniversity	Kolkata	61.9	59.6
Kolkata_RabindraSarobar	Kolkata	69.6	54.2

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