Air quality in major Indian cities over the winter months

Key Highlights

- Among seven cities, Varanasi was the only city that met national standards for $PM_{2.5}$ in the winter of 2022-23 and 2023-24. The city made progress despite being part of the IGP region, which is the most polluted in India.
- Despite focused attention on the national capital, PM 2.5 levels in Delhi saw an increase in the winter months of 2023-2024 compared to the previous year.
- During the winter period (October-February), the months of January and February see lower pollution levels across the cities (except Chandigarh) than in October to December despite lower temperatures. This could result from other meteorological factors like windspeeds and fewer sources like crop burning in some states in north India.
- In the winter of 2023-24, there was much uproar over Mumbai's poor air quality days, but data shows that PM 2.5 levels in the city were lower this winter vis-a-vis 2022-2023.
- An in-depth analysis is required to understand the improved levels in some cities so that similar measures can be implemented in other cities too.

Background

Air pollution poses a significant global environmental and public health challenge, adversely impacting human health, ecosystems, and the economy. Air pollution is a pressing concern in densely populated urban areas like major cities in India, particularly during winter when pollution levels often reach hazardous levels.

Winter pollution is exacerbated by various factors, including temperature inversions, stagnant atmospheric conditions, increased emissions from heating sources, and accumulating pollutants over time. These conditions lead to elevated concentrations of $PM_{2.5}$ and other pollutants, posing serious health risks to residents, especially vulnerable populations such as children, the elderly, and individuals with pre-existing health conditions.

Objective of the Study

The objective of this study is to conduct a comparative analysis of winter pollution $PM_{2.5}$ levels in major cities in India, Including Mumbai, Varanasi, Patna, Delhi, Chandigarh, Lucknow, and Kolkata, for the years 2022-2023 and 2023-2024. By analysing temporal trends in $PM_{2.5}$ levels and comparing pollution levels across cities, this study aims to provide insights into the status of winter air quality and identify areas for targeted intervention to mitigate pollution and protect public health.

Methodology

We obtained air quality data for various cities from the Central Pollution Control Board (CPCB) website for October to February, covering the years 2022-23 and 2023-24. Data from all stations within each city were averaged to obtain representative values for each city. We then processed and visualized the data using MATLAB (programming and numeric computing platform).

RESULTS

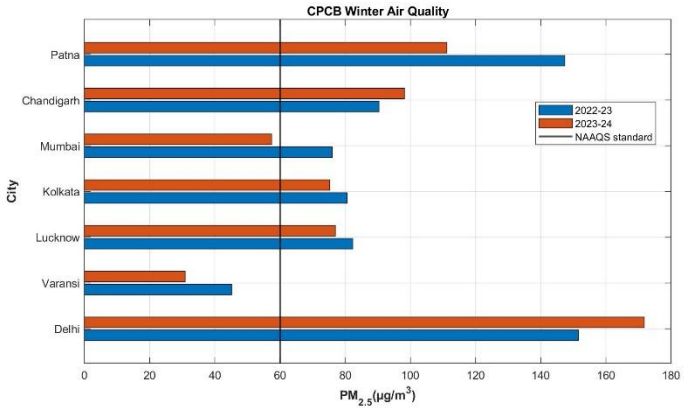

Figure1. Bar plot for all seven cities

In the comparative analysis of winter $PM_{2.5}$ pollution levels across major Indian cities, Varanasi emerged as the sole city meeting national standards for both 2022-23 and 2023-24, while Mumbai also demonstrated pollution levels below the national standard in 2023-24; however, Delhi consistently exhibited the highest pollution levels, followed by Chandigarh, with Patna showing comparatively higher concentrations attributed possibly to industrial emissions and vehicular traffic. Delhi experienced a notable increase in winter pollution levels compared to the preceding year. other cities experienced lower $PM_{2.5}$ levels during the recent winter.

DELHI

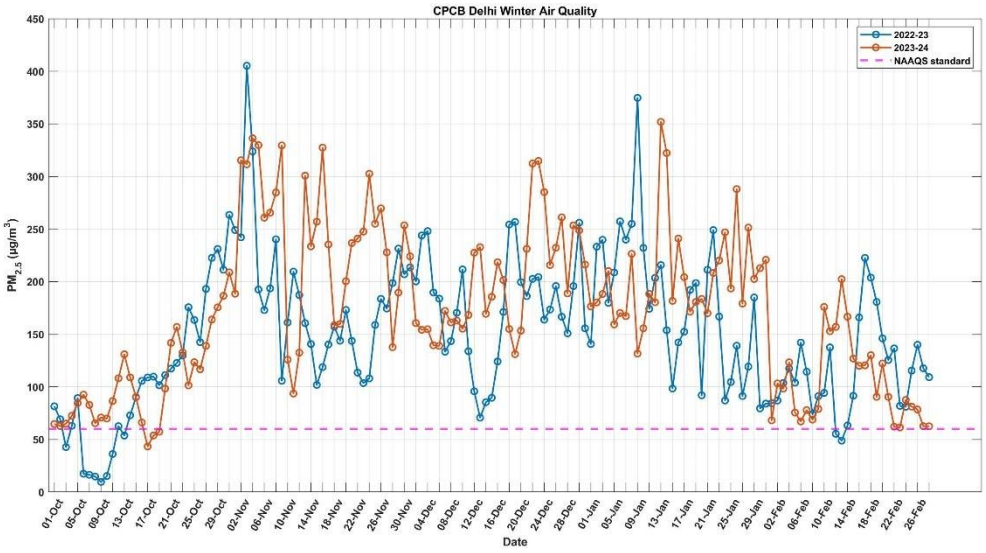

Figure2. Line plot for Delhi.

Figure2. Based on the daily average $PM_{2.5}$ concentration data for winter in Delhi spanning from October 1st, 2022, to February 28th, 2024, the following points are noted:

- The $PM_{2.5}$ concentration in Delhi exhibits significant fluctuations over time, with values ranging from relatively low (9.46) to very high (405.24) levels.

- The data suggests that certain months experience consistently higher or lower $PM_{2.5}$ levels than others, possibly influenced by monthly factors or external events.
- Despite fluctuations, there seems to be a general increasing trend in $PM_{2.5}$ concentration over the observed period, especially noticeable in the later months.

VARANASI

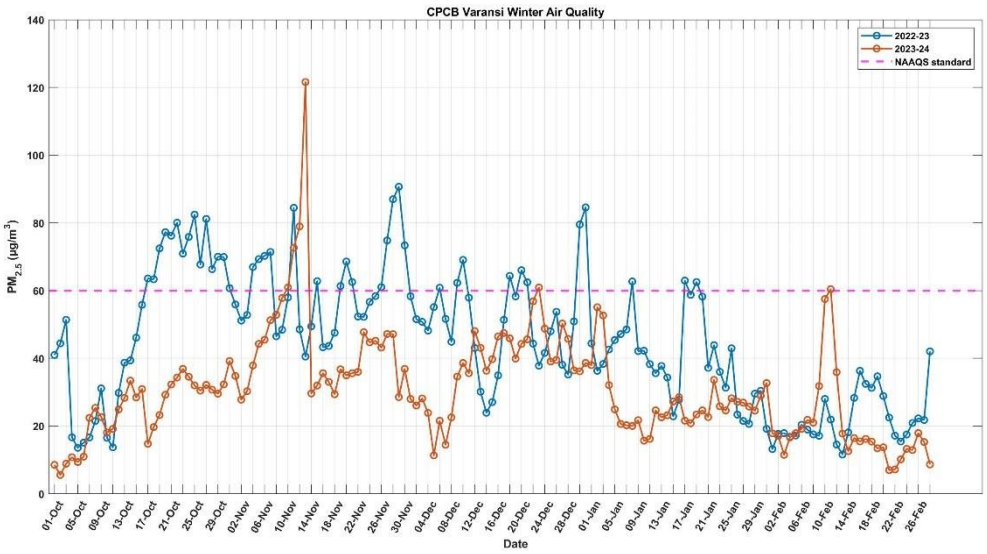

Figure3. Line plot for Varanasi.

Figure3. Based on the daily average $PM_{2.5}$ concentration data for Varanasi spanning from October 1st, 2022, to February 28th, 2024, the following points are noted:

- The $PM_{2.5}$ concentration in Varanasi exhibits significant fluctuations over time, with values ranging from relatively low (5.62) to very high (121.61) levels.
- The data suggests that the trend is not consistent.
- Despite fluctuations, there seems to be a general increasing trend in $PM_{2.5}$ concentration over the observed period

LUCKNOW

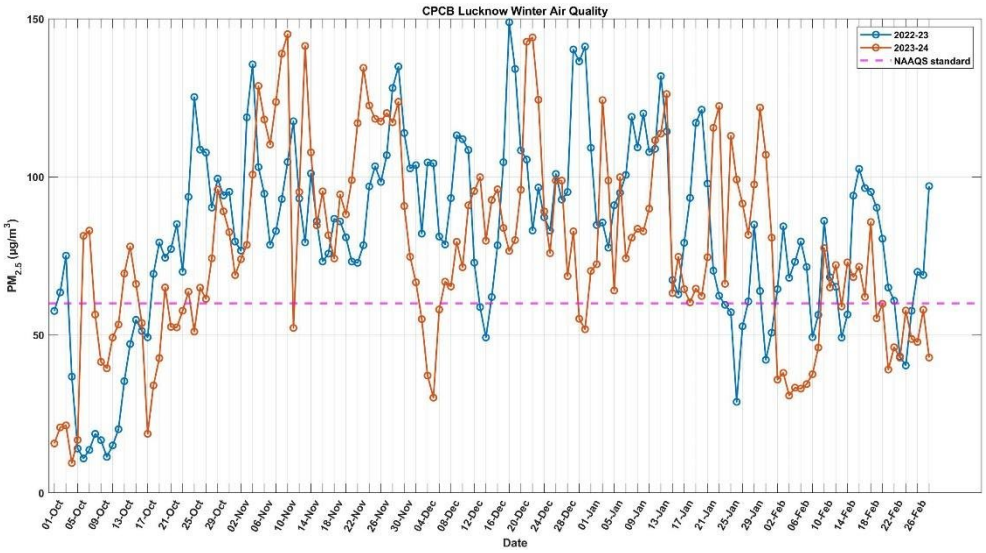

Figure4. Line plot for Lucknow.

Figure4. Based on the daily average $PM_{2.5}$ concentration data for Lucknow spanning from October 1st, 2022, to February 28th, 2024, the following points are noted:

- The $PM_{2.5}$ concentration in Lucknow exhibits significant fluctuations over time, with values ranging from relatively low (9.43) to very high (148.8) levels.
- The data suggests that the trend is not consistent.
- Most of the day's pollution level exceeded the national standard.

KOLKATA

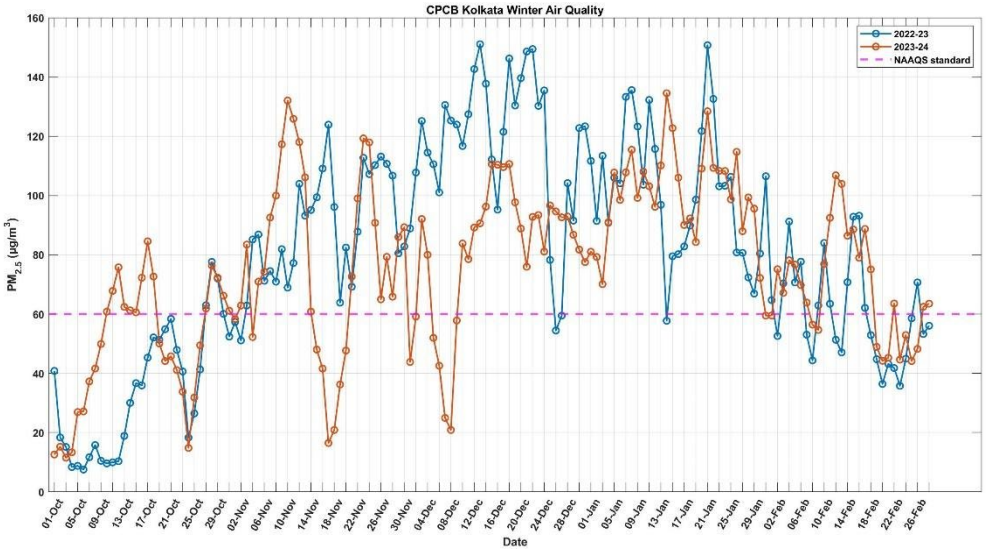

Figure5. Line plot for Kolkata.

Figure5. Based on the daily average $PM_{2.5}$ concentration data for Kolkata spanning from October 1st, 2022, to February 28th, 2024, the following points are noted:

- The $PM_{2.5}$ concentration in Kolkata exhibits significant fluctuations over time, with values ranging from relatively low (7.53) to very high (151.08) levels.
- The data suggests that the trend is not consistent.

MUMBAI

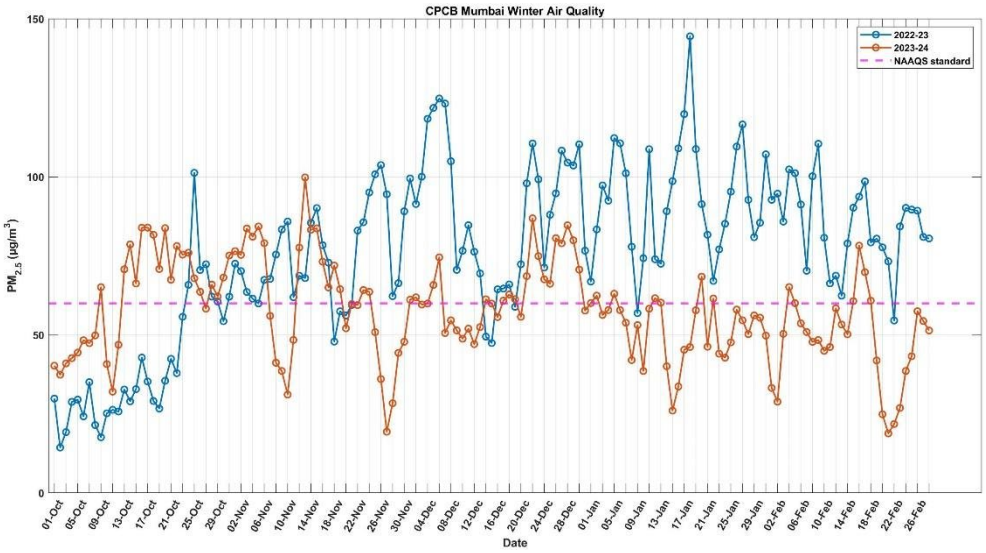

Figure6. Line plot for Mumbai.

Figure6. Based on the daily average $PM_{2.5}$ concentration data for Mumbai spanning from October 1st, 2022, to February 28th, 2024, the following points are noted:

- The $PM_{2.5}$ concentration in Mumbai exhibits significant fluctuations over time, with values ranging from relatively low (14.35) to very high (144.43) levels.
- The data suggests that the trend is not consistent.

CHANDIGARH

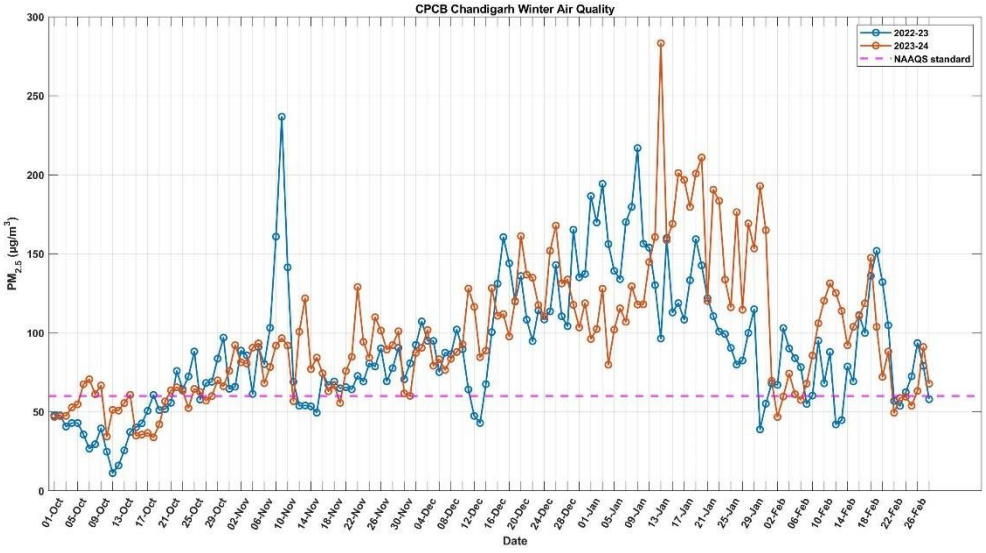

Figure7. Line plot for Chandigarh.

Figure7. Based on the daily average $PM_{2.5}$ concentration data for Chandigarh spanning from October 1st, 2022, to February 28th, 2024, the following points are noted:

- The $PM_{2.5}$ concentration in Chandigarh exhibits significant fluctuations over time, with values ranging from relatively low (11.24) to very high (283.26) levels.
- The data suggests that the trend is not consistent.
- Most of the day pollution levels exceeded the national standard.
- In Chandigarh, mid-December and January were the most polluted months.

PATNA

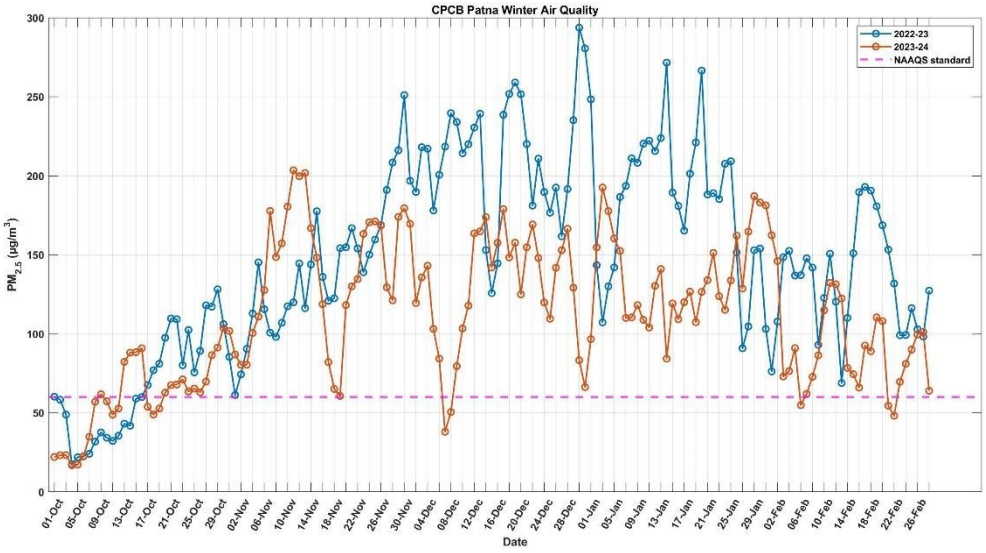

Figure8. Line plot for Patna.

Figure8. Based on the daily average $PM_{2.5}$ concentration data for Patna spanning from October 1st, 2022, to February 28th, 2024, the following points are noted:

- The $PM_{2.5}$ concentration in Patna exhibits significant fluctuations over time, with values ranging from relatively low (16.89) to very high (293.68) levels.
- The data suggests that the trend is not consistent.
- Most of the day pollution levels exceeded the national standard.

EXPERTS CALL FOR FURTHER RESEARCH

Dr. Sagnik Dey, Associate Professor, Center for Atmospheric Sciences, IIT-Delhi.

> *"Although cities show promising results, we need to demonstrate how much of the observed changes in $PM_{2.5}$ can be attributed to reduced emission from local sources after incorporating meteorological impacts. Further deep dive is required to dissect the data in terms of local and regional factors."*

Dr. Atenderpal Singh, Assistant Professor, Department of Environmental Studies, University of Delhi.

> *"The present study describes the current status of ambient* $PM_{2.5}$ *across the seven Indian Cities and it provides the baseline data. However, to plan any effective pollution mitigation strategies, it is important to understand the sources of* $PM_{2.5}$*. So, the source apportionment studies should be one of the objectives of future studies."*

For more details, contact Dr Palak Balyan, Research Lead, Climate Trends, Mob: +91 99998 88029 or palak.balyan@gsccnetwork.org

About Climate Trends

Climate Trends is a research-based consulting and capacity building initiative that aims to bring greater focus on issues of environment, climate change and sustainable development. We specialise in developing comprehensive analyses of complex issues to enable effective decision making in the private and public sector.