Status Assessment of Graded Response Action Plan Implementation in the Indo-Gangetic Plain

March, 2023

CREA
Centre for Research on Energy and Clean Air

CREA is an independent research organisation focused on revealing the trends, causes, and health impacts, as well as the solutions to air pollution.

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Key Highlights

- Continuous Ambient Air Quality Monitoring Stations (CAAQMS) increased from 59 stations across 23 cities in 2017-18 to 185 stations across 85 cities in 2022-23 in the seven Indo-Gangetic Plain (IGP) states and union territories in northern India. These are Punjab, Chandigarh, Haryana, Delhi, Uttar Pradesh, Bihar, and West Bengal.
- Only 23 of 85 cities with 185 CAAQMS have two or more stations installed as of January 2023. All other cities just have one CAAQMS installed to assess the real-time ambient air quality of the city.
- Seven of the 39 non-attainment cities in the IGP region do not have a single CAAQMS. These are Naya Nangal (Punjab), Pathankot/Dera Baba (Punjab), Dera Bassi (Punjab), Anpara (Uttar Pradesh), Gajraula (Uttar Pradesh), Raebareli (Uttar Pradesh) and Barrackpore (West Bengal). All 39 non-attainment cities have formulated GRAP. Apart from Kolkata, 36 are available publicly as per the National Clean Air Programme (NCAP) portal PRANA and State Pollution Control Board (SPCB)/ Pollution Control Committee (PCC) websites.
- Between October 1, 2022, and February 15, 2023, 26 cities reported $PM_{2.5}$ levels under the 'Severe+' category, 38 cities reported 'Severe', and 78 cities 'Very Poor' air quality. Non-attainment cities and the National Capital Region (NCR) should initiate GRAP implementation as soon as air quality reaches 'Poor' levels.
- No city beyond Delhi-NCR had any public communication or direction to the relevant stakeholders about the implementation of GRAP stages between October 1, 2022, and February 15, 2023, indicating failure of the regulation. Interagency communications such as minutes of meetings of the Task Force or City Implementation Committee under NCAP regarding GRAP are not available publicly on State Pollution Control Board websites either.
- Among the IGP states and UTs, highest particulate matter levels were reported in towns of Bihar which have recently strengthened their real-time ambient air quality network. The true extent of the issue of continuously deteriorating air quality could be several-fold worse and can be analysed only with more monitoring stations.

Introduction

India's national ambient air quality standards (NAAQS) for particulate matter (PM_{10} - 60µg/m^3 and $PM_{2.5}$ - 40µg/m^3) are significantly higher than guidelines set by the World Health Organization (WHO) - PM_{10}- 15µg/m^3 and $PM_{2.5}$ - 5µg/m^3 (*NAAQS*, 2009), (WHO, 2021). However, India State-Level Disease Burden Initiative – a report of various stakeholders estimated that the population-weighted mean fine ambient particulate matter concentration was even higher than these standards in 2019 at 91.7 µg/m^3 (India State-Level Disease Burden Initiative Air Pollution Collaborators, 2021).

As the temperature drops, perennial pollution sources, changing meteorology, and seasonal activities cause the air quality index to reach hazardous levels every winter. And every winter, New Delhi's Air Quality Index (AQI) becomes a central talking point amongst mainstream media, policymakers, and on social media. However, the issue of toxic air goes beyond the administrative boundaries of Delhi-NCR and affects millions of people – especially those residing in the Indo-Gangetic Plain. The land-locked region, covering an area of about 700,000 square kilometres, is home to 40% of India's population across five states and two union territories. The population density of the region is more than three times that of the rest of the country (AQLI, 2019). The geographical region of the IGP, however, extends beyond India. It includes most of northern and eastern India, half of Pakistan, the whole of Bangladesh, and southern Nepal (NGT, 2021). Combined with unregulated industrial growth, unfavourable topographical and meteorological conditions have exacerbated the health impacts of air pollution on its population. To tackle this issue, air pollution needs to be seen as a transboundary problem.

Air pollution abatement and airshed management strategies need to be holistic and go beyond the administrative boundaries of just a few cities or towns to effectively improve the air quality of the region. The Million Death Study estimated a significant relative risk (RR) of 1.09 for stroke deaths per 10 µg/m^3 increase in $PM_{2.5}$ among nearly 2.12 lakh deaths at ages between 15 and 69 years. This study also reported that over 99% of the country's population was exposed to $PM_{2.5}$ levels over 10 µg/m^3 between 1998 and 2014, with notable hot spots in north India, especially in the regions south of the Himalayan range, and West Bengal (Brown et al., 2022).

The increasing particulate matter pollution in the IGP region is consistent with increasing economic, industrial development, and fossil fuel consumption. To address this, the National Green Tribunal, in 2021, set up an Expert Committee to identify the reasons for higher pollution in the Indo-Gangetic Plain and formulate science-based solutions for sustainable development of the region (NGT, 2021). The Committee identified 8-9 major air sheds of

varying geographic coverage in India. Under the National Clean Air Programme (NCAP), the Central Pollution Control Board (CPCB) identified 131 cities that exceeded the NAAQS between 2015 and 2019, or cities with a million+ population exposed to particulate matter pollution as non-attainment cities. Of these, 39 cities are situated in the Indo-Gangetic Plain (IGP) (PRANA, 2023).

The National Green Tribunal directed CPCB and states to have a robust Emergency Response System (ERS) under the NCAP and increase preparedness by conducting mock drills for measures to be implemented if air pollution levels reach 'Severe' and 'Severe+' under the GRAP. Furthermore, the Tribunal directed the State Disaster Management Authorities (SDMA) to coordinate with the SPCBs/PCCs and state units of meteorological departments to combat air pollution as an emergency and that the ERS may be made available in the public domain (NGT, 2019).

The availability of real-time ambient air quality monitoring led to the adoption of the use of the National Air Quality Index (NAQI) as a simple measure to share complex air quality data (PIB, 2014),(CPCB, 2016). This has helped citizens, researchers, and policymakers to make better-informed decisions and avoid getting exposed to polluted air, understand the issue more holistically, and implement mitigation strategies accordingly. Strengthening of real-time monitoring networks in the country with a focus on the IGP is a part of the National Clean Air Programme (NCAP), launched in 2019. Real-time air quality data makes it easy to investigate the prevailing pollution levels and identify their sources, ultimately helping mitigate emissions and issue health and precautionary advisories to the public. All non-attainment cities under NCAP were directed to formulate clean air city action plans incorporating an Emergency Response System similar to the Graded Response Action Plan (GRAP) of Delhi (CREA, 2023).

As mentioned earlier, while Delhi's toxic air quality gets attention at all levels, several other cities/towns with similar or worse air quality are left on their own as authorities fail to implement even the simplest measures to safeguard its public from hazardous air pollution levels and direct the polluting sectors to reduce their emissions during the high pollution episodes.

This report examines the status of ambient air quality in the Indo Gangetic Plain since 2021 during the post-monsoon and winter seasons. The report also highlights the implementation of GRAP in Non-Attainment Cities (NACs) within IGP. Data from Continuous Ambient Air Quality Monitoring Stations (CAAQMS) and websites of various state pollution control boards were examined for this study. Data from October to February has been considered for every year till 2022. For the year 2023, data up till February 15 was considered.

Real-Time Ambient Air Quality Monitoring Network

The report analyses data from five states and two union territories in the Indian Indo-Gangetic Plain; Punjab, Chandigarh, Delhi, Haryana, Uttar Pradesh, Bihar, and West Bengal.

The number of Continuous Ambient Air Quality Monitoring Stations (CAAQMs) in the IGP has increased from 59 in 2017-18 to 185[1] in 2022-23.

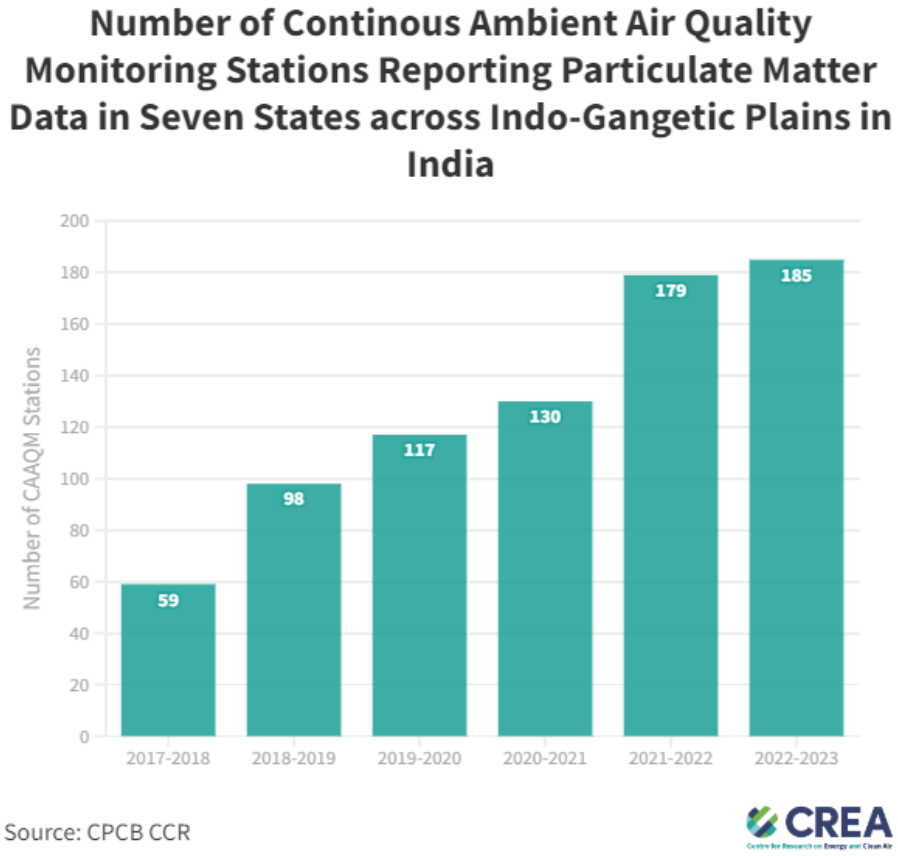


Figure 1. Growth of CAAQMS in IGP

[1] The total number of CAAQMs reported by CPCB is 187, however only stations wherein $PM_{2.5}$ and PM_{10} data were available were considered in this report.

As of February 2023, Bihar, Haryana, Uttar Pradesh, Punjab and West Bengal have 25, 24, 20, 8, and 6 cities and towns, respectively, that have made real-time ambient air quality data available in the public domain. Only 23 of 85 cities with 185 CAAQMS have two or more stations installed as of January 2023. All other cities have only one CAAQMS.

State-wise distribution and growth of CAAQMS that provide $PM_{2.5}$ data are given in the figure below.

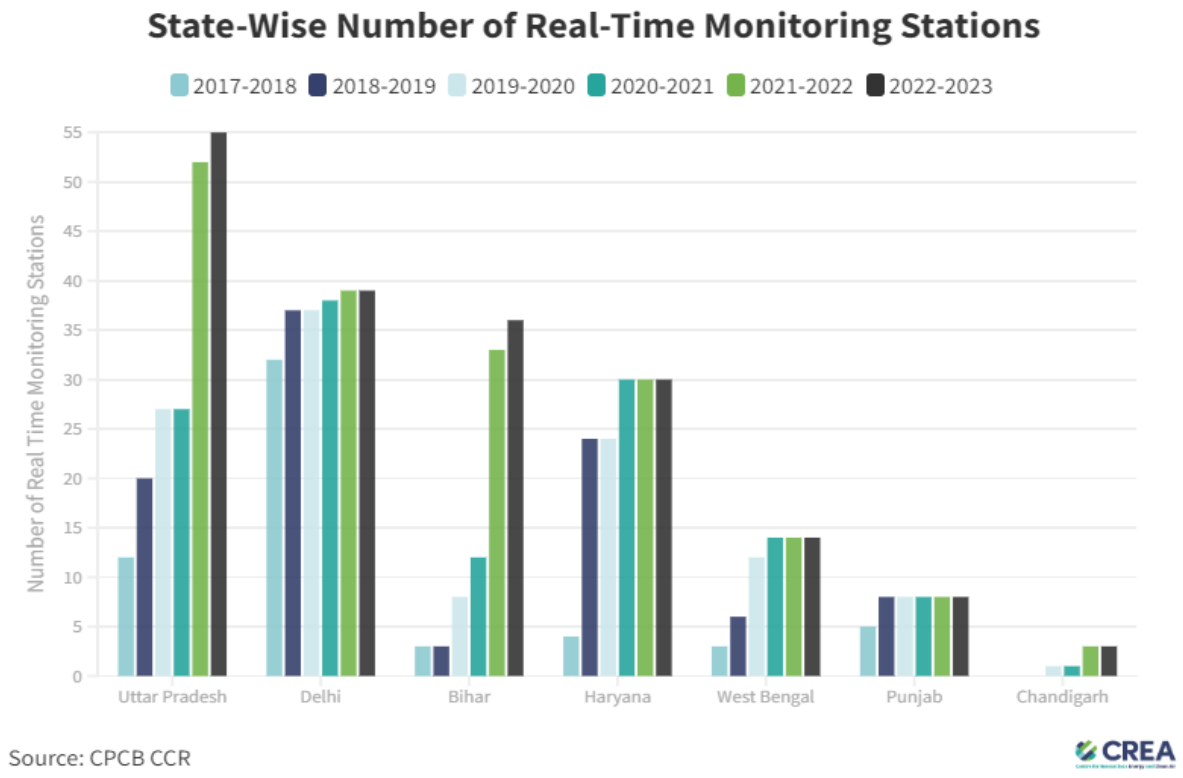


Figure 2. State/UT-wise number of CAAQMS

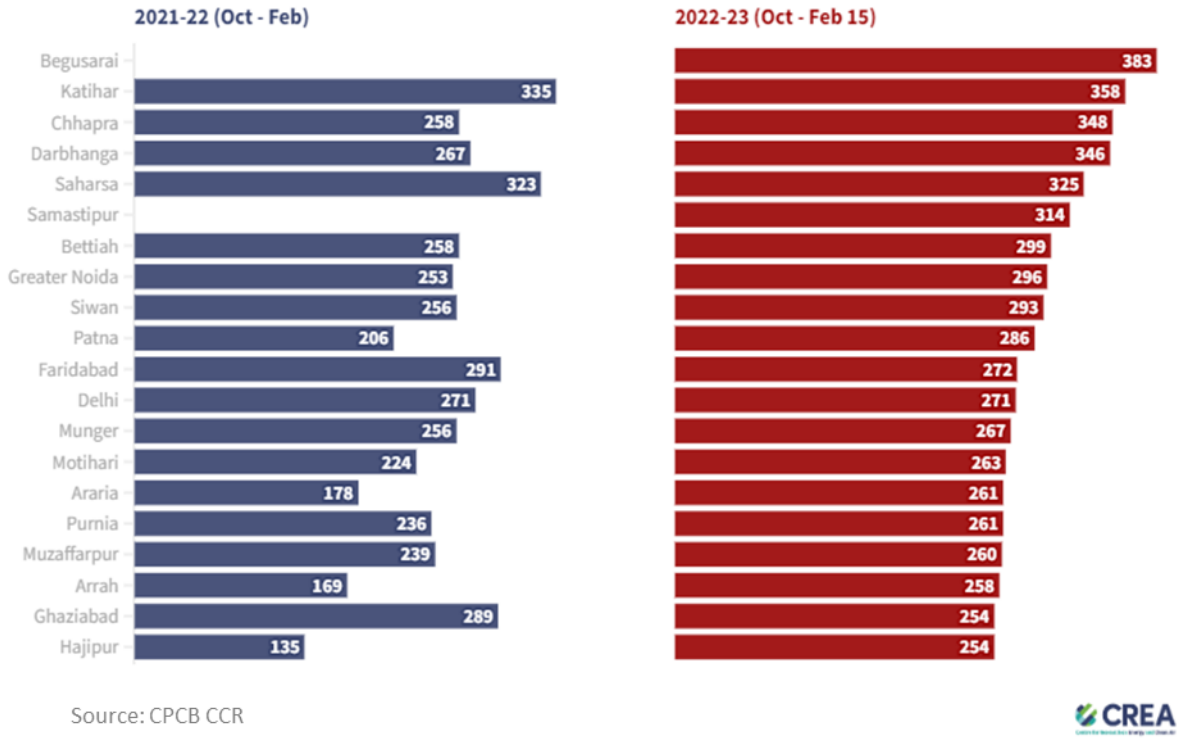
As per the NCAP, there are 39 non-attainment cities in the IGP. However, seven out of those 39 cities/towns i.e, Naya Nangal, Pathankot/Dera Baba, Dera Bassi in Punjab, Anpara, Gajraula, Raebareli in Uttar Pradesh, and Barrackpore in West Bengal are yet to have an operational CAAQMS (CPCB, 2023a). While the manual ambient air quality data is available monthly for these NACs through State Pollution Control Board websites, real-time air quality data needed for GRAP implementation is not available in these NACs. West Bengal Pollution Control Board has launched an “Air Quality Information System'' for reporting AQI based on manual as well as real-time monitoring stations (WBCPB, 2023).

Particulate Matter in IGP During 2022-23 Winters

PM_{10} data were analysed for 83 cities and towns of IGP. Further, $PM_{2.5}$ data from 85 cities and towns of IGP were analysed. Data from the CPCB indicates that Bihar was home to 16 out of 20 towns and cities with the highest average PM_{10} levels in the IGP from October 1, 2022, to February 15, 2023. Similarly, 15 of the 20 towns and cities with the highest average $PM_{2.5}$ levels were also in Bihar. Ghaziabad, Delhi, Faridabad, and Greater Noida also reported PM_{10} levels higher than 250 µg/m^3 and $PM_{2.5}$ levels higher than 120 µg/m^3 this winter.

The top 20 cities and towns for PM_{10} and $PM_{2.5}$ pollution in 2022–2023 along with their levels the year before are listed below:

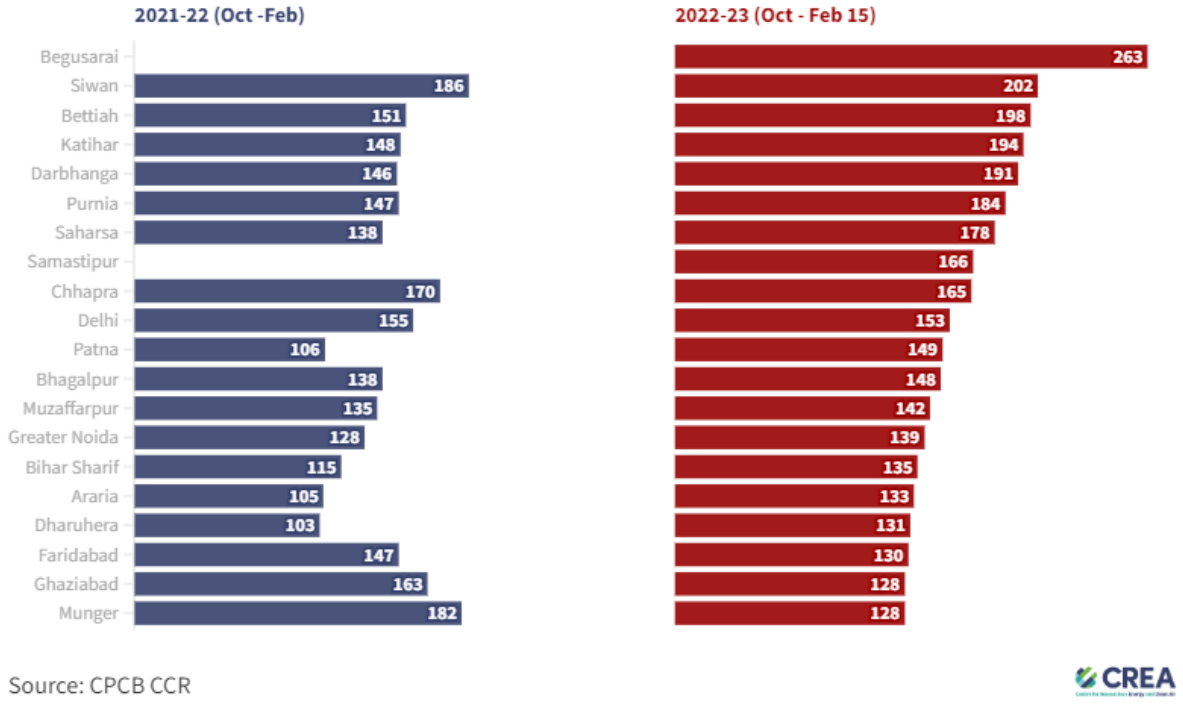
Figure 3. Most polluted cities by PM_{10} in IGP in 2022-23 and corresponding levels in 2021-22



PM_{10} data for Begusarai and Samastipur is not available for 2021-22

Note: Numbers inside the bar chart indicate average PM_{10} concentration(µg m^{-3})

Figure 4. Most polluted cities by $PM_{2.5}$ in IGP in 2022-23 and corresponding levels in 2021-22



$PM_{2.5}$ data for Begusarai and Samastipur is not available for 2021-22

Note: Numbers inside the bar chart indicate average $PM_{2.5}$ concentration ($\mu g\ m^{-3}$)

Graded Response Action Plan

The Central Pollution Control Board (CPCB), in 2017, formulated a Graded Response Action Plan (GRAP) to initiate stringent and immediate protocols to combat spikes in air pollution in Delhi and NCR (CPCB, 2017). As the name suggests, GRAP is a precautionary policy document that enlists specific and graded actions based on current prevailing air quality. The ambient air quality is classified into different categories, each invoking an appropriate measure. These measures range from disseminating warnings through public channels to limiting the number of cars on the road, to even shutting down large industries in the vicinity.

In August 2022, the Commission for Air Quality Management in the National Capital Region and Adjoining Areas (CAQM) published a revised GRAP for NCR (CAQM, 2022). Similarly, the

CPCB, in compliance with the National Green Tribunal's directions, directed all state pollution control boards and committees to formulate an Emergency Response System - Graded Response Action Plan (GRAP) for all non-attainment cities. Out of 39 non-attainment cities across IGP, the largest state in the area, Uttar Pradesh, has the most NACs (17), followed by Punjab (9), West Bengal (7), Bihar (3), and Haryana (1). New Delhi and Chandigarh are the two UTs in this region and are non-attainment cities as well. As per the NCAP portal PRANA and SPCB/ PCC websites, all 39 non-attainment cities have formulated GRAP, and copies of the same are available publicly except Kolkata.

The various stages of GRAP in Non-Attainment Cities and Delhi NCR are listed below:

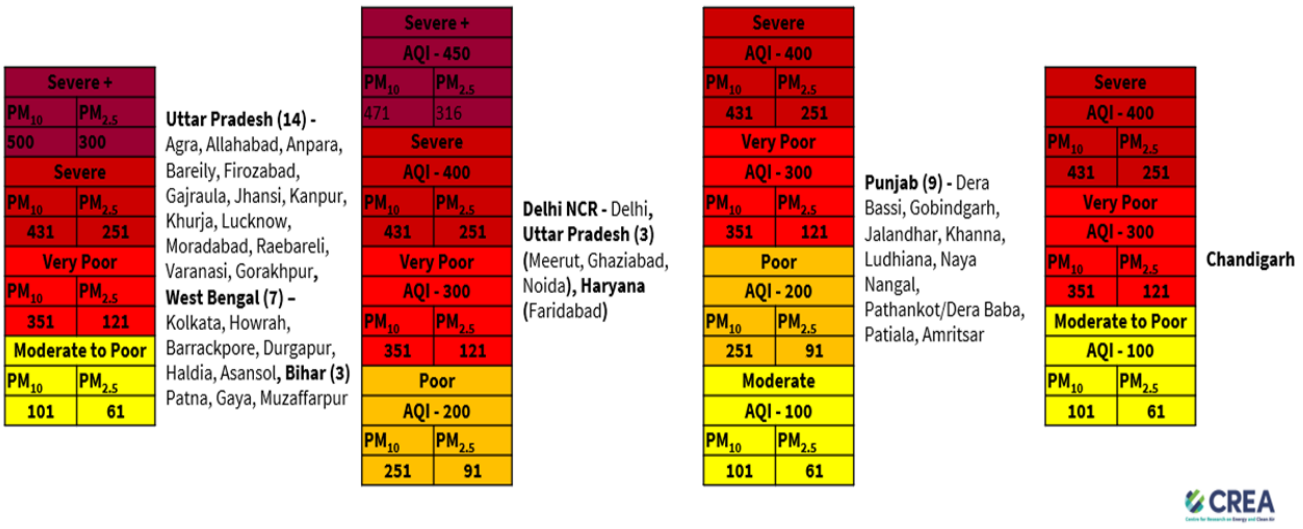
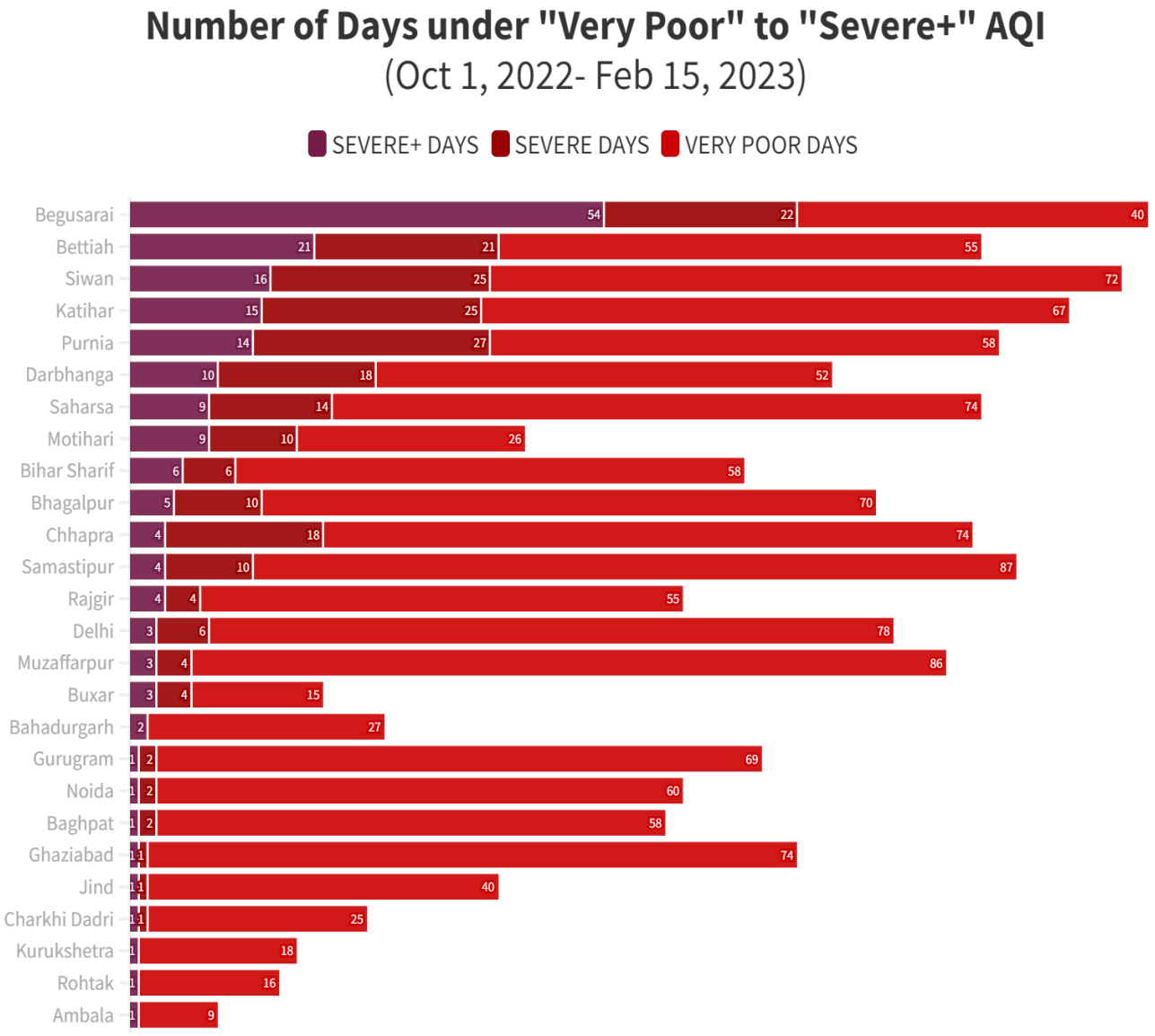


Figure 5. Stages of Graded Response Action Plan of IGP Non-Attainment Cities

The GRAP stages for Uttar Pradesh, Bihar and West Bengal are based on PM concentrations, while it is based on AQI in Delhi-NCR, Punjab, and Chandigarh. Delhi-NCR, Uttar Pradesh, West Bengal, and Bihar have identified actions to be taken under the 'Severe+' category of GRAP. However, PM_{10} and $PM_{2.5}$ concentrations for implementing actions under this category are different. This is because Delhi NCR GRAP Stage IV or 'Severe+' stage is initiated when AQI reaches 450 . The CPCB 's AQI calculator was used to estimate the corresponding PM_{10} and $PM_{2.5}$ levels for 450 AQI as 471 µg m^{-3} and 316 µg m^{-3} respectively. However, for non NCR NACs of Uttar Pradesh as well as West Bengal and Bihar, actions under the 'Severe+' category of GRAP have to be implemented when PM_{10} exceeds 500 µg m^{-3} and $PM_{2.5}$ levels exceed 300 µg m^{-3} for 48 hours. Punjab and Chandigarh have identified actions till 'Severe' category.

$PM_{2.5}$ levels of the 85 cities and towns of the Indo-Gangetic Plain were categorised into AQI categories based on the breakpoints stipulated by the CPCB. City-wise number of days experiencing “Very Poor”, “Severe” and “Severe+” AQI days was analysed and presented in Figure 6 (a) and 6 (b).



Source: CPCB CCR • Note: Numbers inside bar chart indicate AQI based on breakpoints of PM2.5

Figure 6 (a). City-wise number of monitored days above poor AQI

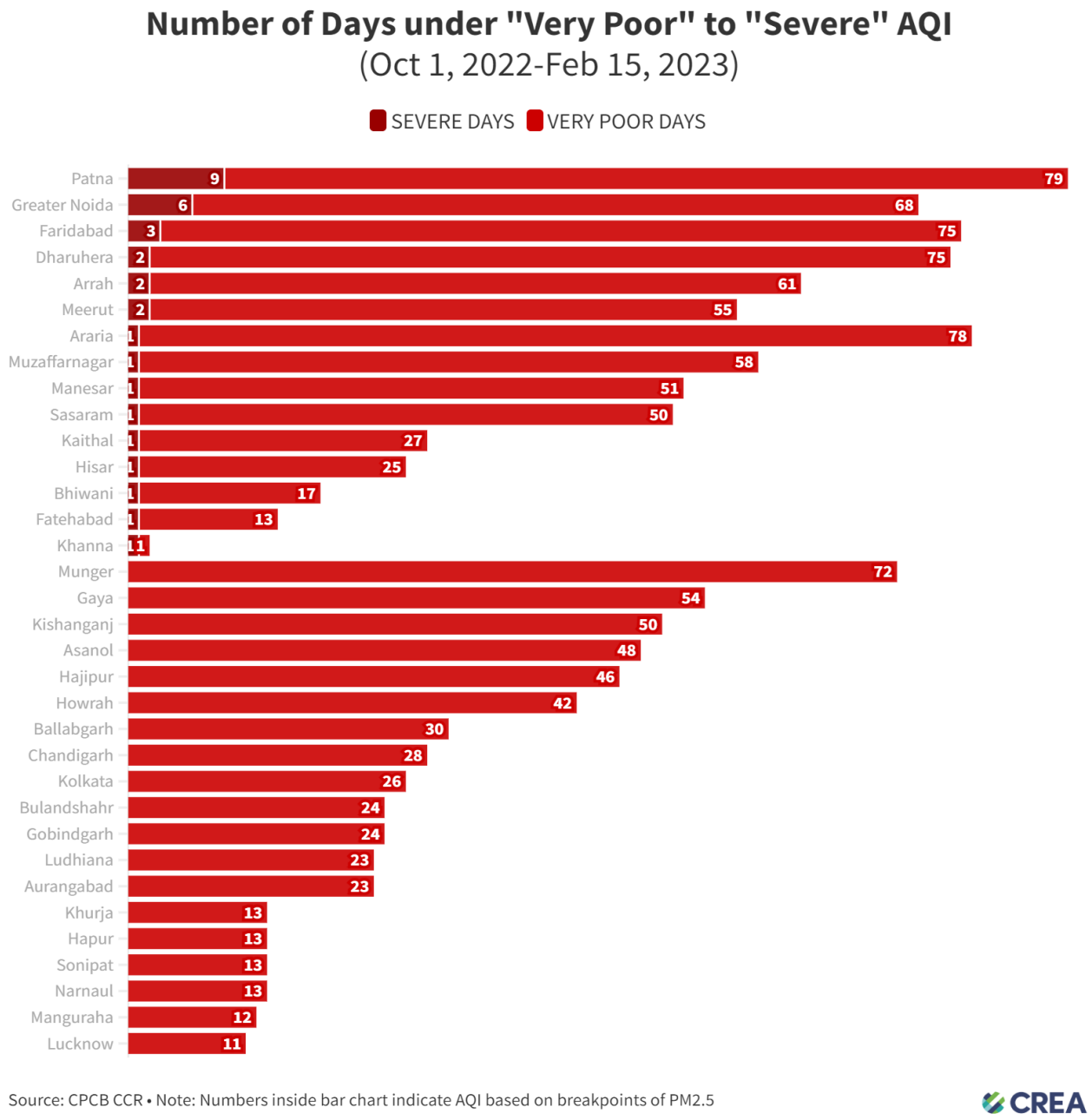


Figure 6 (b). City-wise number of monitored days above poor AQI

Twenty-six cities have reported $PM_{2.5}$ levels under the 'Severe+' category, 38 cities reported 'Severe' and 78 cities had 'Very Poor' air quality. Out of 85 cities and towns, only seven cities reported AQI levels better than 'Very Poor' category from October 1, 2022, to February 15,

2023. These were Mandikhera & Palwal in Haryana, Prayagraj, Agra, Varanasi, and Vrindavan in Uttar Pradesh, and Haldia in West Bengal. (CPCB, 2022a).

Particulate matter levels indicate that all states and union territories in the IGP experienced “Very Poor” and worse air quality levels from October to February. However, as the implementation of GRAP is restricted to non-attainment cities and the National Capital Region, the rest of the IGP region has seen little to no action despite high levels of particulate matter pollution.

The authors of this report could not find any communication issued by any government agency, including state pollution control boards and local administrative authorities on mainstream media, social media, or through their official websites regarding GRAP stages/actions. The minutes of the various meetings by specifically formed Task Forces were also not to be found.

However, Delhi, West Bengal, and Bihar made plausible efforts to increase public awareness by educating the public about air quality and air pollution mitigation measures through their social media channels.

GRAP directions, including a ban on non-essential diesel vehicles, and closure of industries which that do not run on fuels apart from approved fuels for NCR were notified in Delhi NCR when AQI was forecasted to reach “Severe+” by the CAQM. However, despite being a part of GRAP, equivalent measures were not taken in 26 non-attainment cities with "Very Poor" or worse air quality.

Delhi-NCR experience also shows that the technical capacities for air quality forecasting, decision support systems (DSS), and real-time source apportionment exist in Indian cities. However, the lack of efficient coordination between regulators is a significant barrier to using this capacity.

Existing resources and tools must be extended across the IGP for a holistic approach towards mitigating air pollution and used in conjunction with each other for efficient governance.

State-wise status of GRAP implementation is as below:

Table 1: Status of GRAP Implementation in Non-Attainment Cities of IGP

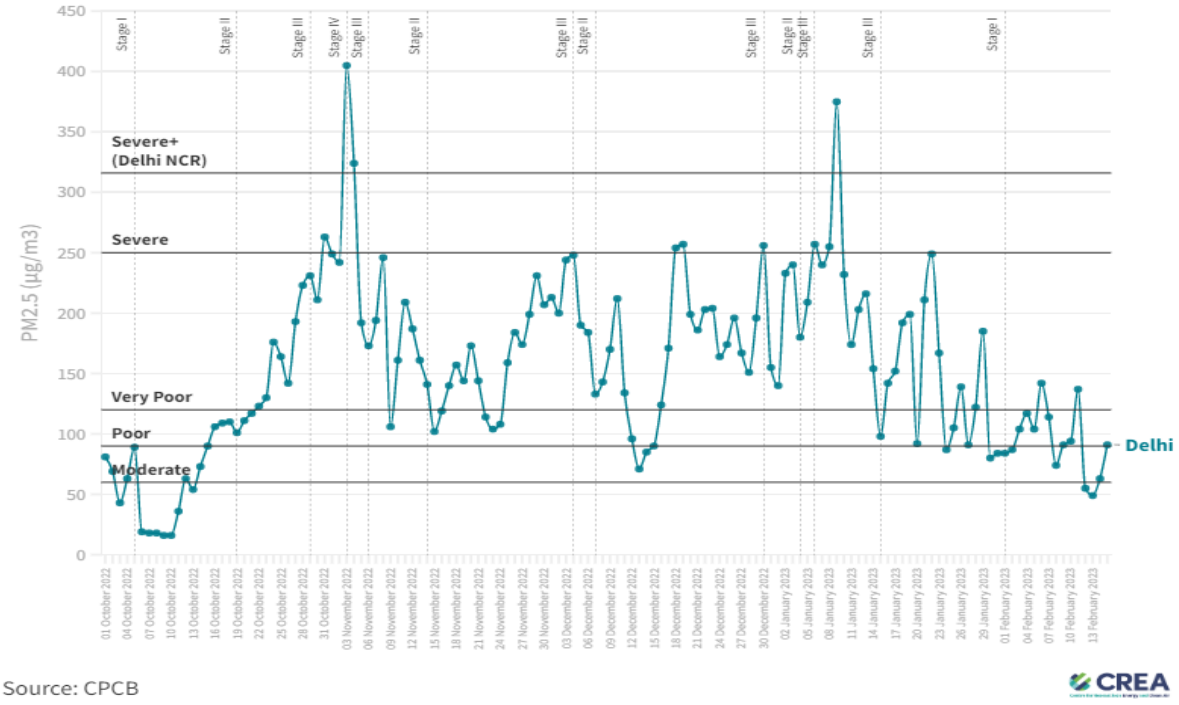
State/ Region	Communication of actions/direction under GRAP by				Public Advisory
	CAQM	SPCB/PCC	ULB	Media Alerts	
Bihar	-	No	No	No	Yes
Chandigarh	-	No	No	No	Yes
Delhi - NCR	Yes	Yes	Yes	Yes	Yes
Haryana	-	No	No	No	No
Punjab	-	No	No	No	No
Uttar Pradesh	-	No	No	No	No
West Bengal	-	No	No	No	Yes

Note: Public Advisory issued on Twitter and SPCB & ULB websites from October-February of the years in the scope of this study

Daily $PM_{2.5}$ concentrations for non-attainment and other cities were analysed to examine whether the ambient air quality levels breached the prescribed GRAP stages across various states, and is depicted in the following figures.

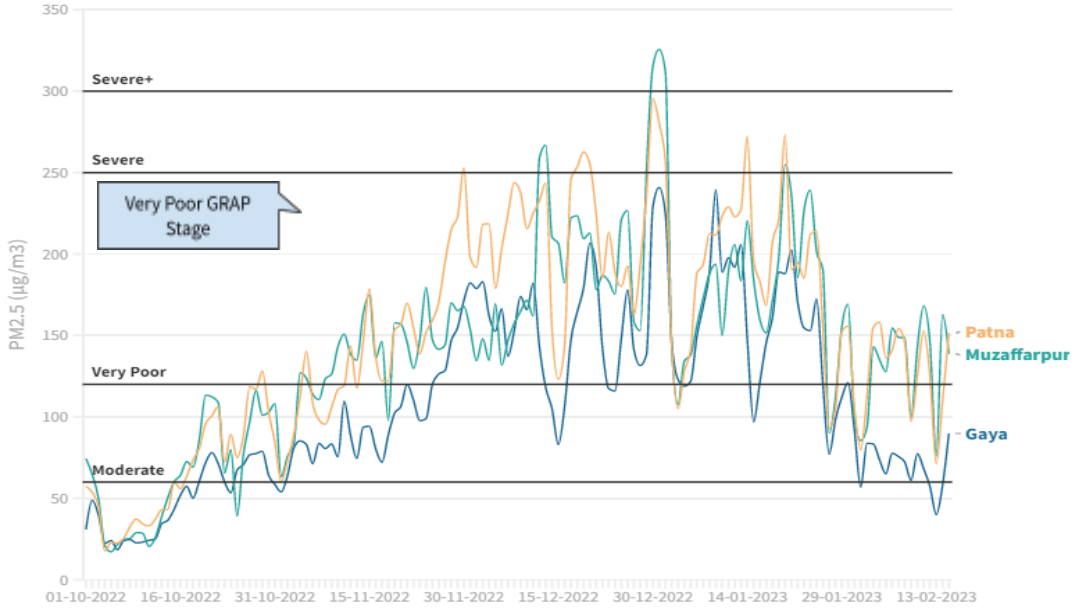
The analysis confirms that apart from Delhi-NCR, cities like Patna, Gaya, Muzaffarpur, Chandigarh, Ludhiana, Amritsar, Lucknow, Durgapur, Hadia, and Howrah breached “Very Poor” air quality breakout points. These breaches should have triggered the protocols under prevailing GRAP stages but as depicted in table 1, the same have not been implemented .

Figure 7. Daily $PM_{2.5}$ Concentrations of Delhi and GRAP Stages (Oct 1, 2022 - Feb 15, 2023)



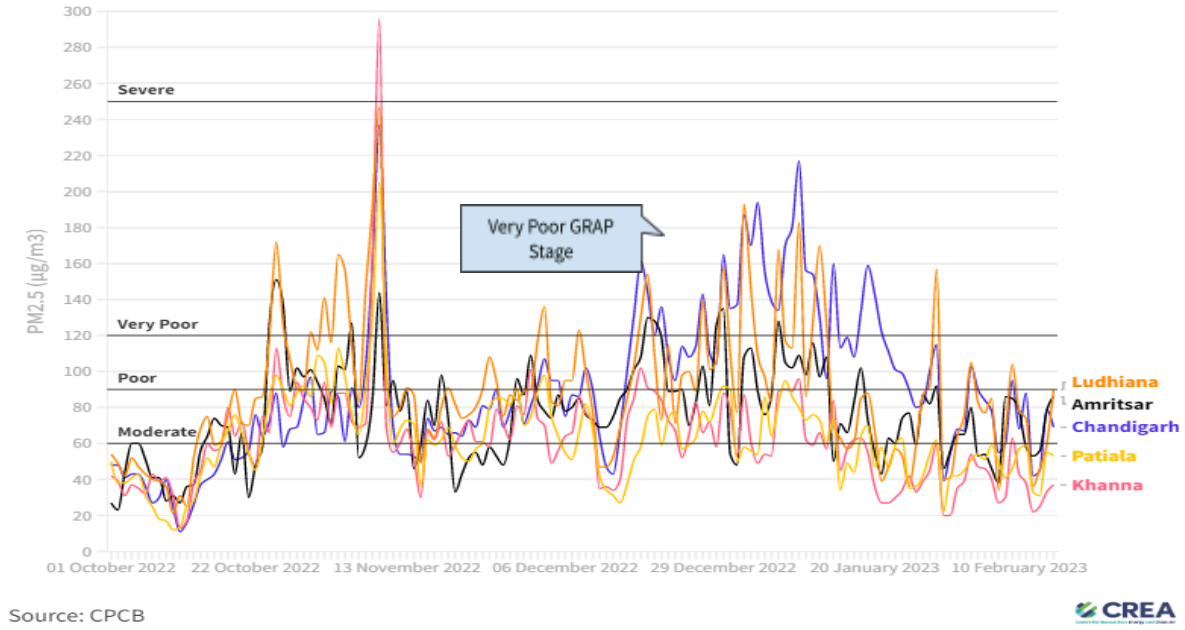
Source: CPCB

Figure 8. Daily $PM_{2.5}$ Concentrations of Non-Attainment Cities in Bihar (Oct 1, 2022 - Feb 15, 2023)



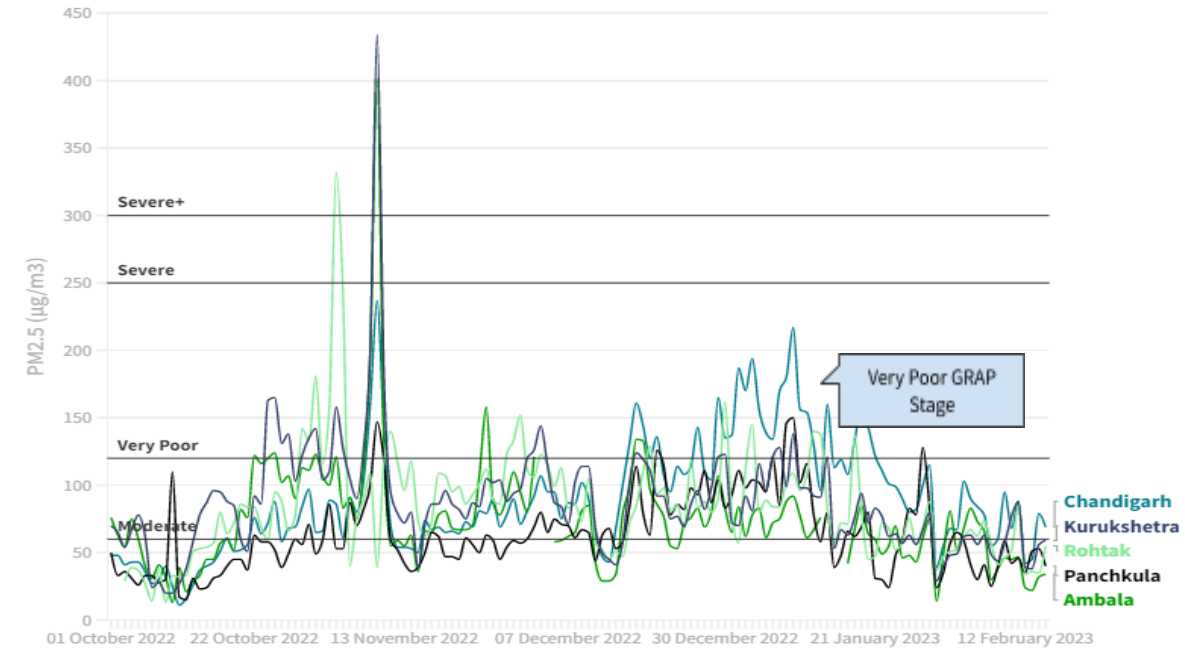
Source: CPCB

Figure 9. Daily $PM_{2.5}$ Concentrations of Non-Attainment Cities in Punjab (Oct 1, 2022 - Feb 15, 2023)



Source: CPCB

Figure 10. Daily $PM_{2.5}$ Concentrations of Cities in Haryana (Oct 1, 2022 - Feb 15, 2023)



Source: CPCB

Figure 11. Daily $PM_{2.5}$ Concentrations of Cities in Uttar Pradesh (Oct 1, 2022 - Feb 15, 2023)

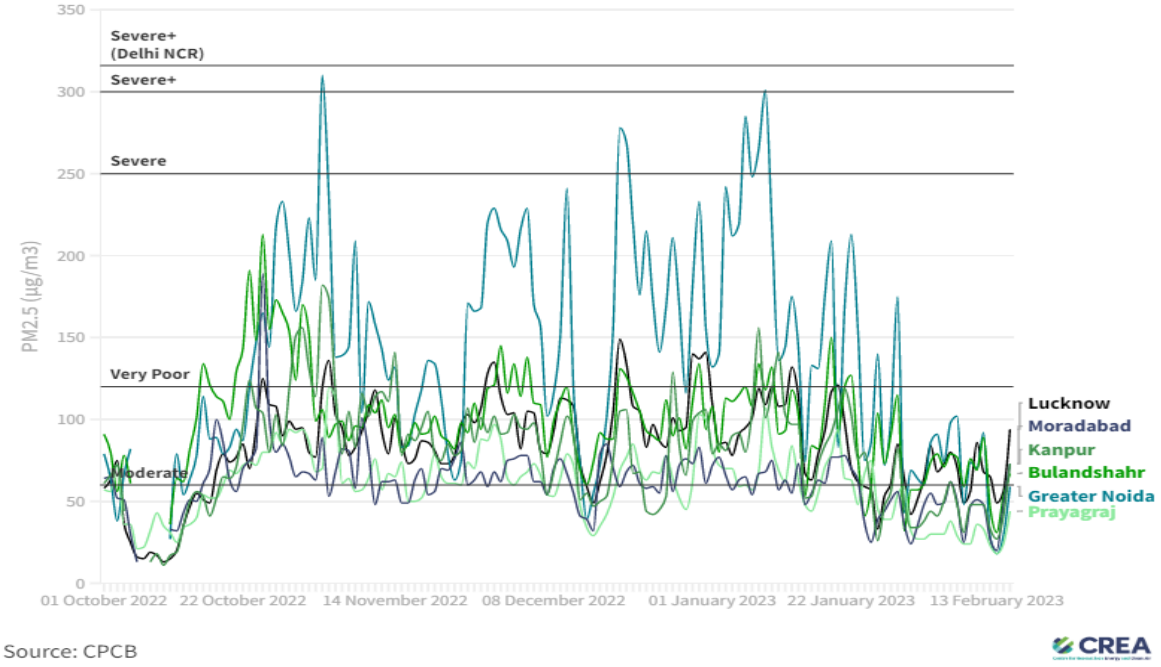
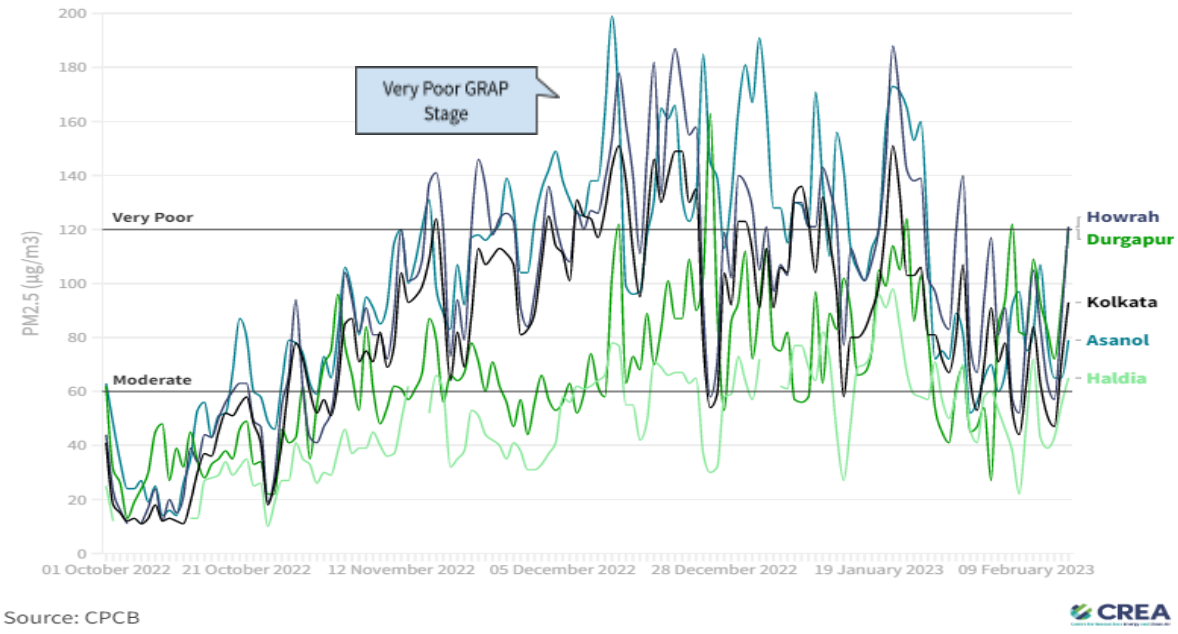


Figure 12. Daily $PM_{2.5}$ Concentrations of Non-Attainment Cities in West Bengal (Oct 1, 2022 - Feb 15, 2023)



Recommendations

Though air pollution peaks during the winter, it persists throughout the year. Efforts to mitigate it cannot be seasonal. Year-round efforts, in coordination with stakeholders and government agencies beyond administrative boundaries, are imperative to ensure that the worst part of the year is somewhat bearable and sustained air quality improvement goals are achieved. Consistent and holistic implementation of the various policies from the Centre and states is crucial in achieving the country's clean air goals – a fundamental right as espoused under Article 21 of the Constitution.

Based on the assessment in this report we recommend:

Air Quality Control Plan for Areas other than Non-Attainment Cities

Several states are in the process of formulating their State Action Plan as mandated under the National Clean Air Programme (NCAP) (MOEF, 2022). ***Graded Response Action Plans should be applicable and be implemented across all cities exceeding the NAAQS in the respective states***.

Strengthening real-time ambient air quality network in the entire IGP

The ambient air quality monitoring network across IGP states has been strengthened to 185 stations for reporting $PM_{2.5}$ data. While this is a positive step, this study also highlights that $PM_{2.5}$ levels from October to February were above 'Very Poor' in most IGP cities irrespective of whether they had an NAC tag or not. **The true extent of the issue of continuously deteriorating air quality could be several-fold worse and can be analysed only with more monitoring stations**.

Public Awareness and Outreach

Air quality is a people's issue that requires a monumental national effort. The daily AQI bulletin is published by the CPCB and National AQI dashboard displays air quality at all locations with real-time air quality monitoring stations (CPCB, 2023b). Further, CPCB also disseminates AQI levels through social media platforms (CPCB, 2023c).

However, **increased awareness and advisories regarding staying indoors in the event of an increase in pollution levels through SPCB websites, local social media platforms and newspapers will benefit the public, especially children and the elderly**. Moreover, executing actions like "Shutting down of schools' which is advised in most Graded Response Action Plans for cities need better ground level implementation by the PCBs.

Sectoral Policy Measures to Reduce Air Pollution at Source

Medium and small-scale experimental ambient air purification towers are springing up in several cities. These systems, apart from being cost intensive, also have a very low return on investment (CPCB, 2022b).

Stakeholders, therefore, should focus on mitigating air pollution at source level through actions as outlined in various plans formulated under the NCAP. **Time-bound emission load reduction through effective pollution control at source and transition to cleaner fuels and technologies** should be adopted across sectors for systematic and sustained air quality improvements.

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