Tracking overall and winter air pollution in the eastern region -- cities of West Bengal, Bihar and Odisha

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The winter smog that engulfs North India during early November begins to extend eastward during late December and early January. Bihar, West Bengal and Odisha are affected mostly during this time when winter inversion, cool and calm conditions trap local pollution that is already high.

This analysis of real time air quality data for the period 2019-2021 shows that the downward dip in pollution that was induced by the hard lockdown phases of the pandemic in 2020 is threatening to bounce back with the levels in 2021 already rising. But in many cases the levels are still lower than 2019. This underscores the urgency of scaling up action across all sectors to prevent further worsening and to arrest the trend in this region.

Even though real time air quality monitoring has begun to expand in these states to provide more up to date and real time information on air quality, there are serious concerns around missing data and gaps that makes proper risk assessment difficult. In some stations of Bihar and Odisha data availability is so low that the trend cannot be assessed. Quality control of data is necessary.

This has emerged from the new analysis of real time pollution data by CSE as part of the air quality tracker initiative of the Urban Data Analytics Lab of CSE. The objective of this new analysis is to understand the trend and magnitude of pollution in different regions that have real time air quality monitoring systems. This is an assessment of annual and seasonal trends in PM2.5 concentration for the period 1st January 2019 to 4th January 2022. This analysis is based on the real time data available from the current working air quality monitoring stations. A huge volume of data points have been cleaned and data gaps have been addressed based on USEPA method for this analysis.

This analysis covers 29 continuous ambient air quality monitoring stations (CAAQMS) spread across 12 cities in three states: West Bengal -- seven stations in Kolkata, three stations in Howrah, and one station each in Asansol, Siliguri, Durgapur, Haldia; Bihar - six stations in Patna, three stations in Gaya, three stations in Muzaffarpur and one in Hajipur; Odisha -- one real time station each in Talcher and Brajrajnagar.

Even though there are more real time monitors in a few other cities of these states, those could not be considered due to data gaps and lack of quality data. Moreover, in several cases the real time monitors have been set up recently and therefore long term data is not available. Several cities of Bihar have got their real time monitors between July and November 2021. There are two stations in Bhagalpur and one station each in Bettiah, Bihar Sharif, Darbhanga, Motihari, Araria, Arrah, Buxar, Chhapra, Katihar, Kishanganj, Manguraha, Munger, Purnia, Rajgir, Saharsa, Sasaram, and Siwan. But due to excessive amount of missing data from these stations meaningful analysis has not been possible. Hajipur in Bihar have data availability for over two years.

In West Bengal, real time monitors in Durgapur and Haldia became operational only near the end of 2020 which limits the possibility of doing long term trend analysis for these cities. Odisha has very limited real time monitoring. Therefore, data is indicative of the current status of airquality and seasonal variation in particulate pollution in medium and smaller cities.

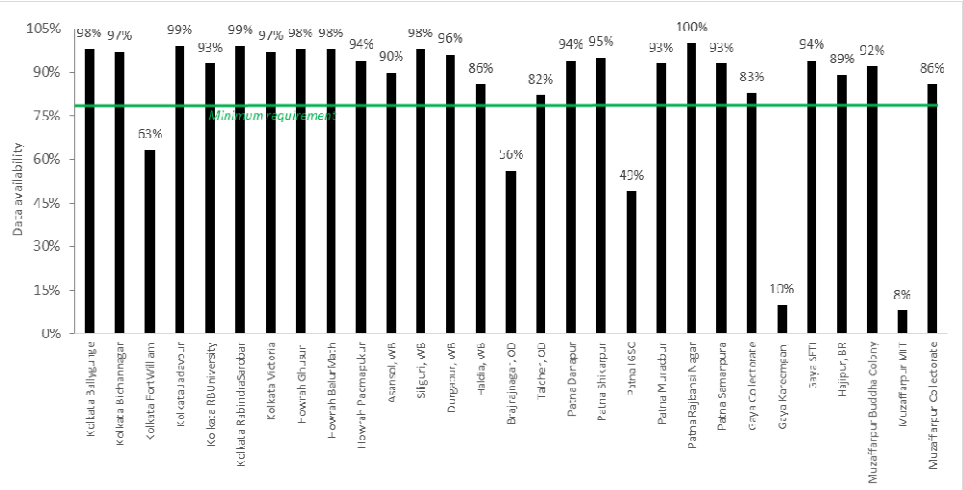
Summary highlights of key findings

Challenge of data gaps and quality despite automation: Review of data availability of from the automated monitoring stations in the region under Continuous Ambient Air Quality Monitoring Stations (CAAQMS) program of CPCB, shows major data gaps. Data availability calculated as number of days with adequate data for computation of a valid 24hr-average has been low in five of the twelve cities in the region. For the year 2021 (January to December) data availability at Kareemganj station of Gaya and MIT station of Muzaffarpur has been just 10 per cent and 8 per cent respectively. Stations at Fort William in Kolkata, Bajrajnagar in Odisha and IGSC in Patna fare better with 63 per cent, 56 per cent, and 49 per cent data availability respectively. Most stations of West Bengal perform better as they have data availability of more than 95 per cent (See Graph 1: Data availability at real time monitoring stations three states in Jan-Dec, 2021).

Stations at Talcher in Odisha, and Collectorate in Gaya meet the minimum 80 per cent data availability requirement. In contrast the CAAQMS stations at Rajbansi Nagar in Patna have 100 per cent data availability. It is not clear why these stations have such poor data availability but it probably has to do with poor electricity and internet connectivity in the region. This requires an assessment.

However, several other stations in Kolkata, Howrah, Siliguri, and Durgapur in West Bengal; and a few in Patna, Gaya, and Muzaffarpur in Bihar show between 95-100 per cent availability with some variation.

Graph 1: Data availability at real time monitoring stations of three states in Jan-Dec, 2021



Source: CSE analysis of real time data from CPCB website

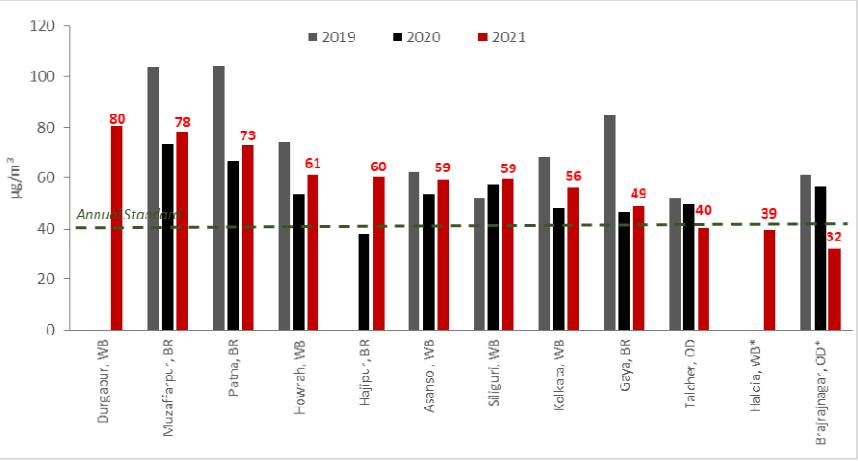
Most cities show a rising trend in annual PM2.5 level after an initial drop during 2020 with more pandemic related lockdown phases: Nearly all cities in the region show a drop in annual average PM2.5 level in 2020 that was also the year with maximum lockdown phases. But there is a rebound and a rising trend once again in 2021 though in several cases the levels are lower than the 2019 level. Durgapur, a big industrial hub of West Bengal that is also designated as a critically polluted area by CPCB, has the most polluted air in the region with 2021 average at 80 ug/m3. This is followed by Muzaffarpur and Patna with 2021 annual average of PM2.5 at 78 ug/m3 and 73 ug/m3 respectively (See Graph 2: PM2.5 trend among cities of West Bengal, Bihar and Odisha – 2019-2021).

If the real time data is taken as an indicator, in West Bengal, Durgapur needs to reduce annual average PM2.5 by 50 per cent to meet the annual PM2.5 standard, Howrah 34 per cent, Asansol 32 per cent, Siliguri 32 per cent, Kolkata 28 per cent. Haldia met the standard in 2021.

In Bihar, Muzaffarpur needs reduction in annual average PM2.5 level by close to 49 per cent to meet the standard, Patna 45 per cent, Hajipur 33 per cent, Gaya 18 per cent.

Odisha is the only state where Bajrajnagar and Talcher have met the annual standard with average.

Graph 2: Long term PM2.5 trend among cities of West Bengal, Bihar and Odisha (2019-2021)



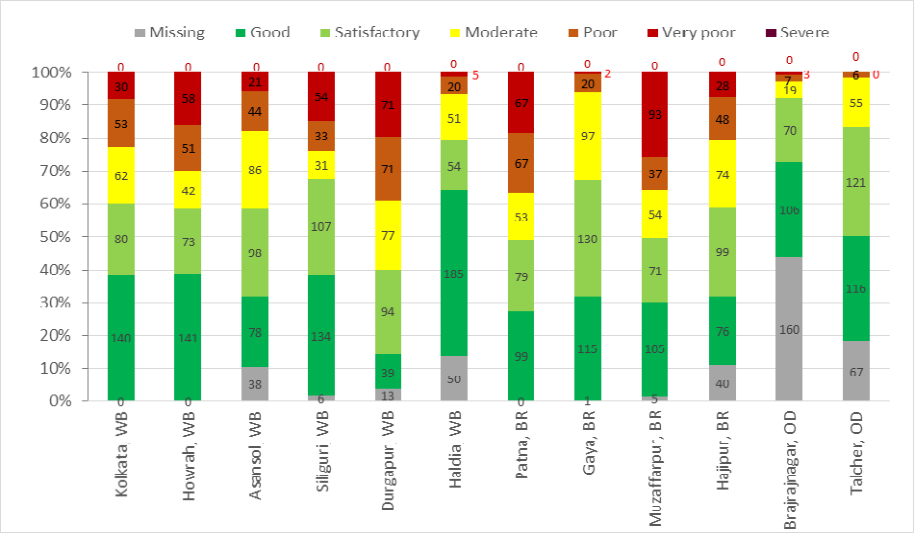
Note: PM2.5 values for Guwahati which has two monitoring stations is based on average of both stations. Data for only those stations is considered that have continuous and adequate data for complete assessment period. Data up till 31 December 2021.
Source: CSE analysis of real time data from CPCB website

The cities in eastern region did not experience 'severe' days during 2021 but the share of 'poor' and 'very poor' days are high: During 2021 severely polluted days have not been noted in any city.

Share of very poor days has been highest in Muzaffarpur at 93 in Bihar followed by Durgapur at 71 in West Bengal, Patna with 67 days in Bihar and Howrah with 58 days in West Bengal. Days with poor air quality is highest in Durgapur at 71 followed by 67 in Patna, 53 in Kolkata and 51 in Howrah. These bad air quality days are concentrated during winter months (See Graph 3: PM2.5 based AQI categorization of days for major cities in West Bengal, Bihar and Odisha – 2021). The overall number of 'good' and 'satisfactory' air quality days have also increased during the pandemic.

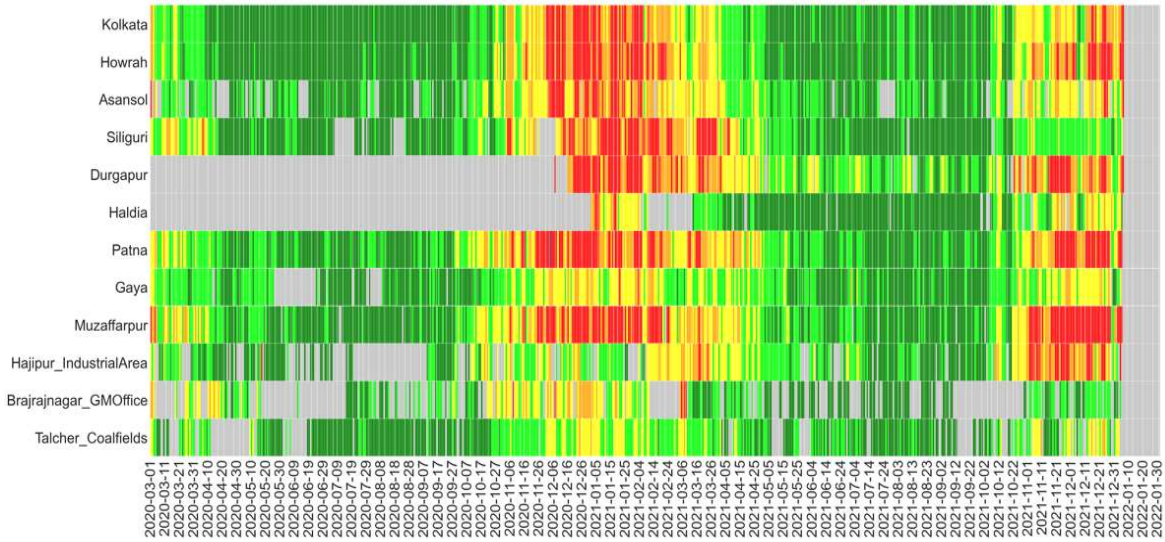
Bad air days begin to build up around the same time in the cities of eastern states that end of December During but it seems it persists longer in some cities like Siliguri, Durgapur, and Patna. In the next rung are Muzaffarpur and Howrah (see Graph 4: Heatmap based on days classified as per PM2.5 air quality index for major cities West Bengal, Bihar and Odisha**).**

Graph 3: PM2.5 based AQI categorization of days for major cities in West Bengal, Bihar and Odisha – 2021 – (Percentage share and number of days)



Note: PM2.5 values for cities with more than one monitoring stations is based on average of all stations that have continuous and adequate data for complete assessment period. Data up till 31 December 2021.
Source: CSE analysis of real time data from CPCB website

Graph 4: Heatmap based on days classified as per PM2.5 air quality index for major cities West Bengal, Bihar and Odisha

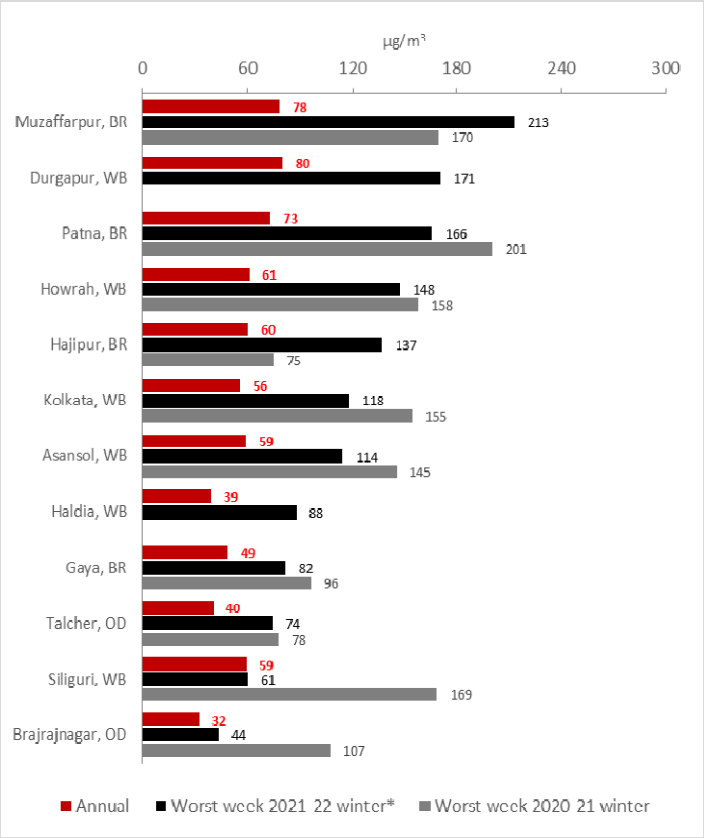


Note: PM2.5 values for cities with more than one monitoring stations is based on average of all stations that have continuous and adequate data for complete assessment period. Cell colors are based on the official AQI category colors. Data up till 4 January 2022.
Source: CSE analysis of real time data from CPCB portal

High weekly pollution episode during winter can be more than double the annual concentration in several cities: During the worst weekly pollution episode in winter the PM2.5 concentration can increase significantly higher than the annual PM2.5 average – about two times high in several cities. During the high pollution episodes weekly PM2.5 levels can go as high as 213 ug/m3 as recorded in

Muzaffarpur in December 2021 (See Graph 5: Weekly PM2.5 levels vs annual level among Cities of East India). This winter so far the highest weekly level has recorded 171 ug/m3 in Durgapur, 166 ug/m3 in Patna, 148 ug/m3 in Howrah, 137 ug/m3 Hajipur, 118 ug/m3 in Kolkata, and 114 ug/m3 in Asansol. The levels are marginally lower this winter compared to last winter except in Hajipur which shows 1.8 times increase comparing to previous winters.

Graph 5: Comparison of worst weekly PM2.5 levels with annual average level in Cities of West Bengal, Bihar and Odisha



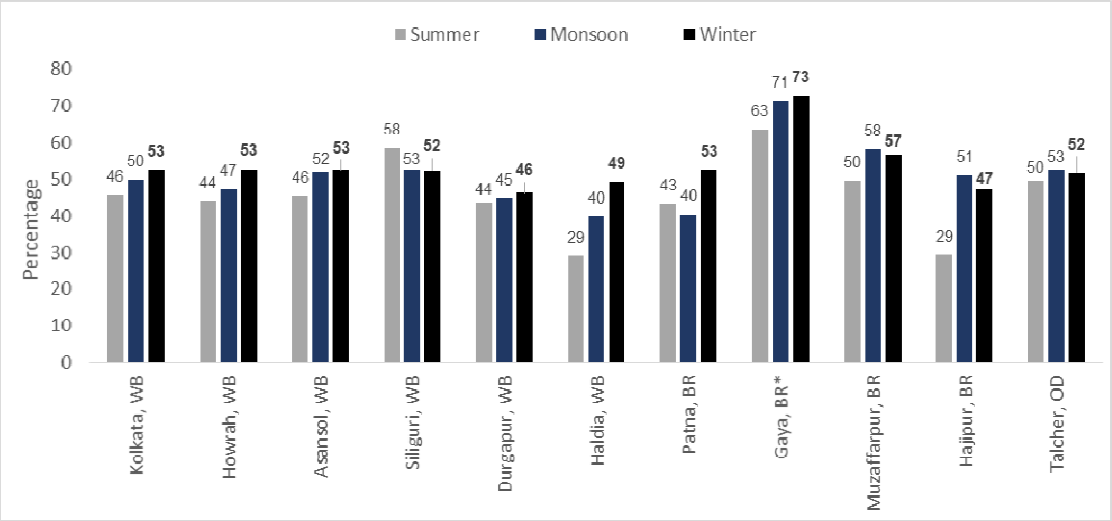
Note: Worst week for Muzaffarpur were weeks ending on 26 Dec 2021 and 6 Dec 2020; Patna were weeks ending on 26 Dec 2021 and 6 Dec 2021; Gaya were weeks ending on 5 Dec 2021 and 3 Jan 2021; Hajipur were weeks ending on 28 Nov 2021 and 6 Dec 2020. Brajrajnagar were weeks ending on 26 Dec 2021 and 3 Jan 2021; Talcher were weeks ending on 19 Dec 2021 and 3 Jan 2021. Worst week for Durgapur were weeks ending on 21 Nov 2021; Howrah and Kolkata have both their worst weeks ending on 3 Jan 2021 and 26 Dec 2021; Asansol were weeks ending on 13 Dec 2021 and 26 Dec 2021; Haldia were weeks ending on 28 Nov 2021; Siliguri were weeks ending on 7 Nov 2021 and 17 Jan 2021. Data up till 4 January 2022.
Source: CSE analysis of real time data from CPCB portal

Changing ratio of PM2.5:PM10 during different seasons of 2021: The PM2.5/PM10 ratio is a useful indicator to understand the impact of coarse dust vs tinier dust from combustion sources on air quality. Higher share of smaller particles in total particle concentration makes the air more toxic. The indicative ratio for all cities show there is a seasonal variation. The share of smaller PM2.5 is higher than the coarser PM10 in monsoon and winter. The long-term variation of the PM2.5/PM10 ratio was analyzed from weekly data average for three different seasons: Summer (March - May), monsoon (June - October), and winter (November – January). (see Graph 6: Changing ratio of PM2.5:PM10 during different seasons of 2021).

The PM2.5/PM10 ratio in all the cities of West Bengal has an increasing slope from summer to winter except Siliguri, which is showing high percentage of PM2.5/PM10 ratio in summers with 58 per cent and then gradually dropping to 50 per cent in monsoon which again spikes to 52 per cent in winter (See Graph 7: Changing ratio of PM2.5:PM10 during different seasons of 2021). Mostly, the concentration of PM2.5/PM10 ratio is higher during winter's months (November to January) hovering around 53 per cent in West Bengal cities. This is indicative and there can be variation across years. However, this trend is broadly consistent with what has been noted in parts of the country.

In Bihar, Gaya has the highest PM2.5/PM10 ratio in all the three seasons with the PM2.5 share as high as 73 per cent in winter. Hajipur is showing high percentage of PM2.5/PM10 ratio in monsoon with 51 per cent and then dropping to 47 per cent in winter. Overall in Bihar the concentration of PM2.5/PM10 ratio is higher during winter (November to January) hovering around 55 per cent. Brajrajnagar in Odisha has data gaps for the month from September to October. Therefore, this station has not been included in this analysis (See Graph 9: Changing ratio of PM2.5:PM10 during different seasons of 2021).

Graph 9: Changing ratio of PM2.5:PM10 during different seasons of 2021

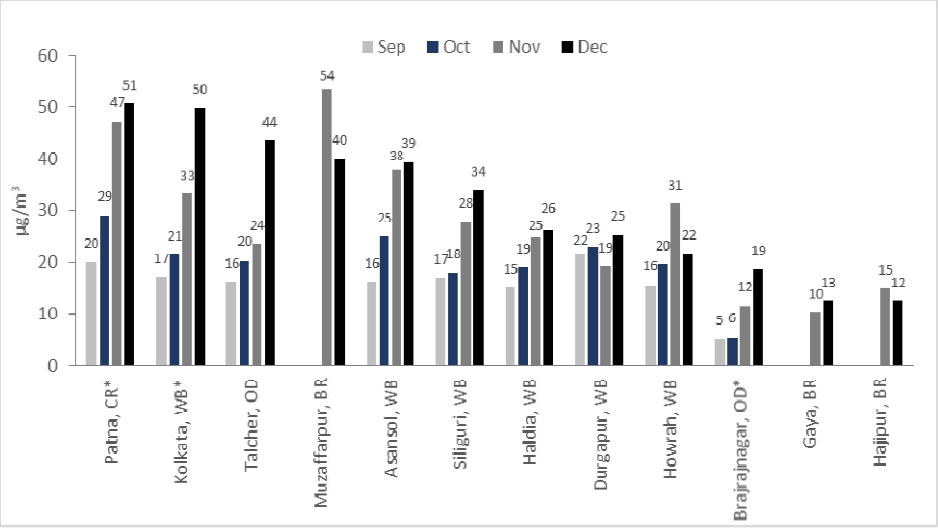


Note: Average PM2.5 concentration for a week is based on mean of all CAAQM stations in the city. Data up till 31 December 2021.
Source: CSE analysis of CPCB's real time air quality data

Winter pollution can be a toxic cocktail of particulate and gases: There is a significant increase in amount of nitrogen dioxide (NO2) in air of all cities of eastern states during December compared to the previous months of November, October and September. Brajrajnagar registered 3.6 times jump in monthly NO2 level, Kolkata registered a 2.8 times increase while Patna, Talcher, and Asansol registered a 2.5 times increase (See Graph 7: Monthly trend in nitrogen dioxide levels in cities of West Bengal, Bihar and Odisha).

In absolute concentration term, Patna registered the highest monthly average of 51 µg/m3 for December. It is followed by Kolkata (50 µg/m3) and Talcher (44 µg/m3). Muzaffarpur, Howrah and Hazipur showed increase in amount of NO2 in month of November as compared to December.

Graph 7: Monthly trend in nitrogen dioxide levels in cities of West Bengal, Bihar and Odisha

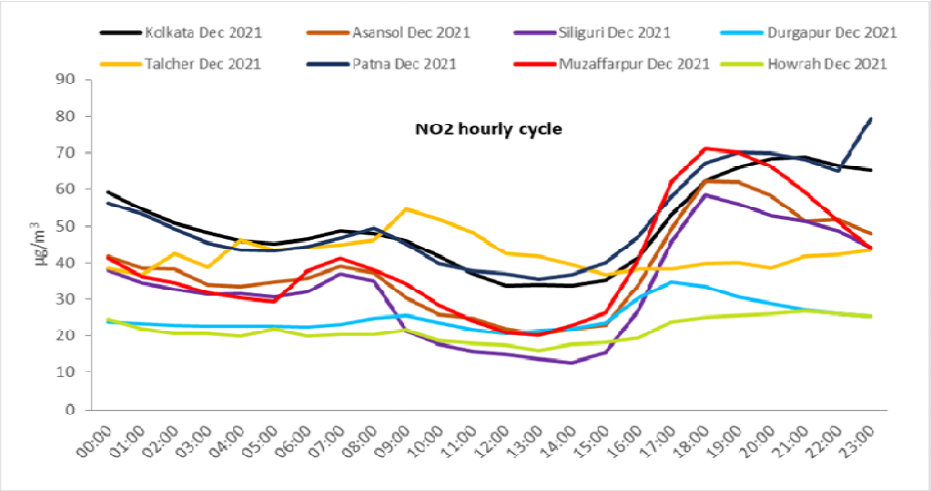


Note: NO2 values for cities with more than one monitoring stations is based on average of all stations that have continuous and adequate data for complete assessment period. Data up till 31 December 2021
Source: CSE analysis of real time data from CPCB portal

NO2 levels corelate well with traffic peaks in cities: All cities show peaking of hourly NO2 concentration between 6pm and 8pm which coincides with evening rush hour in the cities. Hourly NO2 in Siliguri increases 4-folds between noon and 7pm (See Graph 7: Hourly NO2 cycle for December in East India cities). NO2 cycle is equally as sharp in Muzaffarpur and Asansol with 3.5-3 times increase noted at evening compared to afternoon. All cities have a morning NO2 peak around 7-8am but is relatively lower` than the evening peak. In Patna and Kolkata high NO2 levels persist uptill midnight

indicating presence of pollution from night-time truck movement in the city.

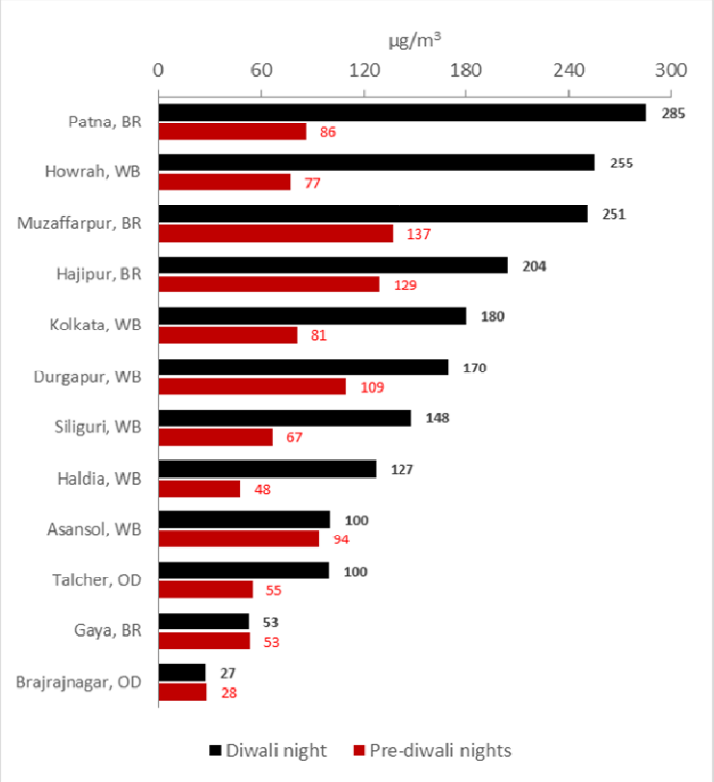
Graph 7: Hourly NO2 cycle for December in East Indian cities



Note: Average NO2 concentration is based on mean of hourly values that have continuous and adequate data for complete assessment period. Data up till 31 December 2021.
Source: CSE analysis of real time data from CPCB website

Diwali is a mega pollution event: Pollution level on Diwali night (8pm to 8am) in cities of east shot up by 1.1 - 3.3 times the average level recorded seven nights preceding Diwali (See Graph 8: Diwali night pollution among cities of East India). Patna and Howrah had the greatest pollution build-up on Diwali night,with a 3.3-fold increase in night-time PM2.5, followed by Haldia that saw 2.7 fold increase. Gaya and Brajrajnagar registered very low PM2.5 levels showing little impact. In absolute concentration terms, Patna dominate the list of most polluted Diwali nights with 285 µg/m3 PM2.5 level. Pollution was very high among all other major cities as well on Diwali night with Howrah(255 ug/m3), Muzaffarpur (251 ug/m3), and Hajipur (204 ug/m3) crossing 200 ug/m3 mark.

Graph 8: Diwali night pollution among cities of East India



Note: PM2.5 values for cities with more than one monitoring stations is based on average of all stations that have continuous and adequate data for complete assessment period. Diwali night is considered from 8.00PM November 4 to 8.00AM November 5. Pre-Diwali night is average of seven nights (8.00PM-8.00AM) preceding Diwali.
Source: CSE analysis of real time data from CPCB website

Take away

The eastern region that spans across middle and low Indo Gangetic Plain experiences winter smog towards the end of December and early January. Pollution trapping can be high during adverse winter conditions as the overall pollution level in cities are high. The region is already experiencing rebound of pollution after the temporary dip in 2020 due to the pandemic linked hard lockdown phases.

The city and state action plans in the concerned states require stronger multi-sector interventions to reduce pollution in a time bound manner and to meet the national ambient air quality standards. Scale up access to clean fuel and technology in industry and power plants, transform public transport, walking and cycling at a scale, address old vehicles and speed up electrification of new fleet, amend municipal bylaws and scale up infrastructure for management and recycling of all waste streams, eliminate solid fuel for cooking, control dust from construction sector and adopt greening and afforestation strategy for dousing dust. This agenda is non-negotiable to meet the clean air target.