Tracking overall and winter air pollution in cities of West Bengal

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Dissecting air quality trends in different parts of Indo Gangetic Plain provides deeper insight into the emerging regional pollution pattern especially during winter. West Bengal which is considered to be part of the lower Gangetic Plains is of special interest as being closer to the sea it has comparatively more open atmospheric conditions and ventilation pattern though there is variance within the state -- inland, upland and coastal regions.

While the winter pollution build up begins early November in the states of trans-Gangetic Plain of Punjab and Haryana and the upper Gangetic Plains of Delhi, Uttarakhand and Uttar Pradesh, it extends to West Bengal towards the end of December. There is wide seasonal variation in pollution levels in this state - with monsoon and summer showing lower concentration compared to winter. However, winter concentration is certainly a reflection of high overall pollution in the region that is trapped the moment atmospheric conditions turn adverse due to inversion, cool and calm conditions.

Centre for Science and Environment (CSE) has analyzed air quality status in cities of West Bengal (Kolkata, Howrah, Asansol, Siliguri, Durgapur and Haldia). This is 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 quantum and nature of the winter pollution in major cities of the West Bengal which have real-time air quality monitoring.

This is an assessment of annual and seasonal trends in PM2.5 concentration for the period 1 January 2019 to 2nd January 2022. This analysis is based on the real time data available from the current working air quality monitoring stations in West Bengal. 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 14 continuous ambient air quality monitoring stations (CAAQMS) spread across 6 cities: seven stations in Kolkata, three stations in Howrah and one station each in Asansol, Siliguri, Durgapur and Haldia.

Four cities – Kolkata, Howrah, Asansol and Siliguri have been selected for long term trend analysis because real time data is available for multiple years for these cities. This has analysed data recorded by 7 air quality monitoring stations in Kolkata, 3 stations in Howrah, and one station each in Asansol and Siliguri under the Continuous Ambient Air Quality Monitoring System (CAAQMS) of CPCB. Real time monitors in Durgapur and Haldia became operational only this year which limits the possibility of long term trend analysis for these cities. This is also an opportunity to understand the air pollution trend even in medium and smaller cities.

This analysis shows that air pollution during winter is a problem in all the cities with Durgapur and Howrah experiencing poor and very poor days comparable to the winter in NCR and UP cities. Winter pollution concentration is also a cocktail of tiny particles and gases such as nitrogen dioxide (NO2) that also increases during winter. Overall, the air quality in the region is slightly higher compared to the 2020 level but due to limited archival monitoring data it is difficult to comment on the trend in the Durgapur and Haldia's air quality.

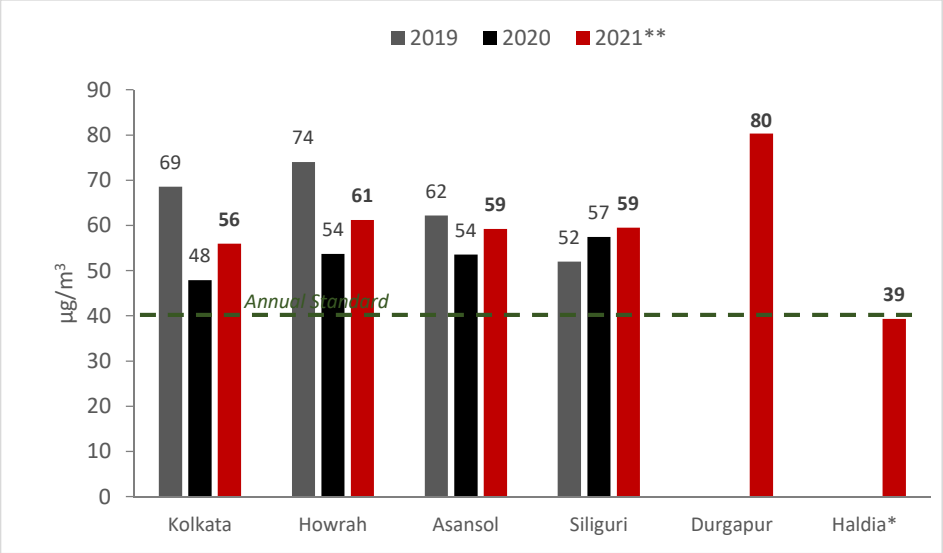
Key summary findings

Annual trends dip in most cities in 2020 to rises again; Cities need to cut annual average concentration substantially to meet the clean air standard: Overall, if the data available from the real time monitors are considered as indicative of the current average baseline of PM2.5 level in cities, then Kolkata requires close to 29 per cent reduction to meet the annual average standard of 40 ug/m3 for PM2.5; Howrah 34 per cent; Asansol 32 per cent and Durgapur 50 per cent reduction.

Moreover, the annual trend in average annual PM2.5 concentration since 2019 shows a dip in 2020 that had several pandemic linked lock down and semi lock down phases. But levels rose again in 2021. Despite the rise in 2021, the levels in Kolkata, Howrah, and Asansol are lower than the 2019 levels. But Siliguri shows levels higher than even 2019. Longer term trend for Durgapur and Haldia

could not be constructed as the realtime monitors became operational near the end of 2020 only.. But Durgapur which a major industrial hub of West Bengal, has the most polluted air in the region in 2021 with an average annual PM2.5 concentration of 80 ug/m3. It is followed by Howrah, Asansol and Siliguri with 2021 annual averages of 61 ug/m3 and 59 ug/m3 respectively (See Graph 1: Trend in annual average PM2.5 concentration in cities of West Bengal). Haldia has the lowest 2021 average value of 39 ug/m3 meeting the average annual standard. (Detail city-wise trends are in Annex)

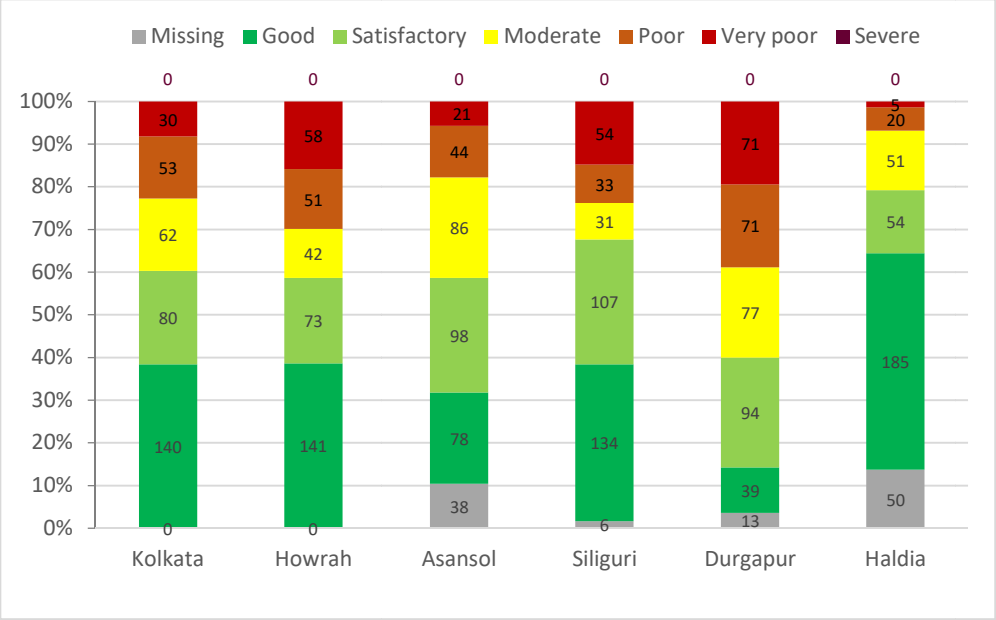
Graph 1: Trend in annual average PM2.5 concentration in cities of West Bengal



Note: PM2.5 values for Kolkata which has seven monitoring stations and Howrah which has three monitoring stations is based on average of these 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

Bad air quality days are substantial and mostly concentrated in winter months. The combined share of days in poor and very poor category of air quality as per the air quality index classification for PM2.5 in 2021 are highest in Durgapur (close to 39 per cent), followed by Howrah (close to 30 per cent), Siliguri (about 24 per cent), Kolkata (22 per cent), Asansol (about 18 per cent) and Haldia (about 7 per cent). Very poor days are highest in Durgapur (19 per cent), followed by Howrah with about 16 per cent, Siliguri 14 per cent, Kolkata 8 per cent, Asansol about 6 per cent, Haldia 1.3 per cent. Days in 'severe' air quality have not been noticed in 2021. Durgapur have had over almost three months of very poor air quality days this year

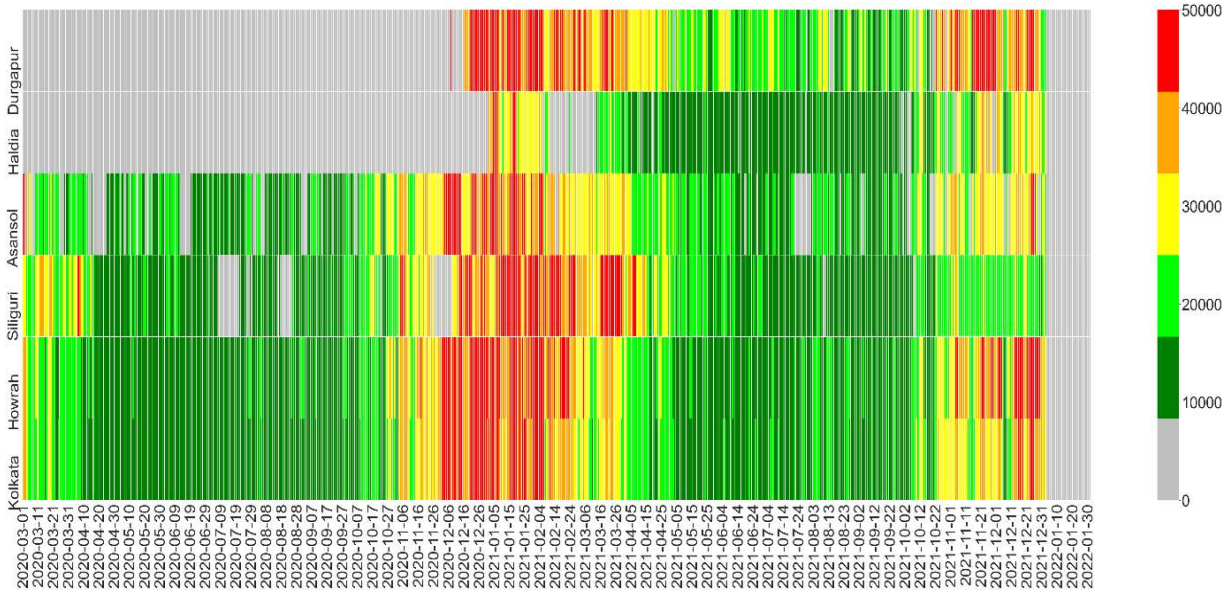
Graph 2: PM2.5 AQI categorization of days for major cities in West Bengal



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

Winter pollution build up is quite synchronised across cities but lasts longer in Siliguri and Durgapur: The pollution heatmap based on daily concentration of PM2.5 concentration shows that poor and very poor days begin to build up in December and subsides by early February in most cities except in Siliguri and Durgapur that persists further. Also Howrah ad Durgapur have more very poor days during November to December compared to Asansol and Kolkata. Kolkata and Asansol have more poor and very poor days during last week of December 2021 (See Graph 3: PM2.5 AQI heatmap calendar for West Bengal cities)

Graph 3: PM2.5 AQI heatmap calendar for West Bengal cities

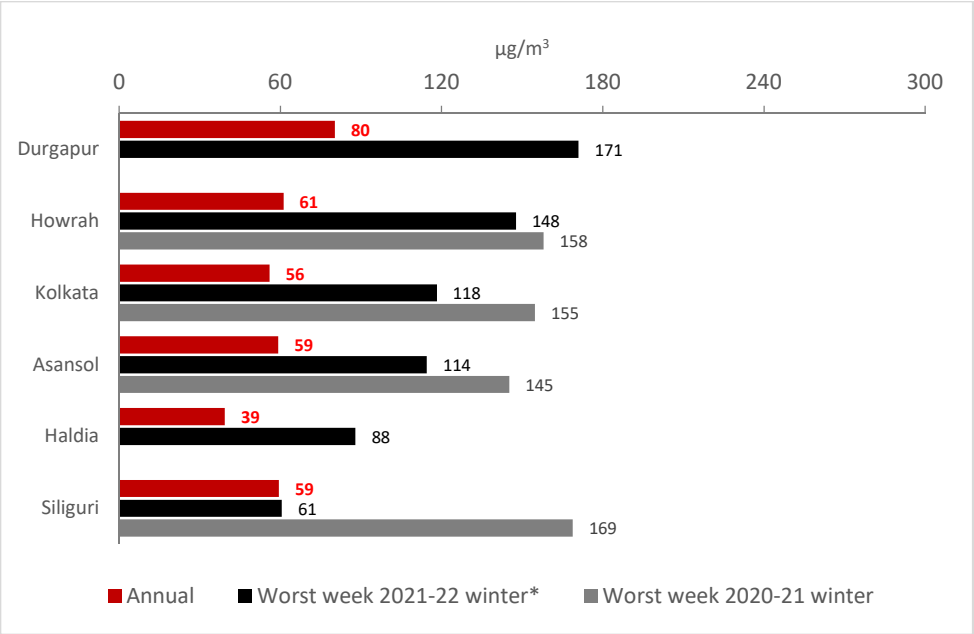


Note: PM2.5 values for cities with more than one monitoring stations is based on average of all stations that have continuous and adequate data for complete assessment period. Cell colours are

based on the official AQI category colours. Data up till 2 January 2022.
Source: CSE analysis of real time data from CPCB portal

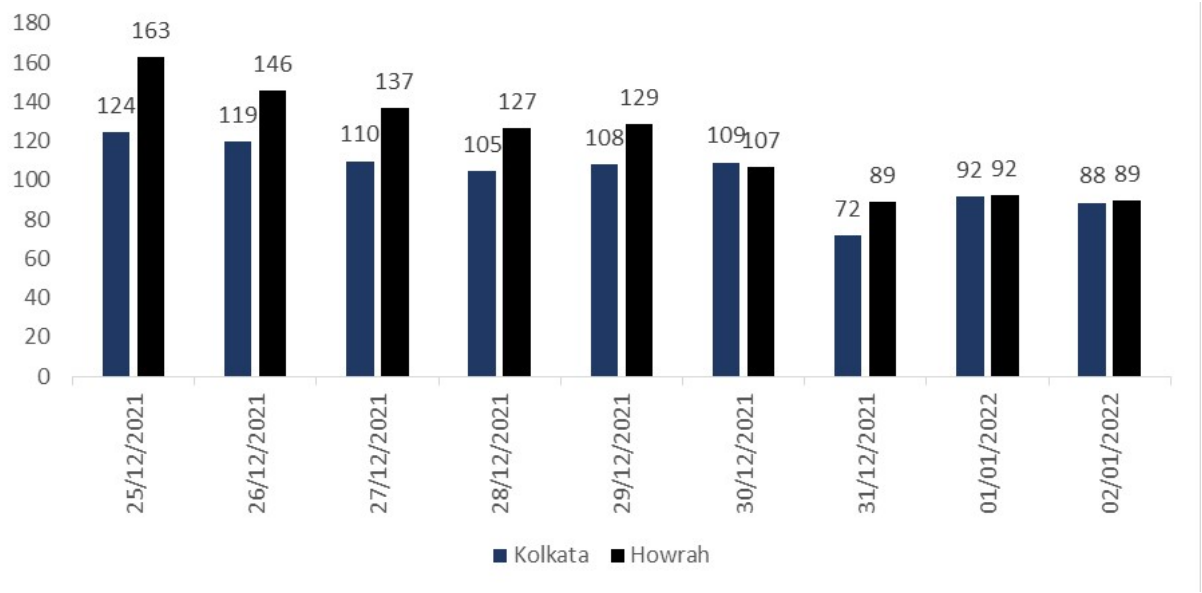
The worst polluted week during winter is several times more polluted than the annual average concentration of the cities: The deterioration in air quality during the worst affected week in winter is substantially worse than the annual average concentration in most cities. In 2021, during the weekly pollution episodes in winter the weekly average of PM2.5 indicates that it was two times higher than the annual average in Durgapur, 2.4 times higher in Howrah, two times higher in Kolkata, 1.9 times in Asansol, and 2 times in Haldia. But in Siliguri looks the worst weekly average in 2021 winter is nearly the same as the annual average, but the 2020 worst week was 2.8 times higher (See Graph 4: Weekly PM2.5 levels vs annual level among Cities of West Bengal).

Graph 4: Weekly PM2.5 levels vs annual level among Cities of West Bengal



Note: 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 2 January 2022.
Source: CSE analysis of real time data from CPCB portal

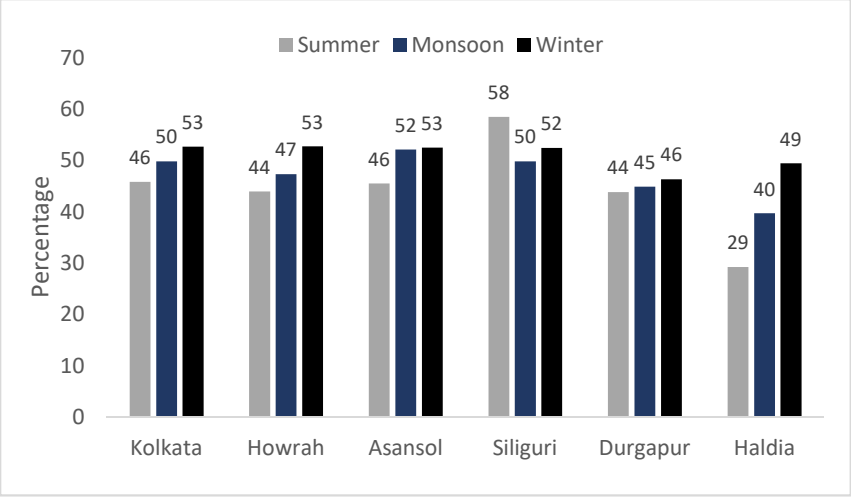
Graph 5: Daily PM2.5 level in Kolkata and Howrah between December 25, 2021 and January 2, 2022



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 6: 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. 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.

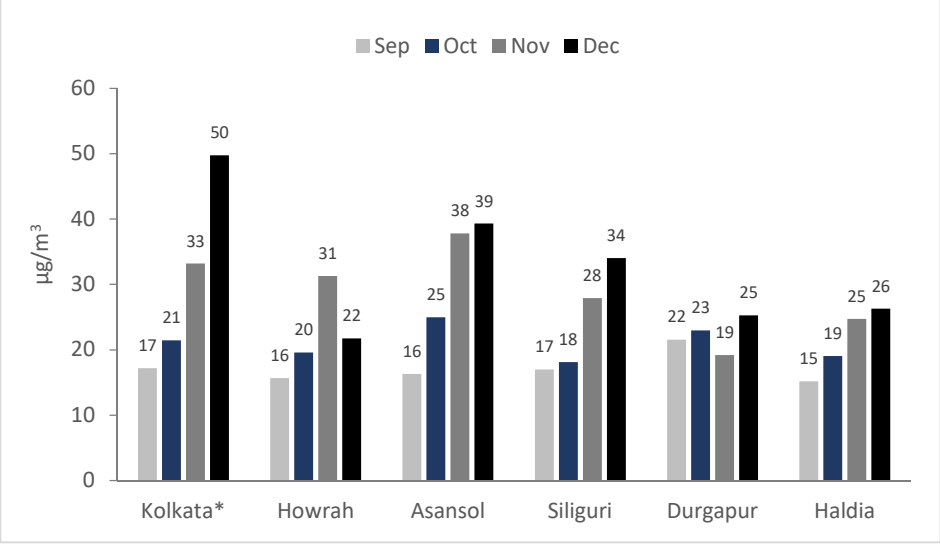
Graph 6: Changing ratio of PM2.5:PM10 during different seasons of 2021



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 is a cocktail of particulates and toxic gases: There is a significant increase in the NO2 concentration during winter in nearly all cities of West Bengal. Kolkata has registered 3 times jump in monthly NO2 level while Asansol has registered a 2.5 times increase (See Graph 7: Monthly trend in NO2 levels in cities of West Bengal). In absolute concentration term, Kolkata has registered the highest monthly average of 50 µg/m3 for December. It is followed by Asansol (39 µg/m3) and Siliguri (34 µg/m3). Howrah recorded higher NO2 levels in November.

Graph 7: Monthly trend in NO2 levels in cities of West Bengal

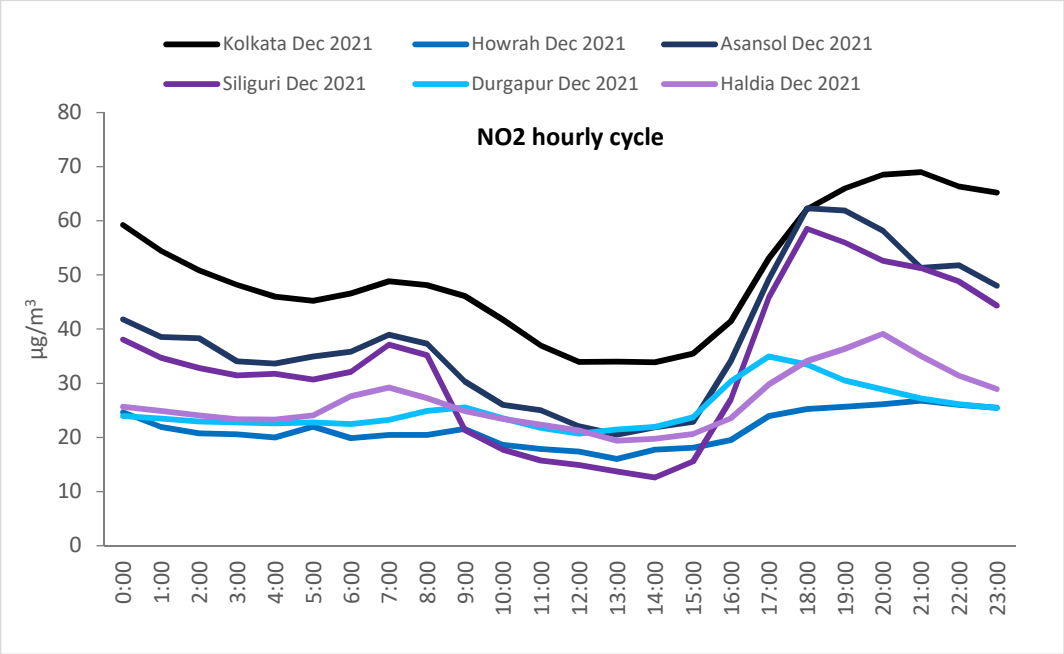


Note: NO2 values for cities with more than one monitoring stations is based on average of all stations that have continuous and adequate data for complete assessment period. Data up till 31 December 2021
Source: CSE analysis of real time data from CPCB portal

NO2 trend corelates strongly with the traffic peaks: All cities show peaking of hourly NO2 concentration between 6pm and 8pm which coincides with evening rush hour in the cities. Hourly NO2 in Kolkata increases 2-folds between noon and 6pm (See Graph 8: Hourly NO2 cycle for December in West Bengal cities). NO2 cycle is equally as sharp among cities Asansol and Siliguri with 3-4 times increase in noted at evening from afternoon. All cities have a morning NO2 peak

around 7-8am but is relatively smaller to evening peak. In Kolkata high NO2 levels persist up till midnight indicating presence of pollution from night-time truck movement in the city.

Graph 8: Hourly NO2 cycle for December in West Bengal 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

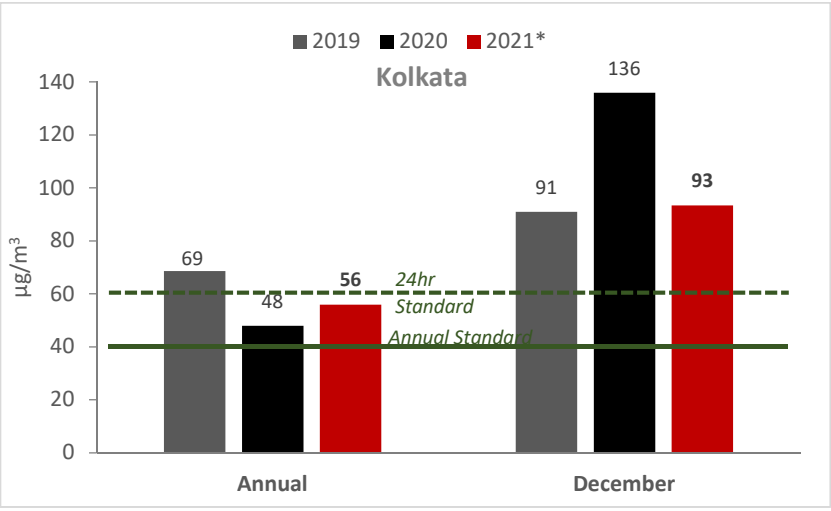
Detail city-wise trends

Kolkata

The annual average of PM2.5 concentration declined in 2020 to increase again in 2021 but it is still lower than 2019. The pandemic and related lockdown phases have contributed to this trend. However, It needs to cut annual average level by 28 per cent to meet the National Ambient Air Quality Standard (NAAQS) for PM2.5. (See Graph 9: PM2.5 annual and winter trend in Kolkata).

During winter, the average for December this year is lesser compared to 2020 December. Past record shows that the most polluted months are December and January.

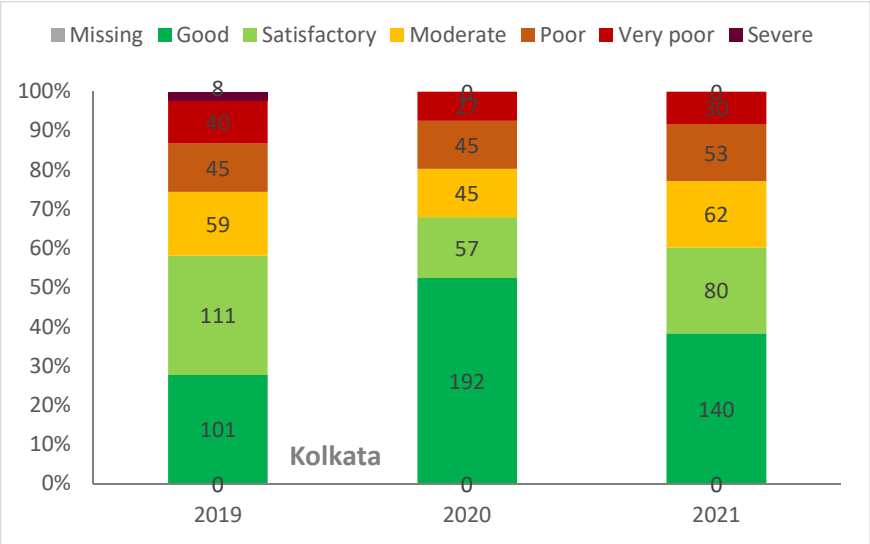
Graph 9: PM2.5 annual and winter trend in Kolkata



Note: PM2.5 values is based on 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

Analysis of days as per the categorisation of the national air quality index related to PM2.5 shows that 8 days in severe air quality category was recorded in 2019 but not after that. The total number of poor, very poor and severe category days have reduced from 93 in 2019 to 83 in 2021. Good air quality days have increased from 101 in 2019 to 140 days in 2021. While satisfactory days (that meet the standards) have reduced from 111 to 80, poor days have increased from 45 to 53. However, 2020 was cleaner with higher number of good air quality days at 192 (See Graph 10: PM2.5 AQI trend in Kolkata).

Graph 10: PM2.5 AQI trend in Kolkata



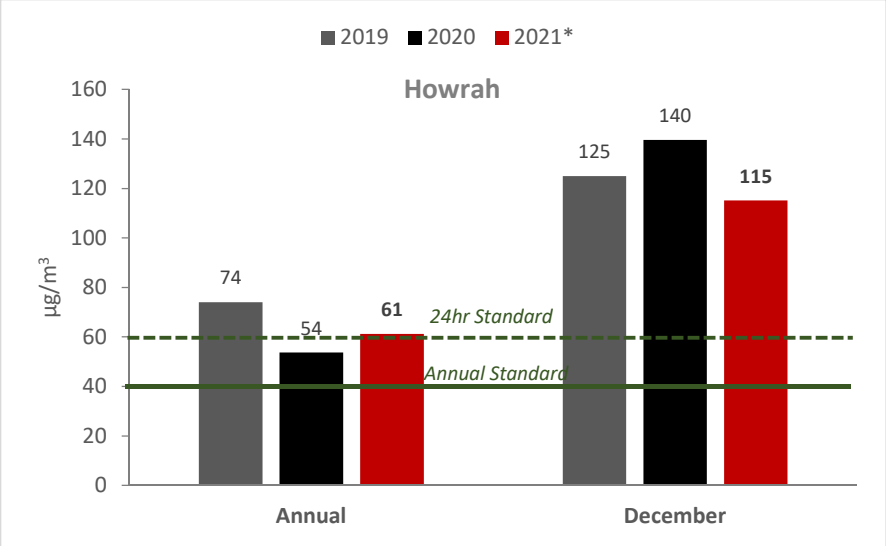
Note: PM2.5 value is based on stations that have continuous and adequate data for complete assessment period. AQI is based on PM2.5 sub-category only. Data up till 31 December 2021.
Source: CSE analysis of real time data from CPCB portal

Howrah

The annual average PM 2.5 concentration declined in 2020 compared to 2019 level but increased again in 2021 (See Graph 11: PM2.5 annual and winter trend in Howrah). Howrah needs to cut annual average concentration by 34 per cent to meet the annual PM2.5 standard.

The monthly average for December (when pollution level normally peak), this year is lesser compared to the corresponding last two years.

Graph 11: PM2.5 annual and winter trend in Howrah

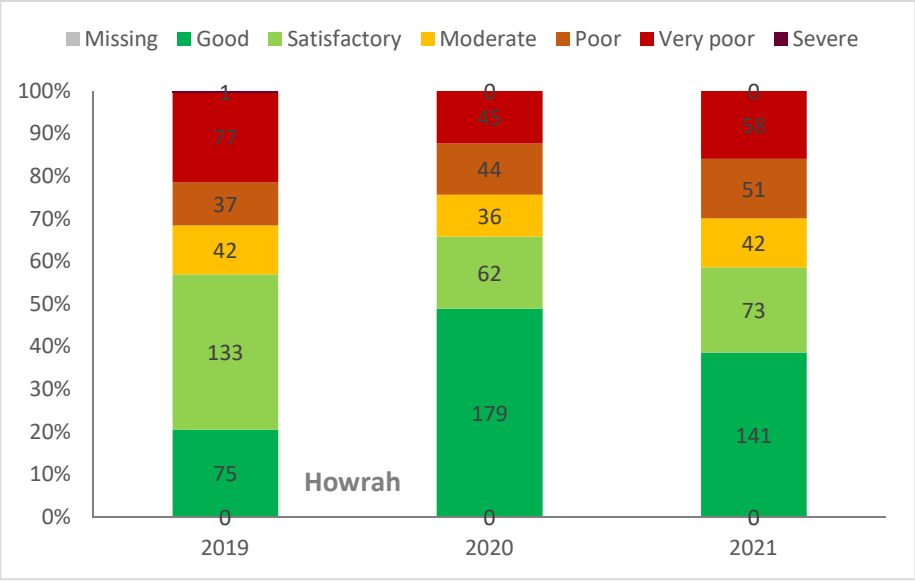


Note: PM2.5 values is based on stations that have continuous and adequate data for complete assessment period. Data up till 31 December 2021.
Source: CSE analysis of real time data from CPCB portal

Analysis of days as per the categorisation of the national air quality index related to PM2.5 shows that very poor days have declined from 77 (there was only one severe day) in 2019 to 58 very poor days in 2021. But this is an increase from 45 very poor days in 2020 which was a cleaner year. Good air days (that is 50 per cent below the standard) have also increased from 75 in 2019 to 141 in 2021 though 2020 had much higher number of good air days at 179. But the number of poor days have increased overall in Howrah.

the city is experiencing increasingly higher number of days with poor air quality, and most of these days are concentrated during winter months. Also the Number of days with good air quality has declining from 179 in 2020 to 141 in 2021 (See Graph 12: PM2.5 AQI trend in Howrah).

Graph 12: PM2.5 AQI trend in Howrah

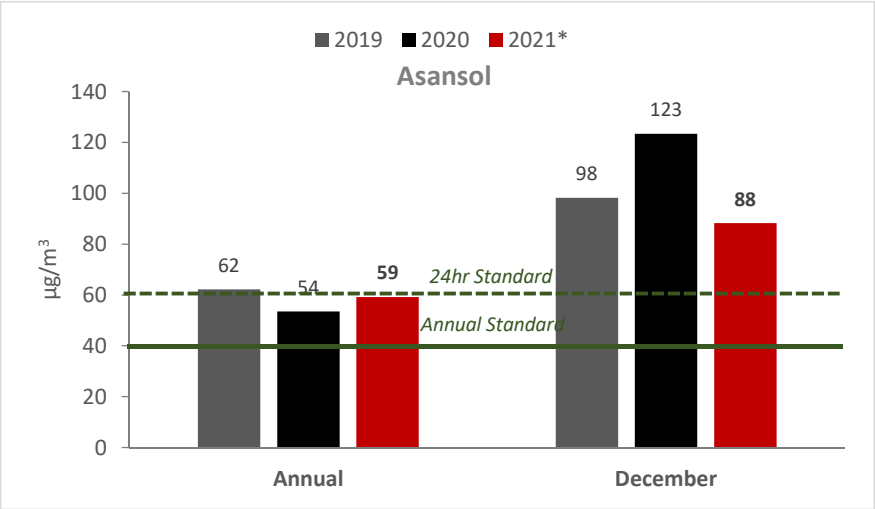


Note: PM2.5 value is based on stations that have continuous and adequate data for complete assessment period. AQI is based on PM2.5 sub-category only. Data up till 31 December 2021.
Source: CSE analysis of real time data from CPCB portal

Asansol

The annual PM2.5 levels seem to have stabilised in Asansol and is downward. But Asansol needs to cut annual average PM2.5 level by at least 32 per cent to meet the standard. (See Graph 13: PM2.5 annual and winter trend in Asansol). Further, December pollution this year is lesser compared to last two Decembers.

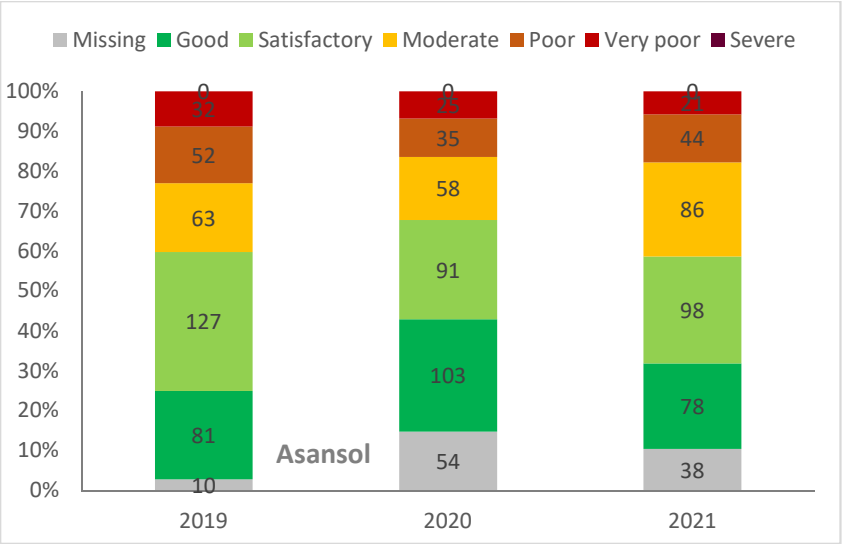
Graph 13: PM2.5 annual and winter trend in Asansol



Note: PM2.5 values is based on 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

Categorisation of the national air quality index shows that the city has not experienced severe levels. The number of days in very poor category has reduced from 32 in 2019 to 21 in 2021. Similarly, the number of poor air quality days have reduce from 52 in 2019 to 44 in 2021. However, there are data gaps as data is not available for 38 days in 2021. (See Graph 14: PM2.5 AQI trend in Asansol). 2020 was comparatively a cleaner year.

Graph 14: PM2.5 AQI trend in Asansol

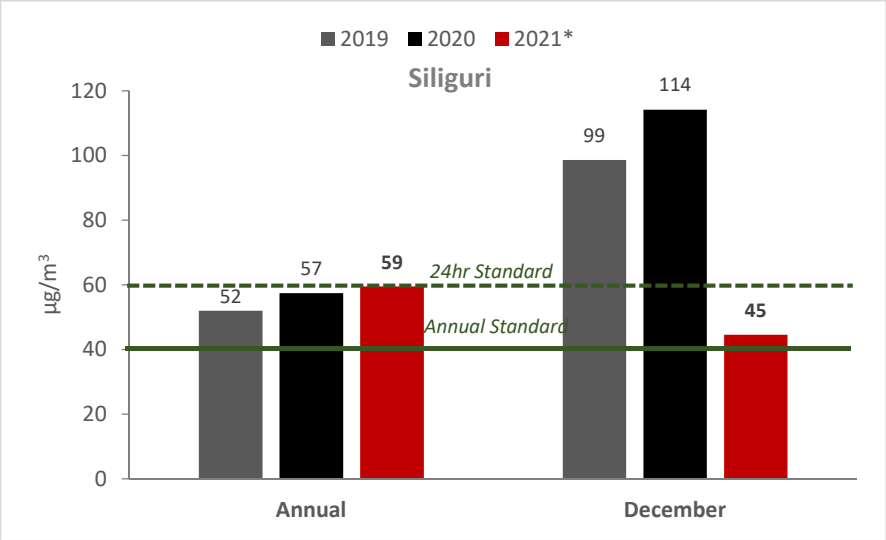


Note: PM2.5 value is based on stations that have continuous and adequate data for complete assessment period. AQI is based on PM2.5 sub-category only. Data up till 31 December 2021.
Source: CSE analysis of real time data from CPCB portal

Siliguri

The annual average level of PM2.5 is showing a rising trend in Siliguri. This has steadily increased from 52 ug/m3in 2019 to 59 ug/m3in 2021 City.. It does not meet the annual standard for PM2.5. Siliguri needs to cut annual average level of PM2.5 by 32 per cent to meet the standard (See Graph 15: PM2.5 annual and winter trend in Siliguri). Further, December pollution this year is far lesser compared to last two Decembers.

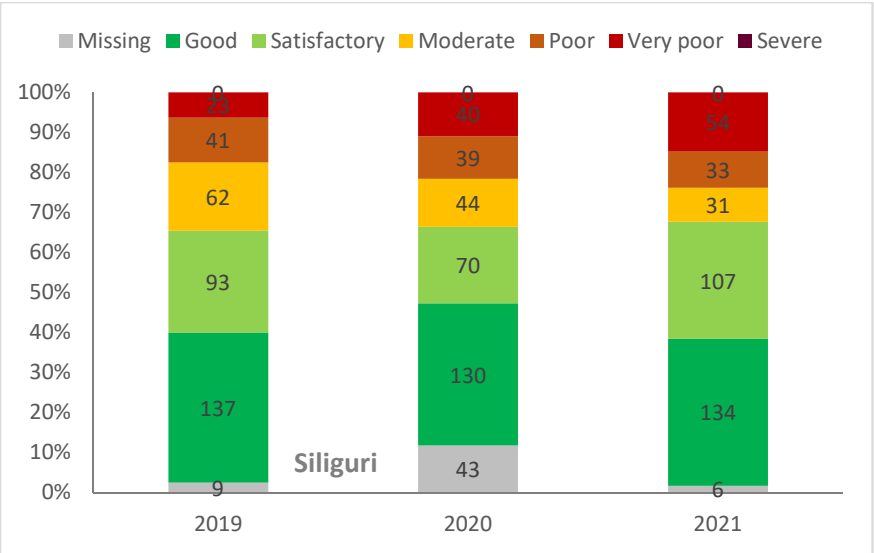
Graph 15: PM2.5 annual and winter trend in Siliguri



Note: PM2.5 values is based on 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

Analysis of days as per the categorisation of the national air quality index shows that the number of very poor days have increased dramatically from 23 in 2019 to 54 in 2021. Even in 2020 it was on higher side at 40. (See Graph 16: PM2.5 AQI trend in Siliguri).

Graph 16: PM2.5 AQI trend in Siliguri



Note: PM2.5 value is based on stations that have continuous and adequate data for complete assessment period. AQI is based on PM2.5 sub-category only. Data up till 31 December 2021.
Source: CSE analysis of real time data from CPCB portal