Tracking overall and winter air pollution in the western region -- cities of Maharashtra and Gujarat

Anumita Roychowdhury, Avikal Somvanshi and Sharanjeet Kaur

Centre for Science and Environment, New Delhi, January 12, 2022

When the winter inversion triggers smog episode and engulfs entire North India, the western region by contrast looks cleaner. But air pollution is a matter of concern in the western states of Maharashtra and Gujarat too. Winter pollution sets in these states during late December and early January when cooler and calmer conditions trap local pollution that is high. Even though the trapping of winter pollution in the western region is not as high as that of the Indo Gangetic plain due to its proximity to the sea and improved ventilation, the levels increase despite the geographical advantages and favorable meteorology, finds the latest analysis by the Centre for Science and Environment (CSE).

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. Also in many cases the levels are even higher than 2019. Number of bad air days in Mumbai have doubled between 2019 and 2021, good days are down by 20 per cent. 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 Maharashtra and Gujarat, 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 9th 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 56 continuous ambient air quality monitoring stations (CAAQMS) spread across 15 cities in two states: Maharashtra -- one station each in Aurangabad, Kalyan, Nagpur, Nashik and Solapur, two stations in Chandrapur, four stations in Navi Mumbai, eight stations in Pune, and 21 stations in Mumbai; Gujarat - one station each in Ankleshwar, Nandesari, Vapi, and Vatva, four stations in Gandhi Nagar, and eight stations in Ahmedabad.

Even though there are multiple real time monitors in a few cities of these states but many could not be considered for long term analysis 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 Gujarat have got their real time monitors in June 2021. Many stations in Maharashtra have got their real time monitors in June 2019 and November 2020. Thane station stopped reporting PM2.5 data in early 2019, therefore it could not be included in this analysis.

Summary highlights of key findings

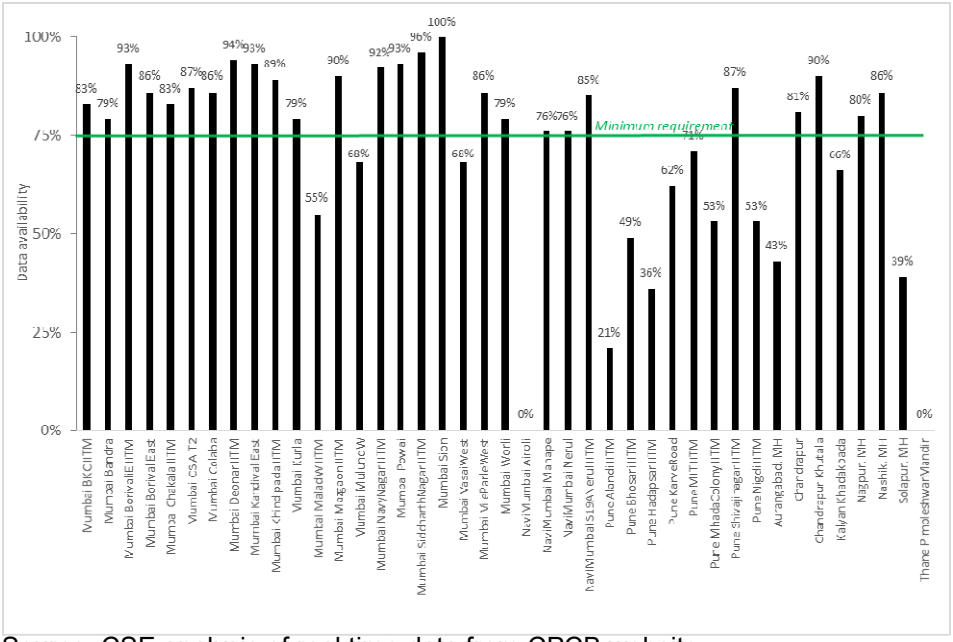
Challenge of data gaps and quality despite automation: Review of data availability from the automated monitoring stations in the region under Continuous Ambient Air Quality Monitoring Stations (CAAQMS) program of CPCB, shows major data gaps. Data availability calculated as number of days with adequate PM2.5 data for computation of a valid 24hr-average has been low in five of the twelve cities in the region. For the year 2021 (June to December) data availability at Airoli station of Navi Mumbai and Pimpleshwar Mandir station of Thane has zero per cent of data availability. Alandi & Hadapsar station of Pune has been just 21 and 36 per cent and Solapur station has just 39 per cent respectively.

Among Mumbai stations Kurla has only 55 per cent data while Malad West in Mumbai with 68 per cent. Kalyan and Aurangabad are data poor as well with 66 per cent and 43 per cent data availability respectively. Only one out of eight stations of Pune meet the minimum requirement as

they have data availability of less than 75 per cent (See Graph 1: Data availability at real time monitoring stations of Maharashtra in June-Dec, 2021). It is not clear why these stations have such poor data availability despite minimal problems of electricity and internet connectivity in the region. This requires an assessment.

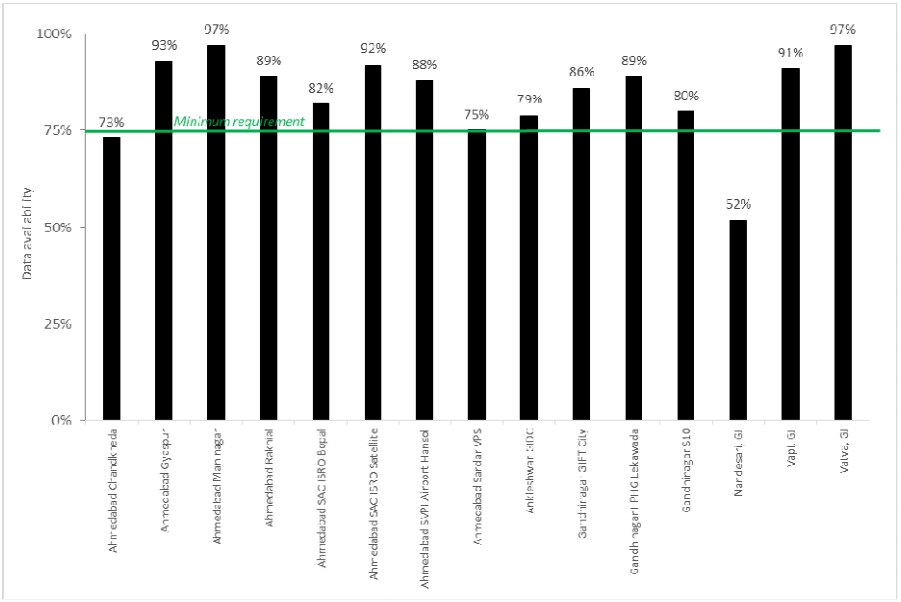
In contrast most stations of Gujarat perform better as they have data availability of more than 85 per cent (See Graph 2: Data availability at real time monitoring stations of Gujarat in June-Dec, 2021). Only stations at Chandkheda in Ahmedabad, and Nandesari are below the minimum 75 per cent data availability requirement.

Graph 1: Data availability at real time monitoring stations of Maharashtra in June-Dec, 2021



Source: CSE analysis of real time data from CPCB website

Graph 2: Data availability at real time monitoring stations of Gujarat in June-Dec, 2021



Source: CSE analysis of real time data from CPCB website

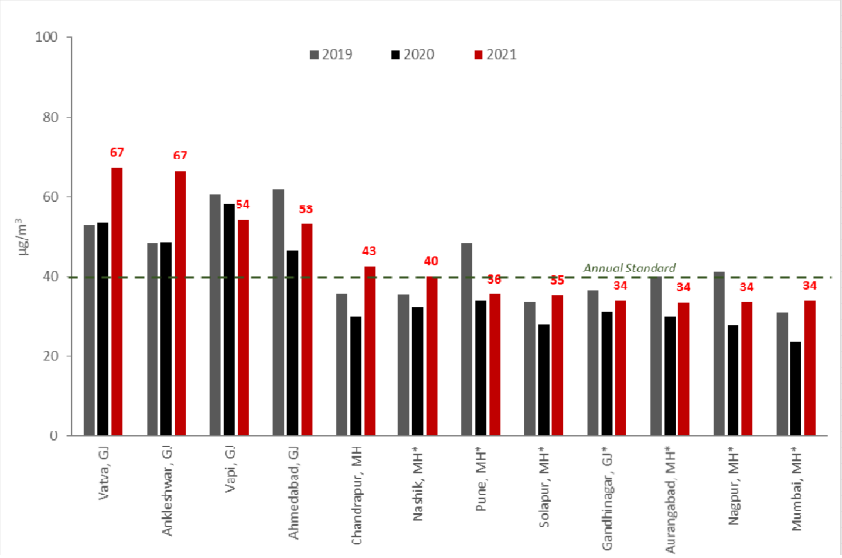
Most cities show a rising trend in annual PM2.5 level after an initial drop during 2020 with more pandemic related lockdown phases: Nearly all cities in the region show a drop in annual average PM2.5 level in 2020 that was also the year with maximum lockdown phases. But there is a rebound and a rising trend once again in 2021. Gujarat cities are much more polluted than Maharashtra. Vatva and Ankleshwar in Gujarat, has the most polluted air in the region with 2021

average at 67 ug/m3. This is followed by Vapi and Ahmedabad with 2021 annual average of PM2.5 at 54 ug/m3 and 53 ug/m3 respectively (See Graph 3: PM2.5 trend among cities of Maharashtra and Gujarat – 2019-2021).

In Maharashtra, Chandrapur, an industrial city has recorded levels marginally above the annual standard at 43 ug/m3. Other stations have met the annual standard though all of them are showing a rising trend in 2021 after the dip in 2020.

If the real time data is taken as an indicator, in Gujarat, Vatva and Ankleshwar needs to reduce annual average PM2.5 by 40 per cent to meet the annual PM2.5 standard, Vapi 25 per cent, and Ahmedabad Maninagar 24 per cent.

Graph 3: Long term PM2.5 trend among cities of Maharashtra and Gujarat (2019-2021)

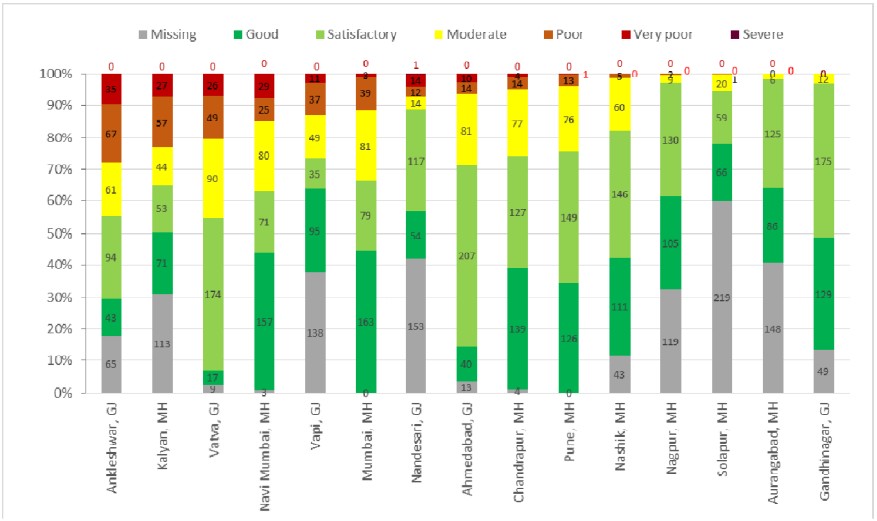


Note: PM2.5 values for Chandrapur which has two monitoring stations is based on average of both stations. Data for only those stations is considered that have continuous and adequate data for complete assessment period. Data up till 31 December 2021. Source: CSE analysis of real time data from CPCB website

Despite low annual levels cities of Maharashtra experience high number of days with 'poor' and 'very poor' AQI: With 102 days of poor and very poor AQI Ankleshwar, Gujarat has the unhealthiest days in the region. It is followed by Kalyan with 84 days, Vatva with 75 days, and Navi Mumbai with 54 days. Vapi has 48 days of poor and very poor AQI. However, data is missing for 138 days (mainly for winter months). Mumbai has registered 42 days of poor and very poor AQI despite meeting the annual standard (See Graph 4: PM2.5 based AQI categorization of days for major cities in Maharashtra and Gujarat – 2021).

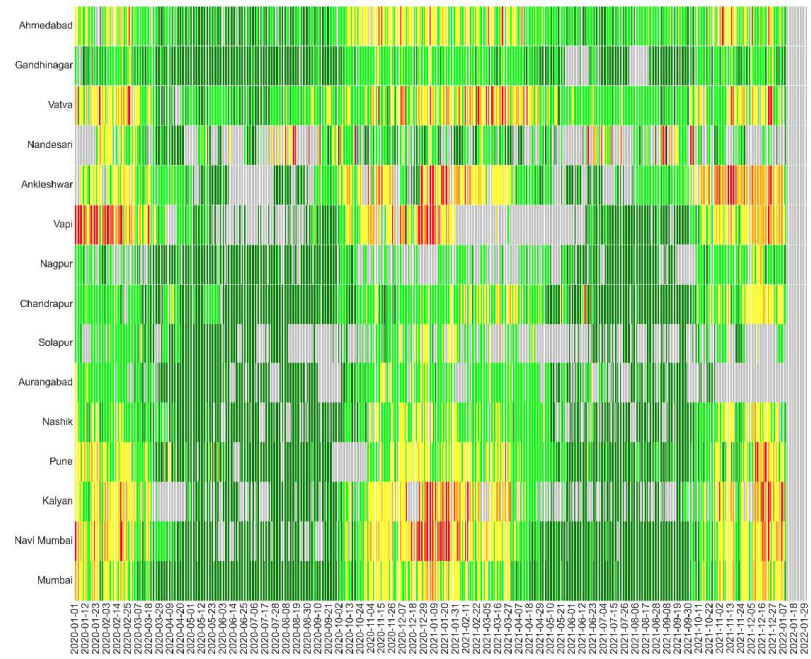
Bad air days begin to build up around the same time in the cities of western states during end of December and persists till end of January. Cities in the Mumbai Metropolitian Region show more pronounced impact of winter pollution compared to cities of other regions. Industrial towns show bad air days across the year but there is some clustering during winter (See Graph 5: Heatmap based on days classified as per PM2.5 air quality index for major cities Maharashtra and Gujarat).

Graph 4: PM2.5 based AQI categorization of days for major cities in Maharashtra and Gujarat – 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 5: Heatmap based on days classified as per PM2.5 air quality index for major cities in Maharashtra and Gujarat

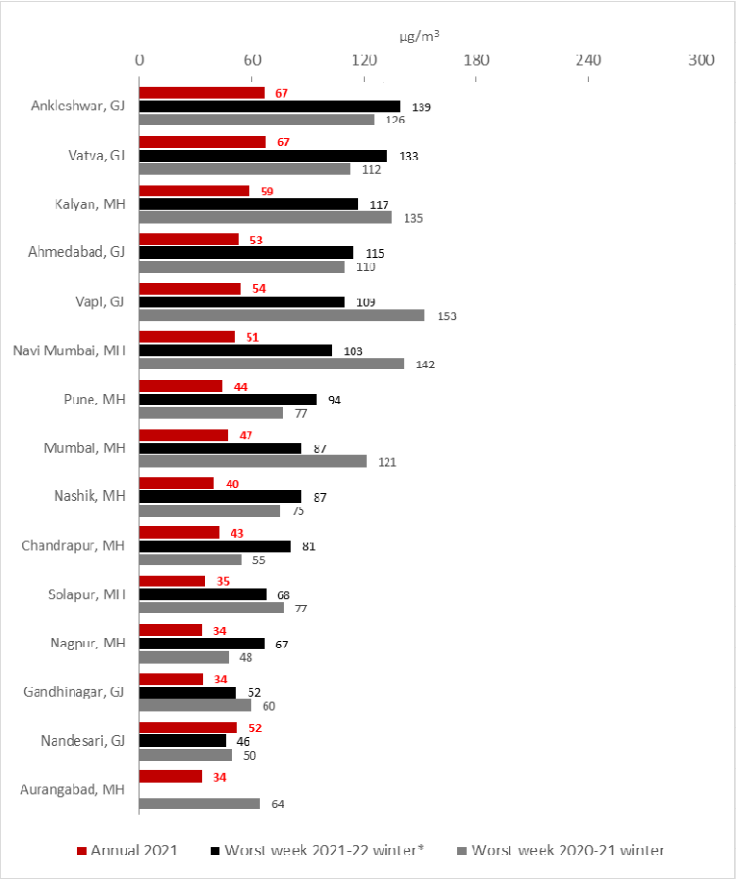


Note: PM2.5 values for cities with more than one monitoring stations is based on average of all stations that have continuous and adequate data for complete assessment period. Cell colors are based on the official AQI category colors. Data up till 9 January 2022. Source: CSE analysis of real time data from CPCB portal

The levels during high weekly pollution episode in 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 139 ug/m3 as recorded in Ankleshwar in December 2021 (See Graph 6: Weekly PM2.5 levels vs annual level among in cities of Maharashtra and Gujarat). This winter so far the highest weekly level was 133 ug/m3 in Vatva, 117 ug/m3 in Kalyan, 115 ug/m3 in Ahmedabad Maninagar, 109 ug/m3 Vapi, and 103 ug/m3 in Navi Mumbai. The levels are marginally higher this winter compared to last winter with Chandrapur being the highest which shows 1.5 times increase comparing to previous winters.

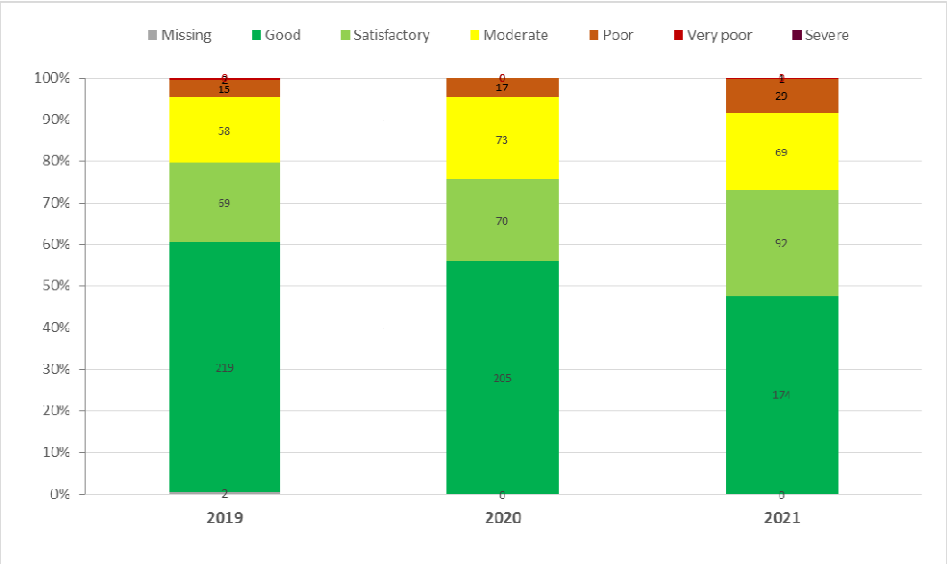
Graph 6: Comparison of worst weekly PM2.5 levels with annual average level in Cities of Maharashtra and Gujarat



Note: Worst week for Ahmedabad Maninagar were weeks ending on 7 Nov 2021 and 15 Nov 2020; Ankleshwar were weeks ending on 14 Nov 2021 and 1 Nov 2020; Gandhinagar S10 were weeks ending on 26 Dec 2021 and 15 Nov 2020; Vapi were weeks ending on 26 Dec 2021 and 10 Jan 2021. Vatva were weeks ending on 26 Dec 2021 and 24 Jan 2021; Nandesari were weeks ending on 26 Dec 2021 and 10 Jan 2021. Worst week for Kalyan were weeks ending on 26 Dec 2021 and 10 Jan 2021; Navi Mumbai were weeks ending on 19 Dec 2021 and 24 Jan 2021; Mumbai were weeks ending on 19 Dec 2021 and 10 Jan 2021; Pune were weeks ending on 14 Nov 2021 and 27 Dec 2020. Nashik were weeks ending on 12 Dec 2021 and 3 Jan 2021; Nagpur and were weeks ending on 19 Dec 2021 and 31 Jan 2021; Solapur were weeks ending on 12 Dec 2021 and 3 Jan 2021; Chandrapur were weeks ending on 19 Dec 2021 and 31 Jan 2021. Data up till 9 January 2022. Source: CSE analysis of real time data from CPCB portal

Number of bad air quality days are increasing in Mumbai: Over the years the air quality in Mumbai seems to be declining. Daily AQI analysis based on 10 oldest stations shows 20 per cent drop in number of good AQI days in the city between 2019 and 2021. While days with poor or very poor AQI have doubled (See Graph 11: Trend in PM2.5 AQI in Mumbai 2019-21).

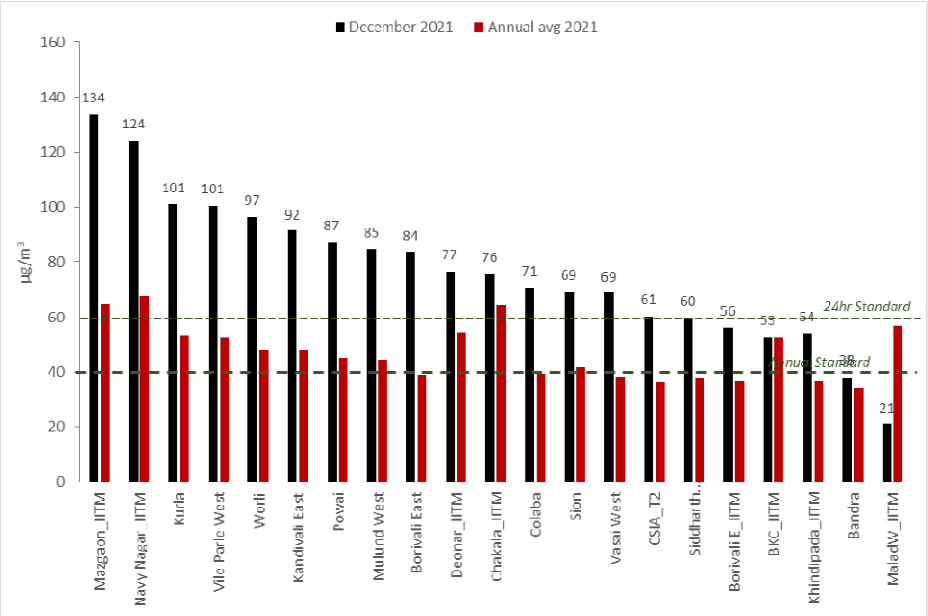
Graph 11: Trend in PM2.5 AQI in Mumbai 2019-21



Note: PM2.5 values for Mumbai is based on average of 10 oldest 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

South Mumbai has the worst air within the city during winter: The stations in the south Mumbai report significantly higher PM2.5 levels compared to rest of the city this past December. Mazgaon with monthly average of 134 ug/m3 was the most polluted neighborhood of the city followed by Navy Nagar-Colaba (124 ug/m3), Kurla (101 ug/m3), Vile Parle West (101 ug/m3) and Worli (97 ug/m3). Khindipada at the edge of Sanjay Gandhi National Park in the suburbs with monthly average of 54 ug/m3 was the least polluted neighborhood. Bandra and Malad West report low numbers but the values are not considered valid due to significantly large amount of missing data from these two stations. (See Graph 12: Station wise PM2.5 levels within Mumbai).

Graph 12: Station wise PM2.5 levels within Mumbai



Source: CSE analysis of real time data from CPCB website

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),

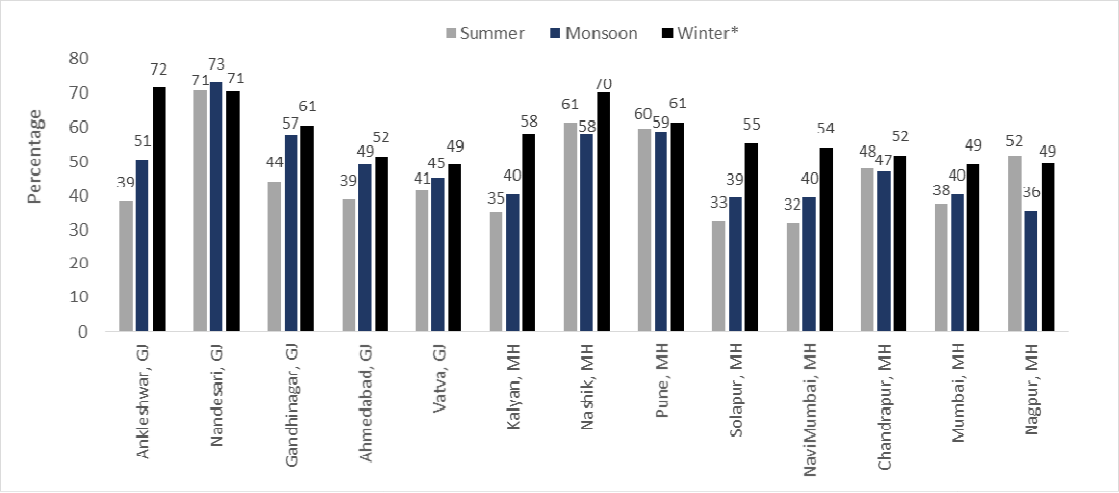
monsoon (June - October), and winter (November – January). (See Graph 7: Changing ratio of PM2.5:PM10 during different seasons of 2021).

The PM2.5/PM10 ratio in all the cities of these states has an increasing slope from summer to winter except Nagpur, which is showing high percentage of PM2.5/PM10 ratio in summers with 52 per cent and then gradually dropping to 36 per cent in monsoon which again spikes to 49 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 between 50 to 60 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.

In Gujarat, Nandesari has the highest PM2.5/PM10 ratio in all the three seasons with the PM2.5 share as high as 71 per cent in winter. Ankleshwar is showing high percentage of PM2.5/PM10 ratio in winters with 72 percent. The highest percentage of PM2.5/PM10 ratio in monsoon was at 73 percent in Nandesari Overall in Gujarat the concentration of PM2.5/PM10 ratio is higher during winter (November to January).

Nasik in Maharashtra recorded the highest percentage of PM2.5/PM10 ratio in winters with 70 percent. Vapi in Gujarat and Aurangabad in Maharashtra has data gaps for the month for summer and winter season. Therefore, these stations has not been included in this analysis (See Graph 7: Changing ratio of PM2.5:PM10 during different seasons of 2021).

Graph 7: Changing ratio of PM2.5:PM10 during different seasons of 2021



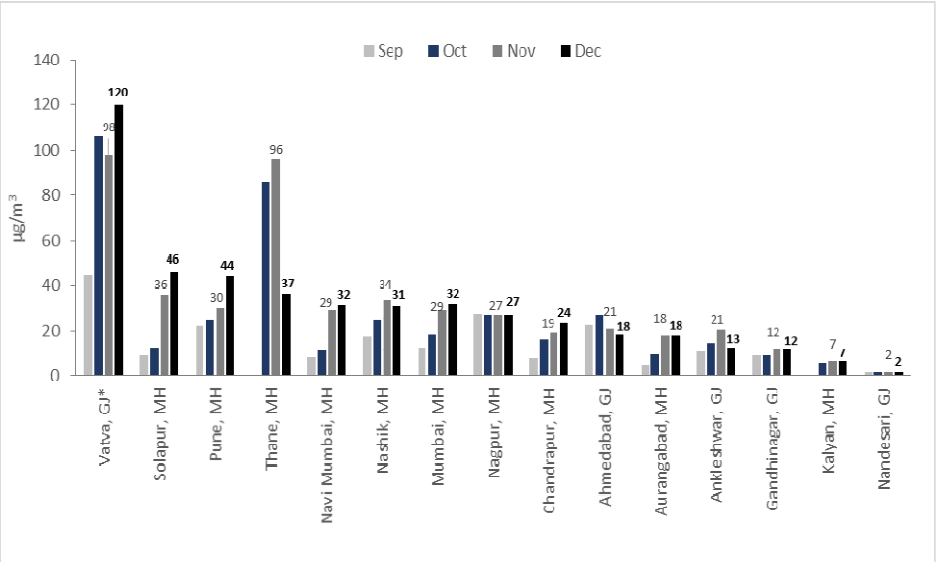
Note: Average PM2.5 concentration for a week is based on mean of all CAAQM stations in the city. Data up till 9 January 2022. Source: CSE analysis of CPCB's real time air quality data

Winter pollution can be a toxic cocktail of particulate and gases: There is a significant increase in amount of nitrogen dioxide (NO_2) in air of all cities of western states during December compared to the previous months of November, October and September. Solapur registered 4.9 times jump in monthly NO_2 level, Navi Mumbai registered a 3.9 times increase while Aurangabad with 3.6 times increase, Chandrapur with 3 times increase, Vatva with 2.7 times increase and Mumbai registered a 2.5 times increase (See Graph 8: Monthly trend in nitrogen dioxide levels in cities of Maharashtra and Gujarat).

In absolute concentration term, Vatva registered the highest monthly average of 120 µg/m3 for December. This is higher than 24-hr standard for NO_2. It is followed by Solapur (46 µg/m3) and Pune (44 µg/m3). Such high levels are not recorded even in North Indian cities.

Thane showed a dramatic increase in amount of NO_2 in month of November and October as compared to December. It has a missing data for the month September (See Graph 8: Monthly trend in nitrogen dioxide levels in cities of Maharashtra and Gujarat). Vapi station in Gujarat is not included in the analysis due to data gaps.

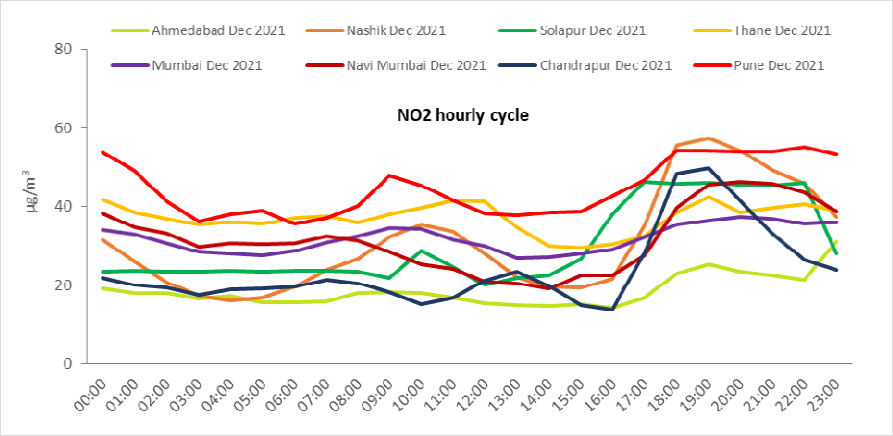
Graph 8: Monthly trend in nitrogen dioxide levels in cities of Maharashtra and Gujarat



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 correlate 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 Vatva increases 3.4-folds between noon and 7pm (See Graph 9: Hourly NO2 cycle for December in cities of Maharashtra and Gujarat). NO2 cycle is equally as sharp in Nashik and Navi Mumbai with 2.6-2.2 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 Pune, Mumbai, and Ahmedabad high NO2 levels persist uptill midnight indicating presence of pollution from night-time truck movement in the city.

Graph 9: Hourly NO2 cycle for December in cities of Maharashtra and Gujarat



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

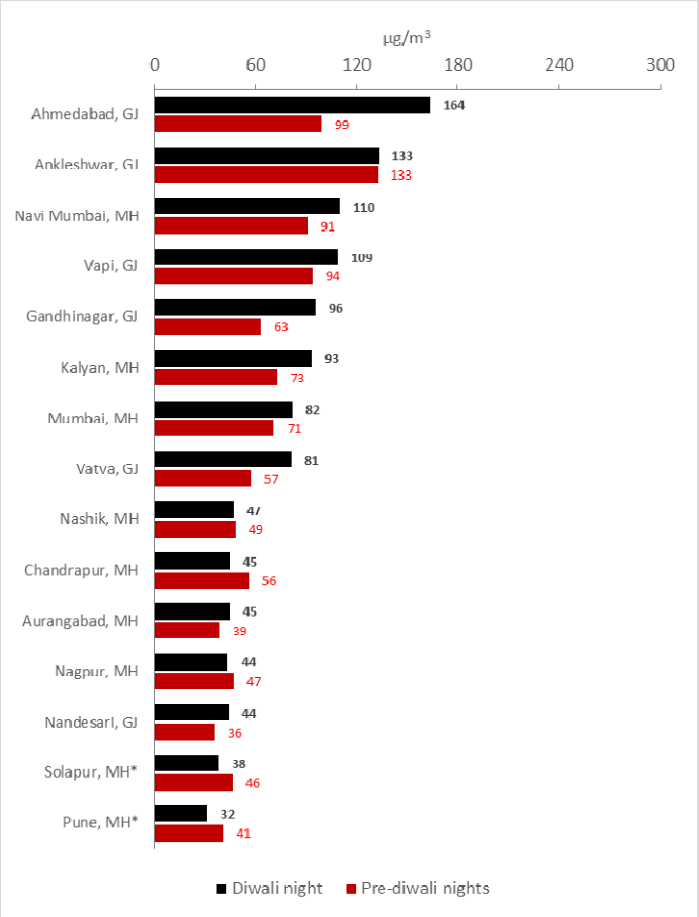
Diwali is a mega pollution event: Pollution level on Diwali night (8pm to 8am) in cities of east shot up by 0.8 – 1.6 times the average level recorded seven nights preceding Diwali (See Graph 10: Diwali night pollution among cities of Maharashtra and Gujarat). Ahmedabad had the greatest pollution build-up on Diwali night with a 1.6-fold increase in night-time PM2.5, followed by Ankleshwar that saw 1 fold increase i.e, it is almost same on Diwali and seven night preceding Diwali.

Chandrapur, Nagpur, Nashik, Solapur, and Pune registered low PM2.5 levels on Diwali night comparing to seven night preceding Diwali. Solapur and Pune registered very low PM2.5 levels on Diwali showing little impact, and also met the annual average standard.

In absolute concentration terms, Ahmedabad dominate the list of most polluted Diwali nights with 164 µg/m3 PM2.5 level. Pollution was very high among all other major cities as well on Diwali night

with Ankleshwar (133 ug/m3), Navi Mumbai (110 ug/m3), and Vapi (109 ug/m3) crossing 100 ug/m3 mark.

Graph 10: Diwali night pollution among cities of Maharashtra and Gujarat



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

Way ahead

The western region has its own unique challenges and will have to be addressed. 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. Key industrial towns and clusters are located in these two states that require attention. Maharashtra is among the states with highest number of non-attainment cities under the national clean air programme.

Stronger multi-sector interventions are needed to reduce pollution in a time bound manner and to meet the national ambient air quality standards and prevent further worsening of the trend. This requires massive scaling up of the access to clean fuel and technology in industry and power plants, transformation of public transport, walking and cycling at a scale, renewal of vehicle fleet, rapid electrification of new vehicle fleet, amendment of municipal bylaws based on central waste management rules and regulations and scaling up of infrastructure for management and recycling of all waste streams, elimination of solid fuels for cooking, controlling dust from construction sector and adopting greening and afforestation strategy for dust control. This agenda is non-negotiable to meet the clean air target.