$PM_{2.5}$ levels in NCAP and non-NCAP cities: Blurred difference

Broaden the action to combat air pollution in all cities and across all regions

Anumita Roychowdhury and Avikal Somvanshi
Research inputs: Sharanjeet Kaur

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On the occasion of the UN International Day of Clean Air for Blue Sky, the Centre for Science and Environment (CSE), based on its latest analysis, shows that there is barely any difference in overall PM2.5 trends between the group of cities under the National Clean Air programme (NCAP) and those outside its ambit. Both reflect similar mixed trends in air quality in different climatic zones requiring substantial reduction to meet the national ambient air quality standards for particulate matter.

Even though the NCAP has set a national level target of 20–30 per cent reduction of $PM_{2.5}$ and PM_{10} concentration by 2024 from the 2017 base year, the latest performance assessment by the Central Pollution Control Board of NCAP cities for disbursement of performance linked funds has considered only PM_{10} data that is largely coarse dust particles. As the monitoring of $PM_{2.5}$, the tinier particles that are more harmful, is limited, a uniform assessment of cities based on $PM_{2.5}$ reduction has not been considered for performance assessment.

The National Clean Air Programme (NCAP) covers 132 cities. 82 cities have been funded under NCAP and 50 cities under 15th Finance Commission. Rs 6,425 Cr has been released till 2021-22 and Rs. 2,299 Cr has been earmarked for 2022-23. Cities are required to quantify improvement starting 2020-21 that requires 15 per cent and more reduction in the annual average PM_{10} concentration and concurrent increase in good air days to more than 200. Anything less than that will be considered low and reduce the funding.

CSE has carried out national analysis of $PM_{2.5}$ levels in cities for which data is available to understand the trend in both NCAP and non-NCAP cities, and the level of reduction needed in both the groups of cities to meet the national clean air standards. This has also brought out the status of air quality monitoring in terms of manual and real time monitoring, extent of PM_{10} and $PM_{2.5}$ monitoring in cities, and challenges of data quality to construct and verify a longer term air quality trend.

Background on NCAP cities: There are 132 cities on hook for cleaning their air under two separate central government programs. There are 124 non-attainment cities notified by CPCB which are given a target of reducing their air pollution by 20-30 per cent by 2024 under the National Clean Air Program (NCAP). At same time, the 15th Finance Commission (FC-XV) is providing funds to 42 out of 50 cities/urban agglomerations with million-plus population in India to clean their air. Eight million-plus cities/urban agglomerations (all seven Kerala cities/urban agglomerations and Coimbatore) were excluded from FC-XV beneficiary list as MoEFCC concluded that air pollution is not a major problem in these cities and thus they don´t need support from FC-XV.

Of the 132 cities, 34 cities are both non-attainment and FC-XV cities. There are eight cities which are FC-XV cities but are not non-attainment, namely Faridabad, Meerut, Chennai, Vasai–Virar, Jabalpur, Ranchi, Jamshedpur, and Rajkot.

Cities included or excluded in these funding schemes are exclusively decided by manual monitoring data from National Air Quality Monitoring Programme (NAMP). Data from Real-Time Ambient Air Quality Monitoring Network which uses Continuous Ambient Air Quality Monitoring Stations (CAAQMS) has not been considered in this process. Due to which no Haryana city is included in the non-attainment list as most don´t have manual monitoring and three cities which did have manual monitors have not reported any data since 2015. In fact, due to lack of manual monitoring in NCR only four cities of the region, namely Ghaziabad, Noida, Khurja and Alwar, are on the non-attainment list.

This is despite the known fact that at least 26 NCR cities/towns are highly polluted given the data available from official realtime monitoring in them.

Moreover, CAAQMS are essential for reporting AQI to the public especially in cities that are deemed non-attainment. It is critical for raising awareness about daily local air quality and alerting the public to take steps to safeguard their health in event of high pollution episodes. CAAQMS also have proven to be a more reliable and consistent source of air quality data compared to manual monitors. In 2019, 84 per cent of the 314 manual PM2.5 monitors in the country didn't meet the minimum 104 days of monitoring as per the NAMP 2019 report (last official report that published information on monitoring days). Meanwhile, 87 per cent of 332 CAAQMS have over 104 days of monitoring data in 2021. Therefore, CAAQMS network also provides much more robust and credible means to track progress in air quality for the purpose of NCAP.

Methodology: This analysis has included 332 realtime monitoring stations in India spread across 172 cities in 27 states and union territories that were active in 2021. This study has relied on data that is publicly available on CPCB website. However, the Minutes of the 5th meeting of the steering committee of the NCAP programme dated July 29, 2022 has listed more stations. Accordingly there are currently 882 manual stations in 378 cities and there are 361 CAAQM stations in 192 cities.

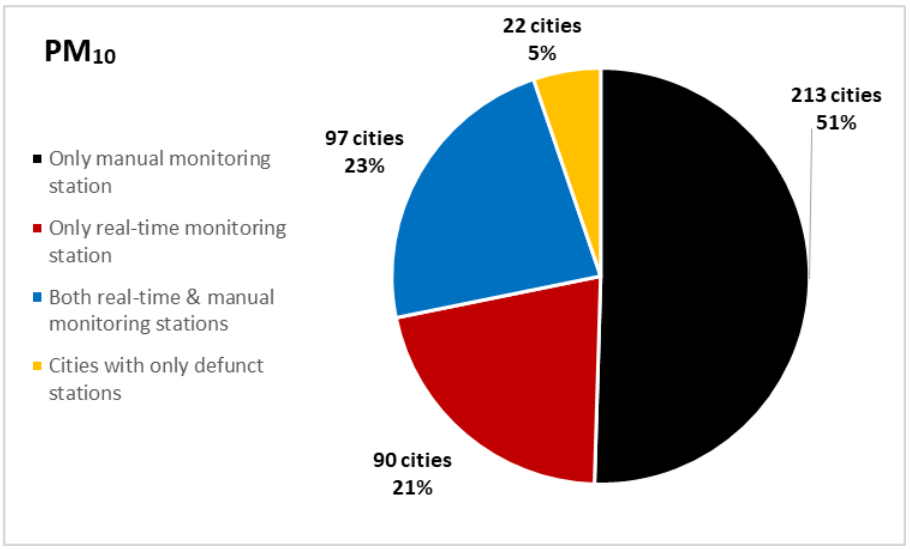
This analysis is focused on $PM_{2.5}$ data only. Data is sourced from CPCB realtime data portal in its most granular format. This is cleaned and processed, 24-hr values are calculated for each station based on USEPA methodology. Annual average is calculated as the mean of quarterly averages as per the USEPA methodology but given issues of data quality the requirement of data completeness have been slightly modified to enable inclusion of large pool of cities in this analysis. USEPA requires each quarter to have data for minimum 75 per cent of monitoring days but for this analysis data completeness requirements have been modified in the following ways:

- Minimum data completeness requirement is set at 60 days with valid 24hr values in each quarter of the year.
- Data adequacy is considered as minimum 15 days with valid 24hr values in each quarter of the year. (Based on CPCB´s practice of reporting annual city average based on adequate data which is defined as 50 monitored daily values in a year.)
- Annual value is not assigned to a station if it has less than 15 days of valid 24hr values in any quarter in a year.
- Annual values meeting only data adequacy are not compared with the standard, but are used to establish long term trends.
- Cities that have more than one station are represented by average of stations that meet the data adequacy requirement for all three years of assessment (2019, 2020, and 2021) -- termed as trend-stations. For many cities like Mumbai there is often only one station which meets this criteria of trend-station despite having added multiple stations in 2020 and 2021. For these special cases annual city value is still based on trend-station/s but the range of annual values reported from new stations is reported in parentheses next to city value in the final data table. This is done to ensure that trend is based on apple to apple comparison.

Key highlights of the findings on monitoring coverage

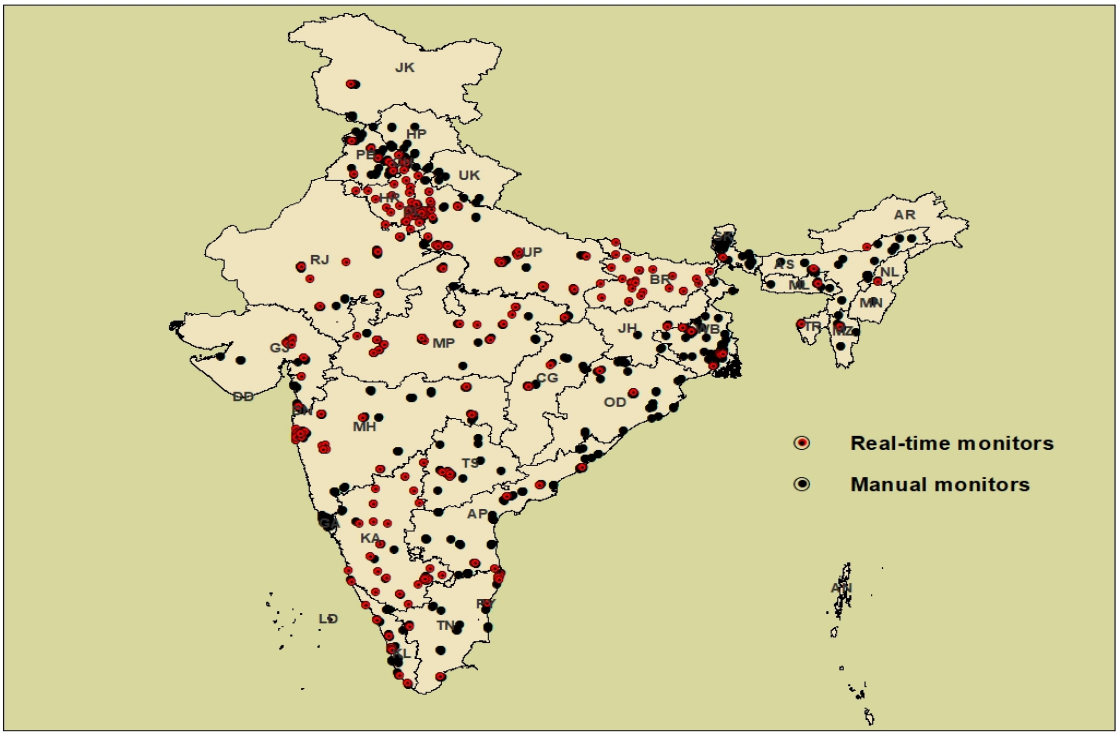
Only 10 per cent of statutory/census towns have air quality monitoring: According to the 2011 census India has 4041 statutory towns and 3894 census towns. Between NAMP (manual) and CAAQMS (realtime) only 400 cities/towns have PM_{10} quality monitoring. Out of these, 213 cities/towns (51 per cent) only have manual monitoring, 90 cities/towns (21 per cent) have only realtime monitoring, and 97 cities/towns (23 per cent) have both manual and realtime monitoring (see *Graph 1: PM_{10} monitoring coverage*). There are 22 cities/towns (5 per cent) that have manual stations that have not reported any data since 2015. These cities together account for 1,176 PM_{10} monitoring stations–804 manual stations and 372 realtime stations (see *Map 1: Distribution of manual and realtime monitors*).

Graph 1: PM_{10} monitoring coverage



Note: Manual station data is taken from CPCB website and NAMP 2020 and 2019 reports. Realtime station data is taken from the Central Control Room for Air Quality Management (4 Sept 2022).
Source: CSE analysis

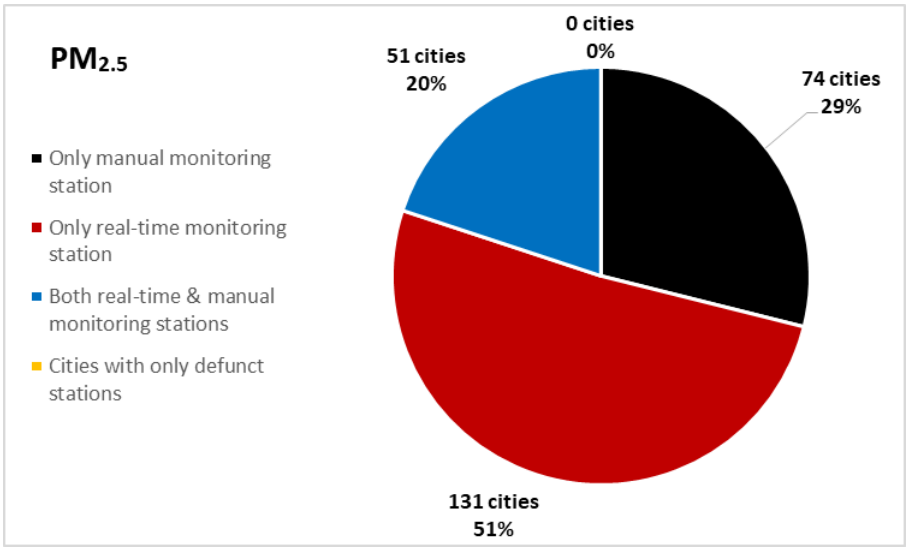
Map 1: Distribution of manual and realtime monitors



Source: CSE analysis

$PM_{2.5}$ monitoring is limited in scope compared to PM_{10}: Between National Air Monitoring Programme (NAMP) that is manual monitoring and Continuous Ambient Air Quality Monitoring Stations (CAAQMS) that are real time monitors, only 256 cities/towns have $PM_{2.5}$ monitoring. Out of these, 74 cities/towns (29 per cent) have only manual monitoring, 131 cities/towns (51 per cent) have only realtime monitoring, and 51 cities/towns (20 per cent) have both manual and realtime monitoring (see *Graph 2: $PM_{2.5}$ monitoring coverage*). These cities together account for 360 PM2.5 monitoring stations (315 manual stations and 345 realtime stations). The fact that the performance assessment of NCAP cities is done only on the basis of PM10 monitoring is because the network of PM_{10} monitoring is more extensive than $PM_{2.5}$. $PM_{2.5}$ monitoring needs to be expanded and considered for performance monitoring to be able to address better prioritisation.

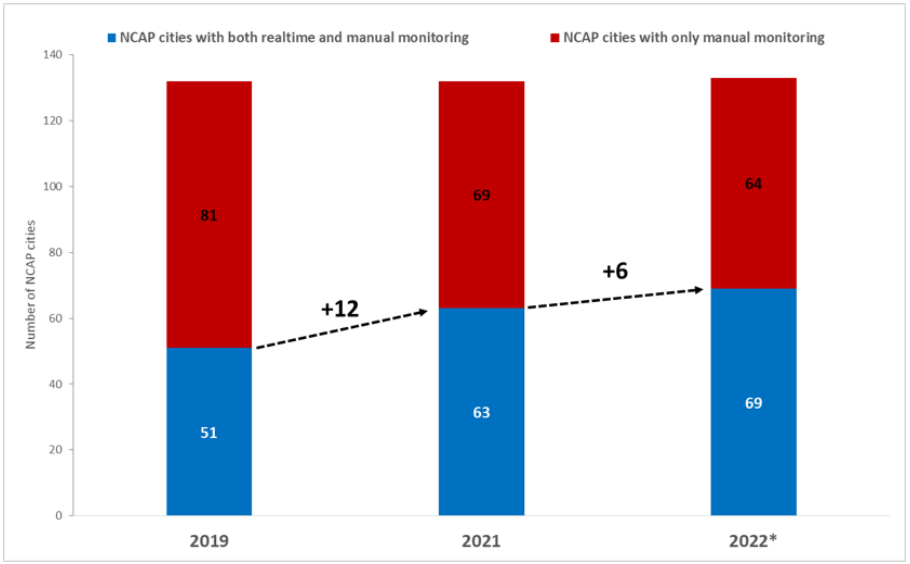
Graph 2: $PM_{2.5}$ monitoring coverage



Note: Manual station data is taken from CPCB website and NAMP 2020 and 2019 reports. Realtime station data is taken from the Central Control Room for Air Quality Management (4 Sept 2022).
Source: CSE analysis

Only about half of NCAP cities have real time monitoring: In 2019 only 51 out 132 NCAP cities had real time monitoring stations. The number grew to 63 NCAP cities in 2021 and six more NCAP cities have installed real time monitors in 2022 so far (See *Graph 3: Realtime monitoring in NCAP cities*).

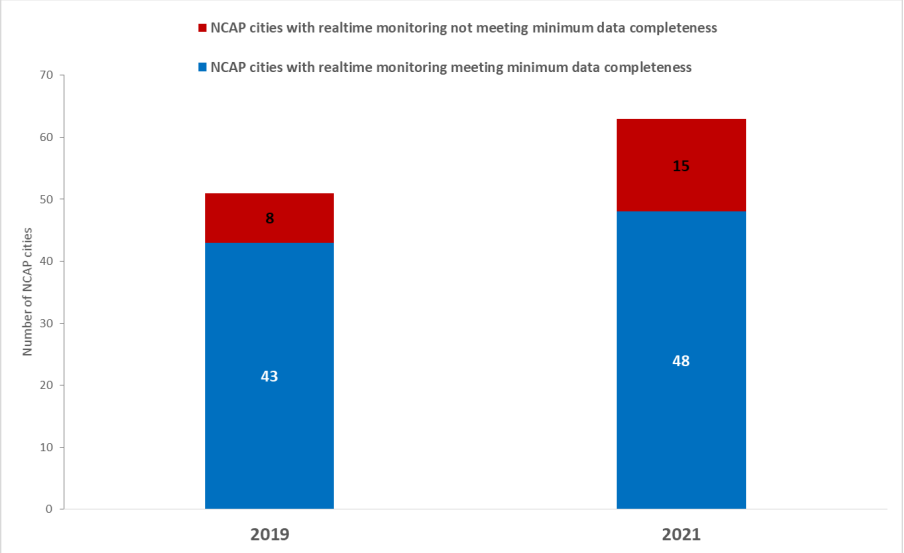
Graph 3: Realtime monitoring in NCAP cities



Note: * Data up till 4 Sept 2022
Source: CSE analysis of CPCB´s realtime data.

Almost a quarter of NCAP cities with realtime monitoring do not meet minimum data completeness requirement: In 2021, 15 out of the 63 NCAP cities (24 per cent) did not meet the minimum data completeness requirement (60 days of valid 24-hr values in each quarter of the year). In 2019, the number was lower as only 16 per cent didn't meet the minimum data completeness requirement (See *Graph 4: Data completeness among NCAP cities with realtime monitoring*).

Graph 4: Data completeness among NCAP cities with realtime monitoring



Source: CSE analysis of CPCB´s realtime data.

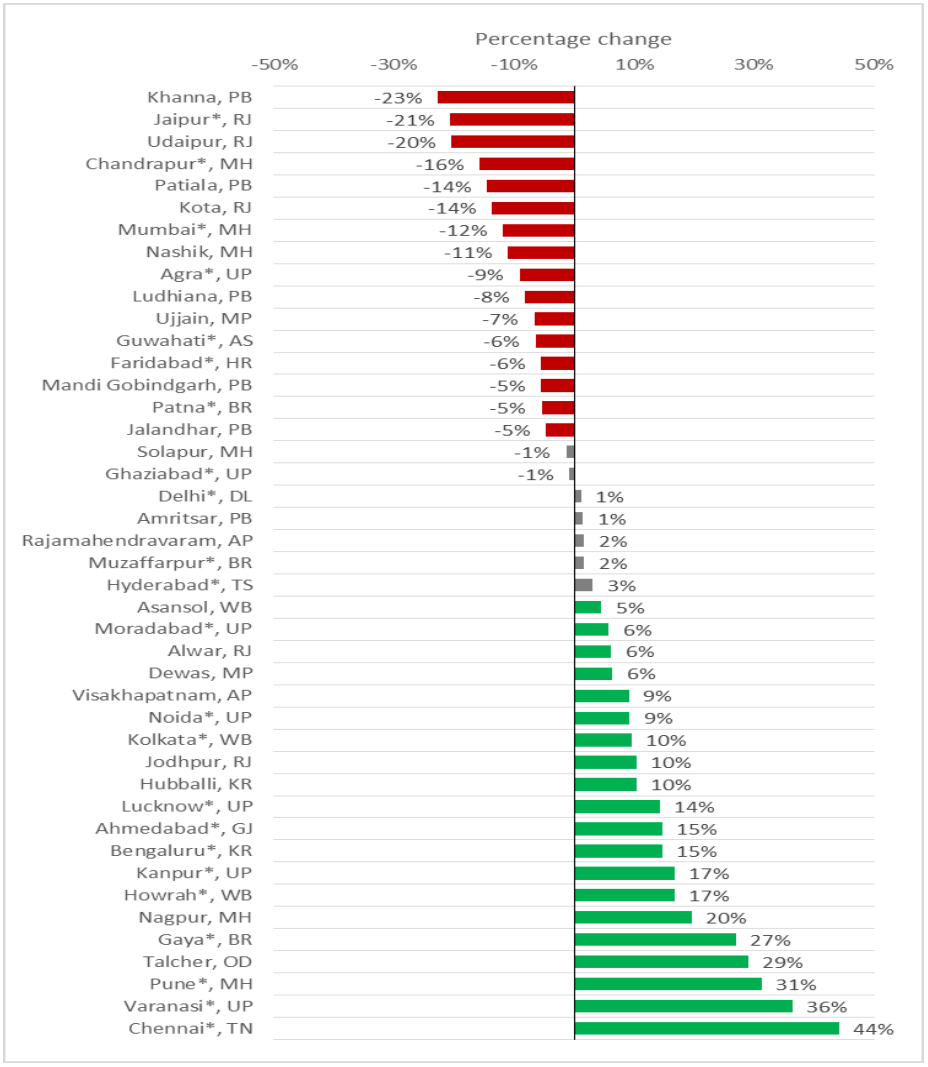
Key highlights of the findings on $PM_{2.5}$ trends

How NCAP cities have performed on $PM_{2.5}$ levels between 2019-2021: Only 43 NCAP cities have adequate $PM_{2.5}$ data for the period 2019 to 2021 be able to create a reasonable trend for tracking progress. However, it may be noted that 2020 has been an exceptional year due to the hard lock down phases and is an aberration. Nearly all cities have recorded a dip during that year followed by subsequent increase in 2021. Therefore, the comparison between 2019 and 2021 shows that only 14 of 43 cities have registered 10 per cent or more reduction in their $PM_{2.5}$ level between 2019 and 2021. Seven cities show negligible (less than 5 per cent) change, these include Delhi and Ghaziabad.

There are 16 cities that have registered significant increases (5 per cent or more) in their $PM_{2.5}$ levels. Khanna, Jaipur, and Udaipur have registered the most deterioration with their 2021 annual value increasing by over 20 per cent compared to 2019 annual value (see *Graph 5: Percentage change in annual $PM_{2.5}$ levels between 2019 and 2021 (NCAP cities)*). Faridabad with six per cent increase is the only NCR NCAP city in this pool of cities with significant worsening of air quality, it is also the only city outside the non-attainment list.

Punjab, Rajasthan and Maharashtra cities dominate the list of cities which have registered a significant increase in $PM_{2.5}$ levels between 2019 and 2021. Chennai, Varanasi, and Pune show the most improvement among NCAP cities. But unlike cities with increasing pollution levels which have a very clear regional pattern, there is no regional pattern seen among cities reporting significant improvement in their air quality.

Graph 5: Percentage change in annual $PM_{2.5}$ levels between 2019 and 2021 (NCAP cities)



Note: Cities with multiple stations are represented by the average of trend stations. Trend stations are stations that meet data adequacy requirements for all three years (2019, 2020, and 2021). * Cities with multiple stations.
Source: CSE analysis of CPCB´s realtime data.

How have non-NCAP cities performed? There are 46 cities that are not covered under NCAP but have adequate realtime data for both 2019 and 2021. In this non-NCAP cities pool, 15 cities have registered significant worsening of annual $PM_{2.5}$ levels between 2019 and 2021. Ankleshwar in Gujarat with 34 per cent increase in annual PM2.5 value is the worst performer in the pool. It is followed by Satna (MP), Vatva (GJ), Bahadurgarh (HR), and Bhatinda (PB); all of which registered over 20 per cent increase (See *Graph 6: Percentage change in annual $PM_{2.5}$ levels between 2019 and 2021 (non-NCAP cities)*).

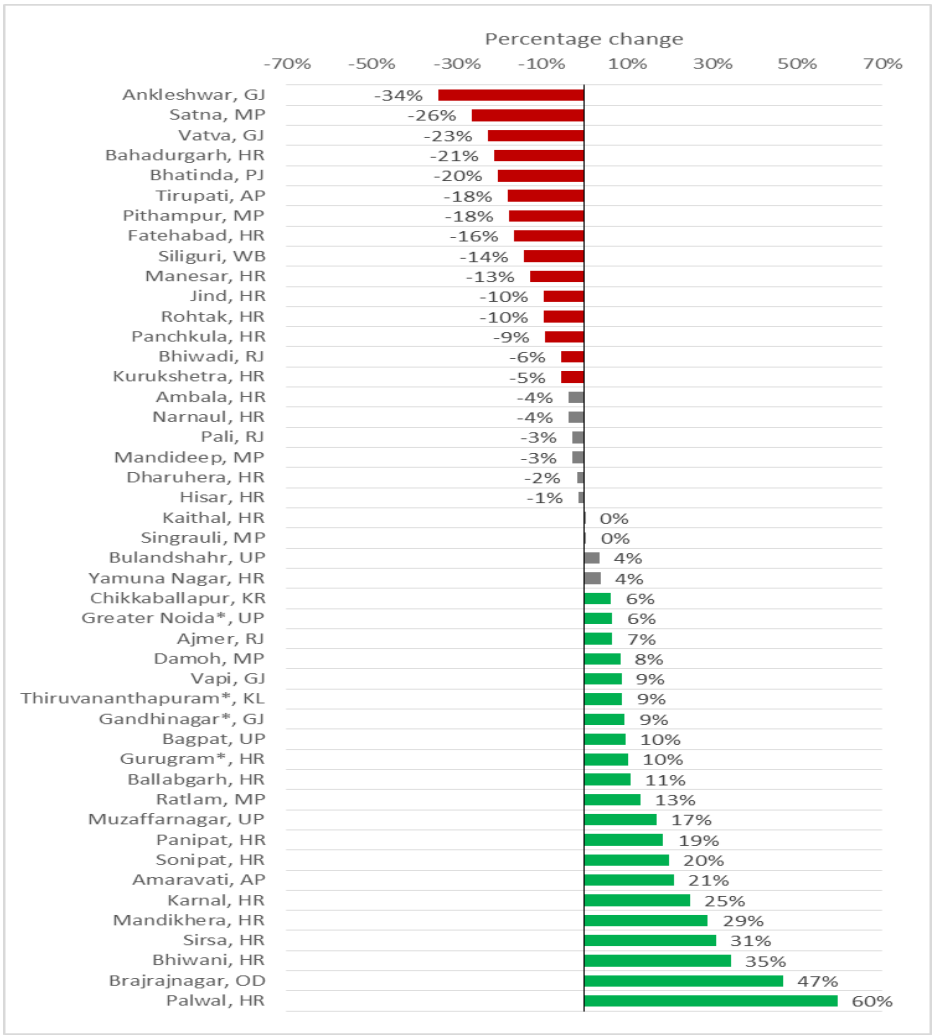
10 cities registered negligible change (less than 5 per cent) in their annual values.

21 cities in this pool have recorded significant improvement in their annual $PM_{2.5}$ value with 5 per cent or more decline between 2019 and 2021.

Cities of Haryana, MP and Gujarat dominate the list of non-NCAP cities that have registered significant increases in air pollution between 2019 and 2020. Tirupati in AP and Siliguri in WB are only cities from other regions in the group. Interestingly, most of these cities are outside NCR.

Palwal in southern Haryana with 60 per cent improvement in its annual $PM_{2.5}$ level is the best performer among non-NCAP cities. In fact, NCR cities dominate the list of most improved non-NCAP cities. Most change (positive or negative) is noted among north Indian cities. Cities within NCR show improvement while cities outside NCR show worsening.

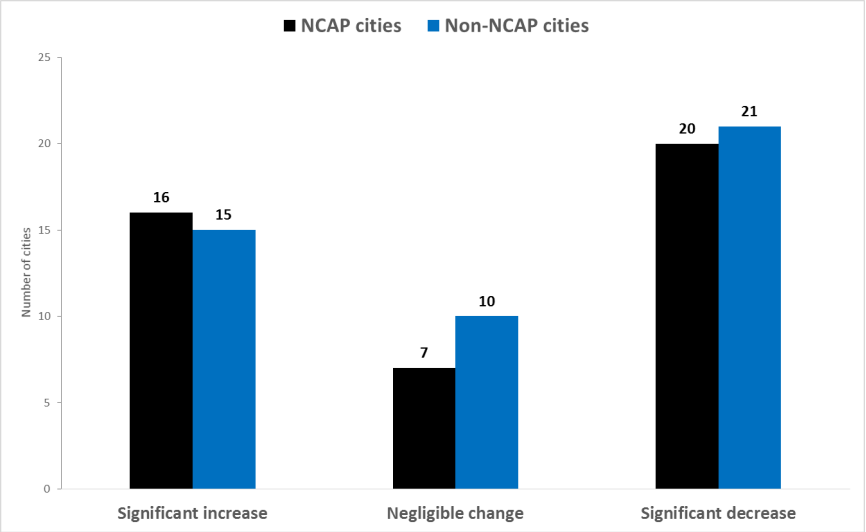
Graph 6: Percentage change in annual $PM_{2.5}$ levels between 2019 and 2021 (non-NCAP cities)



Note: Cities with multiple stations are represented by the average of trend stations. Trend stations are stations that meet data adequacy requirements for all three years (2019, 2020, and 2021). * Cities with multiple stations.
Source: CSE analysis of CPCB´s realtime data.

Performance of NCAP vs non-NCAP cities: Data is adequate to construct $PM_{2.5}$ trend for 43 NCAP cities and 46 non-NCAP cities for 2019-21. The non-NCAP cities can be treated as a control group to see how the NCAP funding has improved the air quality performance of cities. There is hardly any difference between the performance of NCAP and non-NCAP cities between 2019 and 2021 (see *Graph 7: Relative performance of NCAP and non-NCAP cities*). There are 16 NCAP cities and 15 non-NCAP cities that registered significant increases in their annual $PM_{2.5}$ level. Near identical numbers. Same goes for cities that registered significant improvement in their annual $PM_{2.5}$ levels; 20 NCAP cities and 21 non-NCAP cities (see *Map 2: Trend in $PM_{2.5}$ among NCAP and non-NCAP cities*).

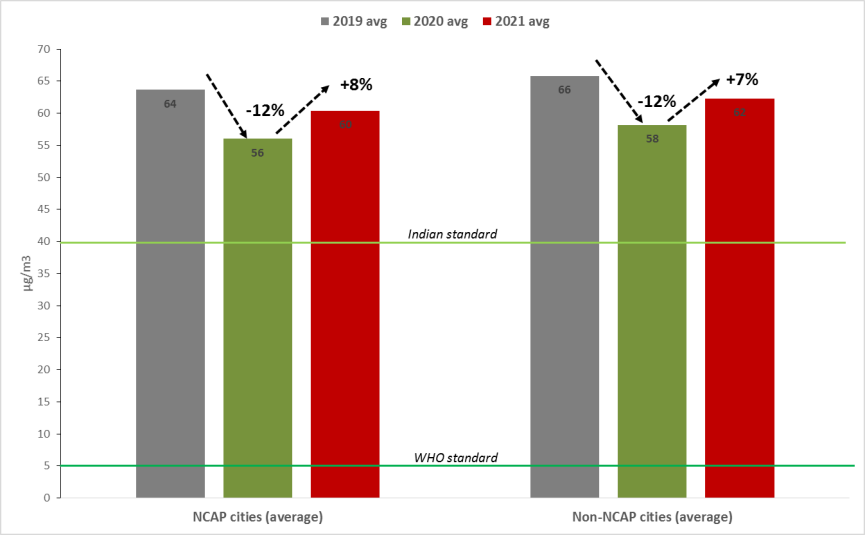
Graph 7: Relative performance of NCAP and non-NCAP cities



Note: Cities with multiple stations are represented by the average of trend stations. Trend stations are stations that meet data adequacy requirements for all three years (2019, 2020, and 2021).
Source: CSE analysis of CPCB´s realtime data.

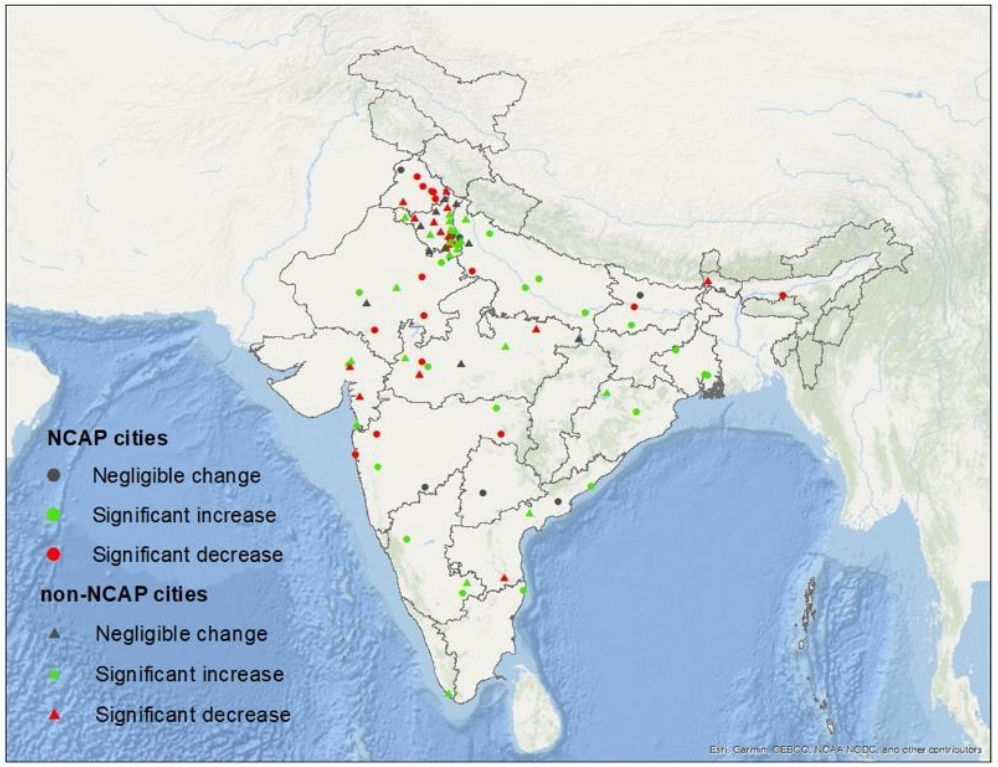
NCAP vs non-NCAP cities and impact of lockdowns: Hard and extended lockdowns in 2020 due to the pandemic had significant air quality impact in all monitored cities. There is negligible difference between its impact on NCAP and non-NCAP cities. Both groups of cities recorded nearly 12 per cent reduction in their aggregate 2020 $PM_{2.5}$ level compared to the previous year (See *Graph 8: Relative impact of 2020 lockdowns on NCAP and non-NCAP cities*). Pollution bounced back in both groups of cities in 2021. NCAP cities on aggregate registered 8 per cent increase in their annual PM2.5 levels in 2021 from the low of 2020. Similarly, non-NCAP cities registered a 7 per cent increase.

Graph 8: Relative impact of 2020 lockdowns on NCAP and non-NCAP cities



Note: Cities with multiple stations are represented by the average of trend stations. Trend stations are stations that meet data adequacy requirements for all three years (2019, 2020, and 2021).
Source: CSE analysis of CPCB´s realtime data.

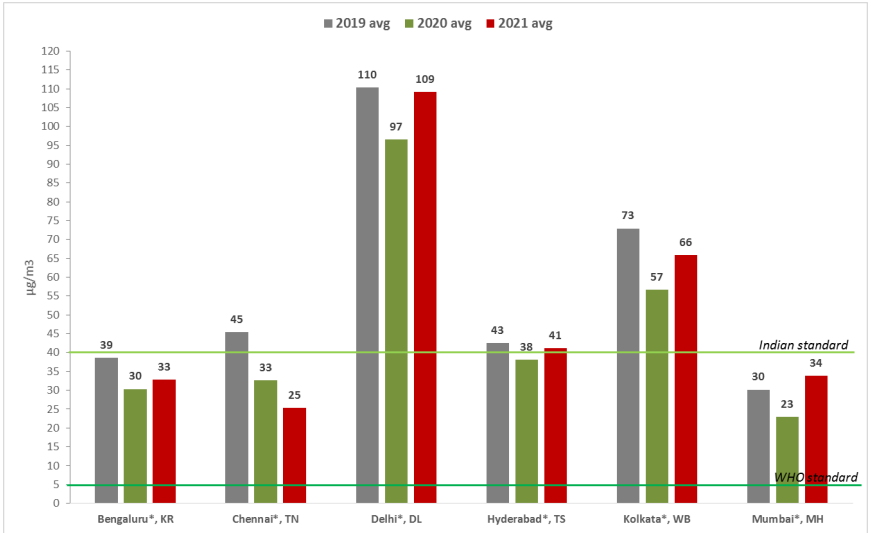
MAP 2: Trend in $PM_{2.5}$ among NCAP and non-NCAP cities (2019-21)



Source: CSE

How have megacities performed? All six mega cities registered a drop in their annual PM2.5 levels in 2020 but pollution bounced back everywhere except in Chennai (See *Graph 9: Relative performance of megacities*). In Delhi pollution dropped by 13 per cent in 2020 but it rose by 13 per cent in 2021 nullifying all the gains made by the national capital. In Kolkata pollution has dropped by 22 per cent in 2020 and it rose by 16 per cent in 2021. Mumbai with a 48 per cent increase in 2021 saw the most negative impact of unlocking the economy after the lockdowns. Hyderabad has the least variation in its annual levels across the three years. Bengaluru air improved by 21 per cent in 2020 and with just 8 per cent increase in 2021 the southern metropolis has retained most of its gains. Chennai saw a 29 per cent drop in its $PM_{2.5}$ level in 2020 and it dropped by another 23 per cent in 2021, making it the least polluted mega city in the country.

Graph 9: Relative performance of megacities



Note: Cities with multiple stations are represented by the average of trend stations. Trend stations are stations that meet data adequacy requirements for all three years (2019, 2020, and 2021). * Cities with multiple stations.
Source: CSE analysis of CPCB´s realtime data.

Key highlights of the findings on $PM_{2.5}$ levels

Methodology: There is a significant difference in methodologies used for accessing trends in air quality and determining compliance with a standard. Minimum data quality requirements for the two are very different. It is critical that a city meet the minimum data completeness required for credibly establishing their standing vis-à-vis the annual $PM_{2.5}$ standard. Keeping these in consideration, the analysis presented in this section uses stricter data quality benchmarks compared to previous section, therefore a few cities which might have been included in previous section might not make the cut for this.

CPCB currently uses spatial average of all stations in a city to establish its compliance with the standard, which it recognizes that this is not a scientifically sound practice but is used for sake of simplicity. But internationally the practice for establishing compliance with the standard has moved away from spatial averaging. USEPA requires that all monitoring stations in a city should meet the standard for that city to be deemed compliant with the standard. Contrary to this, trend analysis is based on spatial averaging and uses only a few select stations in the city.

To ensure continuity between the two sections, the city annual level is continued to be calculated using data from only the trend stations in the city. It is acknowledged that many cities have added new stations since 2019 and many of these also meet the minimum data completeness requirement but they have not been included in computation of the annual average of the city. Nevertheless, data from these new stations is captured in the maximum and minimum information published in the parenthesis next to the annual level of the city. This is a hybrid approach that uses CPCB´s current practice of spatial averaging for cities with multiple stations but ensures apple to apple comparison by introducing the trend station concept. It also captures the worst station data in the city allowing comparison vis-à-vis USEPA methodology.

There are 48 NCAP cities and 55 non-NCAP cities that meet the minimum data completeness for computing annual $PM_{2.5}$ levels for 2021. Only these 103 cities have been analyzed in this section.

Adopt standardized method for assessing air quality trends for complying with the national ambient air quality standards: India needs to adopt a robust protocol for estimating air quality trends and its compliance with the national ambient air quality standards. It is critical that a city meets the minimum data completeness required to credibly establish their longer term air quality trend vis-à-vis the annual PM2.5 standard.

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Both NCAP and non-NCAP cities need substantial reduction to meet the national ambient air quality standards: It is acknowledged that many cities have added new stations since 2019 and many of these also meet the minimum data completeness requirement but they have not been included in computation of annual average of the city. Nevertheless, data from these new stations is captured in the maximum and minimum information published in the parenthesis next to the annual level of the city. This is a hybrid approach that uses CPCB´s current practice of spatial averaging for cities with multiple stations but ensures apple to apple comparison by introducing the trend station concept. It also captures the worst station data in the city allowing comparison vis-à-vis USEPA methodology.

There are 48 NCAP cities and 55 non-NCAP cities that meet the minimum data completeness for computing annual PM2.5 levels for 2021. Only these 103 cities have been analyzed in this section.

Status of national air quality: There are an equal number (39) of NCAP and non-NCAP cities that didn´t meet the annual $PM_{2.5}$ standard in 2021.

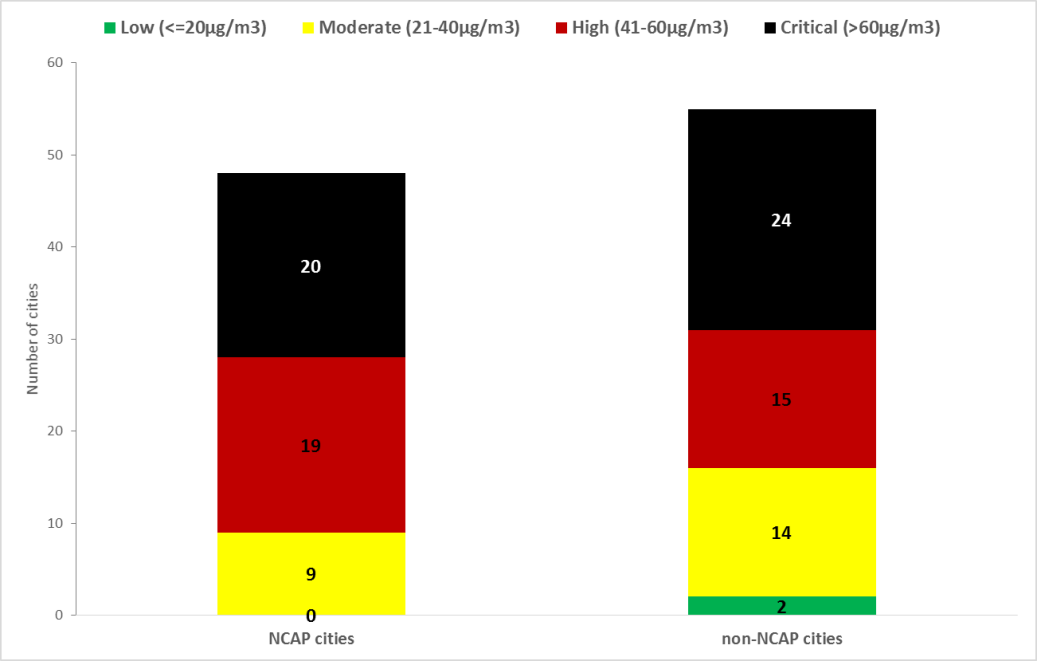
CPCB classifies cities that have their annual average higher than 1.5 times the annual standard as critically polluted. In 2021, 20 NCAP cities and 24 non-NCAP cities qualified as critically polluted (See *Graph 7: Classification of NCAP and non-NCAP cities as per their 2021 annual $PM_{2.5}$ level*). Which means there are more critically polluted cities that are not covered by NCAP than there are under the program.

Nine NCAP cities that met the annual NAAQS in 2021. These are Chennai, Hubballi, Bengaluru, Rajamahendravaran, Mumbai, Sagar, Nashik, Dewas and Chandigarh. Cities with multiple stations like Chennai, Bengaluru, Mumbai and Chandigarh meet the standard based on average value from their trend station/s but there are stations within the city which reported annual values higher than the standard, implying the pollution is not low throughout these cities.

Only 16 non-NCAP cities meet the standard and 13 of them are located in south India.

Only two cities in the country out of 103 monitored via CAAQMS network can be classified as low pollution (less than half the annual standard) as per CPCB matrix. These are Kozhikode in Kerala and Madikeri in Karnataka.

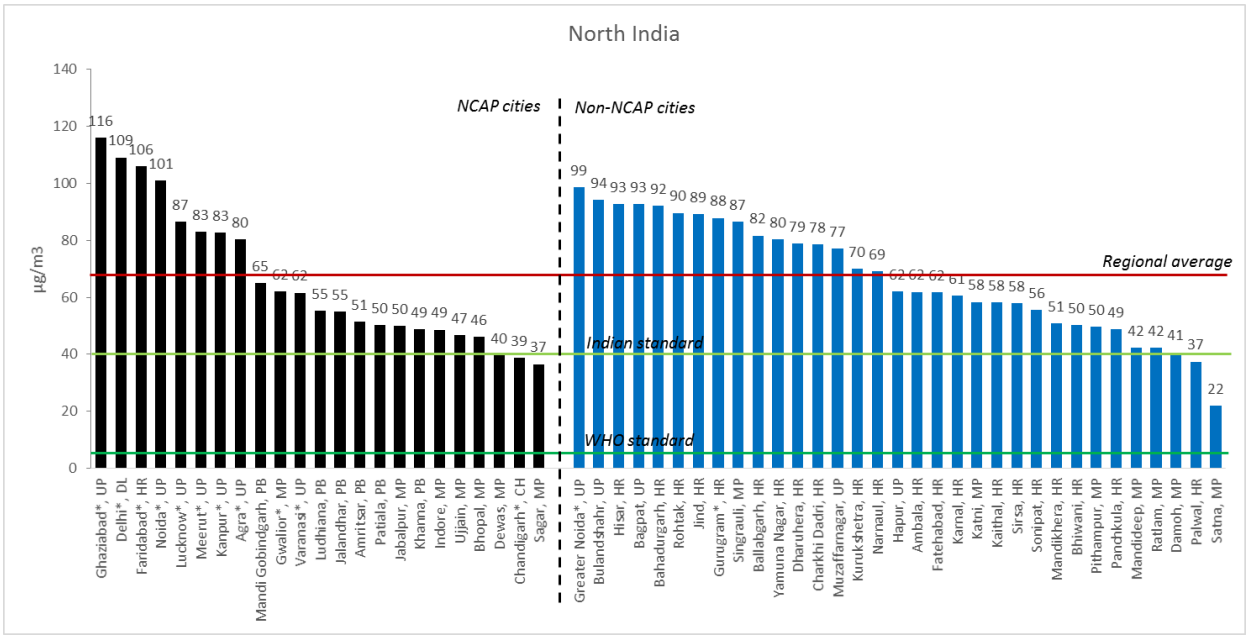
Graph 10: Classification of NCAP and non-NCAP cities as per their 2021 annual $PM_{2.5}$ level



Note: Cities with multiple stations are represented by the average of trend stations. Trend stations are stations that meet data adequacy requirements for all three years (2019, 2020, and 2021). * Cities with multiple stations.
Source: CSE analysis of CPCB´s realtime data.

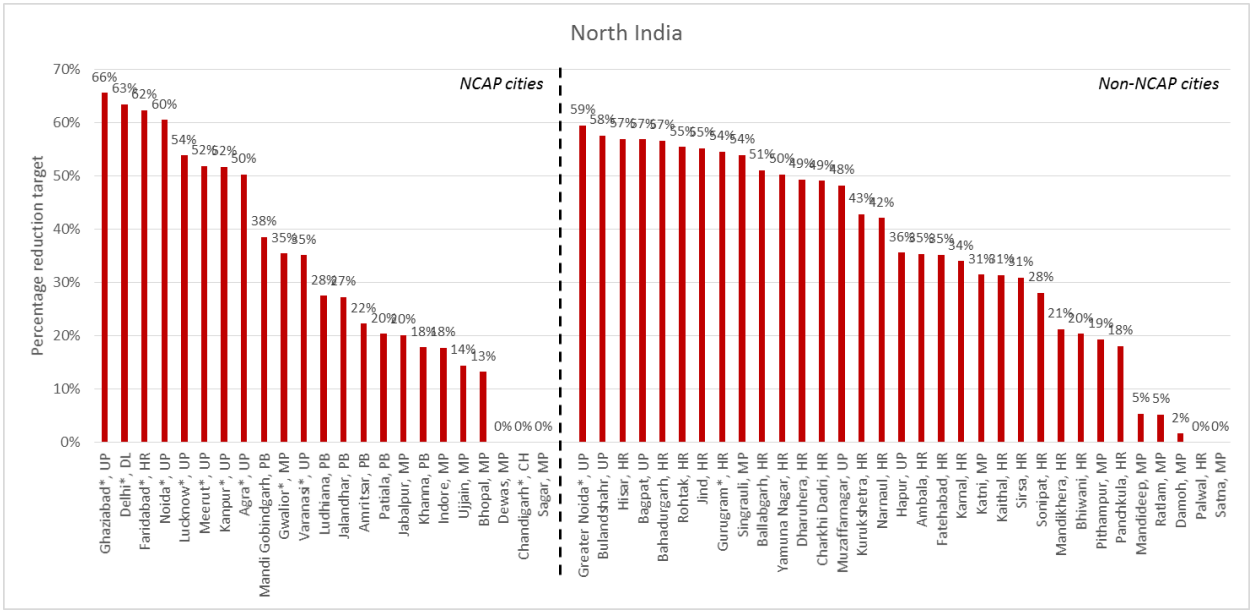
Status of air quality in North India: Ghaziabad is the most polluted NCAP city in the North, closely followed by Delhi. There are 16 non-NCAP cities that exceed the regional average compared to eight NCAP cities (See *Graph 11: 2021 annual PM2.5 level in North Indian cities*). There are as many non-NCAP cities as NCAP cities that require over 50 per cent reduction (See *Graph 12: Pollution reduction targets for North Indian cities to meet the annual PM2.5 standard*). Most NCR cities require over 50 per cent reduction from their 2021 PM2.5 level to meet the NAAQS.

Graph 11: 2021 annual PM2.5 level in North Indian cities



Note: Cities with multiple stations are represented by the average of trend stations. Trend stations are stations that meet data adequacy requirements for all three years (2019, 2020, and 2021). * Cities with multiple stations.
Source: CSE analysis of CPCB´s realtime data.

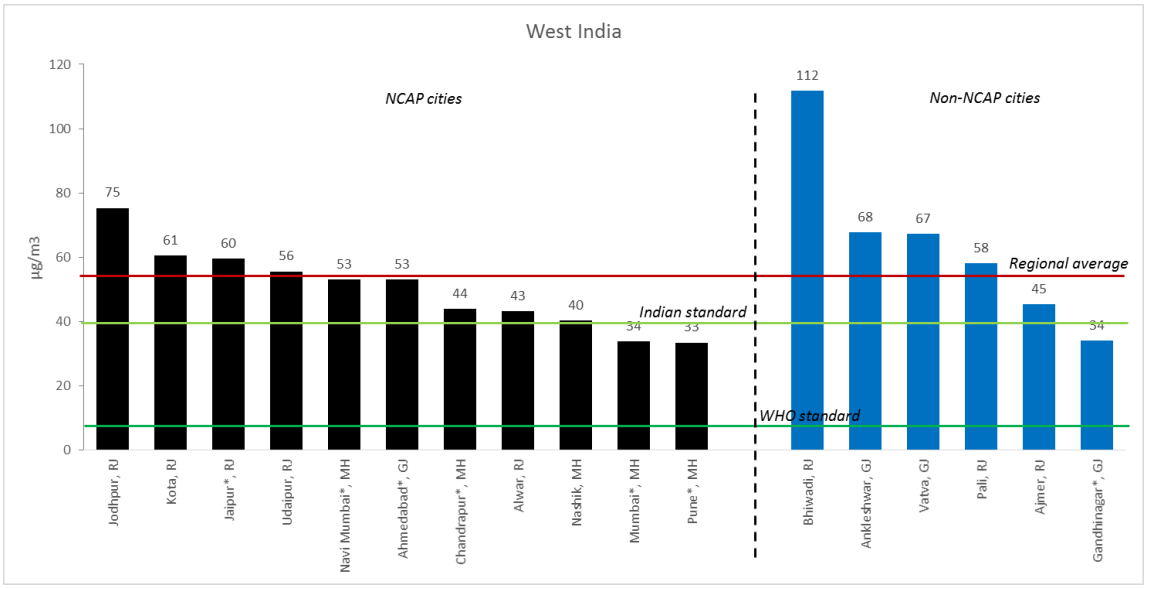
Graph 12: Pollution reduction targets for North Indian cities to meet the annual PM2.5 standard



Note: Cities with multiple stations are represented by the average of trend stations. Trend stations are stations that meet data adequacy requirements for all three years (2019, 2020, and 2021). * Cities with multiple stations.
Source: CSE analysis of CPCB´s realtime data.

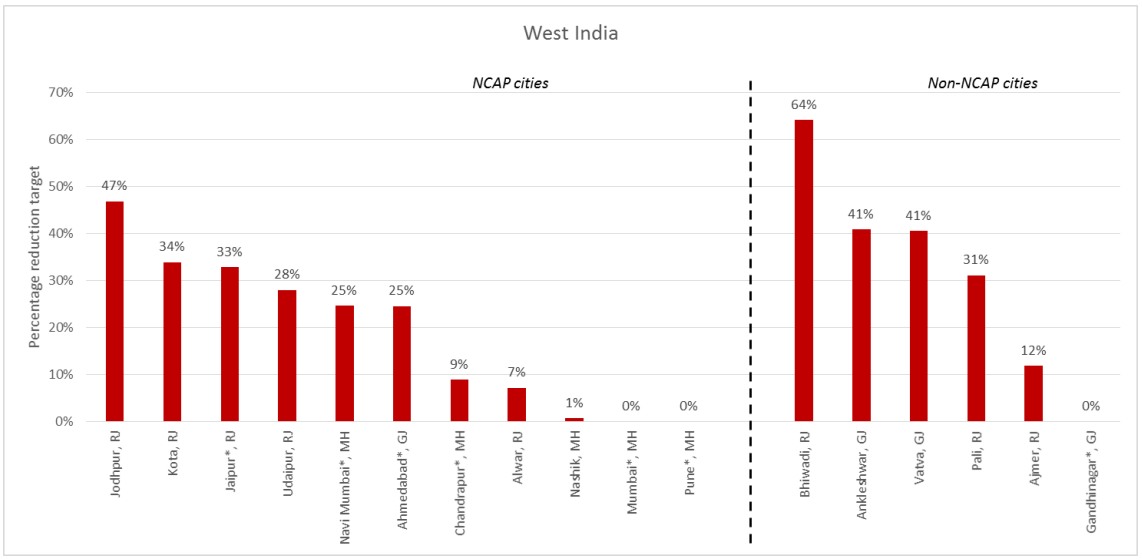
Status of air quality in West India: Jodhpur is the most polluted NCAP city in the West, followed by Kota and Jaipur. Bhiwadi, though a non-NCAP city, is still the most polluted in the region. Ankleshwar and Vatva in Gujarat are worse than most NCAP cities of the region as well (See *Graph 13: 2021 annual PM2.5 level in West Indian cities*). Six NCAP cities and four non-NCAP cities need reduction of over 25 per cent to meet the annual standard (See *Graph 14: Pollution reduction targets for North Indian cities to meet the annual PM2.5 standard*).

Graph 13: 2021 annual PM2.5 level in West Indian cities



Note: Cities with multiple stations are represented by the average of trend stations. Trend stations are stations that meet data adequacy requirements for all three years (2019, 2020, and 2021). * Cities with multiple stations.
Source: CSE analysis of CPCB´s realtime data.

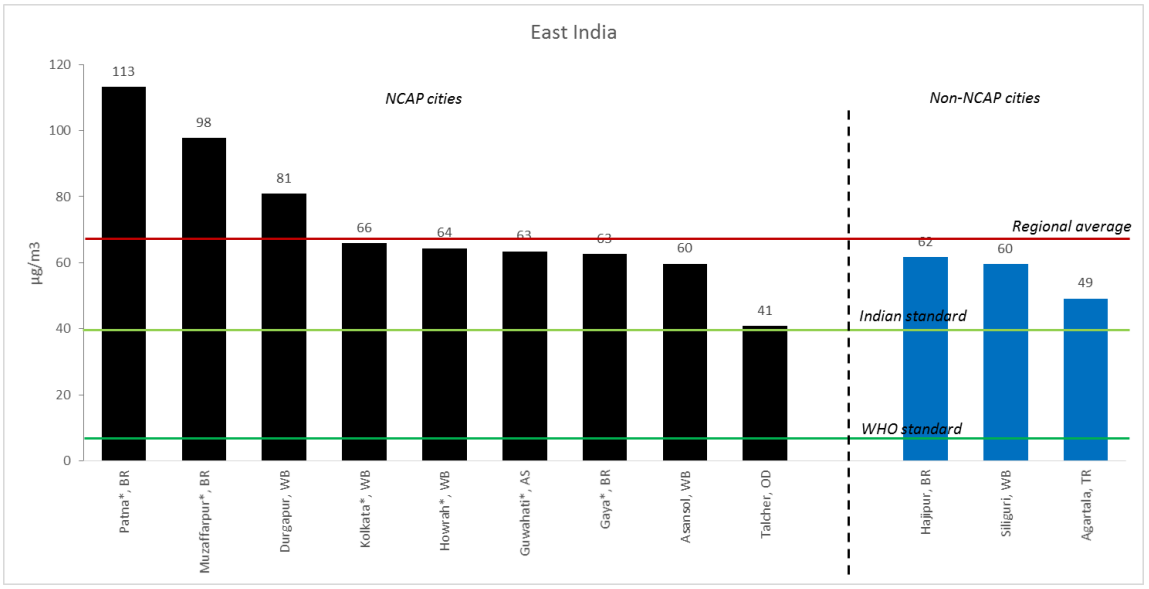
Graph 14: Pollution reduction targets for West Indian cities to meet the annual PM2.5 standard



Note: Cities with multiple stations are represented by the average of trend stations. Trend stations are stations that meet data adequacy requirements for all three years (2019, 2020, and 2021). * Cities with multiple stations.
Source: CSE analysis of CPCB´s realtime data.

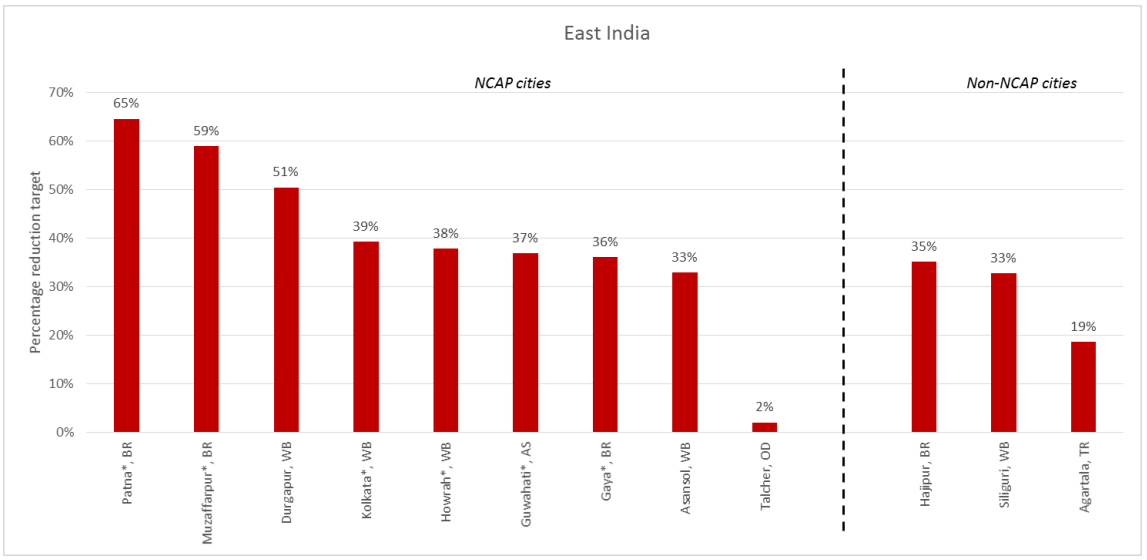
Status of air quality in East India: Patna is the most polluted NCAP city in the East, followed by Muzaffarpur and Durgapur. Hajipur and Siliguri are the most polluted non-NCAP cities in east India. This is the only region where no city, NCAP or non-NCAP, meets the annual standard (See *Graph 15: 2021 annual PM2.5 level in West Indian cities*). Except Talcher in Odisha and Agartala in Tripura, all cities in the region require over 20 per cent reduction to meet the annual standard (See *Graph 16: Pollution reduction targets for East Indian cities to meet the annual PM2.5 standard*).

Graph 15: 2021 annual PM2.5 level in East Indian cities



Note: Cities with multiple stations are represented by the average of trend stations. Trend stations are stations that meet data adequacy requirements for all three years (2019, 2020, and 2021). * Cities with multiple stations.
Source: CSE analysis of CPCB´s realtime data.

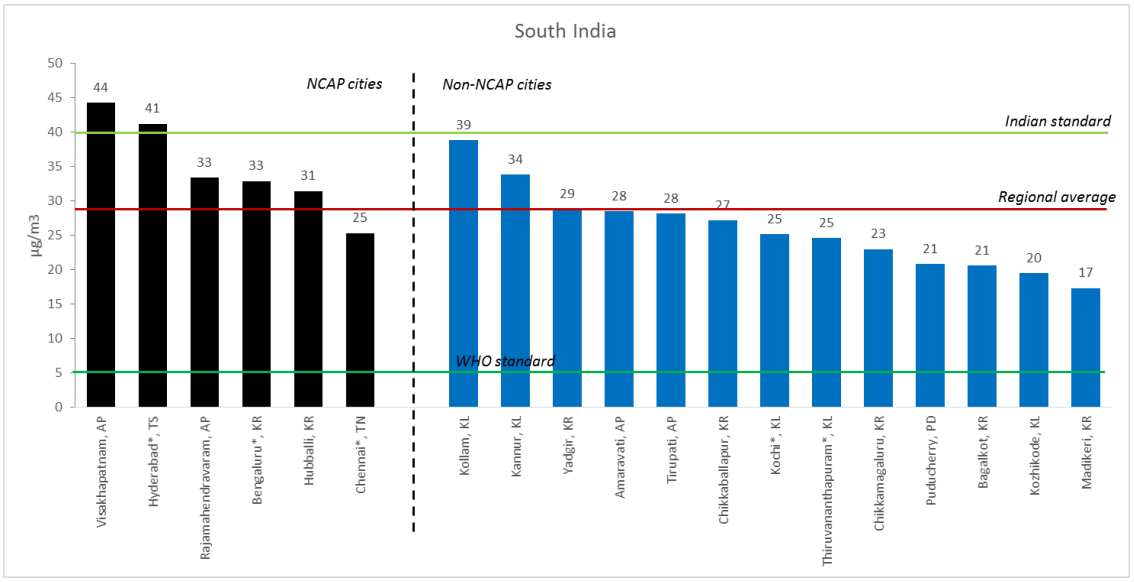
Graph 16: Pollution reduction targets for East Indian cities to meet the annual PM2.5 standard



Note: Cities with multiple stations are represented by the average of trend stations. Trend stations are stations that meet data adequacy requirements for all three years (2019, 2020, and 2021). * Cities with multiple stations.
Source: CSE analysis of CPCB´s realtime data.

Status of air quality in South India: Visakhapatnam is the most polluted NCAP city in the South, followed by Hyderabad. All the other cities in the region, NCAP and non-NCAP, meet the annual standard (See *Graph 17: 2021 annual PM2.5 level in South Indian cities*). Visakhapatnam needs to reduce pollution by 10 per cent and Hyderabad by 3 per cent to meet the standard (See *Graph 18: Pollution reduction targets for South Indian cities to meet the annual PM2.5 standard*).

Graph 17: 2021 annual PM2.5 level in South Indian cities



Note: Cities with multiple stations are represented by the average of trend stations. Trend stations are stations that meet data adequacy requirements for all three years (2019, 2020, and 2021). * Cities with multiple stations.
Source: CSE analysis of CPCB´s realtime data.

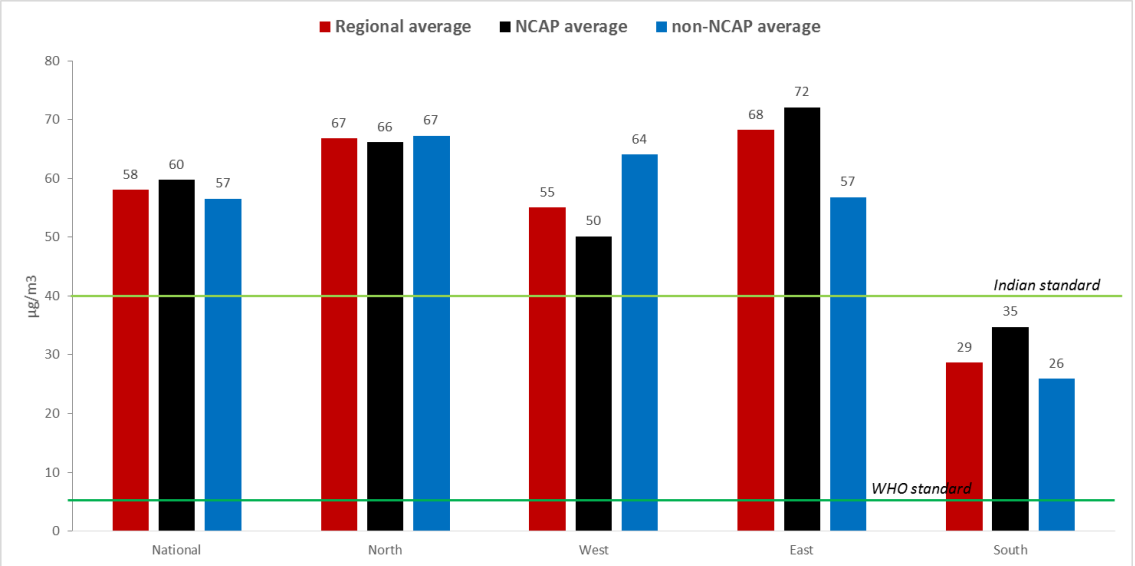
Graph 18: Pollution reduction targets for South Indian cities to meet the annual PM2.5 standard

Note: Cities with multiple stations are represented by the average of trend stations. Trend stations are stations that meet data adequacy requirements for all three years (2019, 2020, and 2021). * Cities with multiple stations.
Source: CSE analysis of CPCB´s realtime data.

NCAP vs non-NCAP cities pollution level: On average at national level there is barely any difference in the pollution level between NCAP and non-NCAP cities. There is some difference at regional level though. In West India non-NCAP cities on average are more polluted and these are located inland in the arid and semi-arid sub-region. In the North, non-NCAP cities on average are marginally more polluted than NCAP cities. In the East and South India NCAP cities are on average significantly more polluted (See *Graph 19: Regional average 2021 annual PM2.5 level*).

On average cities of East India are the most polluted in the country. While cities of South India are least polluted.

Graph 19: Regional average 2021 annual PM2.5 level



Note: Cities with multiple stations are represented by the average of trend stations. Trend stations are stations that meet data adequacy requirements for all three years (2019, 2020, and 2021). * Cities with multiple stations.
Source: CSE analysis of CPCB´s realtime data.

Way forward

It is clear that the current practice of keeping the focus only on selected cities without considering the larger urban and regional landscape can limit the effectiveness of the NCAP programme and resource investment. The current mandate of developing a state action plan has to be refined to ensure regional approach to have a wider impact.

Moreover, the ongoing funding strategy based on performance of cities on air quality improvement requires robust air quality monitoring of all key parameters along with strong data quality control and standardized protocol for establishing air quality trends and addressing data gaps especially for real time data, for reporting compliance with clean air targets.

As the current focus of NCAP is to reduce particulate pollution, immediate strategy is needed to consider PM2.5 data for performance assessment of cities. PM2.5 being smaller is more harmful as these penetrate deep inside the lungs. The larger share of PM2.5 is emitted by combustion sources including vehicles, industry, power plants, waste and solid fuel burning. Otherwise, the expansion of PM2.5 monitoring as well as real time monitoring will be wasteful if not leveraged for performance assessment. This also needs to be supported by a roadmap to include the gasses for targeted mitigation.

Appendix 1: Trend stations for cities with multiple stations

City	Trend stations
Agra*, UP	Sanjay Palace
Ahmedabad*, GJ	Maninagar
Bengaluru*, KR	BTM Layout, BWSSB, Bapuji Nagar, Hebbal, Hombegowda Nagar, Jayanagar, Peenya, and Silk Board
Chandigarh*, CH	Sector 25
Chandrapur*, MH	Chandrapur, and Khutala
Chennai*, TN	Alandur, Manali, and Velachery
Delhi*, DL	Anand Vihar, Ashok Vihar, Aya Nagar, Bawana, CRRI Mathura Road, DrKS Shooting Range, DTU, Dwarka Sector 8, IHBAS, ITO, Jahangirpuri, JLN Stadium, Lodhi Road, MDC National Stadium, Mandir Marg, Mundka, Najafgarh, Narela, Nehru Nagar, North Campus DU, NSIT Dwarka, Okhla Phase 2, Patparganj, Punjabi Bagh, Pusa DPCC, Pusa IMD, RK Puram, Rohini, Shadipur, Sirifort, Sonia Vihar, Sri Aurobindo Marg, Vivek Vihar, and Wazirpur
Faridabad*, HR	Sector 16A
Gandhinagar*, GJ	Sector 10
Gaya*, BR	Collectorate
Ghaziabad*, UP	Indirapuram, Loni, Sanjay Nagar, and Vasundhara
Greater Noida*, UP	Knowledge Park III
Gurugram*, HR	Gwal Pahari, and Vikas Sadan
Guwahati*, AS	Railway Colony
Gwalior*, MP	City Center
Howrah*, WB	Ghusuri and Padmapukur
Hyderabad*, TS	Bollaram, Central University, ICRISAT, IDA Pashamylaram, Sanathnagar, and Zoo Park
Jaipur*, RJ	Adarsh Nagar, Police Commissionerate, and Shastri Nagar
Kanpur*, UP	Nehru Nagar
Kochi*, KL	Udyogamandal Eloor
Kolkata*, WB	RB University, and Victoria
Lucknow*, UP	Central School, Lalbagh, and Talkatora
Meerut*, UP	Ganganagar, Jaibhimnagar, and Pallavpuram
Moradabad*, UP	Lajpat Nagar
Mumbai*, MH	Bandra
Muzaffarpur*, BR	Collectorate
Navi Mumbai*, MH	Mahape and Nerul
Noida*, UP	Sector 125 and Sector 62
Patna*, BR	IGSC
Pune*, MH	Karve Road
Thiruvananthapuram*, KL	Plammoodu
Varanasi*, UP	Ardhali Bazar

Source: CSE

Appendix 2: Annual values for 2021

City	2021 Annual Average (based on trend stations)	Min	Max
NCAP Cites			
Ghaziabad*, UP	116	105	140
Patna*, BR	113	54	113
Delhi*, DL	109	79	148
Faridabad*, HR	106	87	111
Noida*, UP	101	99	111
Muzaffarpur*, BR	98	63	98
Lucknow*, UP	87	64	105
Meerut*, UP	83	83	97
Kanpur*, UP	83	70	83
Durgapur, WB	81		
Agra*, UP	80		
Jodhpur, RJ	75		
Kolkata*, WB	66	45	84
Mandi Gobindgarh, PB	65		
Howrah*, WB	64	54	74
Guwahati*, AS	63	60	63
Gaya*, BR	63	38	63
Gwalior*, MP	62		
Varanasi*, UP	62		
Kota, RJ	61		
Asansol, WB	60		
Jaipur*, RJ	60	53	70
Udaipur, RJ	56		
Ludhiana, PB	55		
Jalandhar, PB	55		
Navi Mumbai*, MH	53	45	61
Ahmedabad*, GJ	53		
Amritsar, PB	51		
Patiala, PB	50		
Jabalpur, MP	50		
Khanna, PB	49		
Indore, MP	49		
Ujjain, MP	47		
Bhopal, MP	46		
Visakhapatnam, AP	44		
Chandrapur*, MH	44	41	47
Alwar, RJ	43		
Hyderabad*, TS	41	33	48
Talcher, OD	41		
Nashik, MH	40		
Dewas, MP	40		
Chandigarh*, CH	39		
Sagar, MP	37		
Mumbai*, MH	34	34	68
Rajamahendravaram, AP	33		
Bengaluru*, KR	33	26	40
Hubballi, KR	31		
Chennai*, TN	25	20	35
Non-NCAP cities			
Bhiwadi, RJ	112		

City	2021 Annual Average (based on trend stations)	Min	Max
Greater Noida*, UP	99	97	99
Bulandshahr, UP	94		
Hisar, HR	93		
Bagpat, UP	93		
Bahadurgarh, HR	92		
Rohtak, HR	90		
Jind, HR	89		
Gurugram*, HR	88	80	112
Singrauli, MP	87		
Ballabgarh, HR	82		
Yamuna Nagar, HR	80		
Dharuhera, HR	79		
Charkhi Dadri, HR	78		
Muzaffarnagar, UP	77		
Kurukshetra, HR	70		
Narnaul, HR	69		
Ankleshwar, GJ	68		
Vatva, GJ	67		
Hapur, UP	62		
Ambala, HR	62		
Hajipur, BR	62		
Fatehabad, HR	62		
Karnal, HR	61		
Siliguri, WB	60		
Katni, MP	58		
Kaithal, HR	58		
Pali, RJ	58		
Sirsa, HR	58		
Sonipat, HR	56		
Mandikhera, HR	51		
Bhiwani, HR	50		
Pithampur, MP	50		
Agartala, TR	49		
Panchkula, HR	49		
Ajmer, RJ	45		
Mandideep, MP	42		
Ratlam, MP	42		
Damoh, MP	41		
Kollam, KL	39		
Palwal, HR	37		
Gandhinagar*, GJ	34		
Kannur, KL	34		
Yadgir, KR	29		
Amaravati, AP	28		
Tirupati, AP	28		
Chikkaballapur, KR	27		
Kochi*, KL	25	25	32
Thiruvananthapuram*, KL	25	25	26
Chikkamagaluru, KR	23		
Satna, MP	22		
Puducherry, PD	21		
Bagalkot, KR	21		
Kozhikode, KL	20		

City	2021 Annual Average (based on trend stations)	Min	Max
Madikeri, KR	17		
NCAP Cites not meeting minimum data completeness			
Moradabad*, UP	99		
Haldia, WB	41		
Srinagar, JK	35		
Solapur, MH	34		
Nagpur, MH	34		
Pune*, MH	33	33	54
Davanagere, KR	14		
Non-NCAP Cites not meeting minimum data completeness			
Manesar, HR	100		
Panipat, HR	62		
Kalyan, MH	60		
Vapi, GJ	57		
Nandesari, GJ	53		
Gummidipoondi, TN	46		
Bhatinda, PJ	41		
Gadag, KR	39		
Raichur, KR	33		
Kohima, NL	33		
Brajrajnagar, OD	33		
Thrissur, KL	27		
Mangalore, KR	27		
Ramnagara, KR	26		
Chamarajanagar, KR	25		
Vijaypura, KR	24		
Shivamogga, KR	23		
Mysuru, KR	21		
Aizwal, MZ	17		
Koppal, KR	14		

Note: Cities with multiple stations are represented by the average of trend stations. Trend stations are stations that meet data adequacy requirements for all three years (2019, 2020, and 2021). * Cities with multiple stations.
Source: CSE analysis of CPCB´s realtime data.

Appendex 3: List of 132 Non-attainment/ Million plus cities in India under NCAP

State	S.No.	City
Andhra Pradesh (13)	1,	Guntur
	2,	Kurnool
	3,	Nellore
	4,	Vijayawada
	5,	Vishakhapatnam
	6,	Anantapur
	7,	Chitoor
	8,	Eluru
	9,	Kadapa
	10,	Ongole
	11,	Rajahmundry
	12,	Srikakulam
	13,	Vizianagaram
Assam (05)	14,	Guwahati
	15,	Nagaon
	16,	Nalbari
	17,	Sibsagar
	18,	Silchar
Bihar (03)	19,	Patna
	20,	Gaya
	21,	Muzaffarpur
Chandigarh (01)	22,	Chandigarh
Chhattisgarh (03)	23,	Bhilai
	24,	Korba
	25,	Raipur
Delhi (01)	26,	Delhi
Gujarat (04)	27,	Surat
	28,	Ahmedabad
	29,	Vadodara
	30,	Rajkot*
Himachal Pradesh (7)	31,	Baddi
	32,	Damtal
	33,	Kala Amb
	34,	Nalagarh
	35,	Paonta Sahib
	36,	Parwanoo
	37,	Sunder Nagar
Jammu & Kashmir (2)	38,	Jammu
	39,	Srinagar
Jharkhand (03)	40,	Dhanbad
	41,	Jamshedpur*
	42,	Ranchi*
Karnataka (04)	43,	Bangalore
	44,	Devanagere
	45,	Gulburga
	46,	Hubli-Dharwad
Madhya Pradesh (07)	47,	Bhopal
	48,	Dewas

State	S.No.	City
	49,	Indore
	50,	Sagar
	51,	Ujjain
	52,	Gwalior
	53,	Jabalpur*
Maharashtra (19)	54,	Akola
	55,	Amravati
	56,	Aurangabad
	57,	Badlapur
	58,	Chandrapur
	59,	Jalgaon
	60,	Jalna
	61,	Kolhapur
	62,	Latur
	63,	Mumbai
	64,	Nagpur
	65,	Nashik
	66,	Navi Mumbai
	67,	Pune
	68,	Sangli
	69,	Solapur
	70,	Ulhasnagar
	71,	Thane
	72,	Vasai-Virar*
Meghalaya (01)	73,	Byrnihat
Nagaland (02)	74,	Dimapur
	75,	Kohima
Orissa (07)	76,	Angul
	77,	Balasore
	78,	Bhubaneswar
	79,	Cuttack
	80,	Rourkela
	81,	Talcher
	82,	Kalinga Nagar
Punjab (09)	83,	Dera Bassi
	84,	Gobindgarh
	85,	Jalandhar
	86,	Khanna
	87,	Ludhiana
	88,	Naya Nangal
	89,	Pathankot/Dera Baba
	90,	Patiala
	91,	Amritsar
Rajasthan (05)	92,	Alwar
	93,	Jaipur
	94,	Jodhpur
	95,	Kota
	96,	Udaipur
Tamilnadu (04)	97,	Thoothukudi
	98,	Trichy
	99,	Madurai
	100,	Chennai*
Telangana (04)	101,	Hyderabad

State	S.No.	City
	102,	Nalgonda
	103,	Patancheruvu
	104,	Sangareddy
Uttar Pradesh (17)	105,	Agra
	106,	Allahabad
	107,	Anpara
	108,	Bareily
	109,	Firozabad
	110,	Gajraula
	111,	Ghaziabad
	112,	Jhansi
	113,	Kanpur
	114,	Khurja
	115,	Lucknow
	116,	Moradabad
	117,	Noida
	118,	Raebareli
	119,	Varanasi
	120,	Gorakhpur
	121,	Meerut*
Uttarakhand (03)	122,	Kashipur
	123,	Rishikesh
	124,	Dehradun
West Bengal (07)	125,	Kolkata
	126,	Asansol
	127,	Barrackpore
	128,	Durgapur
	129,	Haldia
	130,	Howrah
	131,	Raniganj
Haryana (1)	132,	Faridabad*
*Million plus cities but not part of non-attainment cities Source: CPCB		