CLEAN AIR ASIA

Air Quality Management in India

Status of 30 Cities

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FOREWORD

For us at Clean Air Asia, India is critically important in our effort to help with addressing one of the key challenges of our times: Air Pollution. Our report 'Air Quality Management in India: Status Report of 30 Cities' is an important step in this direction as it provides an overview of the status of air quality management across Indian cities. The report details most of the key initiatives being undertaken at the national and city level and the progress Indian cities are making to mitigate air pollution and its detrimental effects on the environment and the health of the people of India.

One of the key strengths of the report is that we have assessed the status of a city through the use of Clean Air Asia's Clean Air Scorecard Tool (CAST), which was developed keeping in mind that cities are complex entities and differ in topology, resources, administrative setup, monitoring potential and city level studies to mention a few. To capture these differences and highlight the actions that are taking place/should take place the CAST tool was used to arrive at a representative picture of where Indian cities are positioned and what areas need more investment versus others. This assessment also provides a clearer picture of the areas in which capacity should be built with the potential for a resulting more focussed and comprehensive approach to improving air quality management of Indian cities. Undoubtedly, one the biggest learnings of this assessment has been that there are a number of important initiatives already underway in many cities and there is indeed a positive impetus for assessing, monitoring and abating air pollution across cities. It is clearly identified that national level policies and the institutional structures in India for air quality monitoring is becoming more robust. That said, there is equally room for development in certain areas to help and enable Indian cities to achieve the National Ambient Air Quality Standards in the future. This report will become an important baseline for tracking progress of air quality action initiatives across Indian cities in the coming years. We will be documenting progress (and where progress is needed) in the next years. As we look forward to the challenges ahead in respect to improving air quality across Asia generally and India specifically, I would like to thank all those that contributed to making this report a reality, and I look forward to the work we will do together and the impact we will have to achieve better air quality and more liveable cities in Asia.

Bjarne Pedersen
Executive Director

PREFACE

When we began our new India strategy for Advancing Better Air Quality in Indian Cities in 2016, a major challenge we faced was access to information on cities and air quality. While the Central Pollution Control Board does publish air quality data about cities detailed information on the air quality management status of cities in terms of monitoring facilities available, research studies on emissions inventories, source apportionment, health impacts and even basic data on how many persons within the city are involved in managing air pollution is difficult to gain access to, mainly because there is no single platform for all this information. It is with an objective to make available all this data that we began our work on the assessment of air quality management profiles of 30 Indian cities. Selecting the cities was a challenge and we had a lot of discussion on what the criteria should be. Our matrix was prepared based on national criteria like non- attainment levels specified by the Central Pollution Control Board, the smart city criteria and regional representation so we have a representative picture of different air pollution sources. To generate data online through secondary research, especially if we are looking at what we called" government validated" data is always a difficult process. We had to substantiate our work with primary level data collection through meetings and city level consultations to ensure that nothing was missed. However this was essential to making this document more useful as today we are confident about sharing it with cities since information was gathered through a consultative process. Also a national level peer review process was conducted to strengthen the report and incorporate inputs from the CPCB, MoEF & CC and other national agencies involved in air pollution work.

Cities were assesse dusing Clean AirAsia's Clean Air Asia's Scorecard Tool (CAST). This is an objective and comprehensive analysis tool for understanding the air quality management status in cities and identifying areas for improvement which incorporates (1) air quality levels, (2) clean air management capacity and (3) clean air policies and action. Air quality management (AQM) refers to the entire process of protecting the air quality of a city. AQM involves determining emission sources, assessing air quality status and its impacts and formulating and implementing solutions that are effective and target main pollution sources. This report assesses the capacity of 30 cities in India and attempts to generate information on what is required for these cities to improve management capacity. Clean Air Asia would like to put on record everyone who has contributed to this report and thank them for their invaluable inputs. We hope that this will serve as a useful research document for those involved in engaging with Indian cities to improve air quality.

Prarthana Borah
India Director

ACKNOWLEDGEMENTS

Clean Air Asia is grateful for the inputs and contributions made by the following experts who were part of the peer review process that has strengthened the report :

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J.S Kamyotra	Former Member Secretary	Central Pollution Control Board






ABOUT CLEAN AIR ASIA

Clean Air Asia was established in 2001 by the Asian Development Bank, the World Bank, and USAID. Today, we are registered as an international non-governmental organization that leads the regional mission for better air quality and healthier, more livable cities in Asia. We aim to reduce air pollution and greenhouse gas emissions in 1000+ cities in Asia through policies and programs that cover air quality, transport, industrial emissions, and energy use. We work with ministries (energy, urban development, environment, health, and transport), cities in Asia, the private sector and development agencies to provide leadership and technical knowledge for Air Quality Management. Clean Air Asia is headquartered in Manila and has offices in Beijing and New Delhi.

Clean Air Asia (CAA)'s work in India involves engaging with Indian cities for better air quality management (AQM). This aligns with the overall CAA work program on broad air quality (AQ) interventions. Our work in India comprises providing scientific inputs to city governments for better air quality, sustainable transport/mobility programs and education/ communication for cleaner air. The focus of CAA's work in India is in cities with high impact potential, as well as potential for leveraging wider change.

Clean Air Asia completed assessment of AQM capacity in 30 cities in India to identify capacity building and other management needs for improving air quality. We are now facilitating air action in key cities by providing support for air quality monitoring, capacity building and direct interventions focused on solutions. CAA India has also facilitated the Clean Air Knowledge Network (CAKN), (www.allaboutair.in), a forum that connects AQ experts and practitioners from across India and city officials with an objective to promote knowledge-sharing across cities on AQ issues and share best practices.

A major component of CAA's India program is education for better air quality. Our work involves working with children, parents and schools to improve air quality for better health of the child. Our programmes focus on promoting air quality as a strong component of road safety and child friendly spaces/cities.

Clean Air Asia actively engages youth for seeking solutions and innovative ideas to improve air quality. CAA's Youth Clean Air Network (YCAN) is a volunteer program in which youth can passionately work together for better air quality.

CAA has been working in India since 2008. In the past, the India team has worked on green freight and sustainable mobility projects, conducting walkability studies in Indian cities, developing the Walkability app, the National Bus Fuel Efficiency Framework, the Green Trucks Toolkit for India, and an online freight brokerage platform.


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CLEAN AIR AND A HEALTHY ENVIRONMENT
CLEAN AIR AND A HEALTHY ENVIRONMENT
A SAFE AND HEALTHY JOURNEY TO SCHOOL
YCAN
WORLD
DAY


YCAN
Youth for Clean Air


DELL

ABBREVIATIONS AND ACRONYMS

ADB	Asian Development Bank
AQI	Air Quality Index
AQM	Air Quality Management
AS	Arsenic
BC	Black Carbon
CAST	Clean Air Scorecard Tool
CDP	City Development Plan
CAAMS	Continuous Ambient Air Monitoring System
CMP	Comprehensive Mobility Plan
CO	Carbon Monoxide
CPCB	Central Pollution Control Board
EI	Emissions Inventory
GHGs	Greenhouse Gas Emissions
JNNURM	Jawaharlal Nehru National Urban Renewal Mission
MoEF	Ministry of Environment, Forests and Climate Change
MoUD	Ministry of Urban Development
NAAQS	National Ambient Air Quality Standards
NAMP	National Air Quality Monitoring Programme
NCR	National Capital Region
NH3	Ammonia
Ni	Nickel
NO2	Nitrogen dioxide
O3	Ozone
Pb	Lead
PM2.5	Particulate Matter 2.5 micrometers
PM10	Particulate Matter 10 micrometers
SA	Source Apportionment
SAFAR	System of Air Quality and Weather Forecasting And Research
SO2	Sulphur dioxide
SOE	State of Environment
SLCPs	Short-Lived Climate Pollutants
SPCB	State Pollution Control Board
UNICEF	United Nations Children’s Fund
WHO	World Health Organization

1

Understanding Air Quality Management through the Clean Air Scorecard Tool

1.1 Introduction

In the past five years, there has been increasing discourse on air pollution in India. This started with the publication of scientific articles that drew attention to the extent of air pollution worldwide and began to assess its impacts on human health. This raised awareness about the extent of the problem in the Indian subcontinent and in India itself (ICMR, PHFI and IHME 2017; WHO 2016). Since then, much has been written on the state of air pollution in India. And much has changed in approaching the issues of deterring air quality; from Delhi becoming the most polluted city in the world in 2014, to the National Green Tribunal (the highest court in the country dealing with environmental issues) being instrumental in instituting the Graded Response Action Plan to tackle air pollution in the Delhi National Capital Region (NCR) in 2017, to the central government setting up a special task force to tackle air pollution-related issues in the country. This can be seen in the increased reporting of air pollution issues in India's mainstream print and electronic media. Most of these reports cover the state of air pollution in a particular region/city, the seasonal causes of air pollution, and the activities undertaken by the government, courts and civil society to address poor air quality. Even those reports that focus on Indian cities concentrate on the annual average level of pollutants and the number of air pollution monitoring stations in different cities.

1.2 Air Quality Management

AQM refers to the entire process of protecting the air quality of a city, region or nation. The process involves determining emission sources, assessing air quality status and its impacts, and formulating and implementing solutions that are effective and target the main pollution sources.

While a range of tools exist to measure environmental performance, there is no generally accepted methodology for an objective, comprehensive assessment of a city's management of air pollutants and greenhouse gas emissions (GHGs) that also identifies areas in which it has improved. A city is traditionally evaluated using a good-versus-bad list analysis based on available air quality data, such as the WHO's list of the world's most polluted cities. However, such analyses provides an incomplete picture as they penalize cities that monitor air quality and rank them without taking into consideration the measures and policies that are being implemented. In addition, these tools do not provide guidance on areas of AQM and the specific measures that cities can take. Recognizing this need, Clean Air Asia developed a comprehensive analysis tool for understanding the AQM status in cities – the Clean Air Scorecard Tool (CAST). CAST is an Excel-based tool incorporating three indices: (i) Air Pollution and Health; (ii) Clean Air Management Capacity; and (iii) Clean Air Policies and Actions, which taken together provide the AQM status of a city. While these initiatives are important, they do not capture the entire problem. Air pollution is not just about the level of pollutants in a city, the number of monitoring stations, the city-level policies that are in place, the health impact studies and scientific assessments that have been conducted; rather, it is composite of all of these features. Moreover, a well thought-out combination of these factors can systematically and sustainably address air pollution issues. This is called Air Quality Management (AQM).

The formula for computing the overall clean air score is:
Overall Clean Air Score [Total of 100] = (Air Pollution and Health Index/3) + (Clean Air Management Capacity Index/3) + (Clean Air Policies and Actions Index/3).
Whereby each index has a maximum score of 100, and when divided by 3 can contribute a maximum of 33.3 points to the total score.

1.3 Air Quality Management of 30 Indian Cities

In order to provide a more holistic understanding of the status of the AQM capacity of cities in India, Clean Air Asia undertook an assessment of 30 Indian cities. The assessment is based on desk research that was conducted from September 2016 to July 2017. If there have been new developments since then, they are not reflected in this report.

The 30 Indian cities that were selected for the CAST assessment were based on seven criteria that are explained in detail below. The overall intent was to select all types of cities to provide a comprehensive view of the AQM status of Indian cities.

CRITERIA 1
High Population Density

It is a well-established fact that air pollution has hazardous health effects that are exacerbated by anthropogenic factors such as vehicular emissions, industrial development and inefficient biofuel burning. High population density in cities is thus not only a causative agent of increasing emissions; it also bears the brunt of the effects of those emissions. This is aggravated by the fact that urban populations are rapidly increasing. Hence, cities with higher population densities should be assisted in addressing the problem of air pollution as early as possible.

CRITERIA 2
Smart City

The Smart City Awas Yojana Mission was launched in 2015 by Prime Minister Narendra Modi. The Smart Cities Mission is an urban renewal program that aims to provide state allocated funds for 100 cities make them people friendly and sustainable. Selected cities can leverage state funds to improve their capacity to tackle air pollution. Different mechanisms have to be put into place to equip cities to do this depending on their "smart city" status. The liveability index for smart cities highlights the need for clean air.

CRITERIA 3
Non-Attainment Cities

The Central Pollution Control Board (CPCB) identifies cities exceeding the prescribed National Ambient Air Quality Standards under the National Air Quality Monitoring Program and designates them as non-attainment cities. Non-attainment cities are those requiring immediate action to address air pollution issues

CRITERIA 4
Air Action Plan

As per the National Air Quality Monitoring Program all cities that are in the non-attainment category, must come up with an air action plan that specifically proposes constructive steps to be taken to deal with air pollution and bring pollutant levels within the permissible limit. Not all non-attainment cities have proposed an air action plan, but are mandated to have a plan.

CRITERIA 5
City Development Plan

A City Development Plan (CDP) is both a perspective and a vision for the future development of a city. A CDP is anchored in the Jawaharlal Nehru National Urban Renewal Mission (JNNURM) goal of creating economically productive, efficient, equitable and responsive cities. It provides a basis for cities to undertake urban sector reforms that help direct investment into city-based infrastructure and is a map of future steps to be taken by city governments to aid in the development of the city. Though all cities in India have a CDP, not many have outlined steps to be taken to address air pollution. Thus, making air pollution an agenda for concern in the CDP is central to making air pollution a management issue at the city level.

CRITERIA 6
Comprehensive Mobility Plan

In 2008 the Ministry of Urban Development (MoUD), with the assistance of the Asian Development Bank (ADB), prepared and issued a toolkit for the preparation of a Comprehensive Mobility Plan (CMP) for cities. MoUD encouraged cities to prepare CMPs before seeking funding for urban transport projects under Jawaharlal Nehru National Urban Renewal Mission (JnNURM). More than 50 cities have prepared CMPs using the CMP toolkit. Clearly, efficient management of the mobility of a city is necessary in being able to systematically address issues of air pollution. This is especially important as with increasing migration to cities, there is a need to managed vehicular and pedestrian mobility to diminish emissions and encourage walkability.

Based on these six criteria, 30 cities were selected across India to assess their AQM status. Care was taken to ensure a balanced selection by distributing the cities evenly across four zones: North, West, East and South. The 30 cities are listed here.

Zone	Cities	State	High Population Density	Smart City	Non-Attainment City	Air Action Plan	CDP	CMP
North	New Delhi	Delhi	✔	✔	✔	✔	✔	✔
	Chandigarh	UT	✔	✔	✔	✕	✔	✔
	Kanpur	Uttar Pradesh	✔	✔	✔	✔	✔	✔
	Varanasi	Uttar Pradesh	✔	✔	✔	✔	✔	✔
	Shimla	Himachal Pradesh	✔	✔	✕	✕	✔	✔
	Jaipur	Rajasthan	✔	✔	✔	✕	✔	✔
	Udaipur	Rajasthan	✔	✔	✔	✕	✔	✔
	Ludhiana	Punjab	✔	✔	✔	✕	✔	✔
	Kurukshetra	Haryana	✔	✕	✕	✕	✔	✕
West	Mumbai	Maharashtra	✔	✕	✔	✕	✔	✔
	Aurangabad	Maharashtra	✔	✔	✔	✕	✔	✕
	Nagpur	Maharashtra	✔	✔	✔	✕	✔	✔
	Nashik	Maharashtra	✔	✔	✔	✕	✔	✕
	Pune	Maharashtra	✔	✔	✔	✕	✔	✔
	Solapur	Maharashtra	✔	✔	✔	✕	✔	✕
	Ahmedabad	Gujarat	✔	✔	✕	✔	✔	✔
	Indore	Madhya Pradesh	✔	✔	✔	✔	✔	✔
	Surat	Gujarat	✔	✔	✔	✕	✔	✔
East	Kolkata	West Bengal	✔	✔	✔	✕	✔	✔
	Bhubaneshwar	Odisha	✔	✔	✔	✕	✔	✔
	Guwahati	Assam	✔	✔	✔	✕	✔	✔
	Raipur	Chhattisgarh	✔	✔	✕	✕	✔	✔
	Jamshedpur	Jharkhand	✔	✕	✕	✕	✔	✕
	Patna	Bihar	✔	✔	✕	✕	✔	✕
South	Chennai	Tamil Nadu	✔	✔	✕	✕	✔	✔
	Bengaluru	Karnataka	✔	✔	✕	✕	✔	✔
	Coimbatore	Tamil Nadu	✔	✔	✕	✕	✔	✔
	Kochi	Kerala	✔	✔	✕	✕	✔	✔
	Hyderabad	Telangana	✔	✕	✔	✕	✔	✔
	Vishakhapatnam	Andhra Pradesh	✔	✔	✔	✔	✔	✔

Figure 1: Criteria for 30 Cities selected for CAST assessment

1.4 Outline of Report

The results and discussions of the AQM Assessment of the 30 Indian Cities is presented in the report in the following chapters.

Chapter 1	**Scorecard Tool –** This chapter outlines the CAST and the selection of the 30 cities, highlighting the need for such an assessment.
Chapter 2	**Air Quality Monitoring System and Reporting –** This chapter examines AQM capacity across the 30 cities, the status of ambient air quality and the accessibility of air quality data across cities.
Chapter 3	**Understanding Health Impacts and Disseminating Air Quality Data –** This chapter examines the status of city-specific air quality and health studies across the 30 cities and the different platforms with which air quality data across cities is freely accessible.
Chapter 4	**Studies on the Sources and the State of Air Pollution in Indian Cities –** This chapter highlights city-specific source apportionment and emissions inventories for Indian cities.
Chapter 5	**Policy and Institutional Framework of AQM in India –** This chapter provides an understanding of how air pollution policies have developed in India and the institutional frameworks that are in place to manage and implement those policies.
Chapter 6	**AQM Status of 30 Indian Cities –** This chapter assesses how each city fared under CAST, broken down in accordance with the three indexes that comprise the AQM assessment.
Chapter 7	**Challenges, Limitations and Learnings -** This chapter details the research process, conceptualization and limitations of the report, while stating the main findings.
Chapter 8	**Way Forward -** Based on the information gained from the assessment of the AQM status of 30 cities in India, this chapter details how capacity can be built in the future to improve the AQM status of Indian cities.

2

Air Quality Monitoring System and Reporting

2.1 Introduction

Air Quality Management emerged in India with the enactment of the Air (Prevention and Control of Pollution) Act, 1981 (also known as the Air Act, 1981). The body responsible for the governance and implementation of Air Act is the Central Pollution Control Board (CPCB). The CPCB was set up in September 1974 under the Water (Prevention and Control of Pollution) Act, 1974. With the enactment of the Air Act, 1981, the CPCB was entrusted with the powers and functions under the Air Act.

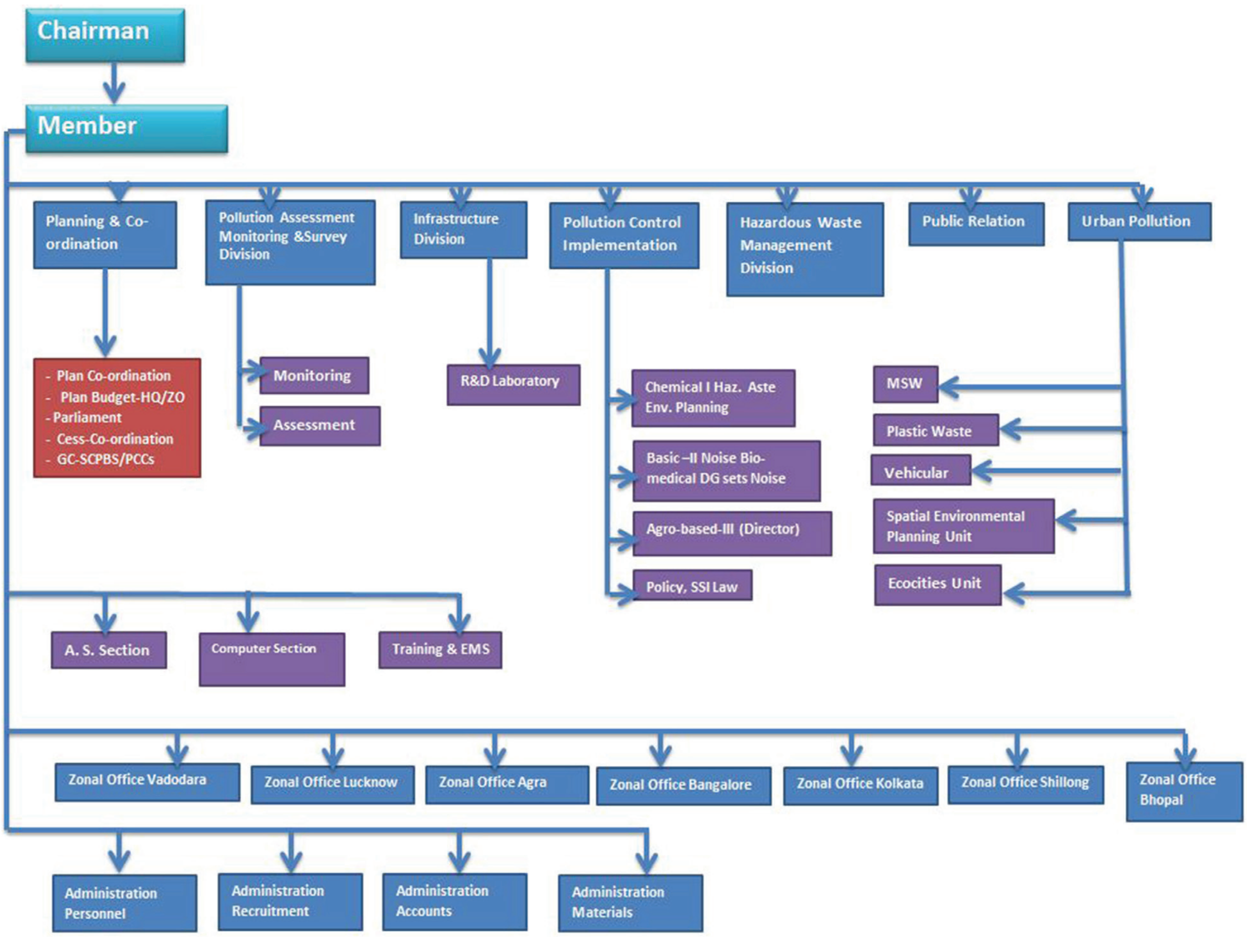

Figure 2: Organizational structure of the CPCB

Section 16 of the Air Act of 1981 specifies the main roles of the CPCB. Three of those functions will be explored in this chapter:

- Plan and cause to be executed a nationwide programme for the prevention, control or abatement of air pollution;Collect, compile and publish technical and statistical data relating to air pollution and the measures devised for its effective prevention, control or abatement, and prepare manuals, codes or guides relating to prevention, control or abatement of air pollution; and
- Lay down standards for the quality of air.

Each of these three functions has led to the establishment of the national network of air quality monitoring stations, setting guidelines of their proper functioning and generation, and the collection and dissemination of air quality data from this network. The CPCB's efforts are focused on expanding this network to not only cover a greater number of cities in India, but also on simultaneously improving the quality of the data being generated and upgrading the technology that is used to generate this data. This is important as good (reliable) quality data on ambient air conditions not only enables the assessment of trends and tendencies, but also enables better solutions and policies to be developed to address issues specific to the needs of a city or region. This chapter is an assessment of how the ambient air monitoring network is functioning across 30 cities, and gives an overview of the CPCB's policy on managing this network. In addition, the annual averages of pollutants in cities are tabulated from the data available from state-supported monitoring stations to arrive at a comparative assessment of air quality across the 30 cities, which is used to assess the mode of data-sharing for air quality data.

2.2 National Air Quality Monitoring Programme (NAMP)

The CPCB is managing and operating a national AQ monitoring programme for monitoring ambient air across India, an effort that began in 1984. The network consists of 638 monitoring stations covering 300 cities and towns in 29 states and six Union Territories. There are consistent efforts to not only expand the NAMP to cover more regions of the country, but also to monitor and update the quality of data accrued from the monitoring stations. The parameters for selection of areas for monitoring stations as outlined by the CPCB are shown in Figure 3.

Objectives of NAMP:

- To determine status and trends of ambient air quality: Allows for an assessment of whether implemented policies are reaping the desired effects.
- To ascertain whether the prescribed ambient air quality standards are violated: How many cities surpass the Indian ambient air quality standards prescribed in 2009.
- To Identify Non-attainment Cities: The CPCB identifies cities in which the prescribed National Ambient Air Quality Standards are being violated under the NAMP and are designated as non- attainment. Twenty of the selected cities are non-attainment cities, which implies that they require immediate steps to aid in addressing air pollution issues.
- To obtain the knowledge and understanding necessary for developing preventive and corrective measures.

Frequency and pollutants monitored

Four air pollutants have been identified for regular monitoring at all locations: Sulphur dioxide (So2), nitrogen oxides (NO), respirable suspended particulate matter (RSPM/PM10) and fine particulate matter (PM2.5). The monitoring of pollutants is carried out twice a week for 24 hours (four-hourly sampling for gaseous pollutants and eight-hourly sampling for particulate matter), adding up to 104 observations per year. However, some cities have continuous air monitors that are not manually managed and generate hourly AQ data. Those cities that do have continuous monitoring stations share AQ data on both State Pollution Control Board (SPCB) and CPCB websites.

Monitoring agencies

Monitoring is being carried out by the CPCB, SPCBs, Pollution Control Committees and the National Environmental Engineering Research Institute (NEERI), Nagpur. The CPCB coordinates with these agencies to ensure the uniformity and consistency of AQ data and provides technical and financial support to operate the monitoring stations.


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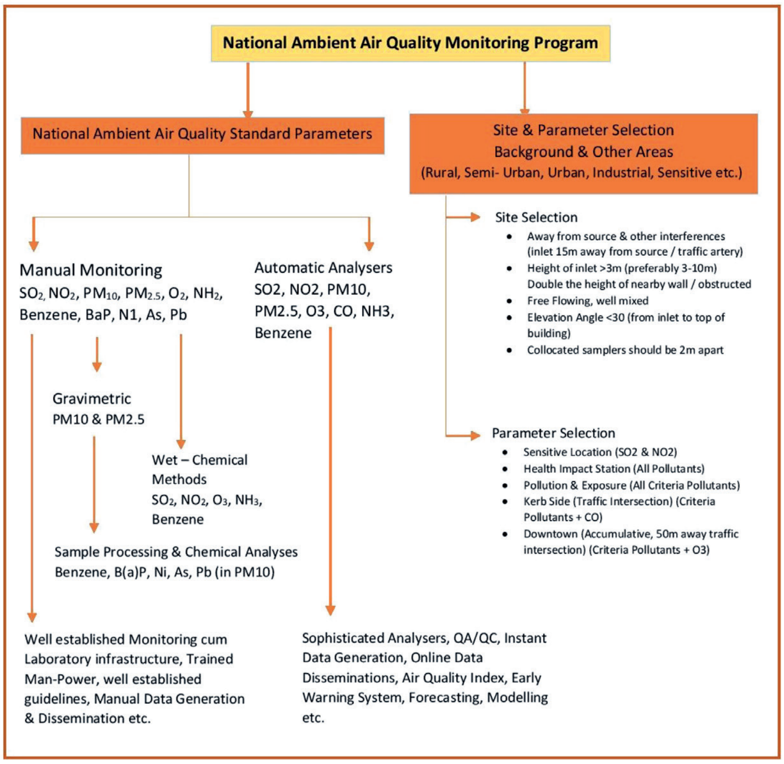
Figure 3: CPCB site and parameter selection criteria under NAMP



Data management

All data gathered by monitoring stations under the NAMP has to be submitted to the CPCB. The CPCB publishes annual reports that give an overall picture of India's ambient air quality across all the cities with monitoring stations under the NAMP. In addition, SPCBs and Pollution Control Committees display AQ data, although this is not consistent across all SPCBs.

2.3 CAST Assessment

The CAST assessment provided an overview of how the NAMP was functioning and gives the status of air quality across cities. The CAST enabled an assessment of how many monitoring stations should be present in each city in relation to a city's population. The CAST determined the number of stations a city should have based on its population. It emerged that while most cities had monitoring stations, there were still a few without any or enough monitoring stations in line with the population. The majority of cities are monitoring three types of pollutants: SO2, NO2 and PM10, although more pollutants (such as PM2.5, O3 and CO) are progressively being monitored in cities. In addition, the number of cities with continuous monitoring station are still limited (details are provided here). While the existing NAMP allows for an assessment of air pollution across cities, it is important to highlight some caveats in the information accrued.

Caveats:

- As stated in the introduction, the data is based on desk research conducted from September 2016 to July 2017. Thus, any new developments since then are not reflected in the report.
- PM10 is used as the pollutant for comparison among cities for the number of monitoring stations and state of the air for two reasons:

1. Most cities monitor three pollutants: PM10, SO2 and NO2. Very few cities monitor pollutants such as PM 2.5, CO, O3. Thus, in order to provide a balanced comparison, PM10 was used as the pollutant upon which to base comparisons.
2. In the list of non-attainment cities in India issued by the CPCB, 94 cities are listed across 22 states. The main pollutant of concern identified in this list is PM10. Of the 94 non-attainment cities, five cities have also identified NO2 as a "pollutant of concern" along with PM10.2

For annual concentrations, the report attempts to provide the most recent data for cities. However, data for 2015-2016 was not available for most cities. The most recent CPCB report for annual concentrations in cities covers 2014-2015. Thus, with the exception of two cities there is no data later than 2014-15.

Those two cities do not have monitoring stations under the NAMP, whose air quality data is available. Attempts were made to assimilate the latest data possible for 2015-2016 by referring to data available on SPCB websites.

2.4 Status of monitoring stations

For the complete list shared by the CPCB, please see:
http://www.cpcb.nic.in/Non_attainment.php.
See Appendix 1 for a complete list of the CPCB's non- attainment cities.

The first line of inquiry is to assess the status of ambient air monitoring stations in a city in order to get a sense of the number of monitoring stations per city.

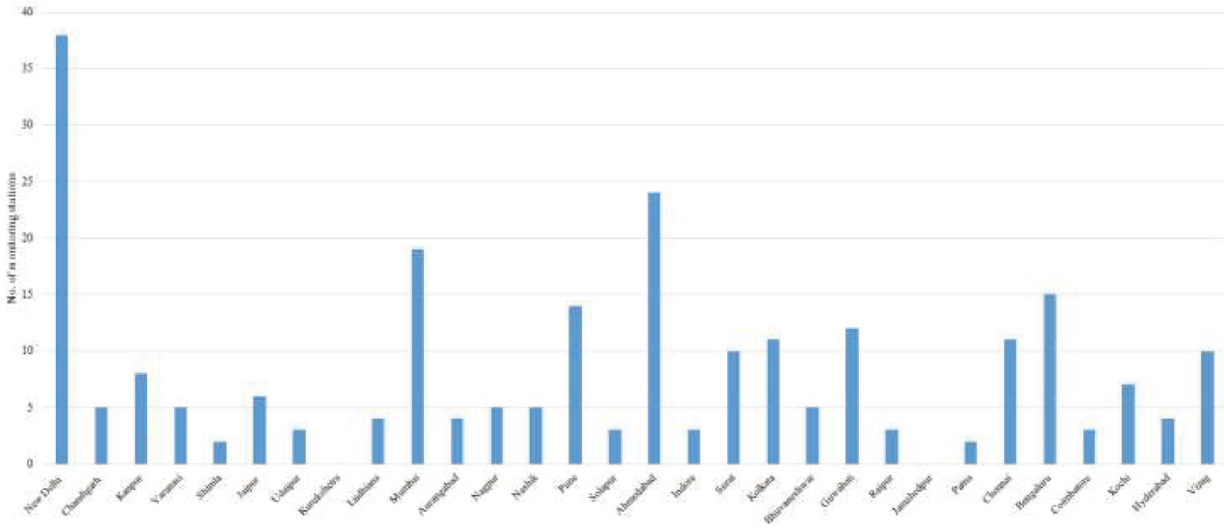


Figure 3: Monitoring Stations for PM10

As Figure 4 illustrates, with the exception of Kurukshetra and Jamshedpur, most cities have monitoring stations. Again, it is important to bear in mind that only state-supported monitoring stations monitoring PM10 have been mentioned as that is the pollutant used for comparisons. With the exception of Hyderabad, all monitoring stations across the 28 cities monitor PM10. In Hyderabad, there are six monitoring stations, of which only four monitor PM10, which is why four monitoring stations have been indicated for the city in Figure 4.

The majority of stations in a city are manually operated. Very few cities have continuous AQ monitoring stations, also known as CAAMS (Continuous Ambient Air Quality Monitoring Systems), as shown in Figure 5. As illustrated, more than 50 percent of the sample (19 cities) have continuous monitoring stations.

It is important to understand the difference between continuous and manual stations to appreciate the difference in the type of data and the utility of the data gathered. A manual station requires an expert to periodically visit the station to collect data and calibrate equipment to ensure that the station is functioning correctly. As per the CPCB mandate to establish an annual arithmetic mean, a minimum of 104 measurements are required in a year from a particular site.

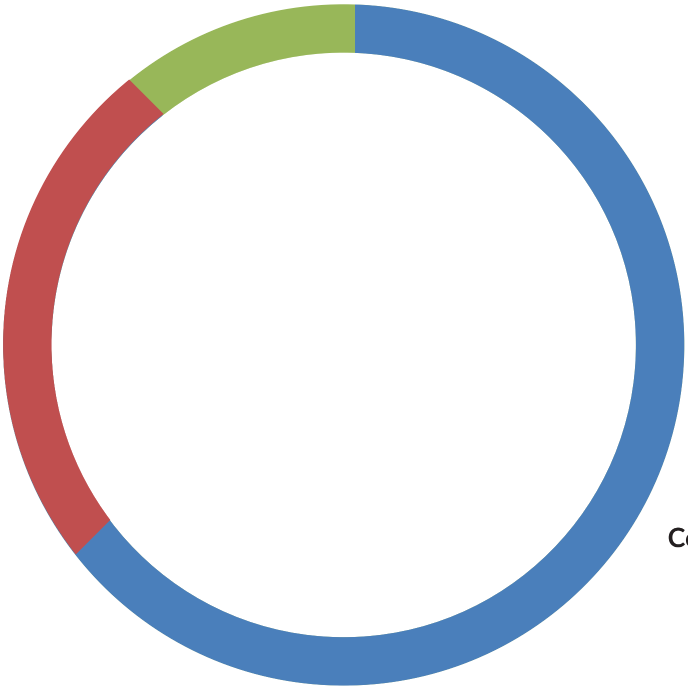


Figure 5: Types of Monitoring Stations

This means that readings must be manually taken from a station twice a week that give 24-hourly values at a uniform interval. Depending on the type of pollutant, the CPCB has specified in the national ambient air quality standards (see Appendix 2) how the average weighted value of a pollutant is to be calculated; for instance, annual and/or daily for PM10, eight hourly and/or hourly for ozone, and annually for benzopyrene. These guidelines also apply to the way that data is assessed for continuous monitoring stations. However, continuous monitoring stations differ from manual stations in that AQ data is directly fed into a server and is regularly updated. Most significantly, online data obtained from these stations is available at 15-minute intervals.

Most of the data from these stations, whether on the CPCB or SPCB websites, is made available at hourly intervals. This is significant as it allows end-users of the data to assess air quality in real time. In contrast, data obtained from manual stations is always from the previous day and not in real time, and hence has lesser utility. Thus, the fact that 19 cities in the sample have continuous monitoring stations is a huge advantage for policymakers and citizens alike to take planned steps and assess the air quality of a region. With the exception of Delhi, all cities have more manual monitoring stations than continuous monitoring stations, and in the future there is a need to increase the number of continuous monitoring stations to improve the quality of data.

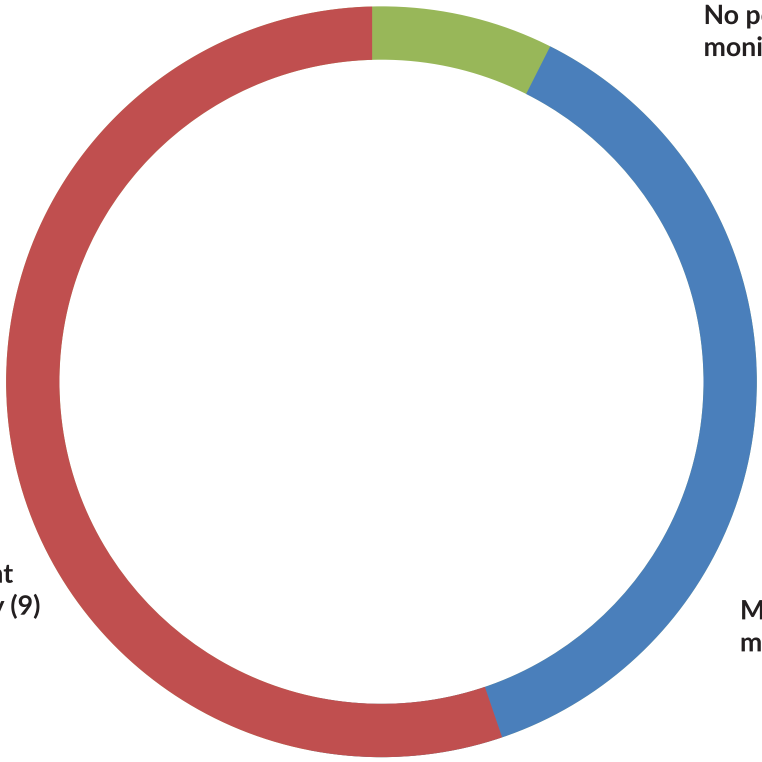


Figure 6: Pollutants Monitored

In a meeting at the planning commission, it was decided that the CPCB would start air quality monitoring in major cities and critically polluted areas by installing continuous air quality monitoring stations through the public-private partnership model (IIM 2010). This decision was made as there is a shortage of technical manpower in the CPCB and continuous monitoring stations not only give real-time data but are less human-resource intensive.

As stated earlier, most cities monitor three main pollutants: PM10, SO2 and NO2. The cities monitoring only these three pollutants and those monitoring more is shown in Figure 6. There isn't a direct correlation between the type of monitoring station and the number of pollutants monitored. That said, most cities with a continuous monitoring station do monitor more than three pollutants. However, some cities such as Indore, Surat, Bhubaneshwar and Raipur have only manual monitoring stations but monitor more than the three most common pollutants. This means that the CPCB has mandated that all the pollutants listed in the NAAQS can be assessed even with manual stations, as shown in Figure 7. As can be seen, both manual and continuous monitoring systems can be used to monitor SO2, NO2, O3, NH3, CO, PM2.5, benzene and PM10.

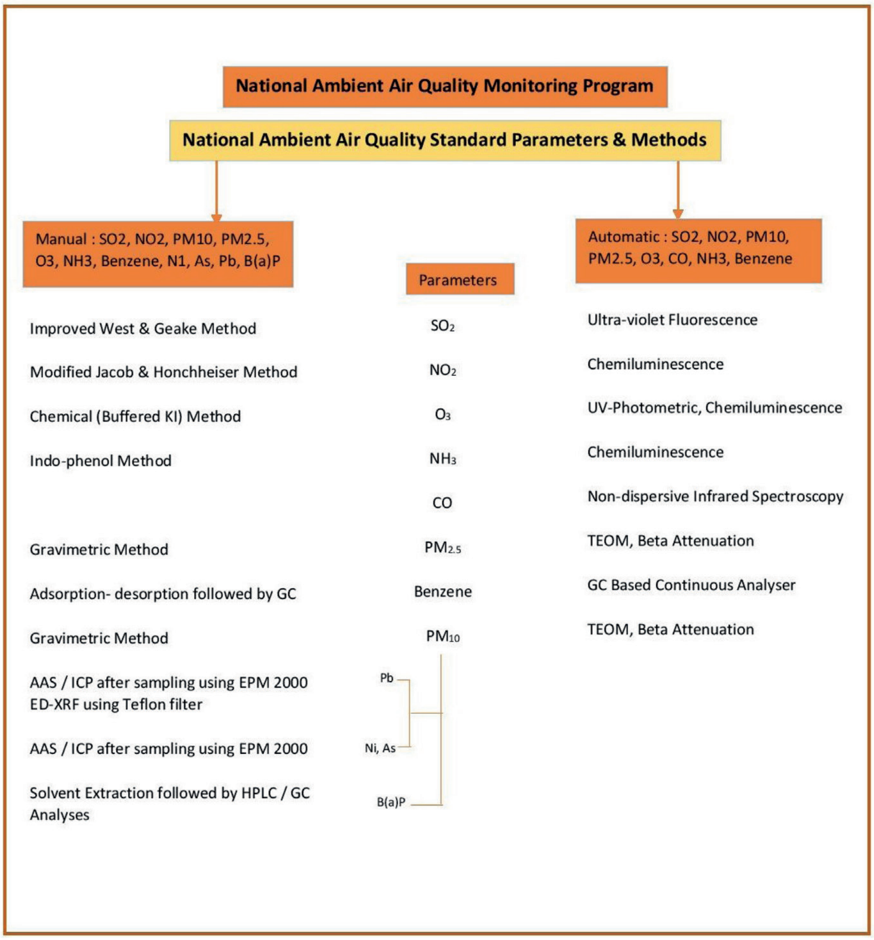


Figure 7: CPCB methods for pollutant monitoring

The city breakdown of pollutants monitored and whether cities have continuous monitoring stations is shown in Figure 8. As can be seen, the majority of cities monitor the three main pollutants of PM10, NO2 and SO2. Of the 19 cities with CAAMS, eight monitor more than three pollutants. This is not to say that the other cities do not monitor more pollutants; rather, that this assessment is based on data that was available on SPCB and Pollution Control Committee websites. The 2014-2015 CPCB annual report provides data for only the three main pollutants monitored. In other words, there may be more pollutants that are being monitored but data for only those pollutants listed in Figure 8 is available in the public domain. The accessibility of AQ data will be discussed in detail in the next chapter. The CAST allowed for calculations of the required number of monitoring stations in cities based on their population. This enabled an understanding of those cities in which there was a pronounced need to increase the number of monitoring stations versus those where there were sufficient and where emphasis should be placed on technology upgrades (such as replacing manual stations with continuous stations) and putting to better use the data gathered from the existing monitoring stations.

No.	Zone	Cities	Pollutants Monitored	Does the city have a CAAMS	No. of CAAMS in the city
1	North	New Delhi	PM2.5, PM10, SO2, NO2, O3, CO	✓	29
2		Chandigarh	PM10, SO2, NO2	✗	✗
3		Kanpur	PM10, SO2, NO2	✓	CAAMS
4		Varanasi	PM10, SO2, NO2	CAAMS	1
5		Shimla	PM10, SO2, NO2	✗	✗
6		Jaipur	PM10, SO2, NO2	✓	4
7		Udaipur	PM2.5, PM10, SO2, NO2, O3, CO	✓	1
8		Kurukshetra	-	✗	✗
9		Ludhiana	PM10, SO2, NO2	✓	1
10	West	Mumbai	PM2.5, PM10, SO2, NO2, O3, CO	✓	11
11		Aurangabad	PM10, SO2, NO2	✓	1
12		Nagpur	PM10, SO2, NO2	✓	1
13		Nashik	PM10, SO2, NO2	✓	1
14		Pune	PM2.5, PM10, SO2, NO2, O3, CO	✓	11
15		Solapur	PM10, SO2, NO2	✓	1
16		Ahmedabad	PM2.5, PM10, SO2, NO2, O3, CO	✓	11
17		Indore	PM2.5, PM10, SO2, NO2, O3	✗	✗
18		Surat	PM2.5, PM10, SO2, NO2, O3, CO	✗	✗
19	East	Kolkata	PM10, SO2, NO2, O3, CO	✓	2
20		Bhubaneshwar	PM2.5, PM10, SO2, NO2, O3	✗	✗
21		Guwahati	PM10, SO2, NO2	✗	✗
22		Raipur	PM2.5, PM10, SO2, NO2	✗	✗
23		Jamshedpur	-	✗	✗
24		Patna	PM10, SO2, NO2	✓	1
25	South	Chennai	PM2.5, PM10, SO2, NO2, O3, CO	✓	3
26		Bengaluru	PM2.5, PM10, SO2, NO2, O3, CO	✓	5
27		Coimbatore	PM10, SO2, NO2	✗	✗
28		Kochi	PM10, SO2, NO2	✗	✗
29		Hyderabad	PM10, SO2, NO2	✓	6
30		Vishakhapatnam	PM2.5, PM10, SO2, NO2, O3, CO	✓	2

Figure 8: Pollutants monitored and presence of CAAMS in cities

This is detailed in Figure 9, where again the comparison is on the need for monitoring stations in accordance with those that monitor PM10 as that has been established as the pollutant of comparison. Further, it has been identified in the table whether or not a city is a non-attainment city to highlight those cities in which there is a heightened need to address the question of adequate monitoring stations. The CPCB has identified a list of polluted cities in which the prescribed NAAQS have been consistently violated for five years. The most updated list of cities is based on data from 2011-2015 under the NAMP (see Appendix 1). These cities signify those in which there is a need to take action to improve the air quality. As can be seen in Figure 9, some interesting analyses emerge. Firstly, 20 of the 30 cities are non- attainment cities, which means they have consistently not met the NAAQS for five years. Of these 20 cities, 16 do not have a sufficient number of monitoring stations based on the population of the city. Thus, there is a need to increase the AQ monitoring capacity of these cities as proper data on a city's air quality allows for the assessment of air pollution, which can lead to the development of appropriate mitigation policies. Increasing the number of monitoring stations in a city or state is not an easy task owing to the cost of installation and the operating costs of such stations. That said, there have been a number of initiatives in the recent past aimed at increasing the number of monitoring stations in cities and states. For example, in 2017 Delhi pledged to have 20 more continuous monitoring stations and the state of Haryana pledged to install continuous air monitoring stations in nine cities in 2017.

This raises the issue of the agencies managing and running monitoring stations. While it is true that the CPCB oversees the NAMP, in specific cases there are monitoring stations that are being run by the SPCBs and Pollution Control Committees, and in some cases other ministries such as the Ministry of Earth Sciences that runs the System of Air Quality and Weather Forecasting And Research (SAFAR) which is headquartered in the Indian Institute of Tropical Meteorology in Pune. There are monitoring stations in four cities currently under SAFAR: Ahmedabad, Mumbai, Pune and Delhi. These four cities are included in our sample of 30 cities. Thus, the higher number of monitoring stations in these cities is due to the fact that monitoring stations are being run under the SAFAR and the NAMP.

No.	Cities	Monitoring Stations for PM10	Need of the city (CAST - PM10)	Non-Attainment Cities by CPCB
1	New Delhi	25	15	✔
2	Chandigarh	5	6	✔
3	Kanpur	8	10	✔
4	Varanasi	5	6	✔
5	Shimla	2	2	✕
6	Jaipur	6	10	✔
7	Udaipur	3	3	✔
8	Kurukshetra	0	7	✕
9	Ludhiana	4	7	✔
10	Mumbai	19	15	✔
11	Aurangabad	4	6	✔
12	Nagpur	5	8	✔
13	Nashik	5	8	✔
14	Pune	14	8	✔
15	Solapur	3	4	✔
16	Ahmedabad	24	13	✕
17	Indore	3	7	✔
18	Surat	10	11	✔
19	Kolkata	11	11	✔
20	Bhubaneshwar	5	15	✔
21	Guwahati	12	6	✔
22	Raipur	3	6	✕
23	Jamshedpur	0	6	✕
24	Patna	2	7	✕
25	Chennai	11	15	✕
26	Bengaluru	15	15	✕
27	Coimbatore	3	6	✕
28	Kochi	7	3	✕
29	Hyderabad	4	8	✔
30	Vishakhapatnam	10	7	✔

Figure 9: Monitoring Stations Needed vis a vis Number of Existing Monitoring Stations in Cities

The SAFAR operates 10 monitoring stations in every city, amounting to a total of 40 stations being run by the SAFAR in India. The SAFAR network of AQ monitoring stations operate around the clock, and data is recorded and stored at five-minute intervals. The pollutants monitored are PM10, PM2.5, O3, CO, NO2, SO2, BC, methane, non-methane hydrocarbons, VOCs, benzene and mercury. These stations add to the quality of data in the four cities. In addition, some cities not only have monitoring stations run by the CPCB, but also by the SPCBs and Pollution Control Committees. For instance, in Delhi and Ahmedabad there are monitoring stations managed by the CPCB, SPCB/Pollution Control Committee and the SAFAR. A detailed breakdown of the agencies managing AQ monitoring stations across cities is listed in Figure 10, which shows 28 cities and two cities that do not have monitoring stations, according to SPCB websites.

Monitoring Agencies	Cities
CPCB	Kanpur, Varanasi, Shimla, Jaipur, Udaipur, Solapur, Indore, Kolkata, Bhubaneshwar, Guwahati, Raipur, Patna, Chennai, Bengaluru, Coimbatore, Kochi, Hyderabad
CPCB & SPCB/PCC	Chandigarh, Ludhiana, Aurangabad, Nagpur. Nashik, Surat, Vizag
CPCB & SAFAR	Mumbai
CPCB, SPCB/PCC & SAFAR	New Delhi, Pune, Ahmedabad

Figure 10: Agencies running monitoring stations in cities

The websites of the respective SPCBs specify whether monitoring stations are being managed under the SPCB or Pollution Control Committees. For those SPCB websites that make no specific mention of the agency managing the monitoring station, instead just listing the number and location of monitoring stations run under the NAMP, it has been assumed that the CPCB is the sole managing agency. What emerges is that CPCB is the main agency that is managing AQ monitoring stations across cities. Cities with a relatively higher number of monitoring stations are the result of an agency other than the CPCB (such as the SPCB/Pollution Control Committee or SAFAR) operating monitoring stations of their own. Thus, the onus of increasing the expanse of the NAMP still lies with the CPCB.

Assistance from agencies or ministries other than Ministry of Environment, Forest and Climate Change (MOEFCC), such as the Ministry of Earth Sciences which runs the SAFAR, significantly impacts the number of monitoring stations in a city. While multiple agencies setting up and running monitoring stations in a city is recommended, it is equally, if not more, important that there is consultation and data-sharing among the different agencies to avoid a replication of efforts to set up monitoring stations.

For more details see
http://safar.tropmet.res.in/MONITORING%20SYSTEM-10-3-Details

2.5 Ambient Air Quality

A sufficient number of AQ monitoring stations is important to understand a city's ambient air quality. With the NAMP having a mix of manual and continuous monitoring stations, the best way to get a sense of the air quality of a city is a comparison of annual averages. As stated previously, the three most common pollutants monitored across cities are PM10, SO2 and NO2, and annual values of all three pollutants are given. The pollutant for comparison used in this report is PM10, with cities compared in terms of ambient air quality levels of PM10. Before the data is presented, it is important to establish the degree of data availability as well as the year in which the data was available. The most recent annual report on ambient air quality for cities in India under the NAMP covers 2014-2015. Thus, cities can be evaluated on the basis of data available for 2014-2015. However, if AQ data is available on either SPCB of Pollution Control Committee websites, as is the case for some cities, more recent data can be found. This is also possible if data is gathered from the CPCB website, which provides real-time data for those cities with CAAMS. Hence it was possible to access data for 2015-2016 for some cities. The cities for which this was possible versus the cities for which the most recent data was only available for the year 2014-15 is presented in figure 11. Of the 30 cities, data is available for 18 cities from 2014-15, for 10 cities from 2015-16, and for two cities there is no data. It is important to note that this does not capture data available under the SAFAR as the SAFAR gathered real-time data that is only available in the public domain via its mobile application, which gives the Air Quality Index (AQI) along with real-time data. As a result, it was not possible to get access to backdated data from the SAFAR monitoring stations.

No.	Cities	Year of Which Data is Available
1	New Delhi	2014-15
2	Chandigarh	2015-16
3	Kanpur	2015-16
4	Varanasi	2015-16
5	Shimla	2015-16
6	Jaipur	2015-16
7	Udaipur	2015-16
8	Kurukshetra	✕
9	Ludhiana	2015-16
10	Mumbai	2015-16
11	Aurangabad	2014-15
12	Nagpur	2014-15
13	Nashik	2014-15
14	Pune	2014-15
15	Solapur	2015-16
16	Ahmedabad	2014-15
17	Indore	2014-15
18	Surat	2014-15
19	Kolkata	2014-15
20	Bhubaneshwar	2014-15
21	Guwahati	2014-15
22	Raipur	2014-15
23	Jamshedpur	✕
24	Patna	2014-15
25	Chennai	2014-15
26	Bengaluru	2015-16
27	Coimbatore	2014-15
28	Kochi	2014-15
29	Hyderabad	2014-15
30	Vishakhapatnam	2014-15

Figure 11: Most Recent Year for which Ambient Air Quality Data is Available for Cities

Comparison of the annual averages for the 18 cities for which data was available for 2014-2015.

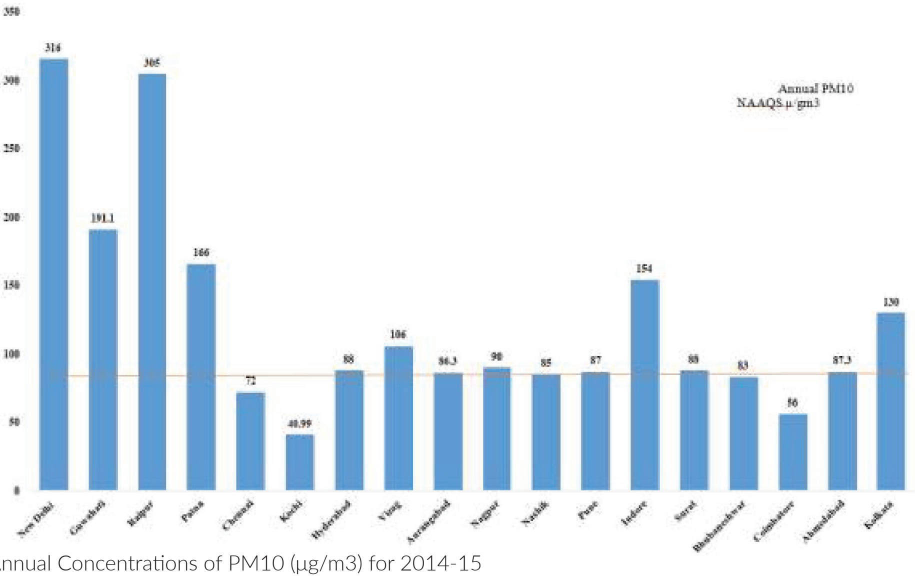


Figure 12: Annual Concentrations of PM10 (µg/m3) for 2014-15

This gives a sense of the position of different cities in terms of the air quality in relation to the NAAQS annual PM10 standard. Similarly, the annual averages for the 10 cities for which data was available for 2015-2016 is given in Figure 13.

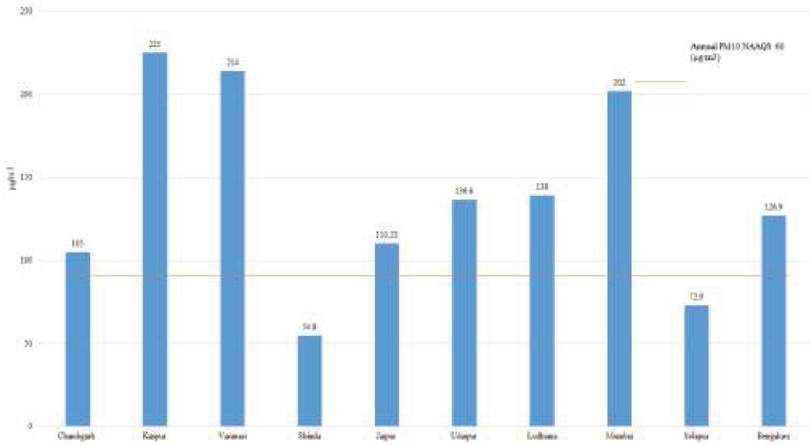


Figure 13: Annual Concentrations of PM10 (µg/m3) for 2015-16

This gives a sense of the position of different cities in terms of the air quality in relation to the NAAQS annual PM10 standard. Both figures indicate that most cities are in need of city-specific AQM policies. Although PM10 was taken as the pollutant of comparison for all 30 cities, data was gathered for annual pollutant levels of PM10, SO2, NO2 and PM2.5. The levels of all three, together with the years for which data was available, is listed in Figure 14.

No.	Cities	Annual concentration of PM10	Annual concentration of SO2	Annual concentration of NoX	Annual concentration of PM2.5	Year of Assessment
1	New Delhi	316.00	11	67	204	2014-15
2	Chandigarh	105	2	17.4	✕	2015-16
3	Kanpur	225	7.5	44.5	✕	2015-16
4	Varanasi	214	40	22	✕	2015-16
5	Shimla	54.8	2	13.5	✕	2015-16
6	Jaipur	110.23	8.71	34.51	✕	2015-16
7	Udaipur	136.6	6.2	32.7	✕	2015-16
8	Kurukshetra	✕	✕	✕	✕	✕
9	Ludhiana	139	11	25	✕	2015-16
10	Mumbai	202	12.93	64.17	✕	2015-16
11	Aurangabad	86.3	21	37.3	✕	2014-15
12	Nagpur	90	10	25	✕	2014-15
13	Nashik	85	28	29	✕	2014-15
14	Pune	87	20	42	✕	2014-15
15	Solapur	72.9	12.7	35	✕	2015-16
16	Ahmedabad	87.3	13.3	20.5	31.9	2014-15
17	Indore	154	11	19	✕	2014-15
18	Surat	88	13	22.7	31.3	2014-15
19	Kolkata	130	13	75	✕	2014-15
20	Bhubaneshwar	83	4	17.1	32.2	2014-15
21	Guwahati	191.1	8.1	17.3	✕	2014-15
22	Raipur	305	14	52	✕	2014-15
23	Jamshedpur	✕	✕	✕	✕	✕
24	Patna	166	6	36	✕	2014-15
25	Chennai	72	14	22	✕	2014-15
26	Bengaluru	126.9	10.1	25.1	✕	2015-16
27	Coimbatore	56	4	24	✕	2014-15
28	Kochi	40.99	2.45	11.38	✕	2014-15
29	Hyderabad	88	5	24	✕	2014-15
30	Vishakhapatnam	106	14.6	79.1	74	2014-15

Figure 14: Annual levels of PM10, SO2, NO2 and PM2.5 for cities along with the year of assessment

2.6 Conclusion

This chapter presents a picture of the status of monitoring stations and air quality across 30 Indian cities. The intent has been to provide the most updated data available in the public domain to understand AQM capacity from the vantage point of air quality monitoring. The overall situation is realistically positive, in so far as there has been steady growth in the spread of the NAMP since it was launched in 1984. In addition, within the existing NAMP network and the measures to expand its monitoring capacity, there is an initiative to upgrade technology in terms of bringing a greater number of continuous ambient air monitoring stations into the network. This is imperative in not only improving the quality of data being generated, but also to increase the capacity of authorities to disseminate timely data on air quality, an aspect which is dealt with in detail in the next chapter. As elaborated in the Guidance Framework on Better Air Quality in Asian Cities, the objective of the first guidance area is to establish and/or strengthen air quality standards and sustainable national and local air quality monitoring programmes which will enable understanding of air quality status. Clearly, India is progressively working to address and strengthen its position in guidance area one. Not only is there an intent to increase the number and quality of monitoring stations to generate better data on AQ monitoring, there is a sharing of efforts to move in this direction. As has been discussed in some cities, the onus of establishing more monitoring stations has assumed by the SPCBs/Pollution Control Committees. Furthermore, the SAFAR program run by the Ministry of Earth Sciences has strongly supported the quality of air pollution data in four cities. There is a need for these agencies to work closely with the CPCB to reap the maximum benefits from the existing system. Additionally, as the Guidance Framework recommends, there is a need to not only increase the number of monitoring stations in those cities where there aren't enough, but also to meet the NAAQS in terms of air quality, which should systematically work towards bringing air quality to levels that are comparable with international standards. This is not an overnight task, but it is reassuring that relevant agencies are taking actions. These initiatives could be hastened if a systematic approach was taken across cities and states to work towards better AQ monitoring in the country.

3

Understanding Health Impacts and Disseminating Air Quality Data

3.1 Introduction

Air quality is a complex issue that is continuing to be understood by specialists and the common citizenry alike in India. The interest in air quality issues on a large scale is a relatively recent occurrence and with time there is increasing interest in being informed about the general state of air and more importantly its effect on human health. The important point, however, is whether good quality data is being used to establish the state of air quality and more importantly how is its link to health being made and disseminated? Further, has there been innovative strategies used to not only educate people about air pollution but is what is already being done achieving the intended goal? The aim of this chapter is to not only discuss the current scenario of how air quality data is shared across cities in India but also how some cities are engaging in interesting and new ways to take action, disseminate information and educate people about air quality. The need to effectively educate and disseminate air quality information is paramount if long-term solutions are to be formulated. Indeed, the onus of taking actions to monitor and reduce air pollution falls not only on the government but citizens alike need to take actions in their everyday lives. A move in this direction can however only take place when people have knowledge about the state of air quality, understand the links between air quality and health and take preventive actions to reduce the effects of bad air quality on their health and take actions to improve the quality of air in the future. This is a long-term process but steps in this direction have already started taking place. This is precisely what will be brought out in this chapter, the current state of data disseminating on air quality and what are future planned efforts for the same to best address the status of air quality in Indian cities.

3.2 Air Act 1981

The Air Act lays down the manner in which data on air quality will be shared and monitored. Under part 16 of the Air Act which spells out the functions of the CPCB, the point labelled (g) reads, 'collect, compile and publish technical and statistical data relating to air pollution and the measures devised for its effective prevention, control or abatement and prepare manuals, codes or guides relating to prevention, control or abatement of air pollution'. The important point is that not only is the CPCB responsible for the collection and compilation of air quality data but it must publish this data for mass out reach too.

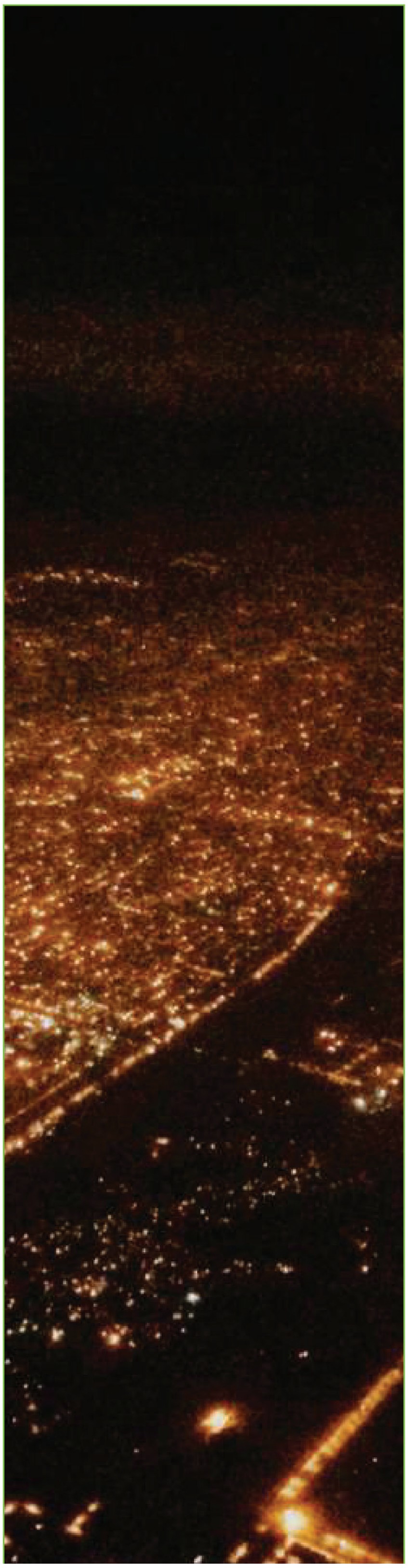
Further under section 17 of the act which lists the functions of the state pollution control boards the point labeled (c) reads, 'to collect and disseminate information relating to air pollution;'. This implies that not only the CPCB but the SPCB/PCC are responsible for the collection and dissemination of air quality data. Further, it is mandated that all SPCB/PCC regularly submit all the data they collect to the CPCB regularly. This is important as the CPCB co-ordinates with the SPCB/PCC to ensure the uniformity and consistency of air quality data. This is important to get a comparable picture of air quality across cities and states in India.

3.3 Monitoring stations and data

As explained in the previous chapter Indian cities have both manual and continuous monitoring stations. There are more manual stations than continuous stations but there is an incentive to increase the number of continuous monitoring stations across cities by the CPCB. The type of data assimilated from both stations varies depending on the technology of either station. In the case of a continuous monitoring station, the data is assimilated online and can be sent to the monitoring agency on a real-time basis and relatedly be displayed on the requisite portals on a real-time basis too. Alternately, with manual stations, data must be manually collected at a minimum of two times a week and then submitted to the monitoring agencies. This means that data assimilated from manual stations cannot be displayed on a real-time basis and when it is displayed it is always post-dated. In other words, the ability of monitoring agencies to share data and enable people to take everyday actions on the basis of air quality is limited or determined by the type of monitoring station present in a city. Those cities without continuous stations generate data that aids in establishing trends of air quality over a period of time in real time. And, while manual stations may not allow for a real-time assessment it is still important in assessing the air quality scenario of a city. As detailed in the previous chapter of the 30 cities being investigated for this report, 19 have CAAMS, 10 have manual monitoring stations and 2 have no monitoring stations. This is discussed in greater details in the previous chapter but it must be mentioned here that the cities with CAAMS also have manual monitoring stations and other than Delhi (19 CAAMS), Jaipur (4 CAAMS), Kolkata (2 CAAMS), Chennai (3 CAAMS), Bengaluru (5 CAAMS), Hyderabad (6 CAAMS) and Vizag (2 CAAMS), all other cities with CAAMS have only one and the rest are manual monitoring stations. The data generated from both manual and CAAMS is freely available through websites (such as on the CPCB website http://www.cpcb.gov.in/CAAQM/mapPage/frmindiamap.aspx, or any of the SPCB/PCC websites that have CAAMS) and reports. Figure 15 depicts the distribution of availability of air quality data across cities. The data available online is on two platforms.

No.	Cities	Data available online	Data available in report
1	New Delhi	✔	✔
2	Chandigarh	✔	✔
3	Kanpur	✔	✔
4	Varanasi	✔	✔
5	Shimla	✔	✔
6	Jaipur	✔	✔
7	Udaipur	✔	✔
8	Kurukshetra	✗	✗
9	Ludhiana	✔	✔
10	Mumbai	✔	✔
11	Aurangabad	✔	✔
12	Nagpur	✔	✔
13	Nashik	✔	✔
14	Pune	✔	✔
15	Solapur	✔	✔
16	Ahmedabad	✔	✔
17	Indore	✔	✔
18	Surat	✔	✔
19	Kolkata	✔	✔
20	Bhubaneshwar	✔	✔
21	Guwahati	✔	✔
22	Raipur	✔	✔
23	Jamshedpur	✗	✗
24	Patna	✔	✔
25	Chennai	✔	✔
26	Bengaluru	✔	✔
27	Coimbatore	✗	✔
28	Kochi	✗	✔
29	Hyderabad	✔	✔
30	Vizag	✔	✔

Figure 15: Availability of air quality data



3.4 Data from websites

The first is on the CPCB (http://www.cpcb.gov.in/CAAQM/mapPage/frmindiamap.aspx) website if the city has a CAAMS, then real-time data for the station or as many CAAMS that are in a city can be viewed. This is a fairly simple process. On the CPCB website by clicking the 'Environmental Data' tab, a drop down menu open up. On this menu, click on 'Air Quality Data,' and then on 'Automatic Monitoring Data'. A new webpage opens with a map of the country indicating all the states with CAAMS. This is shown in figure 16. The pointers show the states and union territories in India with cities that have a CAAMS. On selecting the pointers indicating the active CAAMS, another webpage pops up with the location of the CAAMS. And, finally, on selecting the pointer a window pops up showing the real time AQ data.

Figure 16: CAAMS data on CPCB website

As an example in figure 17, the pointer indicating the active CAAMS in Ludhiana city was selected.

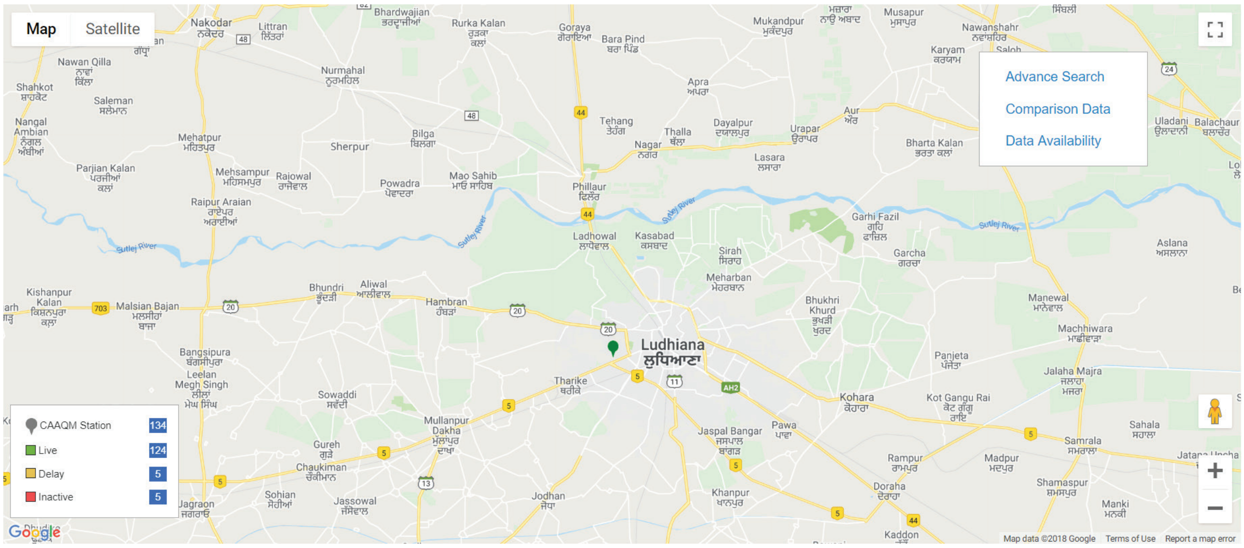


Figure 17: Ludhiana CAAMS station

This led to the pop-up box which, gives the venue of the CAAMS, in this case, the Punjab Agricultural University, Ludhiana, along with detailed live AQ data as depicted in figure 18.

Parameters	From Date	To Date	Concentration	Unit	Concentration (previous 24 Hours)	Remarks
PM2.5	26 Oct 2018 09:15	26 Oct 2018 09:30	76.41	ug/m3	113.92	
PM10	26 Oct 2018 09:15	26 Oct 2018 09:30	121.21	ug/m3	224.75	
NO	26 Oct 2018 09:15	26 Oct 2018 09:30	13.5	ug/m3	42.61	
NO2	26 Oct 2018 09:15	26 Oct 2018 09:30	10.56	ug/m3	47.87	
NOx	26 Oct 2018 09:15	26 Oct 2018 09:30	24.07	ppb	66.14	
NH3	26 Oct 2018 09:15	26 Oct 2018 09:30	41.97	ug/m3	29.44	
SO2	26 Oct 2018 09:15	26 Oct 2018 09:30	23.33	ug/m3	16.22	
CO	26 Oct 2018 09:15	26 Oct 2018 09:30	0.91	mg/m3	1.5	
Ozone	26 Oct 2018 09:15	26 Oct 2018 09:30	14.22	ug/m3	38.79	
Benzene	26 Oct 2018 09:15	26 Oct 2018 09:30	21.91	ug/m3	4.59	
Toluene	26 Oct 2018 09:15	26 Oct 2018 09:30	4.88	ug/m3	34.76	
Temp	26 Oct 2018 09:15	26 Oct 2018 09:30	23.69	degree C	26.93	
RH	26 Oct 2018 09:15	26 Oct 2018 09:30	55.76	%	54.11	
WS	26 Oct 2018 09:15	26 Oct 2018 09:30	0.11	m/s	-	
WD	26 Oct 2018 09:15	26 Oct 2018 09:30	330.39	deg	-	
SR	26 Oct 2018 09:15	26 Oct 2018 09:30	435.67	W/mt2	133.57	

Figure 18: Ludhiana CAAMS data

The user is given a choice to download the data. Clearly, this is only possible for those cities with a CAAMS. Further many cities only have one CAAMS, thus the data is not indicative of the situation in different parts of the city. That said it is a reliable source of data for cities across the country.

The second option to access online data is from the SPCB/PCC website. Depending on the type of station in the city (manual or continuous) data can be accessed on air quality. Some states give annual data, such as the data that is available for the city of Shimla on the Himachal Pradesh State Pollution Control Board website (http://hppcb.nic.in/airquality/Shimla.pdf), as is depicted in figure 19. As can be seen there is annual data for 2015-16 for the three main pollutants of PM10, SO2 and NOx, which are monitored by manual stations, mainly. Shimla has 2 monitoring stations, which are manual. Most cities with manual stations only, give annual averages. Thus, the most recent data that is available for these cities is from 2015-16. The SPCB/PCC are mandated to keep collecting data and submitting it to the CPCP, but usually this is not depicted on either the CPCB or SPCB/PCC website for the most recent period unless it is real-time data that is being collected form a CAAMS. Thus the move should be to equip more and more cities with CAAMS. This comes out even more strongly when considering the types of reports that exist to access air quality data.

STATUS OF AMBIENT AIR QUALITY OF SHIMLA

During 2004-05 | During 2005-06 | During 2006-07| During 2007-08 |During 2008-09 |During 2009-10 |During 2010-11 |During 2011-12 |During 2012-13|During 2013-14|During 2014-15

During 2015-16

Station-1

Tekka Bench (R)

Month	SOx in µg/m³		NOx in µg/m³		RSPM in µg/m³	
	A.M	Annual Standard	A.M	Annual Standard	A.M	Annual Standard
Apr-15	2.0	50.0	9.3	40.0	43.8	60.0
May-15	2.0	50.0	10.8	40.0	52.4	60.0
Jun-15	2.0	50.0	12.8	40.0	50.0	60.0
Jul-15	2.0	50.0	9.3	40.0	31.2	60.0
Aug-15	2.0	50.0	9.8	40.0	23.0	60.0
Sep-15	2.0	50.0	11.6	40.0	40.8	60.0
Oct-15	2.0	50.0	12.2	40.0	38.8	60.0
Nov-15	2.0	50.0	10.1	40.0	38.1	60.0
Dec-15	2.0	50.0	12.1	40.0	39.1	60.0
Jan-16	2.0	50.0	9.9	40.0	44.8	60.0
Feb-16	2.0	50.0	11.6	40.0	51.6	60.0
Mar-16	2.0	50.0	12.6	40.0	40.6	60.0

Station-2

Bus Stand (R)

Month	SOx in µg/m³		NOx in µg/m³		RSPM in µg/m³	
	A.M	Annual Standard	A.M	A.M	Annual Standard	Standard
Apr-15	2.0	50.0	15.2	40.0	74.5	60.0
May-15	2.0	50.0	16.1	40.0	77.2	60.0
Jun-15	2.0	50.0	16.8	40.0	80.9	60.0
Jul-15	2.0	50.0	16.0	40.0	74.7	60.0
Aug-15	2.0	50.0	13.7	40.0	54.6	60.0
Sep-15	2.0	50.0	16.1	40.0	53.6	60.0
Oct-15	2.0	50.0	18.2	40.0	65.7	60.0
Nov-15	2.0	50.0	14.6	40.0	68.0	60.0
Dec-15	2.0	50.0	17.3	40.0	67.0	60.0
Jan-16	2.0	50.0	14.6	40.0	68.3	60.0
Feb-16	2.0	50.0	15.1	40.0	68.8	60.0
Mar-16	2.0	50.0	18.2	40.0	65.9	60.0

Figure 19: Shimla air quality data

3.5 Data from Reports

CPCB Annual report: The most comprehensive report that is available on air quality data across cities in India is the annual report published by CPCB. The report contains the annual averages of the three main pollutants across cities in India that are covered by NAMP. At the time of assimilating data for this report the most recent CPCB annual report that was available in the public domain was for the year 2014-15. This report can be downloaded from the CPCB website. The report contains data for water, noise and air pollution and thus encompasses pollution levels for the environmental programs under the jurisdiction of the CPCB. Thus, for some cities, like the example given above, Shimla more recent data can be accessed on the SPCB and not the CPCB. This is especially true for cities with no CAAMS. That said, there are a few cities such as Coimbatore, which only have manual stations and there is no data available on the SPCB websites. The only way to access data is in the CPCB annual report, which only gives annual averages of 2014-15. Though this does give a sense of the air quality in Coimbatore, it is undoubtedly outdated.

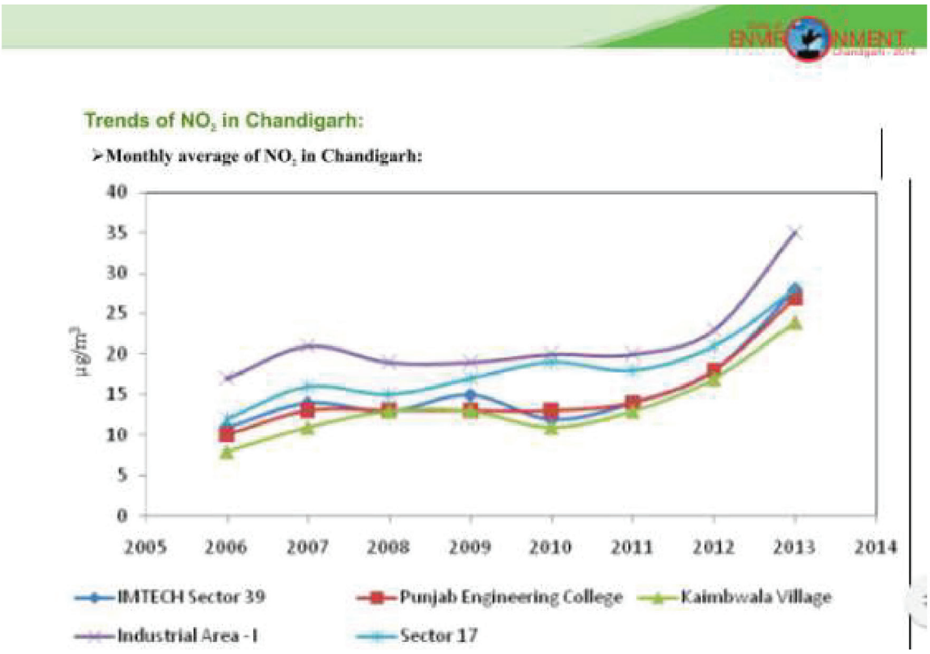


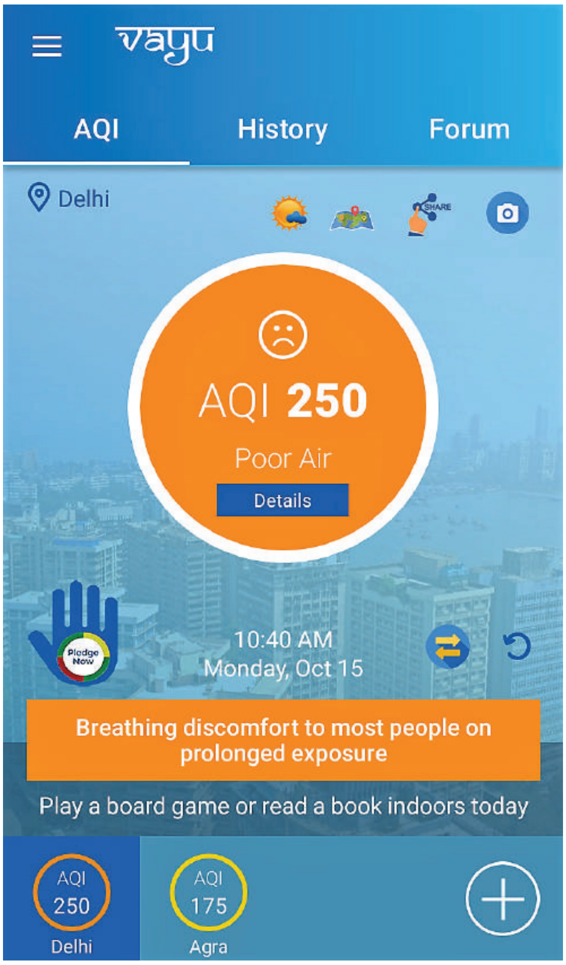
Figure 20: Chandigarh SOE report 2013-14

State of Environment reports: Further, some cities such as Nagpur and Chandigarh have State of Environment (SOE) reports available on their respective movies websites (see figure 20). The envis centers are an initiative undertaken by the Ministry of Environment, Forest and Climate Change with a nodal agency in the center and state wise centers across the country. The envis portals are the platforms to share a country (http://envis.nic.in/), state and union territory reports on environment-related topics. The SOE reports are supposed to be published annually for the country, states and union territories. In order to establish a sense of trends and tendencies of air quality, these reports were accessed. It was not possible to find SOE reports for all the cities under consideration. Thus, it was not possible to understand trends and tendencies for all cities. Other than the SOE reports a CPCB report from 2006-07 titled 'Air Quality Trends and Action Plan for Control of Air Pollution from Seventeen Cities', was used to access information on the trends and tendencies of air quality of different cities. It is important to stress, the types of data that was available for cities from online platforms and reports. The details of this are given in figure 21. As can be seen, all cities with monitoring stations (manual or continuous) have data that can be accessed. As has been detailed in the previous chapter the most recent AQ data is only available for those cities with CAAMS, those with manual stations give annual averages for only as recent as 2015-16. More details on this can be accessed in the previous chapter. It may, however, be mentioned that the tendencies and trends of AQ of cities are not as easily accessible. The SOE reports that usually have these details is not available for all cities and other reports (such as Air Quality Trends and Action Plan for Control of Air Pollution from Seventeen Cities) had to be used as a source to access this sort of data.

That said, the most recent data for cities is available via the CAAMS stations. Thus, there is a need to not only increase the number of CAAMS in cities in India so that real-time data is more easily accessible to the general public, but simultaneously there is a need make the process of data sharing for the manual stations in the country more streamlined so that the general public can access the most recent data to plan appropriate mitigations.

3.6 Air Quality Index

The NAMP leads to the generation of a vast amount of air quality data across Indian cities. This is invaluable and aids in the formulation of scientific policy and actions. As stated earlier the onus of bringing a change in the state of air quality in a city cannot be entirely the concern of the government but requires active participation by the public too. However, to generate public awareness information channels need to be designed in such a way that people can relate to the impact of bad air quality on their health and life. In addition, there needs to be not only a realization of the impact of deteriorating air quality on human health, but an understanding of the complex factors that lead to the state of air quality, and the actions that can be taken to improve the air quality in a city. Indeed with the fast pace of urbanization and migration into cities, there is a need for city residents to make lifestyle changes out of their own violation to catalyze change. This implies that the data generated on air quality must be effectively communicated to people so that these changes can start emerging. There have been a number of initiatives to carry this forward, which will be discussed in this section. Foremost, is the establishment of the Air Quality Index (AQI) for India.



No.	Cities	State	Means (1 hour, 8 hour, daily annual)	Exceedance of national standards	Tendencies and trends
1	New Delhi	Delhi	✔	✔	✔
2	Chandigarh	UT	✔	✔	✔
3	Kanpur	Uttar Pradesh	✔	✔	✕
4	Varanasi	Uttar Pradesh	✔	✔	✕
5	Shimla	Himachal Pradesh	✔	✔	✔
6	Jaipur	Rajasthan	✔	✔	✕
7	Udaipur	Rajasthan	✔	✔	✕
8	Kurukshetra	Haryana	✕	✕	✕
9	Ludhiana	Punjab	✔	✔	✕
10	Mumbai	Maharashtra	✔	✔	✔
11	Aurangabad	Maharashtra	✔	✔	✕
12	Nagpur	Maharashtra	✔	✔	✔
13	Nashik	Maharashtra	✔	✔	✕
14	Pune	Maharashtra	✔	✔	✕
15	Solapur	Maharashtra	✔	✔	✔
16	Ahmedabad	Gujarat	✔	✔	✔
17	Indore	Madhya Pradesh	✔	✔	✕
18	Surat	Gujarat	✔	✔	✕
19	Kolkata	West Bengal	✔	✔	✔
20	Bhubaneshwar	Odisha	✔	✔	✔
21	Guwahati	Assam	✔	✔	✔
22	Raipur	Chhattisgarh	✔	✔	✕
23	Jamshedpur	Jharkhand	✕	✕	✕
24	Patna	Bihar	✔	✔	✔
25	Chennai	Tamil Nadu	✔	✔	✔
26	Bengaluru	Karnataka	✔	✔	✔
27	Coimbatore	Tamil Nadu	✕	✔	✕
28	Kochi	Kerala	✔	✔	✕
29	Hyderabad	Telangana	✔	✔	✕
30	Vishakhapatnam	Andhra Pradesh	✔	✔	✕

Figure 21: Types of AQ data available across cities

An AQI is defined as an overall scheme that transforms weighted values of individual air pollution related parameters (PM10, PM2.5, SO2, CO, visibility, etc.) into a single number or set of numbers. Specifically, it establishes the relationship between human exposure, health effects, and air quality. Most countries that have been engaging with air quality issues have an established AQI. The AQI varies from country to country depending on the breakpoint for different AQI values.

The breakpoint is established depending on the National Ambient Air Quality Standards (NAAQS) for each country as can be seen in figure 22, which gives the breakpoints for particulate matter values in different countries AQI.

INDIA (24-hr)		US (24-hr)[a]		China[b] (24-hr)		EU[c] (8-hr)	
AQI Category	**Break point concentration**	**AQI Category**	**Break point concentration**	**AQI Category**	**Break point concentration**	**AQI Category**	**Break point concentration**
Good	50	Good	55	Excellent	50	Very low	15
Satisfactory	100	Moderate	155	Good	150	Low	30
Moderate	250	Unhealthy for sensitive groups	255	Lightly Polluted	250	Medium	50
Poor	350	Unhealthy	355	Moderately Polluted	350	High	100
Very Poor	430	Very Unhealthy	425	Heavily Polluted	420	Very high	100+
Severe	430+	Hazardous	425+	Severely Polluted	420+		

[a]USEPA (2013) [b]Gao (2013) [c] CAQI (2012)

Figure 22: PM AQI breakpoints

The Central Pollution Control Board and the Ministry of Environment and Forests (MoEF) launched the Indian AQI in 2014. Since then it has enjoyed some degree of proliferation on varied platforms. It is important to understand how the AQI works and is tabulated to appreciate its value. Based on the revised NAAQS in 2009, and notifies values of the following pollutants - PM10, PM2.5, NO2, SO2, CO, O3, NH3, Pb, Ni, As, Benzo(a)pyrene, and Benzene. The AQI considers as many pollutants from the list of notified pollutants as possible. However, the selection of parameters primarily depends on AQI objective(s), data availability, averaging period, monitoring frequency, and measurement methods. While PM10, PM2.5, NO2, SO2, NH3, and Pb have 24-hourly as well annual average standards, Ni, As, benzo(a)pyrene, and benzene have only annual standards and CO and O3 have short-term standards (01 and 08 hourly average). PM10, PM2.5, SO2, NO2, CO, and O3 are measured on a continuous basis at many air quality stations (including NH3 at some stations), Pb, Ni, As, Benzo(a)pyrene, and NH3, if monitored, use manual systems.

To get an updated AQI at short time intervals, ideally, eight parameters (PM10, PM2.5, NO2, SO2, CO, O3, NH3, and Pb) for which, short-term standards are prescribed should be measured on a continuous basis, of which one must be either PM10 or PM2.5. This is the important point – it is absolutely imperative to have real-time data of air quality in order to tabulate the AQI. On the basis of the different pollutants and the breakpoints established the India AQI is represented in figure 23.

Table 3.11 Proposed Breakpoints for AQI Scale 0-500
(units: µg/m³ unless mentioned otherwise)

AQI Category (Range)	PM_{10} 24-hr	$PM_{2.5}$ 24-hr	NO_2 24-hr	O_3 8-hr	CO 8-hr (mg/m³)	SO_2 24-hr	NH_3 24-hr	Pb 24-hr
Good (0-50)	0-50	0-30	0-40	0-50	0-1.0	0-40	0-200	0-0.5
Satisfactory (51-100)	51-100	31-60	41-80	51-100	1.1-2.0	41-80	201-400	0.5 –1.0
Moderately polluted (101-200)	101-250	61-90	81-180	101-168	2.1- 10	81-380	401-800	1.1-2.0
Poor (201-300)	251-350	91-120	181-280	169-208	10-17	381-800	801-1200	2.1-3.0
Very poor (301-400)	351-430	121-250	281-400	209-748*	17-34	801-1600	1200-1800	3.1-3.5
Severe (401-500)	430 +	250+	400+	748+*	34+	1600+	1800+	3.5+

**One hourly monitoring (for mathematical calculation only)*

Figure 23: Breakpoints for AQI Scale 0-500 (units: µg/m3 unless otherwise mentioned)

Since the AQI is a weighted average of the relation between pollutants and impact on health, the health statement for AQI categories is given in figure 24. As can be seen, the AQI values are very technical and based on robust scientific methods, but they certainly help develop the everyday person's understanding of the relation between health and air pollution. The need then is to share the AQI values on platforms that can be easily accessed and used as a means to determine everyday activities. This has been initiated on a number of platforms, such as websites, reports, and mobile applications. That said, it is important to understand that the AQI is not only important for the general citizenry but also a handy tool for policy makers, decision makers and scientific researchers alike, as it helps establish trends, rank cities in terms of AQI levels, allocate resources to come up with implementable solutions and is a means to reduce a large set of data a smaller set for research and understanding.

Table-I: Shows health statements for every AQI category for people to understand health effects and protect themselves from these effects.

AQI Category	Associated Health Impact
Good (0 to 50)	Minimal impact
Satisfactory (51 to 100)	May cause minor breathing discomfort to sensitive people
Moderately Polluted (101 to 200)	May cause breathing discomfort to the people with lung disease such as asthma and discomfort to people with heart disease, children and older adults
Poor (201 to 300)	May cause breathing discomfort to people on prolonged exposure and discomfort to people with heart disease
Very Poor (301 to 400)	May cause respiratory illness to the people on prolonged exposure. Effect may be more pronounced in people with lung and heart diseases
Severe (401 to 500)	May cause respiratory effects even on healthy people and serious health impacts on people with lung/heart diseases. The health impacts may be experienced even during light physical activity

Figure 24: Health statements for Indian AQI categories

No.	Cities	AQI	Does the city have a CAAMS
1	New Delhi	✔	✔
2	Kanpur	✔	✔
3	Varanasi	✔	✔
4	Jaipur	✔	✔
5	Ludhiana	✔	✔
6	Mumbai	✔	✔
7	Aurangabad	✔	✔
8	Nagpur	✔	✔
9	Nashik	✔	✔
10	Pune	✔	✔
11	Solapur	✔	✔
12	Ahmedabad	✔	✔
13	Kolkata	✔	✔
14	Patna	✔	✔
15	Chennai	✔	✔
16	Bengaluru	✔	✔
17	Hyderabad	✔	✔
18	Vizag	✔	✔
19	Udaipur	✔	✔

Figure 25: Cities with real-time AQI data

Thus, there are two types of reports released by the CPCB for AQI – (i) 'NAQI Status of Indian Cities in 2015-16' and (ii) 'National Air Quality Index for 85 cities across 225 locations, June 2015. Bulletin for National Ambient Air Quality. NAMP – Manual Monitoring System'. The first report gives AQI values for 24 cities with CAAMS and the second report gives AQI values for cities with manual stations. The AQI generated from the data of manual stations is post-dated as the data has to be manually generated. Though there is value to the AQI data generated from manual stations to establish trends of cities air quality scenarios yet need of the hour is to have AQI values that are generated from CAAMS so that engaged people can take these values as a means to plan daily activities and reduce the burden on their health.

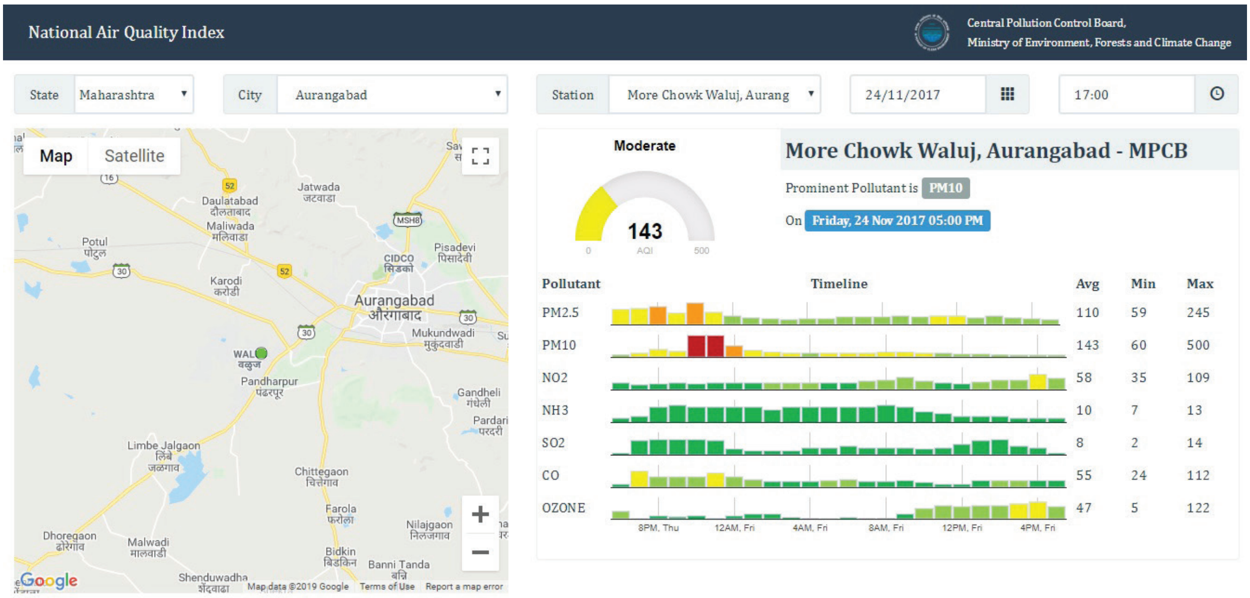


Figure 26: AQI for Aurangabad

Thus, even though some city SPCB/PCC websites do give AQI data, it has not been considered in the compilation of figure 25, as only those cities that have CAAMS can generate real-time AQI values. The manner in which the AQI values for the CAAMS appear on the SPCB/PCC or CPCB website is depicted in figure 26 which shows the AQI for the city of Aurangabad. As can be seen since the value of AQI is 261, the color coding is in yellow to signify moderate AQI (from 101-200) with the associated health impact – 'May cause breathing discomfort to the people with lung disease such as asthma and discomfort to people with heart disease, children, and older adults.'

3.7 Mobile Applications

Further, in order to get maximum impact from the AQI data, the CPCB and the MoEF has also started a mobile-based application for AQI values across cities with CAAMS. This app is called 'Sameer' which is the Hindi word for breeze or wind. Sameer is freely downloadable on the Android and iOS platforms and gives real-time data across Indian cities (see figure 27). Additionally, it allows users to take photographs and issue complaints related to activities that hamper air quality. As can be seen in the screenshot from the app the AQI values are given for different cities and are color coded according to associated health impacts. The first screen gives a map of the country along with color coded real-time AQI values across cities. There is also an option to see more details for the cities (figure 28) which shows the AQI along with the prominent pollutant and the number of CAAMS stations from which data has been accrued. Figure 28 gives a screenshot of the AQI Bulletin for the first 8 cities which are listed in alphabetical order. As can be seen in this screenshot, other than Bengaluru have only one CAAMS from which AQI can be generated. Thus, though the app gives AQI data for 42 cities most of the data is generated from one CAAMS in the city. Thus, there is a need to increase the number of CAAMS across cities in order to improve the quality of data being generated.

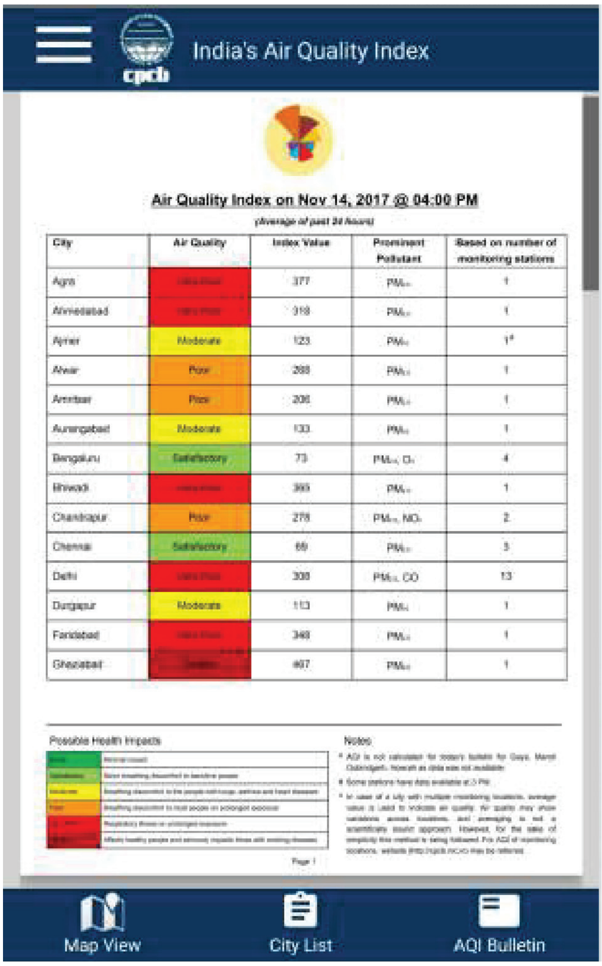


Figure 28: AQI bulletin

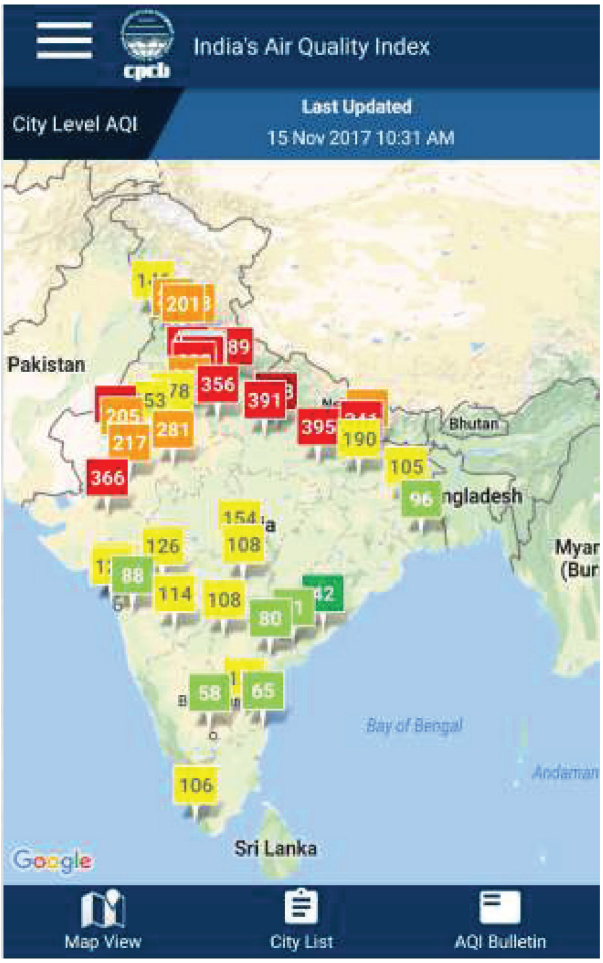


Figure 27: Sameer - AQI across Indian cities

The Ministry of Earth Sciences under its program System of Air Quality and Weather Forecasting And Research (SAFAR), has also launched a mobile application on both Android and iOS platforms called 'SAFAR – Air'. SAFAR – Air showcases real-time data and AQI values for cities in which SAFAR has set up CAAMS. As stated in the previous chapter, SAFAR currently has air quality monitoring stations in 4 cities – Ahmedabad, Mumbai, Pune and Delhi. All four cities are part of the 30 cities that have been assessed for this report.

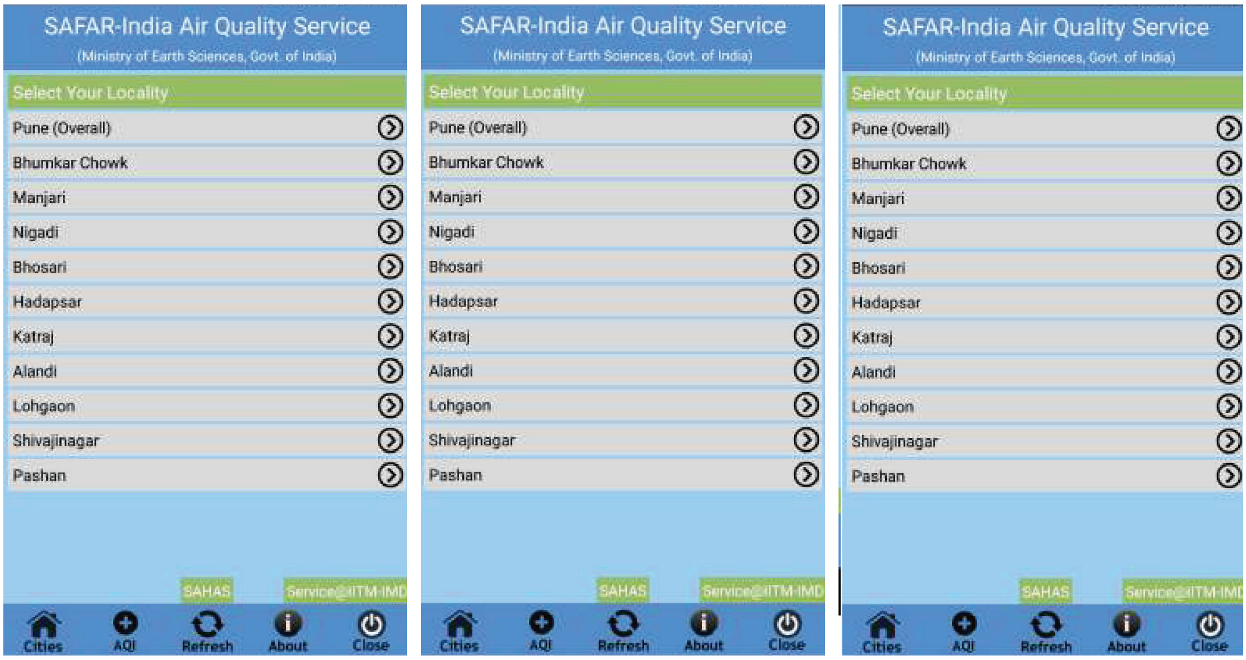
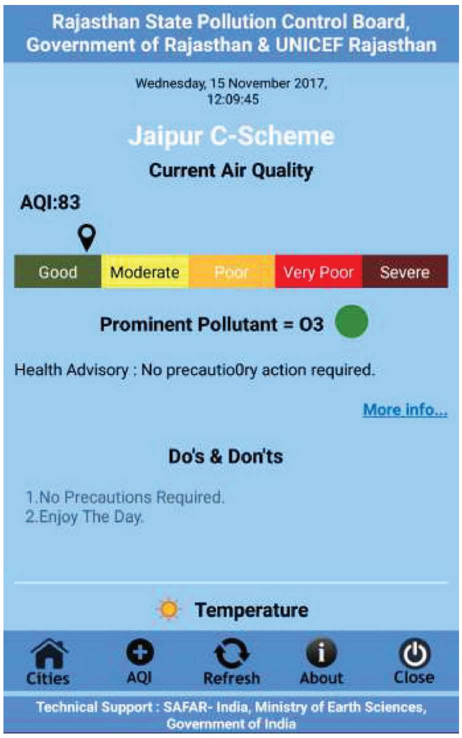


Figure 29: SAFAR – AIR for Pune

As stated in the previous chapter, each of the four cities have ten CAAMS set up under SAFAR. SAFAR – AIR thus gives data for each of the ten stations in each city and also, gives an overall assessment for each city. For instance, in figure 29, the first screenshot is of all the stations in Pune city set up by SAFAR. As can be seen, there are ten stations and an additional option entitled 'Pune (Overall)'. On selecting the option of 'Nigadi' the second screen appears that gives the AQI value '173' and its position on the AQI scale 'moderate'. On selecting the option of 'Pune (Overall)' on the first screen, the third screen depicted in figure 29 opens up. This screen shows the assimilated value of the AQI for Pune from all ten CAAMS stations in the city. As can be seen, in comparison to Sameer, SAFAR – AIR, gives a projected AQI for the next day. In the Pune (overall) screen this is visible under the words 'Tomorrow's Forecast' and shows the projected AQI of 99 for the next day. This is a very important feature and especially important for people to determine their everyday activities, plan travel and outdoor activities.The CPCB currently does not share future projections on its mobile applications or online platforms.



Though SAFAR operates CAAMS in only 4 cities, it has assisted the SPCB of Rajasthan along with UNICEF to create its own mobile application for sharing AQI for cities in the state. The mobile application is called 'RajVayu', which is a word that comes from joining the first three letters of the state of Rajasthan's name 'Raj' and the Hindi word for wind, 'Vayu'. The app is exactly like SAFAR – AIR except it gives station wise data for cities in the state with CAAMS and there is no option for the overall AQI for the city and also, it does not give predictions for the next day's AQI for any CAAMS. Though this an important need, the fact that the state of Rajasthan through the SPCB is trying to actively disseminate real time AQI is an important step in the right direction.

Figure 30: RajVayu app screen for Jaipur

Additionally, in all 4 cities where SAFAR has its CAAMS, there are also AQ boards that display the AQI and pollutant levels. These boards operate round the clock and show the levels of all pollutants monitored by SAFAR - PM1, PM2.5, PM 10, ozone, CO, NO2, SO2, BC, methane, non-methane hydrocarbons, VOCs, Benzene and Mercury – and the resulting AQI.

Clearly, there is a lot being done and a good initiatives are being taken overall by the Ministry of Environment, Forest and Climate Change and the Ministry of Earth Sciences to disseminate the air quality data for the general public, through various platforms. However, as has been discussed there is a need to improve the frequency with which data is shared across the different platforms and also increase the number of outlets for sharing such data in order to increase the spread and effect of air quality data amongst the general masses so that change in lifestyles and efforts to improve air quality can be accelerated.

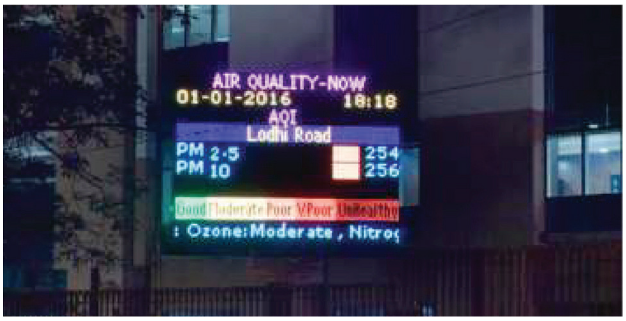
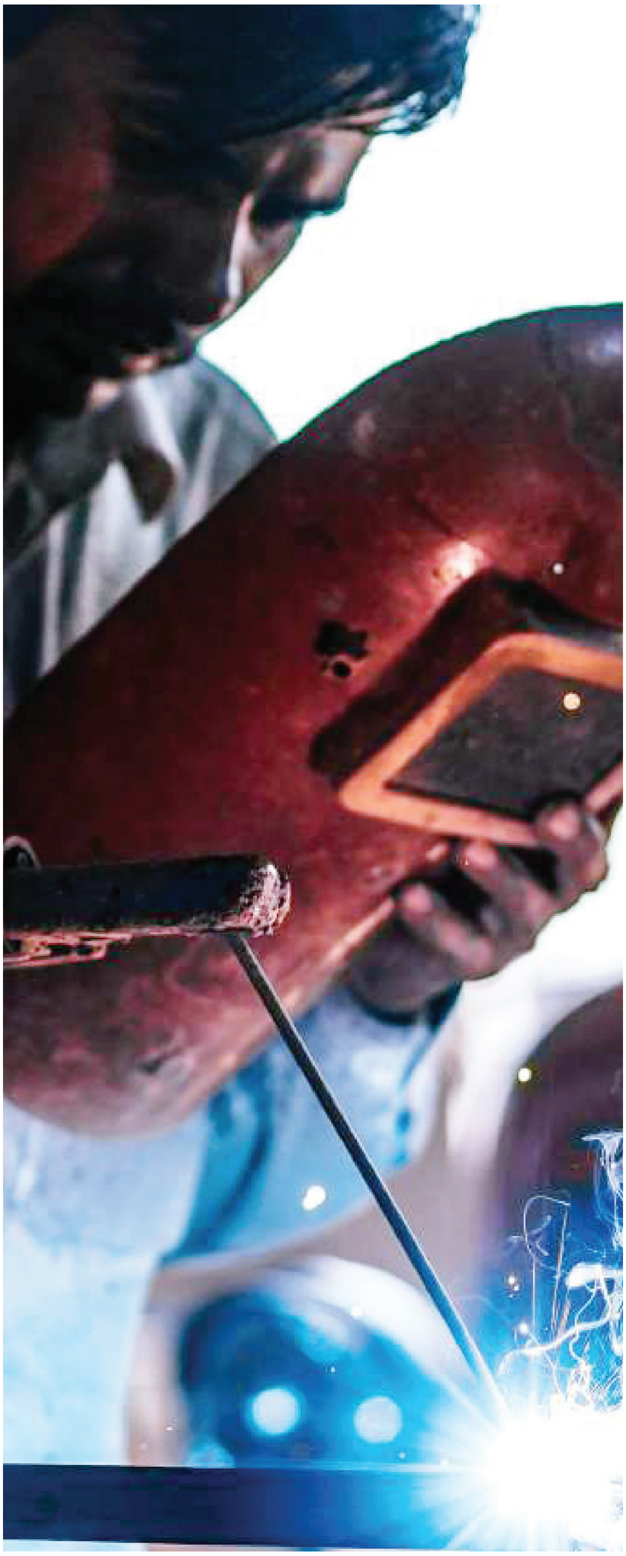


Figure 31: SAFAR AQI Board on Lodhi Road, Delhi



3.8 Health and Air Pollution Studies

The official report that explains the methodology for the tabulation and calculation of the India AQI clearly mentions that there is a general lack of health-specific studies in India on the health effects of different pollutants (CPCB 2015). While there are efforts underway to conduct important research and studies that document the link between air pollution and human health in India, the CAST assessment allowed for the emergence of studies that look at city-specific air pollution and health studies. Not surprisingly, the bulk of the studies were done by private individuals and organizations. The studies supported by the government were few. Further, even those studies that were found to investigate the relationship between health and air pollution in Indian cities were not too recent and in some cases do not directly investigate the relation between air pollution and health, but the issue of health and air pollution figures somewhere in the paper and has thus been considered. The types of health studies that came up are discussed below followed by a table that details the number and types of studies in each city.

Ecological Studies (Rapid Assesment)

This is a type of epidemiological study in which specific individuals are not studied, but rather groups of people are compared, e.g., examining differences in disease rates between countries. As nothing is known about exposures experienced by the specific individuals in the groups, ecological studies may be more prone to biases that can't be controlled. Nevertheless, ecological studies are often a good first approach in examining the health status of communities.

Cross Sectional Studies

An epidemiological study that measures exposure and prevalence of exposure at the same time.

Cohort Studies

Study of incidence of disease or other health outcome in a group of people (cohort) initially free of disease or other outcome, who are classified into subgroups according to exposure to a potential cause of disease or health outcome.

Case-Control Studies

A study that compares two groups of people; those with the disease or condition under study and a very similar group that does not have that condition under study. Researchers study the medical and lifestyle histories of the people in each group to learn what factors may be associated with the disease or condition. Also called retrospective studies.

Time Series Studies

An epidemiological study of the health state of a population exposed e.g. to air pollutions.

Case-Control Studies

These studies capture the proportionate mortality which is the proportion of deaths in a specified population during a period of time that are attributable to different causes. Each cause is expressed as a percentage of all deaths, and the sum of the causes adds up to 100%.

These are the types of studies with regard to air pollution and health that were identified across the 30 cities in India that were assessed by CAST. The number of studies for each city along with the types of studies is given in the table below. The details of the city wise studies are given in the city chapters in this report.

3.9 Conclusion

As can be seen from figure 33, there is a dearth of good research at the city level in India on the linkage between health and air pollution. The research community must focus on investing in a deeper analysis of this issue. It is only when there is robust scientific proof and a deep knowledge of how air pollution impacts the health of people in a city can the move to not only educate people better be accelerated through mobile applications and websites; but more importantly, can progressive policy be framed and implemented. That said, there are enough studies that prove the detrimental effects of air pollution on human health and the lack of city-specific studies should not be a detriment in framing policy and implementing air quality solutions. Further, there is also a need to conduct more research and plan systematic studies to understand how people's perceptions to air pollution change, how they can better understand the link between air pollution and human health and what sorts of information campaigns work. This will greatly aid in speeding up the way in which the air quality data can be shared and have far-reaching effects not only for policy but to encourage people to make changes in their everyday lives and lifestyles so that air quality in their cities can be improved.

4

Studies on the Sources and State of Air Pollution in Indian Cities

4.1 Introduction

Air pollution solutions are the need of the hour. That said, formulating these solutions must be made on the basis of a sound understanding of the issues that cause air pollution in a city such that measures can be devised that work best to address them. This is important as though air pollution has local and transboundary effects yet solutions that are conceived jointly and implemented keeping local specifics in mind have the most significant effects. This is as sources of air pollution and resulting effective solutions vary from city to city in India. For instance, the coastal cities of Mumbai and Chennai have very different ecological factors from New Delhi which is in the Indo—Gangetic Plains and Guwahati which has a water body on one side and mountains on the other three sides. Not only will these cities have different factors that lead to air pollution but relatedly they will need city specific solutions. It is precisely for this reason that though the government of India is leading the process to select and develop the right policies, the challenge in policy development has often been accessing to knowledge from different regions. Information often does not reach policymakers at the right time nor in the form that they need and hence gets interpreted incorrectly. Effective information and communication technologies can support policy development by improving participation in the policy process, shortening the time frame for consultation, increasing transparency, maximizing stakeholder ownership and awareness, and providing opportunities to transfer policy-making responsibilities to a younger generation of policymakers. In other words, there is a need for city-specific data on air pollution sources and effects to frame and implement the most effective policy and measures. This chapter will capture the types of city-specific studies that exist to understand the issues of air pollution.

4.2 Types of Studies

The reasons for the worsening air quality are multiple and diverse but grouped around point sources (such as industries, mining, power plants), area sources (such as biomass burning, road construction, electric generators, fuels filling stations), line sources (on-road and off-road transportation) and natural sources (such as wind-blown dust). Air pollution solutions are the need of the hour. That said, formulating these solutions must be made on the basis of a sound understanding of the issues that cause air pollution in a city such that measures can be devised that work best to address them. This is important as though air pollution has local and transboundary effects yet solutions that are conceived jointly and implemented keeping local specifics in mind have the most significant effects. This is as sources of air pollution and resulting effective solutions vary from city to city in India.

These are the types of studies with regard to air pollution and health that were identified across the 30 cities in India that were assessed by CAST. The number of studies for each city along with the types of studies is given in the table below. The details of the city wise studies are given in the city chapters in this report.

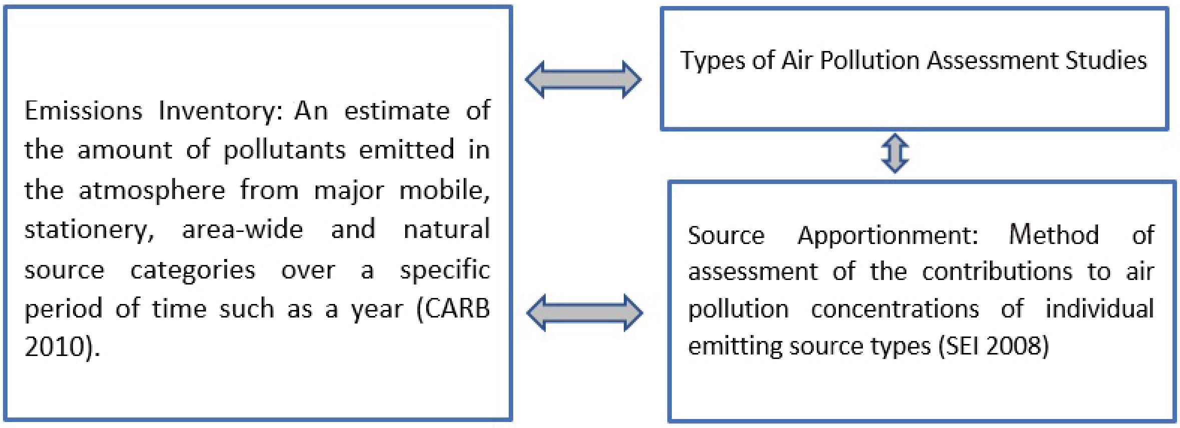


Figure 34: Types of air pollution assessment studies

For instance, the coastal cities of Mumbai and Chennai have very different ecological factors from New Delhi which is in the Indo—Gangetic Plains and Guwahati which has a water body on one side and mountains on the other three sides. Not only will these cities have different factors that lead to air pollution but relatedly they will need city-specific solutions. In other words, there is a need for city-specific data on air pollution sources and effects to frame and implement the most effective policy and measures. An Emissions Inventory (EI) is a listing, by source, of the amounts of air pollutants – including criteria pollutants, greenhouse gases (GHGs), volatile organic compounds (VOCs), among others – actually potentially discharged into the atmosphere of a community during a given time period (Organisation for Economic-Operation and Development [OECD]), 2001; European Environment Agency [EEA], 2013; Stockholm Environment Institute [SEI], 2008). Those cities that do have emissions inventories are often outdated. There are two approaches to establishing EI: top-down and bottom-up approaches. The top-down EI approach uses national- or regional-level emission estimates allocated to a city, area, or grid according to surrogate parameters (i.e. population, employment, energy consumption, resource use, vehicle number, etc.), typically used when local data are not available and resources are limited (SEI, 2008). Activity rate is derived from international, national, regional, or local level statistical information on source and process characteristics. Temporal change is estimated using allocation of the total amount of emissions according to hours of activity and operation of each source (Clean Air Asia 2016).

No.	Cities	Are there city specific health studies	No. of studies?	What types of health studies
1	New Delhi	✔	2	Cross-sectional, rapid assessment and mortality
2	Chandigarh	✔	2	Rapid assessment, case-control
3	Kanpur	✔	2	Cross-sectional, time series
4	Varanasi	✔	1	Rapid assessment
5	Shimla	✔	2	Rapid assessment and mortality
6	Jaipur	✔	3	Cross-sectional, mortality
7	Udaipur	✔	1	Mortality
8	Kurukshetra	✕	✕	✕
9	Ludhiana	✔	1	Time-series
10	Mumbai	✔	6	Cross-sectional and mortality
11	Aurangabad	✔	2	Rapid and cross-sectional
12	Nagpur	✔	2	Cross-sectional and mortality
13	Nashik	✔	1	Mortality
14	Pune	✔	1	Rapid assessment
15	Solapur	✔	2	Rapid and mortality
16	Ahmedabad	✔	3	Cross-sectional, case control and mortality
17	Indore	✔	2	Rapid assessment and mortality
18	Surat	✔	1	Mortality
19	Kolkata	✔	3	Rapid, cross-sectional and case control
20	Bhubaneshwar	✔	1	Time-series
21	Guwahati	✕	✕	✕
22	Raipur	✔	1	Rapid assessment
23	Jamshedpur	✕	✕	✕
24	Patna	✔	1	Mortality
25	Chennai	✔	2	Time-series and mortality
26	Bengaluru	✔	2	Rapid and cross-sectional
27	Coimbatore	✕	✕	✕
28	Kochi	✕	✕	✕
29	Hyderabad	✔	3	Rapid and mortality
30	Vizag	✕	✕	✕

Figure 33: Types of health and air pollution studies across cities

The bottom-up EI approach, on the other hand, gathers information from individual sources, processes, activity rates and their levels, and subsequently estimates emission factors (EFs). Emission factors are the average rate of emission of a pollutant per unit of activity for a given source. The process requires more financial resources to implement but results in more accurate estimates than the top-down approach (SEI, 2008). Emissions inventories provide information on emission loads of primary air pollutants that are directly released from different source categories (shares of pollution loads) in an inventory area. It does not provide information on sources located from outside the domain of emissions nor information on secondary pollutants that are formed in the atmosphere.

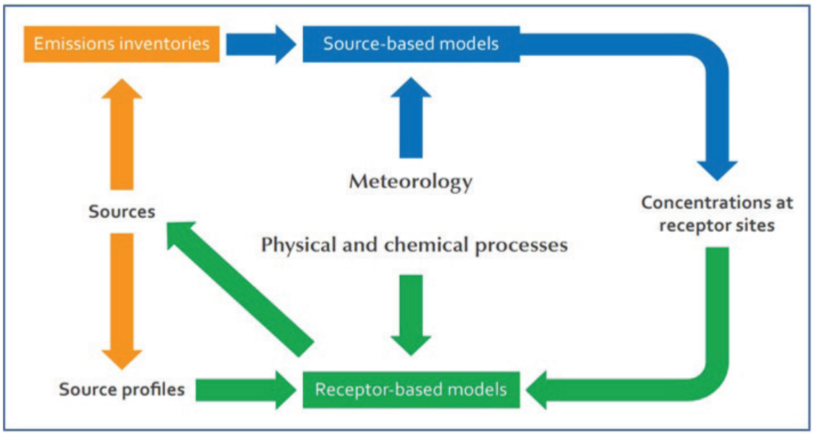


Figure 35: Schematic representation of how emissions inventories and source apportionment models are linked

Source apportionment (SA) by receptor modeling, can provide contributions of different source categories to ambient levels of some pollutants. It involves ambient sampling and measurement of atmospheric particles and/or VOCs, semi-VOCs, followed by laboratory analyses to characterize the chemical composition. Three SA approaches or techniques are in use: (1) source emission shares of pollution load in an area based on EI, (2) SA based on dispersion modeling, and (3) SA based on receptor modeling.

Source apportionment based on EI provides information on the contribution of different source categories (e.g., power plants, vehicles) and sub-categories (e.g., diesel-powered vehicles, two-wheelers, passenger cars within vehicle category) to total emission loads of identified pollutant(s). On the other hand, dispersion models are used to estimate source contribution to an ambient air concentration of identified pollutant(s). While dispersion models use emissions data, meteorological data, and chemical transformation to estimate pollutant concentrations, receptor models use chemically-speciated ambient pollutant concentration data and source profiles to estimate source contribution to ambient levels measured in receptor sites. Receptor models are normally used for SA of pollutants found as mixtures in ambient air with contributions from different sources (i.e. PM, VOCs, or semi-VOCs). In the process, the portion of secondary air pollutants attributed to regional and long-range pollution transport may also be apportioned. The three approaches mentioned above have their own limitations and challenges, and should, therefore, be used complementarity (ibid).

4.3 City Assessment

A robust emissions inventory will have source apportionment studies as a part of the analysis, though that may not always be the case. Further, the most precise emission inventories are based on field level (in this case city specific) data and not just a result of computer models that are generated on the basis of city statistics. In fact, it is only when both modeling results are validated by field-specific data is a representative emissions inventory generated. Clearly, such a detailed study requires huge investment and time. Further, these studies must be constantly updated, bi-annually in the best circumstances to keep the pace with the changing dynamics of how different sources contribute to air pollution in a city. Clearly, these sorts of studies are important in understanding the contributing factors to a cities air pollution to formulate policy and take action. That said, these sorts of studies are also time and labor intensive, thus they are not undertaken unless there is government backing to conduct such studies for policy needs. The CAST assessment brought out that there are very few cities in India that actually have an emissions inventory. Those that do, are often outdated. In order to get a more representative picture, private studies that were not necessarily backed by the state were also considered in quantifying cities with emission inventories and source apportionment studies. This is detailed in figure 36.

No.	Cities	Inventories and Source Apportionment Studies (State or Private supported study)
1	New Delhi	Yes, State-supported (inventory looks at SLCPs) & Private study
2	Chandigarh	None (currently underway and state supported)
3	Kanpur	Yes (state-supported)
4	Varanasi	None
5	Shimla	Yes (private – only looks at GHG emissions)
6	Jaipur	None
7	Udaipur	Yes (a Private study that looks mostly at vehicular pollution)
8	Kurukshetra	None
9	Ludhiana	No (currently underway and state supported)
10	Mumbai	Yes (state-supported)
11	Aurangabad	None
12	Nagpur	None
13	Nashik	None
14	Pune	Yes (both states supported and private)
15	Solapur	Yes (State supported, only looks at vehicular pollution)
16	Ahmedabad	Yes (State supported, only looks at vehicular pollution and private study)
17	Indore	Yes (Private only)
18	Surat	Yes (Private only)
19	Kolkata	Yes (State supported, only looks at vehicular pollution)
20	Bhubaneshwar	None
21	Guwahati	None
22	Raipur	None
23	Jamshedpur	Yes (a Private study that looks at mostly vehicular pollution)
24	Patna	Yes (State supported, only looks at vehicular pollution)
25	Chennai	Yes (both states supported and private)
26	Bengaluru	Yes (state-supported)
27	Coimbatore	None
28	Kochi	Yes (Private only)
29	Hyderabad	Yes (State supported, only looks at vehicular pollution and private study)
30	Vizag	Yes (private study)

Figure 36: Cities with private and state-supported emissions inventories and source apportionment studies

As can be seen, there aren't too many state-supported inventories on emissions for cities in India. This comes out better in figure 37, almost half of the city sample have no studies – 12 – that explain the sources of pollution in the city. There are only 6 cities that have studies supported by the state, which means accepted by the CPCB or the Ministry of Environment, Forests and Climate Change or any other recognized government body such as NEERI (National Environmental Engineering Research Institute), etc. Five cities have both state-supported and private studies. Private studies imply studies that have been undertaken by technical institutions for research purposes or private organizations for research and dissemination purposes.

Status of Studies	No. of Studies
No studies	12
State-supported studies	6
State-supported and private studies	5
Private studies	7

Figure 37: Breakdown of air pollution assessment studies across 30 CAST cities

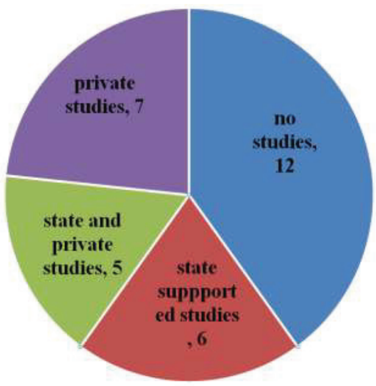


Figure 38: Air quality studies in 30 Indian cities

Many studies that were included in this tabulation as can be seen from figure 36 do not necessarily represent a complete inventory of all possible sources for the entire city. For example, the state-sponsored study for Kolkata only looks as sources and emissions from vehicular pollution. Of the 18 cities with studies (state supported or private), 7 only look at vehicular pollution. Further, even the cities with an EI that covers the prominent sources and accounts for the entire city, such as Delhi, the inventory is not recent and hence does not account for the changing trends and emission sources of the city. This is further compounded by the fact that only two studies consider the role of short-lived climate pollutants (SLCPs). Short-lived climate pollutants are air pollutants that have a relatively short lifetime in the atmosphere and a warming influence on our climate. As opposed to carbon dioxide, which has an atmospheric lifetime of about 100 years, SLCPs have an atmospheric lifetime of a few years to even a few days. SLCPs include black carbon, methane, tropospheric ozone, and hydrofluorocarbons. It is important to consider the role of SLCPs as they tie in the effects of air pollution and climate changes, as is brought out in figure 39

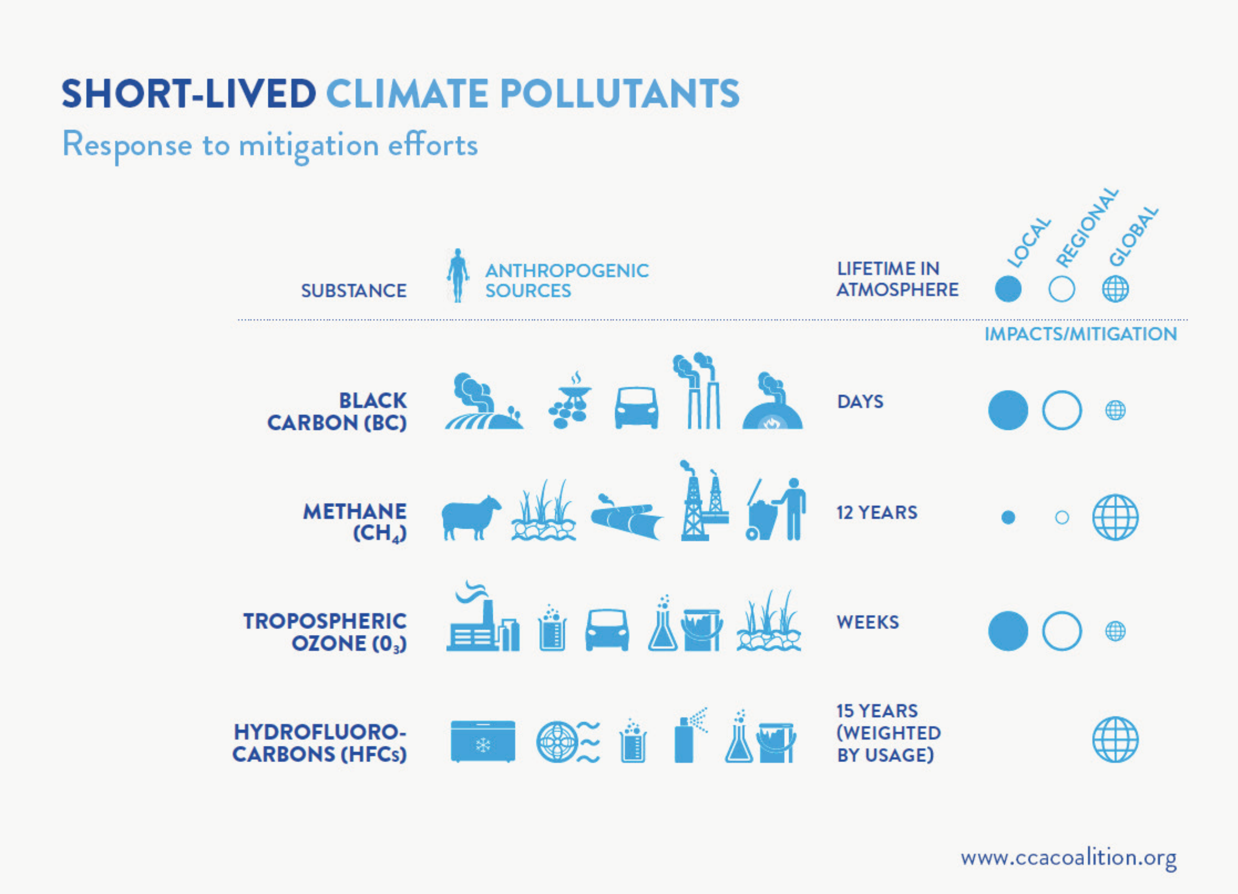


Figure 39: Effect of SLCPs

As can be seen, SLCPs have effects at the local, regional and global level. Thus, they not only impact cities but due to long-range transport they have regional and global implications too. Addressing emissions from pollutants such as ozone (O3) and black carbon (BC) can reduce air pollution levels and result in short-term, immediate climate benefits by reducing the rate of climate change in the near future and supplementing programs to reduce the long-lived climate pollutants. Further, BC is a chief component of PM 2.5 and has been documented to have detrimental effects on human health. One of the main sources of BC emissions other than vehicular diesel emissions is emissions from the burning of inefficient bio-fuels, such as wood, dung cakes, crop residue and dried leaves. Cities in India are sites for a swelling influx of migration from rural parts of the country.

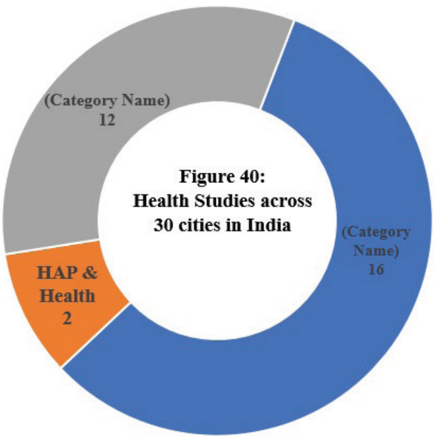


Figure 40: Health studies across 30 Indian cities

This often results in migrants setting up temporary structures to lives in which means that it is almost impossible to have access to clean fuels for cooking and heating purposes. Thus, these individuals rely on burning inefficient biofuels in traditional cookstoves to cook and heat the home, which is a big source of BC emissions, which are not only detrimental to human health but have climate change implications.

Thus the need to account for BC emissions specifically and of household air pollution generally is of paramount importance for any inventory. The CAST assessment brought out that only two cities have studies that have data on SLCPs, and only two cities have studies (Delhi and Mumbai) that look at the link between household air pollution and human health. As was discussed in the previous chapter, most health-related studies investigate the health impacts of either general ambient air pollution or vehicular air pollution. One study could be found for Mumbai, which was done for the slum of Dharavi that states that emissions from slum areas where inefficient biomass burning is the most in the city, also has the most polluted ambient air.

4.4 Conclusion

Only a quantitative knowledge of the emissions from air pollution sources allows mitigating air pollutant concentrations, and, correspondingly, avoiding health and environmental impacts by reducing emissions via appropriate control measures. Holistically, an effective AQM requires a process of continual improvement in knowing where pollution is coming from and how much each of the sources is contributing to the ambient air pollution. For this reason, in an area of concern (i.e. area of non-attainment of air quality standards), it has to be assessed which sources are the most relevant ones for which the reduction of emissions will lead to a significant decrease of pollutant concentrations. Strengthening the capacity for quantification of pollutants, determination of source contributions, and evaluation of existing and future emissions help shape and define policies for improving air quality. Such capacity also helps in the assessment of compliance with national and international targets, and evaluation of the effectiveness of measures to protect human health and the environment. Thus, it is imperative to strengthen the impetus to invest in and develop emission inventories and source apportionment studies for Indian cities so that their air quality management status can be strengthened.

5

Policy and Institutional Framework of Air Quality Management in India

5.1 Ministries directly involved in Air Quality Management Framework

Ministry of Environment, Forest and Climate Change

The ministry implements policies and programmes relating to conservation of the country's natural resources including prevention and abatement of pollution.

Ministry of Earth Sciences
Indian Meteorological Department
Indian Institute of Tropical Meteorology

The ministry promotes scientific research in the country in the field of air quality monitoring, air pollution source, air quality modelling studies and other emission characterisation studies related to various pollutants.

Ministry of Science and Technology

The ministry promotes research which facilitates greater understanding about ambient air quality and its implications on the environment, human beings, crops, animals, etc. and provides both institutional grants for capacity building and individual project funding for research that could enhance India's knowledge capital in this field.

Ministry of Petroleum and Natural Gas

The ministry is an active participant in efforts to reduce vehicular emissions from incomplete combustion and inappropriate usage of fuel. The ministry is also a participant of various inter-ministerial committees, which form policy framework for the air quality management in the country, specially related to automobile fuel policy.

Ministry of Health and Family Welfare

The ministry undertakes various research activities on studying the impact of both 'Indoor Air Pollution' and 'Outdoor Air Pollution' on human health.

Ministry of Power

The ministry emphasize the supply of clean power in the country by mandating conventional power generation to comply with the pollution control norms.

Ministry of Road, Transport and Highways

The ministry is involved in formulation of regulations relating to Emissions, Fuels and Alternative Fuel vehicles.

सत्यमेव जयते
Ministry of Earth Sciences
Government of India

सत्यमेव जयते
Government of India
Department of Science & Technology
Ministry of Science & Technology

सत्यमेव जयते
Ministry of Petroleum & Natural Gas
Government of India

प्रकृतिः रक्षति रक्षिता
Nature Protects if She is Protected

सत्यमेव जयते
Ministry of Health & Family Welfare
Government of India

सत्यमेव जयते
GOVERNMENT OF INDIA
MINISTRY OF POWER

सत्यमेव जयते
MORTH
Government of India

5.2 Ministries indirectly involved in the Air Quality Management framework

Ministry of New and Renewable Energy

MNRE is actively working towards addressing problems related to Indoor Air pollution and Black Carbon.

Ministry of Corporate Affairs

The Ministry had mandated Corporate Social Responsibility activities for PSUs (Public Sector Undertaking) and given voluntary guidelines to corporate entities. These activities can eventually lead to air pollution control.

Ministry of Coal

MoC indicated that industries now run the risk of even having their coal linkage cancelled if the transporters engaged by them are found flouting norms that lead to pollution due to spillage of coal particles that rise in the air.

Ministry of Heavy Industries & Public Industries

The Ministry has various projects aiming at industrial pollution control technologies with respect to air, water and solid wastes to avoid unintended side effects of economic growth.

Ministry of Commerce & Industry

The Ministry recognises the importance of environmental clearances in its 'Industrial Policy'.

CPCB

Central Pollution Control Board

It advises the central government on matters related to abatement and control of air, water and noise pollution and management of solid waste. CPCB also provides technical assistance and guidance to state pollution control boards, plan and organise training of persons engaged on programs for prevention, control and abatement of air pollution and prepare guidelines for the same.

SPCB

State Pollution Control Boards

In India, 29 states have the State Pollution Control Boards (SPCBs) and 7 Union Territories have Pollution Control Committees (PCCs) respectively. The SPCBs/PCCs plan comprehensive program for prevention, control or abatement of air pollution; collaborate with CPCB in organising training of persons engaged in prevention, control or abatement of air pollution and advise the state government in matters concerning with air pollution.

EPCA

Environment Pollution (Prevention Control) Authority for the National Capital Region

The Authority considers issues relating to environment, envisaging vehicular pollution control, sewage treatment and assessment of operations and handing over of Common Effluent Treatment Plants (CETPs) in NCR (National Capital Region).

Figure 43: Government Agencies involved in Air Quality Management

5.4 Other Government Agencies involved in Air Quality Management

Bureau of Energy Efficiency

Bureau of Energy Efficiency aims to assist in developing policies and strategies with a thrust on self-regulation and market principles, within the overall framework of the Energy Conservation Act, 2001 with the primary objective of reducing energy intensity of the Indian economy.

BEE

Technology Information Forecasting Assessment Council

TIFAC's role is to primarily identify, initiate and catalyze collaborative activities that utilize The International Institute for Applied Systems Analysis 's (IIASA) strengths through the India-IIASA Programme which is guided by an Indian National committee chaired by Dr Kirit S Parikh, Member Planning Commission.

TIFAC

Petroleum Planning and Analysis Cell

PPAC provides authentic data for policy analysis in the hydrocarbon sector. It comes up with studies on petroleum products, their demands and their pricing. It also engages in planning policy for the Ministry of Petroleum and Natural Gas (MoPNG).

PPAC

Figure 44: Other Government Agencies involved in Air Quality Management

5.5 Associations involved in Air Quality Management

IAAPC

Indian Association for Air Pollution Control

IAAPC's aim and objectives are to promote an understanding of the Air environment, its pollution and effects on human beings, animals, plants and materials and control of such pollution and provide an effective forum for exchange of views and Information about air environment to help to educate the general public, and to create mass awareness for air pollution control.

SIAM

Society of Indian Automobile Manufacturers

SIAM is an important channel of communication for the Automobile Industry with the Government, National and International organisations. It underlines the need for a holistic framework for controlling pollution in the country. It also emphasises the need for strict Inspection and Certification norms, Fuel quality norms and emission norms.

CII

Confederation of Indian Industry

The Confederation of Indian Industry (CII) works to create and sustain an environment conducive to the growth of industry in India, partnering industry and government alike through advisory and consultative processes. Environment Policy Division of CII works closely with the Government of India. The policy division represents industry on several government committees and over the years has successfully developed a credible partnership with policy makers and regulators like Ministry of Environment, Forests & Climate Change, Central Pollution Control Board and State Pollution Control Boards. The objective of this partnership is to facilitate the formulation and implementation of an enabling policy framework for ensuring sustainable industrial development.

FICCI

Federation of Indian Chambers of Commerce and Industry

FICCI is the largest and oldest apex business organisation in India. It is a non- government, not-for-profit organization. It is the voice of India's business and industry when it comes to influencing policy to encouraging debate, engaging with policy makers and civil society. FICCI undertakes various initiatives in the field of environment through its 'Environment and Climate Change' division.FICCI has recognised the need to address air pollution control and monitoring and is conducting an annual conference cum workshop on the same since 2011.

ASSOCHAM

The Associated Chambers of Commerce and Industry of India

ASSOCHAM is a not for profit organization, facilitating reach of India to all businesses around the globe, for wanting to do business with India. It offers its services in the field of environment and its agenda also includes prevention against pollution.

5.6 Research Institutes involved in Air Quality Management

Pollution Control Research Institute, Haridwar

Pollution Control Research Institute (PCRI) set up under United Nations Development Programme evolves technologies and provides consultancy services to industrial pollution with respect to air, water, noise and solid waste.

National Institute of Occupational Health

NIOH assesses the exposure to various air pollutants at the places of work for high risk population groups and general population through ambient and indoor air monitoring, look for measures to minimize the exposure and associated risks and create awareness about the associated risks of exposure to air pollutants to the exposed groups/general population through various media like radio and TV programmes.`

Bhabha Atomic Research Institute, Mumbai

Environment Survey Laboratories have sophisticated equipment to detect extremely low level of radioactivity and ensures the safety of workers as well as general population.

Automotive Research Association of India, Pune

ARAI plays a crucial role in assuring safe, less polluting and more efficient vehicles. ARAI provides technical expertise in R & D, testing, certification, homologation and framing of vehicle regulations.

Central Institute of Road Transport, New Delhi

Environmental laboratory of CIRT is equipped with state-of-art facilities for testing of paints, safety glass, upholstery fabric, PVC flooring, PU foam, latex foam, bus body materials etc.

Integrated Research and Action for Development (IRADe)

It carries out national projects for both climate mitigation and adaptation in the country.

Centre for Policy Research, New Delhi

CPR is committed to fostering an evidence-based conversation about how to ensure a clean and sustainable environment for a growing India.

CSIR- National Physical Laboratory

CSIR carries out extensive scientific investigations to understand causal mechanisms which change the state of environment and its consequences on health, livelihood, economy and climate.

Centre for Science and Engineering, IIT Kanpur

The mission of Centre for Environment Science and Engineering is to carry out high quality interdisciplinary research, leading to technology development and competency building in various areas related to environmental problems, thereby providing solutions to Indian industry, medical professionals and policy makers.

Centre for Atmospheric Science, IIT Delhi

It conducts research on Urban Meteorology, Air Pollution and Health, Aerosol-Climate Interactions, Heat Island Effect and Fog Prediction and Air Quality Studies.

Centre for the Environment, IIT Guwahati

It conducts research in field of air pollution by connecting people from different fields.

School of Environmental Science, Jawaharlal Nehru University

The school of Environment Science conducts research in various field of air pollution like air quality modelling as well as indoor and outdoor air pollution.

Figure 46: Research Institutes involved in Air Quality Management

5.7 Judiciaries involved in Air Quality Management

Supreme Court	High Courts	High Courts
The Supreme Court is the apex court in India. Any person can challenge the decision or order by the National Green Tribunal by filing an appeal at the Supreme Court of India.	The High Court is the apex judicial forum at the state and union territory level. There are 23 High Courts in India.	Provides effective and swift disposal of cases where a substantial question related to environment is involved. Principle bench in Delhi and coequal benches in Bhopal, Kolkata, Pune and Chennai.

Figure 47: Judiciaries involved in Air Quality Management

5.8 Laws related to Air Quality Management

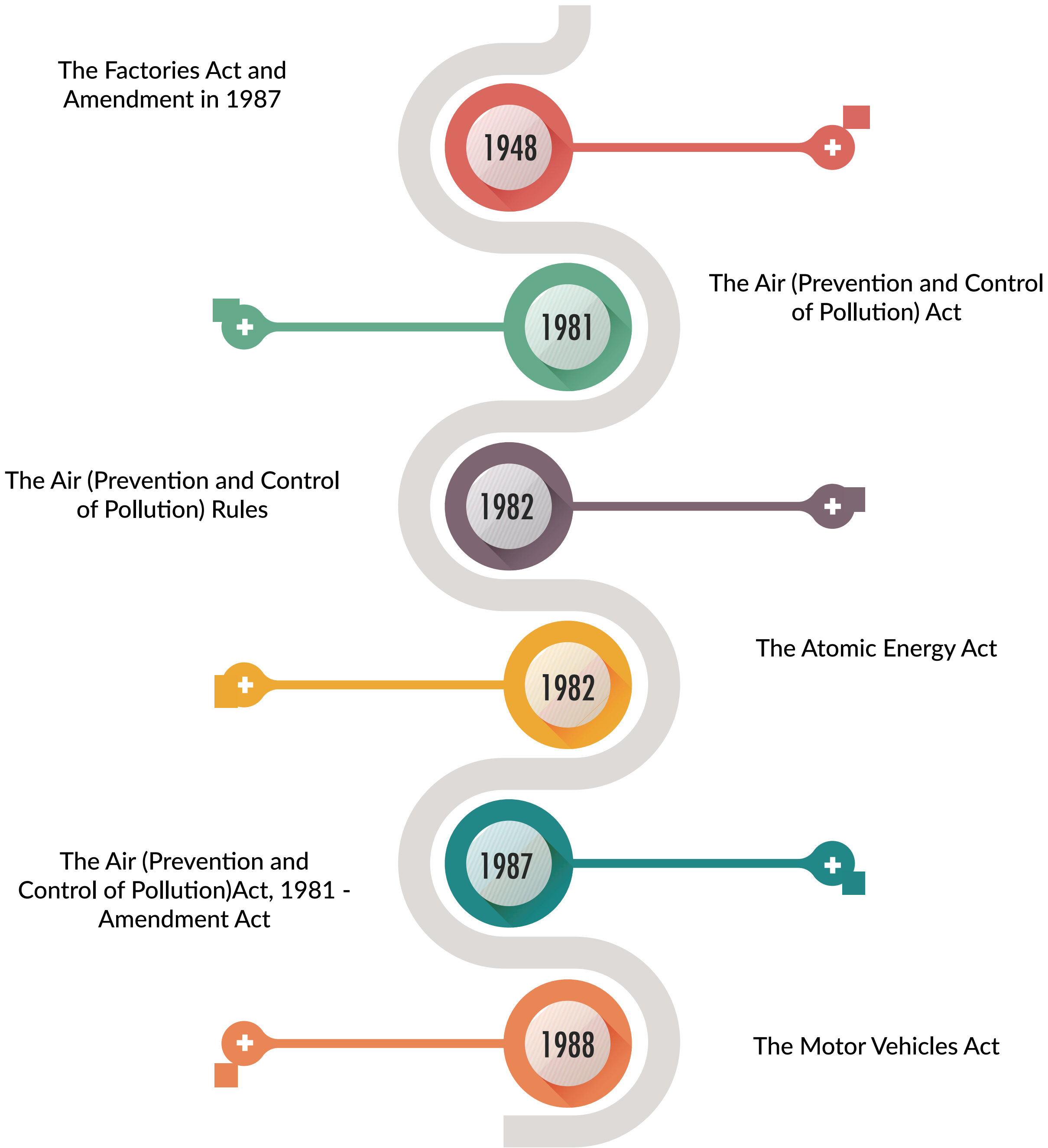


Figure 48: Laws Related to Air Quality Management

5.9 General Environmental Laws

1986 – The Environment (Protection) Act

1986 – The Environment (Protection) Rules

1989 – The Public Liability Insurance Act and Rules and Amendment

1991 – The Public Liability Insurance Act and Rules and Amendment

1995 – The National Environmental Tribunal Act

1997 – The National Environment Appellate Authority Act

1998 – The Biomedical waste (Management and Handling) Rules

2000 – The Municipal Solid Wastes (Management and Handling) Rules

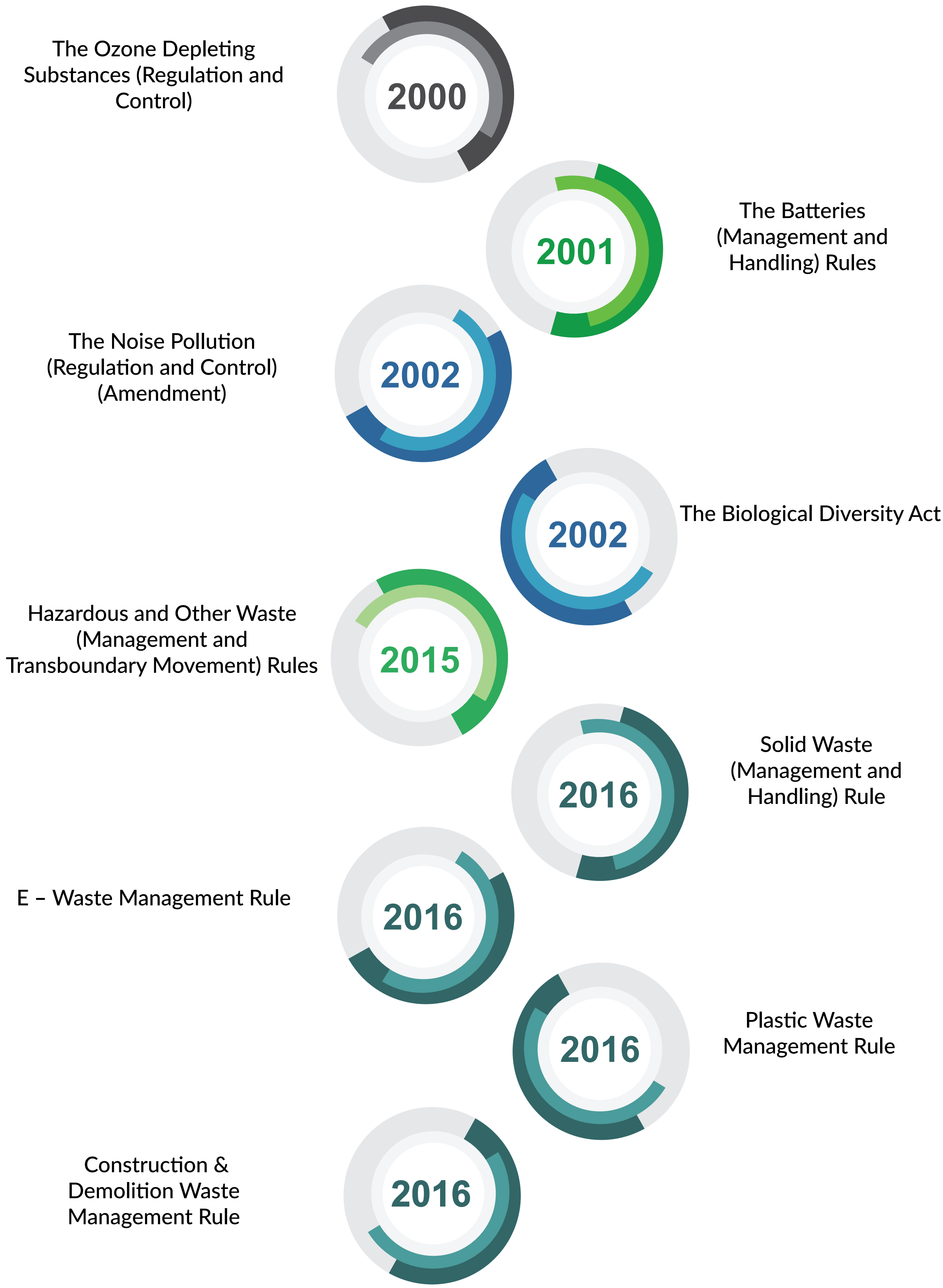


Figure 49: General Environmental Laws

5.10 Main Clean Air Action Plans in India

GRAP (Graded Response Action Plan)

- Instituted When: January 2017
- Area it Covers: Delhi and NCR
- Basic Premise: It is based on the AQI and defines measures that must be instituted by the city government according to different categories of the AQI. For Example, when the AQI is in the "severe" categories the DPCC and Municipal Corporation must ensure that all construction activities are ceased. When the AQI is in either "moderate" or "poor" categories the Municipal Corporation must ensure that there is periodic mechanized sweeping on roads with heavy traffic and water sprinkling.
- This plan is precautionary in nature as it defines measures that the city administration must take only when the AQI is in detrimental categories such as "severe", "very poor", and "moderate".

Comprehensive Action Plans for air pollution control

- Instituted When: April 2017
- Area it Covers: National Capital Territory of Delhi and National Capital Region, including
- states of Haryana, Rajasthan and Uttar Pradesh.
- Basic Premise: It is structured to improve the overall air quality of the Delhi-NCR and adjoining regions by defining short, medium and long-term actions.
- This plan is a systematic roadmap to bring ambient air quality levels within the permissible range over an extended period of time.
- Web link: http://www.epca.org.in/EPCA-Reports1999-1917/Final-EPCA-Report-71-CAP-for- Delhi-NCR.pdf

_NCAP (National Clean Air Programm

- Instituted When: April 2018
- Area it Covers: All locations in the country
- Basic Premise: The main goal is to meet the prescribed annual average ambient air quality standards at all locations in the country. It defines actions that must be taken at a national level to improve the air quality management status of the country. It is the first plan that proposes the extension of the NAMP to rural parts of India.
- The plan specifies that the cost for city specific plan implementation will have to be majorly borne by SPCBs/PCCs.
- Web Link: http://envfor.nic.in/sites/default/files/NCAP%20with%20 annex-ilovepdf- compressed.pdf

6

City Profiles from the Clean Air Scorecard

6.1 Introduction

This section will bring out the main results from the Clean Air Scorecard Assessment. The intent is to highlight the main findings across the three indexes on the basis of which the clean air score for each city was calculated – air pollution and health index, clean air management capacity index and clean air policies and actions index. It is to be noted that policies that operate at the all India level have not been highlighted as the intent was to bring out city-specific differences, hence aspects in which cities differed have been showcased. Further, the overall CAST score for each city has been given in accordance to city-specific air quality management capacity and is to be evaluated on the scale that is shown in the box below.

Overall Clean Air Score		
Category	**Score Band**	**Description**
Fully Developed	81-100	Key components of clean air management complete. Strong mandate for air pollution and GHG management and strong sector-based and integrated policies, regulations and institutions to address major sources of pollution (e.g., transport, industry, energy and area sources). Policies and actions contribute to achieving levels equivalent to prescribed WHO guidelines and interim targets for air pollution.
Maturing	61-80	Key components of clean air management complete and some integration with other major sectors (e.g., transport, health and energy sectors). Policies and actions have achieved some success in reducing AP/GHG emissions but air quality levels still exceed healthy levels prescribed by the WHO. Management efforts in all sector sources need to be intensified to bring emissions further.
Emerging	41-60	Majority of key components of clean air management in place. Policies and actions to reduce emissions from identified major sources need to be enhanced. Sector-based institutions need to upgrade technical and management capacity.
Developing	21-40	GHG and AP emissions are increasing and air quality declining. Clean air management activities are scattered in different organizations with limited collaboration. Need to invest in strengthening components of basic air quality management and collaboration between stakeholders.
Underdeveloped	1-20	Ad hoc clean air management; lack in emissions and ambient air quality standards; Needs to build capacity for basic air quality and GHG emissions management.

Please note while assessing the city profiles:

- The population of each city is based on information available from the most recent census record and has been rounded off to the nearest million.
- The number of prescribed monitoring stations is based on the population of the city. This is based on the logic of properly assessing health effects and keeping citizens informed about the status of air quality in their city.
- Since, PM 10 is the pollutant for comparison in this report, the number given for each city to show the need of monitoring stations is based on the needs for stations that monitor PM10.
- There are very few cities where PM 2.5 is monitored. Only those cities that has annual averages for PM 2.5, registered it as the pollutant of concern, otherwise PM 10 remained the pollutant of concern on account of it having been monitored across Indian cities for much longer.

6.2 AHMEDABAD

Demographic	
Population	6 Million
Area	
Total Land Area	466 sq. km

Monitoring Statistics	
Number of Monitoring Stations	24
Type of Monitoring Stations	Continuous and manual air quality monitoring systems
Pollutants Monitored	PM 2.5, PM10, SO2, NO2, O3, CO
Pollutant of Concern	PM10

Monitoring Stations	
Need for Monitoring Stations	13

Capacity to estimate impact of Air Pollution

1. Health Impact Studies Available

- Solanki, RB; Bhise, AR and Danqi, BM.2015. 'A study on spirometry in petrol pumpworkers of Ahmedabad, India.' APrajapati, Bipin; Talsania, Nitiben and KN,Sonaliya. 2011. 'A Study on Prevalence of Acute Respiratory Tract Infections (ARI) In Under Five Children In Urban And Rural Communities Of Ahmedabad District, Gujarat.' National Journal of Community Medicine, Vol 2 Issue 2 July-Sept.
- Guttikunda, Sarath and Jawahar, Puja. 2011. 'Urban Air Pollution Analysis in India. Pune (Mahrashtra), Chennai (Tamil Nadu), Indore (Madhya Pradesh), Ahmedabad (Gujarat), Surat (Gujarat), Rajkot (Gujarat)'. Urbanemissions.info.New Delhi, India.
- Aggarwal, A.L.; Raiyanu, CV; Patel, PD; Shah, PG and Chatterjee, SK. 1982. 'Assessment of exposure to benzo(a)pyrene in air for various population groups in ahmedabad.'
- Atmospheric Environment (1967). Vol 16, Issue 4,

867-870.

2. Cost benefits of mitigating air pollution assessed: None

3. Studies that monitor/assess extent of air pollution:

- Ministry of Environment, Forests and Climate Change. 2011. State of Air Environment. Gujarat.
- Bhaskar, B. Vijay and Mehta, Vikram M. 2010. 'Atmospheric Particulate Pollutants and their Relationship with Meteorology in Ahmedabad.
- Ministry of Environment, Forests and Climate Change, Government of India. 2015. Status of Pollution Generated from Road Transport in Six Mega Cities. GOI

Good Practices

- The city has an air action plan.
- The city administration has a nodal officer responsible for air pollution related issues.
- Compliance with air quality requirements are monitored.
- City Development Plan includes section on air pollution prevention.
- Public bike sharing system.
- Pilot emissions trading scheme has been launched.

Overall Scorecard Score

Overall Structure of the Clean Air Scorecard

Air Pollution and Health Index (APHI) 33.33%	+	Clean Air Management Capacity Index (CAMC) 33.33%	+	Clean Air Policies and Actions Index (CAPA) 33.33%	=	Overall Clean Air Score 100%

Clean Air Scorecard Results

Overall Clean Air Score: 42.9 | Emerging

	Final Weighted Score	Band Category
Index 1 - Air Quality and Health Index	7.56	Poor
Index 2 - Clean Air Management Capacity	16.63	Moderate
Index 3 - Clean Air Policies and Actions	18.75	Moderate

6.3 AURANGABAD

Demographic	
Population	1 Million
Area	
Total Land Area	139 sq. km

Monitoring Statistics	
Number of Monitoring Stations	4
Type of Monitoring Stations	Continuous and manual air quality monitoring systems
Pollutants Monitored	PM10, SO2, NO2
Pollutant of Concern	PM10

Monitoring Stations	
Need for Monitoring Stations	3

Capacity to estimate impact of Air Pollution

1. Health Impact Studies Available

- Maji, Kamal J; Dikshit, Anil K and Deshpande, Ashok. 2016. 'Human health risk assessment due to air pollution in 10 urban cities in Maharashtra, India.' Cogent Environmental Science (2016), 2: 1193110.
- Pawar, Vijaykumar. 2007. Adverse Impact of Air Pollutants on Human Health: A Case Study of Aurangabad City.

2. **Cost benefits of mitigating air pollution assessed:** None

3. **Studies that monitor/assess extent of air pollution:** None

Good Practises

- Compliance with air quality requirements are monitored.
- City Development Plan includes section on air pollution prevention.
- Air Action Plan for the city is being drafted.

Overall Scorecard Score

Overall Structure of the Clean Air Scorecard

Air Pollution and Health Index (APHI) 33.33%	+	Clean Air Management Capacity Index (CAMC) 33.33%	+	Clean Air Policies and Actions Index (CAPA) 33.33%	=	Overall Clean Air Score 100%

Clean Air Scorecard Results

Overall Clean Air Score: 46 | Emerging

	Final Weighted Score	Band Category
Index 1 - Air Quality and Health Index	7.89	Poor
Index 2 - Clean Air Management Capacity	21.97	Good
Index 3 - Clean Air Policies and Actions	16.10	Moderate

6.4 BENGALURU

Demographic	
Population	10 million
Area	
Total Land Area	741 sq. km

Monitoring Statistics	
Number of Monitoring Stations	15
Type of Monitoring Stations	Continuous and manual air quality monitoring systems
Pollutants Monitored	PM 2.5, PM10, SO2, NO2, O3, CO
Pollutant of Concern	PM10

Monitoring Stations	
Need for Monitoring Stations	15

Capacity to estimate impact of Air Pollution

1. Health Impact Studies Available

- Nagendra, Shiva S.M.; Venugopal, K. and Jones, Steven L. 2007. 'Assessment of air quality near traffic intersections in Bangalore city using air quality indices.' Transportation Research Part D: Transport and Environment. Volume 12, Issue 3, 167-176.
- Hoi, J; Baumgartner, J; Harnden, S, et al.2015. 'Increased risk of respiratory illness associated with kerosene fuel use among women and children in urban Bangalore, India' Occup Environ Med.72:114-122.
- Paramesh, H. 2002. 'Epidemiology of Asthma in India.' The Indian Journal of Pediatrics. Volume 69, Issue 4, 309–312.

2. Cost benefits of mitigating air pollution assessed: None

3. Studies that monitor/assess extent of air pollution:

- The Energy and Resources Institute. 2010. Air quality assessment, emission inventory and source apportionment study for Bangalore City: Final report. New Delhi. The Energy and Resources Institute.
- Mahadevappa, Harish. 2012. 'A Study OnAir Pollution By Automobiles in Bangalore City'.Management Research and Practice. Issue 3, 36 – 61.
- Sabapathy, Ashwin. 2008. 'Air quality outcomes of fuel quality and vehicular technology improvements in Bangalore city, India.' Transportation Research Part D: Transport and Environment. Volume 13, Issue 7, 449-454.
- Vailshery, Lionel Sujay; Jaganmohan, Madhumitha and Nagendra, Harini. 2013. 'Effect of street trees on microclimate and air pollution in a tropical city.' Urban Forestry & Urban Greening. Volume 12, Issue 3, 408-415.
- Kumar, M and Nandini, N. 2013. 'Identification and Evaluation of Air Pollution Tolerance Index of Selected Avenue Tree Species of Urban Bangalore, India.' International Journal of Emerging Technologies in Computational and Applied Sciences (IJETCAS). 5(4), 388- 390.
- Central Pollution Control Board. 2010. Air quality monitoring, emission inventory and source apportionment study for Indian cities. National Summary Report. New Delhi.

Good Practices

- Compliance with air quality requirements are monitored.
- City Development Plan includes section on air pollution prevention.
- Intelligent Transport System, including smart traffic lights and passenger information systems.

Overall Scorecard Score

Overall Structure of the Clean Air Scorecard

Air Pollution and Health Index (APHI) 33.33%	Clean Air Management Capacity Index (CAMC) 33.33%	Clean Air Policies and Actions Index (CAPA) 33.33%	Overall Clean Air Score 100%

Clean Air Scorecard Results

Overall Clean Air Score: 38 | Developing

	Final Weighted Score	Band Category
Index 1 - Air Quality and Health Index	3.94	Very Poor
Index 2 - Clean Air Management Capacity	15.56	Moderate
Index 3 - Clean Air Policies and Actions	18.52	Moderate

6.5 BHUBANESWAR

Demographic	
Population	840,834
Area	
Total Land Area	186 sq. km

Monitoring Statistics	
Number of Monitoring Stations	5
Type of Monitoring Stations	Manual air quality monitoring systems
Pollutants Monitored	PM 2.5, PM10, SO2, NO2, O3
Pollutant of Concern	PM10

Monitoring Stations	
Need for Monitoring Stations	3

Capacity to estimate impact of Air Pollution

1. Health Impact Studies Available

- Mahapatra, Parth Sarathi; Panda, Sipra; Walvekar, P.P; Kumar, R.; Das, Trupti and Gurjar, B.R. 2014. 'Seasonal trends, meteorological impacts, and associated health risks withatmospheric concentrations of gaseous pollutants at an Indian coastal city.' Environmental Science and Pollution Research. Volume 21, Issue 19, 11418-11432

2. Cost benefits of mitigating air pollution assessed: None

3. Studies that monitor/assess extent of air pollution:

- Mohapatra, K and Biswal, S.K. 2014. 'Assessment of Air Quality Index (AQI) in Bhubaneswar, The Capital City of Odisha.' International Journal of Advance Research In Science And Engineering, Vol. No.3, Issue No.6,190-196.

Good Practices

- Compliance with air quality requirements are monitored.
- City Development Plan includes section on air pollution prevention

Overall Scorecard Score

Overall Structure of the Clean Air Scorecard

Air Pollution and Health Index (APHI) 33.33%	Clean Air Management Capacity Index (CAMC) 33.33%	Clean Air Policies and Actions Index (CAPA) 33.33%	Overall Clean Air Score 100%

Clean Air Scorecard Results

Overall Clean Air Score: 36.8 | Developing

	Final Weighted Score	Band Category
Index 1 - Air Quality and Health Index	9.00	Poor
Index 2 - Clean Air Management Capacity	10.98	Limited
Index 3 - Clean Air Policies and Actions	16.83	Moderate

6.6 CHANDIGARH

Demographic	
Population	1 million
Area	
Total Land Area	114 sq. km

Monitoring Statistics	
Number of Monitoring Stations	5
Type of Monitoring Stations	Manual air quality monitoring systems
Pollutants Monitored	PM10, SO2, NO2
Pollutant of Concern	PM10

Monitoring Stations	
Need for Monitoring Stations	6

Capacity to estimate impact of Air Pollution

1. Health Impact Studies Available

- Chen, B.H; Hong, C J; Pandey, M R and Smith, K R. 1990. 'Indoor Air Pollution In Developing Countries.' Widhlth statist. quart.,Vol 43, 127-136. Gupta, Dheeraj; Boeffetta, Paolo; Gaborieau, Valerie and Jindal, S.K. 2001. 'Risk Factors of Lung Cancer in Chandigarh, India.' Indian Journal of Medical Research. Volume 113, 142-50.
- Guttikunda, Sarath and Jawahar, Puja. 2011. 'Urban Air Pollution Analysis in India. Pune (Mahrashtra), Chennai (Tamil Nadu), Indore (Madhya Pradesh), Ahmedabad (Gujarat), Surat (Gujarat), Rajkot (Gujarat)'. Urbanemissions.info. New Delhi, India.

2. Cost benefits of mitigating air pollution assessed: None

3. Studies that monitor/assess extent of air pollution:

- VS, Chitra and Shiva Nagendra. 2012. 'Indoor air quality investigations in a naturally ventilated school building located close to an urban roadway in Chennai, India.' Building and Environment. Volume 54, 159-167.
- Indian Institute of Technology, Madras. 2006. Air Quality Monitoring, Emission Inventory and Source Apportionment Study for Chennai. Project Summary Report. Madras.
- Central Pollution Control Board. 2010. Air quality monitoring, emission inventory and source apportionment study for Indian cities. National Summary Report. New Delhi.

Good Practices

- Centre for Accessing Real Time Air (Quality) Information Report (CARE AIR), in the city which has a continuous emissions monitoring system and when emission levels exceeds norms it sends out automatic SMS alerts to concerned government officials and necessary industries.
- Compliance with air quality requirements are monitored.
- City Development Plan includes section on air pollution prevention.

Overall Scorecard Score

Overall Structure of the Clean Air Scorecard

Air Pollution and Health Index (APHI) 33.33%	Clean Air Management Capacity Index (CAMC) 33.33%	Clean Air Policies and Actions Index (CAPA) 33.33%	Overall Clean Air Score 100%

Clean Air Scorecard Results

Overall Clean Air Score: 38.3 | Developing

	Final Weighted Score	Band Category
Index 1 - Air Quality and Health Index	5.56	Very Poor
Index 2 - Clean Air Management Capacity	14.93	Moderate
Index 3 - Clean Air Policies and Actions	17.81	Moderate

6.7 CHENNAI

Demographic	
Population	9 million
Area	
Total Land Area	426 sq. km

Monitoring Statistics	
Number of Monitoring Stations	11
Type of Monitoring Stations	Continuous and manual air quality monitoring systems
Pollutants Monitored	PM 2.5, PM10, SO2, NO2, O3, CO
Pollutant of Concern	PM10

Monitoring Stations	
Need for Monitoring Stations	15

Capacity to estimate impact of Air Pollution

1. Health Impact Studies Available

- Balakrishan, Kalpana; Ganguli, Bhaswati; Ghosh, Santu; Sambandam, Sankar; Roy, Sugata Sen and Chatterjee, Aditya. 2011. 'A spatially disaggregated time – series analysis of the shortterm effects of particulate matter exposure on mortality in Chennai, India.' Air Quality, Atmosphere and Health. Volume 6, Issue 1, 111- 121.
- Guttikunda, Sarath and Jawahar, Puja. 2011. 'Urban Air Pollution Analysis in India. Pune (Mahrashtra), Chennai (Tamil Nadu), Indore (Madhya Pradesh), Ahmedabad (Gujarat), Surat (Gujarat), Rajkot (Gujarat)'. Urbanemissions.info. New Delhi, India.

2. Cost benefits of mitigating air pollution assessed: None

3. Studies that monitor/assess extent of air pollution:

- Sharma, Umesh. 2003. 'Environmental Analysis of Urban Road Traffic in Chandigarh.' PEC University of Technology, Chandigarh.
- Dhanda, Priyanka. 2010. 'Ambient AirQuality Modeling with respect to CO Emissions for a Traffic Intersection in Chandigarh City.' PECUniversity of Technology, Chandigarh.
- Ministry of Environment, Forests and Climate Change. Government of India. 2004. State of Environment – Chandigarh. GOI.
- Saini, Randeep Singh. 2009. 'Ambient Air Quality Monitoring for Benzene, Lead and Carbon Monoxide in Chandigarh and Review of National Ambient Air Quality Monitoring Network being run by Chandigarh Pollution Control Committee.' PEC University of Technology, Chandigarh. Bandhu, H.K; Puri, Sanjiv; Garg, M.L.; Singh, B; Shahi, JS; Mehta, D; Swietlicki, E.; Dhawan, D.K.; Mangal, PC and Singh, Nirmal. 2000. 'Elemental composition and sources of air pollution in the city of Chandigarh, India, using EDXRF and PIXE techniques.' Nuclear Instruments and Methods in Physics Research Section B: Beam Interaction with Materials and Atoms. Volume 160, Issue 1, 126-138.

Good Practices

- Compliance with air quality requirements are monitored.
- City Development Plan includes section on air pollution prevention.
- Display boards showing level of pollutants and AQI have been installed at key points in the city.
- Intelligent Transport System for traffic management.
- Availability of adequate sidewalks for pedestrians.

Overall Scorecard Score

Overall Structure of the Clean Air Scorecard

Air Pollution and Health Index (APHI) 33.33% + **Clean Air Management Capacity Index (CAMC) 33.33%** + **Clean Air Policies and Actions Index (CAPA) 33.33%** = **Overall Clean Air Score 100%**

Clean Air Scorecard Results

Overall Clean Air Score: 48.6 | Emerging

	Final Weighted Score	Band Category
Index 1 - Air Quality and Health Index	12.67	Poor
Index 2 - Clean Air Management Capacity	17.49	Moderate
Index 3 - Clean Air Policies and Actions	18.46	Moderate

6.8 COIMBATORE

Demographic	
Population	1 million
Area	
Total Land Area	114 sq. km

Monitoring Statistics	
Number of Monitoring Stations	5
Type of Monitoring Stations	Continuous and manual air quality monitoring systems
Pollutants Monitored	PM10, SO2, NO2
Pollutant of Concern	PM10

Monitoring Stations	
Need for Monitoring Stations	6

Capacity to estimate impact of Air Pollution

1. Health Impact Studies Available

- Chen, B.H; Hong, C J; Pandey, M R and Smith, K R. 1990. 'Indoor Air Pollution In Developing Countries.' Widhlth statist. quart.,Vol 43, 127-136. Gupta, Dheeraj; Boeffetta, Paolo; Gaborieau, Valerie and Jindal, S.K. 2001. 'Risk Factors of Lung Cancer in Chandigarh, India.' Indian Journal of Medical Research. Volume 113, 142-50.
- Guttikunda, Sarath and Jawahar, Puja. 2011. 'Urban Air Pollution Analysis in India. Pune (Mahrashtra), Chennai (Tamil Nadu), Indore (Madhya Pradesh), Ahmedabad (Gujarat), Surat (Gujarat), Rajkot (Gujarat)'. Urbanemissions.info. New Delhi, India.

2. Cost benefits of mitigating air pollution assessed: None

3. Studies that monitor/assess extent of air pollution:

- VS, Chitra and Shiva Nagendra. 2012. 'Indoor air quality investigations in a naturally ventilated school building located close to an urban roadway in Chennai, India.' Building and Environment. Volume 54, 159-167.
- Indian Institute of Technology, Madras. 2006. Air Quality Monitoring, Emission Inventory and Source Apportionment Study for Chennai. Project Summary Report. Madras.
- Central Pollution Control Board. 2010. Air quality monitoring, emission inventory and source apportionment study for Indian cities. National Summary Report. New Delhi.

Good Practices

- Centre for Accessing Real Time Air (Quality) Information Report (CARE AIR), in the city which has a continuous emissions monitoring system and when emission levels exceeds norms it sends out automatic SMS alerts to concerned government officials and necessary industries.
- Compliance with air quality requirements are monitored.
- City Development Plan includes section on air pollution prevention.

Overall Scorecard Score

Overall Structure of the Clean Air Scorecard

Air Pollution and Health Index (APHI) 33.33%	+	Clean Air Management Capacity Index (CAMC) 33.33%	+	Clean Air Policies and Actions Index (CAPA) 33.33%	=	Overall Clean Air Score 100%

Clean Air Scorecard Results

Overall Clean Air Score: 48.8 | Emerging

	Final Weighted Score	Band Category
Index 1 - Air Quality and Health Index	18.00	Moderate
Index 2 - Clean Air Management Capacity	13.50	Moderate
Index 3 - Clean Air Policies and Actions	17.29	Moderate

6.9 GUWAHATI

Demographic	
Population	1.4 million
Area	
Total Land Area	271 sq. km

Monitoring Statistics	
Number of Monitoring Stations	12
Type of Monitoring Stations	Manual air quality monitoring systems
Pollutants Monitored	PM10, SO2, NO2
Pollutant of Concern	PM10

Monitoring Stations	
Need for Monitoring Stations	6

Capacity to estimate impact of Air Pollution

1. Health Impact Studies Available

- None

2. Cost benefits of mitigating air pollution assessed: None

3. Studies that monitor/assess extent of air pollution:

- Gokhale, Sharad. 2014-2017. 'Urban black carbon and mitigations.' Indian Institute of Science, Guwahati.

Good Practices

- Compliance with air quality requirements are monitored.
- City Development Plan includes section on air pollution prevention.

Overall Scorecard Score

Overall Structure of the Clean Air Scorecard

Air Pollution and Health Index (APHI) 33.33%	+	Clean Air Management Capacity Index (CAMC) 33.33%	+	Clean Air Policies and Actions Index (CAPA) 33.33%	=	Overall Clean Air Score 100%

Clean Air Scorecard Results

Overall Clean Air Score: 32.1 | Developing

	Final Weighted Score	Band Category
Index 1 - Air Quality and Health Index	3.33	Critical
Index 2 - Clean Air Management Capacity	12.94	Limited
Index 3 - Clean Air Policies and Actions	15.83	Moderate

6.10 HYDERABAD

Demographic	
Population	4 million
Area	
Total Land Area	217 sq. km

Monitoring Statistics	
Number of Monitoring Stations	4
Type of Monitoring Stations	Continuous and manual air quality monitoring systems
Pollutants Monitored	PM10, SO2, NO2
Pollutant of Concern	PM10

Monitoring Stations	
Need for Monitoring Stations	11

Capacity to estimate impact of Air Pollution

1. Health Impact Studies Available

- Guttikunda, Sarath K and Koppaka, Ramani V. 2014. 'Source emissions and health impacts of urban air pollution in Hyderabad, India.' Air QualAtmos Health. Volume 7, 195–207.
- Srinagesh, B. 2016. 'Air Pollution and its Impact on Human Health – A Geospatial Analysis of Hyderabad'. International Journal of Research. Volume 10, No. 3, 851 – 867.

2. Cost benefits of mitigating air pollution assessed:

- Guttikunda, Sarath, 'Air Pollution & Co-Benefits Analysis for Hyderabad, India.' (November 22, 2008). SIM-air Working Paper Series No. 09-2008. Available at SSRN: https://ssrn.com/abstract=1409492 or http://dx.doi.org/10.2139/ssrn.1409492.

3. Studies that monitor/assess extent of air pollution:

- Satish, P and Rao, Lakhmana V. 2014. 'A Comparative Study of Air Pollution over Coastal and Urban Cities – A Case Study.' International Journal of Innovative Researchin Science, Engineering and Technology. Vol 3, Issue 1, 8756 – 8764.
- Rao, Venkateswara K.; Raveendhar, N. and Swamy, A.V.V.S. 2006. 'Status of Air Pollution in Hyderabad City, Telangana State.' International Journal of Innovative Researchin Science, Engineering and Technology. Vol 5, Issue 4, 4769 – 4780.
- Ministry of Environment, Forests and Climate Change, Government of India. 2015. Status of Pollution Generated from Road Transport in Six Mega Cities. GOI

Good Practices

- Compliance with air quality requirements are monitored.
- City Development Plan includes section on air pollution prevention.

Overall Scorecard Score

Overall Structure of the Clean Air Scorecard

Air Pollution and Health Index (APHI) 33.33%	+	**Clean Air Management Capacity Index (CAMC) 33.33%**	+	**Clean Air Policies and Actions Index (CAPA) 33.33%**	=	**Overall Clean Air Score 100%**

Clean Air Scorecard Results

Overall Clean Air Score: 41.8 | Emerging

	Final Weighted Score	Band Category
Index 1 - Air Quality and Health Index	7.33	Poor
Index 2 - Clean Air Management Capacity	17.81	Moderate
Index 3 - Clean Air Policies and Actions	16.62	Moderate

6.11 INDORE

Demographic	
Population	2 million
Area	
Total Land Area	134 sq. km

Monitoring Statistics	
Number of Monitoring Stations	3
Type of Monitoring Stations	Manual air quality monitoring systems
Pollutants Monitored	PM 2.5, PM10, SO2, NO2, O3
Pollutant of Concern	PM2.5

Monitoring Stations	
Need for Monitoring Stations	7

Capacity to estimate impact of Air Pollution

1. Health Impact Studies Available

- Mahendra, Anjali and Rajagopalan, Lakshmi. 2015. 'Evaluating Health Impacts from a Bus Rapid Transit System Implementation in India. Case Study of Indore, Madhya Pradesh.' Transportation Research Record: Journal of the Transportation Research Board. Volume 2531, 121-128.
- Guttikunda, Sarath and Jawahar, Puja. 2011. 'Urban Air Pollution Analysis in India. Pune (Mahrashtra), Chennai (Tamil Nadu), Indore (Madhya Pradesh), Ahmedabad (Gujarat), Surat (Gujarat), Rajkot (Gujarat)'. Urbanemissions.info. New Delhi, India.

2. Cost benefits of mitigating air pollution assessed: None

3. Studies that monitor/assess extent of air pollution:

- Thakur, Atul. 2013. 'Ambient Air Pollution Monitoring In Urban Area of Indore City with Special Reference to Total Suspended Particulate Matter.' Biological Forum – An International Journal. Vol 5, Issue 2, pp 126-128.
- Panday, Vijayanta and Dohare, DevendraEr. 2016. 'Assessment of Present Ambient Air Quality of Indore City using Indian Air Quality Index – A Case Study.' International Journal of Science Technology & Engineering. Volume 3, Issue 6, 153 -157.

Good Practices

- Compliance with air quality requirements are monitored.
- City Development Plan includes section on air pollution prevention.
- Has an environmental action plan with a component on air pollution for critically polluted areas.

Overall Scorecard Score

Overall Structure of the Clean Air Scorecard

Air Pollution and Health Index (APHI) 33.33%	+	Clean Air Management Capacity Index (CAMC) 33.33%	+	Clean Air Policies and Actions Index (CAPA) 33.33%	=	Overall Clean Air Score 100%

Clean Air Scorecard Results

Overall Clean Air Score: 41.2 | Emerging

	Final Weighted Score	Band Category
Index 1 - Air Quality and Health Index	7.89	Poor
Index 2 - Clean Air Management Capacity	14.48	Moderate
Index 3 - Clean Air Policies and Actions	17.81	Moderate

6.12 JAIPUR

Demographic	
Population	3 million
Area	
Total Land Area	467 sq. km

Monitoring Statistics	
Number of Monitoring Stations	6
Type of Monitoring Stations	Continuous and manual air quality monitoring systems
Pollutants Monitored	PM10, SO2, NO2
Pollutant of Concern	PM10

Monitoring Stations	
Need for Monitoring Stations	10

Capacity to estimate impact of Air Pollution

1. Health Impact Studies Available

- Rahul; Sangeeta, Vyas; Sankhla, Manisha and Gupta, Jitendra. 2016. 'Spirometric evaluation of the pulmonary functions in the petrol pump workers of Jaipur city, Rajasthan, India.' International Journal of Community Medicine and Public Health. Volume 3, Issue 11, 3256-3260.
- Singh, Virendra; Khandelwal, Rakesh and Gupta, A.B. 2003. 'Effect of Air Pollution on Peak Expiratory Flow Rate Variability.' Journal of Asthma. Vol 4, No. 1, 81-86.
- Singh, Virendra; Sharma, Bharat Bhushan; Yadav, Rajeev and Meena, Pradeep. 2009. 'Respiratory Morbidity Attributed to Auto-exhaust Pollution in Traffic Policemen of Jaipur, India.' Journal of Asthma. Vol 46, Issue 2, 118-128.

2. **Cost benefits of mitigating air pollution assessed:** None

3. **Studies that monitor/assess extent of air pollution:** None

Good Practices

- State sponsored mobile application called Raj Vayu that shows AQI for the city.
- Compliance with air quality requirements are monitored.
- City Development Plan includes section on air pollution prevention.

Overall Scorecard Score

Overall Structure of the Clean Air Scorecard

Air Pollution and Health Index (APHI) 33.33%	+	Clean Air Management Capacity Index (CAMC) 33.33%	+	Clean Air Policies and Actions Index (CAPA) 33.33%	=	Overall Clean Air Score 100%

Clean Air Scorecard Results

Overall Clean Air Score: 33 | Developing

	Final Weighted Score	Band Category
Index 1 - Air Quality and Health Index	3.33	Critical
Index 2 - Clean Air Management Capacity	13.24	Limited
Index 3 - Clean Air Policies and Actions	16.45	Moderate

6.13 JAMSHEDPUR

Demographic	
Population	1 million
Area	
Total Land Area	231 sq. km

Monitoring Statistics	
Number of Monitoring Stations	None
Type of Monitoring Stations	Not applicable
Pollutants Monitored	Not applicable
Pollutant of Concern	Not applicable

Monitoring Stations	
Need for Monitoring Stations	6

Capacity to estimate impact of Air Pollution

1. Health Impact Studies Available : None
2. Cost benefits of mitigating air pollution assessed: None
3. Studies that monitor/assess extent of air pollution:

- Sivacoumar, R; Bhanarkar, A.D.; Goyal, S.K.; Gadkari, S.K. and Aggarwal, A.L. 2001. 'Air pollution modeling for an industrial complex and model performance evaluation.' Environmental Pollution. Volume 111, Issue 3, 471 -477.

Overall Scorecard Score

Overall Structure of the Clean Air Scorecard

Air Pollution and Health Index (APHI) 33.33%	+	Clean Air Management Capacity Index (CAMC) 33.33%	+	Clean Air Policies and Actions Index (CAPA) 33.33%	=	Overall Clean Air Score 100%

Clean Air Scorecard Results

#VALUE!

	Final Weighted Score	Band Category
Index 1 - Air Quality and Health Index	#VALUE!	10 concentration is required
Index 2 - Clean Air Management Capacity	9.12	Limited
Index 3 - Clean Air Policies and Actions	16.56	Moderate

Please Note, that since the city has no monitoring stations run by the state, no value for PM10 levels could be entered in the CAST. Thus, Index 1 – Air Quality and Health Index registered an error (#VALUE!) as it required pollutant levels to generate a value. On totaling the values for Index 2 and 3 the value is 25.68, which places the city of Jamshedpur in the **Developing category.**

6.14 KANPUR

Demographic	
Population	3 million
Area	
Total Land Area	260 sq. km

Monitoring Statistics	
Number of Monitoring Stations	8
Type of Monitoring Stations	Continuous and Manual Emissions Monitoring Systems
Pollutants Monitored	PM10, SO2, NO2
Pollutant of Concern	PM10

Monitoring Stations	
Need for Monitoring Stations	10

Capacity to estimate impact of Air Pollution

1. Health Impact Studies Available

- Sharma, Mukesh; Kumar, Narendra V.; Katiyar, Subodh K.; Sharma, Richa; Shukla, P Bhanu and Sengupta, Babu. 2010. 'Effects of Particulate Air Pollution on the Respiratory Health of Subjects Who Live in Three Areas in Kanpur, India.' Archives of Environmental Health: An International Journal. Volume 59, Issue 7, 348-358.
- Devi, Jai J.; Gupta, Tarun; Tripathi, S.N. and Ujinwal, Kamal K. 2009. 'Assessment of personal exposure to inhalable indoor and outdoor particulate matter for student residents of an academic campus (IIT-Kanpur).' Inhalation Toxicology. 1-15.

2. Cost benefits of mitigating air pollution assessed:

- Gupta, Usha. 2008. 'Valuation of Urban Air Pollution: A Case Study of Kanpur City.' Environmental and Resource Economics. Volume 41, Issue 3, 315 – 326.3.

3 . Studies that monitor/assess extent of Air Pollution:

- Sharma, Mukesh and Maloo, Shaily. 2005. 'Assessment of ambient air PM10 and PM2.5 and characterization of PM10 in the city of Kanpur, India.' Atmospheric Environment. Volume 39, Issue 33, 6015-6026.
- Sharma, Mukesh. 2010. Air Quality Assessment, Emissions Inventory and Source Apportionment Studies for Kanpur City. Final Report. Indian Institute of Technology, Kanpur.
- Central Pollution Control Board. 2010. Air quality monitoring, emission inventory and source apportionment study for Indian cities. National Summary Report. New Delhi.

Good Practices

- City has an Air Action Plan.
- Compliance with air quality requirements are monitored.
- City Development Plan includes section on air pollution prevention.

Overall Scorecard Score

Overall Structure of the Clean Air Scorecard

Air Pollution and Health Index (APHI) 33.33%	+	Clean Air Management Capacity Index (CAMC) 33.33%	+	Clean Air Policies and Actions Index (CAPA) 33.33%	=	Overall Clean Air Score 100%

Clean Air Scorecard Results

#VALUE!

	Final Weighted Score	Band Category
Index 1 - Air Quality and Health Index	#VALUE!	10 concentration is required
Index 2 - Clean Air Management Capacity	9.12	Limited
Index 3 - Clean Air Policies and Actions	16.56	Moderate

Please note, that since the city has no monitoring stations run by the state, no value for PM10 levels could be entered in the CAST. Thus, Index 1 – Air Quality and Health Index registered an error (#VALUE!) as it required pollutant levels to generate a value. On totaling the values for Index 2 and 3 the value is 25.68, which places the city of Jamshedpur in the **Developing category.**

6.15 KOCHI

Demographic	
Population	1 million
Area	
Total Land Area	95 sq. km

Monitoring Statistics	
Number of Monitoring Stations	4
Type of Monitoring Stations	Manual Emissions Monitoring Systems
Pollutants Monitored	PM10, SO2, NO2
Pollutant of Concern	PM10

Monitoring Stations	
Need for Monitoring Stations	3

Capacity to estimate impact of Air Pollution

1. **Health Impact Studies Available :** None
2. **Cost benefits of mitigating air pollution assessed:** None
3. **Studies that monitor/assess extent of air pollution:**

- Gargava, Prashant and Aggarwal, A.L. 1999. 'Emission Inventory for an Industrial Area in India.' Environmental Monitoring and Assessment. Volume 55, Issue 2, 299-304.
- Gjaghate, D.G. and Bhanarkar, A.D. 2005. 'Characterisation of particulate matter for toxic metals in ambient air of Kochi City, India'. Environmental Monitoring and Assessment. Volume 102, Issue 1-3, 119-129.
- Guttikunda, Sarath. 2009. 'Motorized Passenger Travel in Urban India Emissions & Co-Benefits Analysis.' SIM-air Working Paper Series. urbanemissions.info.

Good Practices

- Compliance with air quality requirements are monitored.
- City Development Plan includes section on air pollution prevention.
- Intelligent Transport System is operative in the city.

Overall Scorecard Score

Overall Structure of the Clean Air Scorecard

Air Pollution and Health Index (APHI) 33.33%	+	**Clean Air Management Capacity Index (CAMC) 33.33%**	+	**Clean Air Policies and Actions Index (CAPA) 33.33%**	=	**Overall Clean Air Score 100%**

Clean Air Scorecard Results

Overall Clean Air Score: 37.6 | Emerging

	Final Weighted Score	Band Category
Index 1 - Air Quality and Health Index	16.33	Moderate
Index 2 - Clean Air Management Capacity	13.63	Moderate
Index 3 - Clean Air Policies and Actions	17.52	Moderate

6.16 KOLKATA

Demographic	
Population	5 million
Area	
Total Land Area	205 sq. km

Monitoring Statistics	
Number of Monitoring Stations	11
Type of Monitoring Stations	Continuous Ambient Air Quality Monitoring Station
Pollutants Monitored	PM10, SO2, NO2, O3, CO
Pollutant of Concern	PM10

Monitoring Stations	
Need for Monitoring Stations	11

Capacity to estimate impact of Air Pollution

1. **Health Impact Studies Available :**

- Ghose, Mrinal K; Paul, R and Banerjee, R.K. 2004. 'Assessment of the Status of Urban Air pollution And Its Impact on Human Health in the City of Kolkata.' Environmental Monitoring and Assessment. Volume 108, Issue 1-3, 151-167.
- Ray, Manas Ranjan and Lahiri, Twisha. 2011. Air pollution and its effects on health – Case studies, India.The International Council on Clean Transportation.

2. Cost benefits of mitigating air pollution assessed: None

3. Studies that monitor/assess extent of air pollution:

- Majumdar, Baijayanata Kumar; Dutta, Amit; Chakrabarty, Shibnath and Ray, Subhrata. 2010. 'Assessment of vehicular pollution in Kolkata, India, using CALINE 4 model.' Environmental Monitoring and Assessment. Volume 170, Issue 1-4, 33-43.
- Kakar,Kakoli. 2007. 'Source apportionment of PM10 at residential and industrial sites of an urban region of Kolkata, India.' Atmospheric Research. Volume 84, Issue 1, 30-41.
- Gupta, A.K.; Karar, Kakoli; Ayoob, S.and John, Kuruvilla. 2008.'Spatio-temporal characteristics of gaseous and particulate pollutants in an urban region of Kolkata, India.' Atmospheric Research. Volume 87, Issue 2, 103-115.
- Ministry of Environment, Forests and Climate Change. 2010. Study of Urban Air Quality in Kolkata for Source Identification and Estimation of Ozone, Carbonyls, NOx and VOC Emissions. New Delhi.
- Ministry of Environment, Forests and Climate Change, Government of India. 2015. Status of Pollution Generated from Road Transport in Six Mega Cities. GOI

Good Practices

- Compliance with air quality requirements are monitored.

Overall Scorecard Score

Overall Structure of the Clean Air Scorecard

Air Pollution and Health Index (APHI) 33.33%	+	Clean Air Management Capacity Index (CAMC) 33.33%	+	Clean Air Policies and Actions Index (CAPA) 33.33%	=	Overall Clean Air Score 100%

Clean Air Scorecard Results

Overall Clean Air Score: 37.8 | Developing

	Final Weighted Score	Band Category
Index 1 - Air Quality and Health Index	3.70	Very Poor
Index 2 - Clean Air Management Capacity	15.67	Moderate
Index 3 - Clean Air Policies and Actions	18.41	Moderate

6.17 KURUKSHETRA

Demographic	
Population	2 million
Area	
Total Land Area	32 sq. km

Monitoring Statistics	
Number of Monitoring Stations	None
Type of Monitoring Stations	Not applicable
Pollutants Monitored	Not applicable
Pollutant of Concern	Not applicable

Monitoring Stations	
Need for Monitoring Stations	7

Capacity to estimate impact of Air Pollution

1. Health Impact Studies Available : None
2. Cost benefits of mitigating air pollution assessed: None
3. Studies that monitor/assess extent of air pollution: None

Overall Scorecard Score

Overall Structure of the Clean Air Scorecard						
Air Pollution and Health Index (APHI) 33.33%	+	Clean Air Management Capacity Index (CAMC) 33.33%	+	Clean Air Policies and Actions Index (CAPA) 33.33%	=	Overall Clean Air Score 100%

Clean Air Scorecard Results		
#VALUE!		
	Final Weighted Score	**Band Category**
Index 1 - Air Quality and Health Index	#VALUE!	10 concentration is required
Index 2 - Clean Air Management Capacity	6.67	Minimal
Index 3 - Clean Air Policies and Actions	16.79	Moderate

Please Note, that since the city has no monitoring stations run by the state, no value for PM10 levels could be entered in the CAST. Thus, Index 1 – Air Quality and Health Index registered an error (#VALUE!) as it required pollutant levels to generate a value. On totaling the values for Index 2 and 3 the value is 23.46, which places the city of Kurukshetra in the **Developing category.**

6.18 LUDHIANA

Demographic	
Population	2 million
Area	
Total Land Area	160 sq. km

Monitoring Statistics	
Number of Monitoring Stations	4
Type of Monitoring Stations	Continuous Ambient Air Quality Monitoring Station
Pollutants Monitored	PM_{10}, SO_2, NO_2
Pollutant of Concern	PM_{10}

Monitoring Stations	
Need for Monitoring Stations	7

Capacity to estimate impact of Air Pollution

1. Health Impact Studies Available :

- Kumar, R; Sharma, SK; JS, Thakur; PV, Lakshmi; MK, Sharma; and T, Singh. 2010. 'Association of air pollution and mortality in the Ludhiana city of India: a time-series study.' Indian Journal of Public Health. Volume 54, Issue 2, 98-103.

2. Cost benefits of mitigating air pollution assessed: None

3. Studies that monitor/assess extent of air pollution: None

Good Practices

- Compliance with air quality requirements are monitored.
- City has an environment action plan with a section on air pollution.
- City Development Plan includes a section in air pollution.

Overall Scorecard Score

Overall Structure of the Clean Air Scorecard

Air Pollution and Health Index (APHI) 33.33%	+	**Clean Air Management Capacity Index (CAMC) 33.33%**	+	**Clean Air Policies and Actions Index (CAPA) 33.33%**	=	**Overall Clean Air Score 100%**

Clean Air Scorecard Results

Overall Clean Air Score: 33.7 | Developing

	Final Weighted Score	Band Category
Index 1 - Air Quality and Health Index	3.24	Critical
Index 2 - Clean Air Management Capacity	12.73	Limited
Index 3 - Clean Air Policies and Actions	17.77	Moderate

6.19 MUMBAI

Demographic	
Population	12 million
Area	
Total Land Area	458 sq. km

Monitoring Statistics	
Number of Monitoring Stations	19
Type of Monitoring Stations	Continuous Ambient Air Quality Monitoring Station
Pollutants Monitored	PM 2.5, PM10, SO2, NO2, O3, CO
Pollutant of Concern	PM10

Monitoring Stations	
Need for Monitoring Stations	15

Capacity to estimate impact of Air Pollution

1. Health Impact Studies Available :

- Shankar, Ravi. P and Rao, G. Rama. 2002. 'Impact of Air Quality on Human Health: A Case of Mumbai City, India.' IUSSP Regional Conference on Southeast Asia's Population in a Changing Asian Context. 10-13 June. http://archive.iussp.org/Bangkok2002/S09Shankar.pdf
- Joseph, A; Ad, S and Srivastava, A. 2003. 'PM(10) and its impacts on health - a case study in Mumbai.' International Journal of Environmental Health Research. Volume 13, Issue 2, 207-214.
- Raghunath, Radha et al. 1999. 'Assessment of Pb, Cd, Cu, and Zn Exposures of 6- to 10-Year-Old Children in Mumbai.' Environmental Research. Volume 80, Issue 3, 215-225.

2. Cost benefits of mitigating air pollution assessed:

- Srivastava, Anjali and Kumar, Rakesh. 2001. 'Economic Valuation of Health Impacts of Air Pollution In Mumbai.' Environmental Monitoring and Assessment. Volume 75, 135 – 143.
- Patankar, AM and Trivedi, P L. 2011. 'Monetary burden of health impacts of air pollution in Mumbai, India: Implications for public health policy.' Public Health.Volume 125, Issue 3, 157–164.

3. Studies that monitor/assess extent of air pollution:

- Central Pollution Control Board. 2010. Air Quality Assessment, Emissions Inventory& Source Apportionment Studies: Mumbai. Final Report. New Delhi.
- Central Pollution Control Board. 2010.Air quality monitoring, emission inventory and source apportionment study for Indian cities. National Summary Report. New Delhi.

Good Practices

- Compliance with air quality requirements are monitored.

Overall Scorecard Score

Overall Structure of the Clean Air Scorecard

Air Pollution and Health Index (APHI) 33.33%	+	Clean Air Management Capacity Index (CAMC) 33.33%	+	Clean Air Policies and Actions Index (CAPA) 33.33%	=	Overall Clean Air Score 100%

Clean Air Scorecard Results

Overall Clean Air Score: 38.9 | Developing

	Final Weighted Score	Band Category
Index 1 - Air Quality and Health Index	3.33	Critical
Index 2 - Clean Air Management Capacity	17.98	Moderate
Index 3 - Clean Air Policies and Actions	17.60	Moderate

6.20 NAGPUR

Demographic	
Population	2 million
Area	
Total Land Area	225 sq. km

Monitoring Statistics	
Number of Monitoring Stations	5
Type of Monitoring Stations	Continuous and Manual Air Quality Monitoring Systems
Pollutants Monitored	PM10, SO2, NO2
Pollutant of Concern	PM10

Monitoring Stations	
Need for Monitoring Stations	8

Capacity to estimate impact of Air Pollution

1. Health Impact Studies Available :

- Wankheded, Deepak and Wankhede, Shalini. 2009. 'Impact of Vehicular Air Pollution On The Health Status of Traffic Police of Nagpur City: A Study of Urban Environment Degradation.' The Research Journal of Interdisciplinary Policy Research and Action.
- Maji, Kamal Jyoti; Dikshit, Anil Kumar and Despande, Ashok. 2016. 'Human health risk assessment due to air pollution in 10 urban cities in Maharashtra, India.' Cogent Environmental Science. Volume 2, 1-16.

2. Cost benefits of mitigating air pollution assessed: None

3. Studies that monitor/assess extent of air pollution: None

Good Practices

- Compliance with air quality requirements are monitored.
- First city in the country to have launched a fleet of electric vehicles (taxis) for public transport.

Overall Scorecard Score

Overall Structure of the Clean Air Scorecard

Air Pollution and Health Index (APHI) 33.33%	+	Clean Air Management Capacity Index (CAMC) 33.33%	+	Clean Air Policies and Actions Index (CAPA) 33.33%	=	Overall Clean Air Score 100%

Clean Air Scorecard Results

Overall Clean Air Score: 43.5 | Emerging

	Final Weighted Score	Band Category
Index 1 - Air Quality and Health Index	6.67	Very Poor
Index 2 - Clean Air Management Capacity	21.60	Good
Index 3 - Clean Air Policies and Actions	15.25	Moderate

6.21 NASHIK

Demographic	
Population	2 million
Area	
Total Land Area	267 sq. km

Monitoring Statistics	
Number of Monitoring Stations	5
Type of Monitoring Stations	Continuous and Manual Air Quality Monitoring Systems
Pollutants Monitored	PM10, SO2, NO2
Pollutant of Concern	PM10

Monitoring Stations	
Need for Monitoring Stations	7

Capacity to estimate impact of Air Pollution

1. Health Impact Studies Available :

- Maji, Kamal Jyoti; Dikshit, Anil Kumar and Despande, Ashok. 2016. 'Human health risk assessment due to air pollution in 10 urban cities in Maharashtra, India.' Cogent Environmental Science. Volume 2, 1-16.

2. Cost benefits of mitigating air pollution assessed: None

3. Studies that monitor/assess extent of air pollution:

- The Energy and Resources Institute. 2014. Air Quality Status of Maharashtra – 2013-14 (Compilation of Air Quality Data Recorded by MPCB). New Delhi.

Good Practices

- Compliance with air quality requirements are monitored.

Overall Scorecard Score

Overall Structure of the Clean Air Scorecard

Air Pollution and Health Index (APHI) 33.33%	+	Clean Air Management Capacity Index (CAMC) 33.33%	+	Clean Air Policies and Actions Index (CAPA) 33.33%	=	Overall Clean Air Score 100%

Clean Air Scorecard Results

Overall Clean Air Score: 48.5 | Emerging

	Final Weighted Score	Band Category
Index 1 - Air Quality and Health Index	10.67	Poor
Index 2 - Clean Air Management Capacity	21.14	Good
Index 3 - Clean Air Policies and Actions	16.65	Moderate

6.22 NEW DELHI

Demographic	
Population	17 million
Area	
Total Land Area	1483 sq. km

Monitoring Statistics	
Number of Monitoring Stations	38
Type of Monitoring Stations	Continuous and Manual Air Quality Monitoring Systems
Pollutants Monitored	PM 2.5, PM10, SO2, NO2, O3, CO
Pollutant of Concern	PM10

Monitoring Stations	
Need for Monitoring Stations	15

Capacity to estimate impact of Air Pollution

1. Health Impact Studies Available :

- Rizwan, SA; Nongkynrih, Baridalyne and Gupta, Sanjeev Kumar. 2013. 'Air Pollution in Delhi: Its Magnitude and Effects on Health.' Indian Journal of Community Medicine. Volume 38, Issue 1, 4-8.
- Central Pollution Control Board, 2012. Study on Ambient Air Quality, Respiratory Symptoms and Lung Function of Children in Delhi. Ministry of Environment and Forests and Climate Change, New Delhi.

2. Cost benefits of mitigating air pollution assessed:

- Lvovsky, Kseniya. 1998. 'Economic Costs Clean Air Asia of Air Pollution with Special Reference to India.' Prepared for the National Conference on Health and Environment Delhi, India, July 7-9, 1998.

3. Studies that monitor/assess extent of air pollution:

- Central Pollution Control Board. 2011.Air quality monitoring, emission inventory and source apportionment study for Indian cities. National Summary Report. New Delhi.
- Sharma, Mukesh and Dikshit, Onkar. 2016. 'Comprehensive Study on Air Pollution and Green House Gases (GHGs) in Delhi (Final Report: Air Pollution component).' Indian Institute of Technology, Kanpur.
- Central Pollution Control Board. 2015. 'Air Pollution in Delhi - An Analytical Study.' ENVIS Centre, Central Pollution Control Board, New Delhi.
- Department of Environment and Forests Government of NCT of Delhi. 2010. State of Environment Report for Delhi, 2010. New Delhi.

Good Practices

- Compliance with air quality requirements are monitored.
- The city has an air action plan – the graded response action plan – that is implemented in accordance to AQI levels.
- The City Development Plan includes a section on air quality.
- IEC campaigns to encourage public transport have been conducted.
- Display boards to showcase air quality levels and AQI have been set up across the city.

Overall Scorecard Score

Overall Structure of the Clean Air Scorecard

Air Pollution and Health Index (APHI) 33.33%	+	Clean Air Management Capacity Index (CAMC) 33.33%	+	Clean Air Policies and Actions Index (CAPA) 33.33%	=	Overall Clean Air Score 100%

Clean Air Scorecard Results

Overall Clean Air Score: 47.1 | Emerging

	Final Weighted Score	Band Category
Index 1 - Air Quality and Health Index	3.33	Critical
Index 2 - Clean Air Management Capacity	25.71	Good
Index 3 - Clean Air Policies and Actions	18.00	Moderate

6.23 PATNA

Demographic	
Population	2 million
Area	
Total Land Area	99 sq. km

Monitoring Statistics	
Number of Monitoring Stations	2
Type of Monitoring Stations	Continuous and Manual Air Quality Monitoring Systems
Pollutants Monitored	PM10, SO2, NO2
Pollutant of Concern	PM10

Monitoring Stations	
Need for Monitoring Stations	7

Capacity to estimate impact of Air Pollution

1. Health Impact Studies Available :

- Guttikunda, S.K. and P. Jawahar, 2014. 'Characterizing Patna's Ambient Air Quality and Assessing Opportunities for Policy Intervention.' UrbanEmissions.Info (Ed.), New Delhi, India.
- Guttikunda, Sarath and Jawahar, Puja. 2011. 'Urban Air Pollution Analysis in India. Pune (Mahrashtra), Chennai (Tamil Nadu), Indore (Madhya Pradesh), Ahmedabad (Gujarat), Surat (Gujarat), Rajkot (Gujarat)'. Urbanemissions.info. New Delhi, India.

2. Cost benefits of mitigating air pollution assessed: None

3. Studies that monitor/assess extent of air pollution:

- Ministry of Environment, Forests and Climate Change, Government of India. 2015. Status of Pollution Generated from Road Transport in Six Mega Cities. GOI

Good Practices

- Compliance with air quality requirements are monitored.

Overall Scorecard Score

Overall Structure of the Clean Air Scorecard

Air Pollution and Health Index (APHI) 33.33%	+	Clean Air Management Capacity Index (CAMC) 33.33%	+	Clean Air Policies and Actions Index (CAPA) 33.33%	=	Overall Clean Air Score 100%

Clean Air Scorecard Results

Overall Clean Air Score: 40.3 | Emerging

	Final Weighted Score	Band Category
Index 1 - Air Quality and Health Index	3.33	Critical
Index 2 - Clean Air Management Capacity	20.30	Good
Index 3 - Clean Air Policies and Actions	16.63	Moderate

6.24 PUNE

Demographic	
Population	3 million
Area	
Total Land Area	244 sq. km

Monitoring Statistics	
Number of Monitoring Stations	14
Type of Monitoring Stations	Continuous and Manual Air Quality Monitoring Systems
Pollutants Monitored	PM 2.5, PM10, SO2, NO2, O3, CO
Pollutant of Concern	PM10

Monitoring Stations	
Need for Monitoring Stations	8

Capacity to estimate impact of Air Pollution

1. Health Impact Studies Available : None
2. Cost benefits of mitigating air pollution assessed: None
3. Studies that monitor/assess extent of air pollution:

- Central Pollution Control Board. 2011.Air quality monitoring, emission inventory and source apportionment study for Indian cities. National Summary Report. New Delhi.

Good Practices

- Compliance with air quality requirements are monitored.
- Display boards to showcase air quality levels and AQI have been set up across the city.
- Bike sharing program has been launched in the city.

Overall Scorecard Score

Overall Structure of the Clean Air Scorecard

Air Pollution and Health Index (APHI) 33.33%	+	Clean Air Management Capacity Index (CAMC) 33.33%	+	Clean Air Policies and Actions Index (CAPA) 33.33%	=	Overall Clean Air Score 100%

Clean Air Scorecard Results

Overall Clean Air Score: 43.9 | Emerging

	Final Weighted Score	Band Category
Index 1 - Air Quality and Health Index	6.00	Very Poor
Index 2 - Clean Air Management Capacity	21.09	Good
Index 3 - Clean Air Policies and Actions	16.85	Moderate

6.25 RAIPUR

Demographic	
Population	1 million
Area	
Total Land Area	143 sq. km

Monitoring Statistics	
Number of Monitoring Stations	3
Type of Monitoring Stations	Manual Air Quality Monitoring Systems
Pollutants Monitored	PM 2.5,PM10, SO2, NO2
Pollutant of Concern	PM10

Monitoring Stations	
Need for Monitoring Stations	6

Capacity to estimate impact of Air Pollution

1. Health Impact Studies Available :

- Deshmukh, Dhananjay.K; Deb, Manas K, and Mkoma, Stelyus, Mkoma L. 2013. 'Size distribution and seasonal variation of sizesegregated particulate matter in the ambient air of Raipur city, India.' Air Quality, Atmosphere & Health. Volume 6, Issue 1, 259-276.

2. Cost benefits of mitigating air pollution assessed: None

3. Studies that monitor/assess extent of air pollution:

- Dubey, Neha and Pervez, Shamsh. 2008. 'Investigation of Variation in Ambient PM10 Levels within an Urban-Industrial Environment.' Aerosol and Air Quality Research, Vol. 8, No. 1, pp. 54-64.

Good Practices

- Compliance with air quality requirements are monitored.

Overall Scorecard Score

Overall Structure of the Clean Air Scorecard

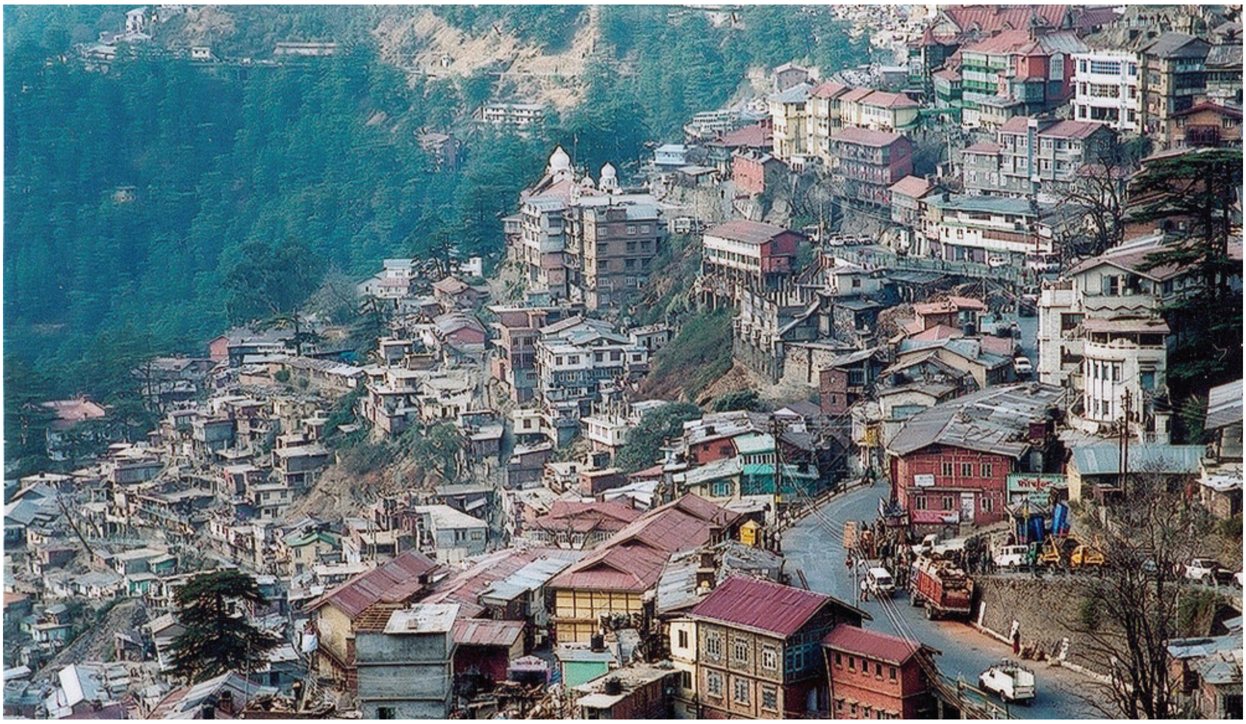
Air Pollution and Health Index (APHI) 33.33%	+	Clean Air Management Capacity Index (CAMC) 33.33%	+	Clean Air Policies and Actions Index (CAPA) 33.33%	=	Overall Clean Air Score 100%

Clean Air Scorecard Results

Overall Clean Air Score: 30.7 | Developing

	Final Weighted Score	Band Category
Index 1 - Air Quality and Health Index	3.33	Critical
Index 2 - Clean Air Management Capacity	9.62	Limited
Index 3 - Clean Air Policies and Actions	17.71	Moderate

6.26 SHIMLA



Demographic	
Population	0.16 million
Area	
Total Land Area	35 sq. km

Monitoring Statistics	
Number of Monitoring Stations	2
Type of Monitoring Stations	Manual Air Quality Monitoring Systems
Pollutants Monitored	PM10, SO2, NO2
Pollutant of Concern	PM10

Monitoring Stations	
Need for Monitoring Stations	2

- **Capacity to estimate impact of Air Pollution**

1.Health Impact Studies Available :

- Vaidya, P; Kashyan, S; Sharma, A; Gupta, D and Mohapatra, PR. 2007. 'Respiratory symptoms and pulmonary function tests in school teachers of Shimla.'Lung India. Volume 24, 6-10.
- Dholakia, Hem H.; Bhadra, Dhiman and Garg, Amit. 2014. 'Short term association between ambient air pollution and mortality and modification by temperature in five Indian cities.' Atmospheric Environment. Volume 99, 168 – 174.

2. Cost benefits of mitigating air pollution assessed: None

3. Studies that monitor/assess extent of air pollution:

- Ganguly, Rajiv and Thapa, Shabnam. 2016. 'An assessment of ambient air quality in Shimla city.' Current Science, Volume. 111, No. 3, 509-516.
- International Council for Local Environmental Initiatives. 2014. Greenhouse Gas Emissions Inventory for Shimla City.

New Delhi.

Good Practices

- Compliance with air quality requirements are monitored.

Overall Scorecard Score

Overall Structure of the Clean Air Scorecard

Air Pollution and Health Index (APHI) 33.33%	+	Clean Air Management Capacity Index (CAMC) 33.33%	+	Clean Air Policies and Actions Index (CAPA) 33.33%	=	Overall Clean Air Score 100%

Clean Air Scorecard Results

Overall Clean Air Score: 48.5 | Emerging

	Final Weighted Score	Band Category
Index 1 - Air Quality and Health Index	18.42	Moderate
Index 2 - Clean Air Management Capacity	13.18	Limited
Index 3 - Clean Air Policies and Actions	16.89	Moderate

6.27 SOLAPUR

Demographic	
Population	1 million
Area	
Total Land Area	179 sq. km

Monitoring Statistics	
Number of Monitoring Stations	3
Type of Monitoring Stations	Continuous and Manual Emissions Monitoring Systems
Pollutants Monitored	PM10, SO2, NO2
Pollutant of Concern	PM10

Monitoring Stations	
Need for Monitoring Stations	4

Capacity to estimate impact of Air Pollution

1. Health Impact Studies Available :

- Maji, Kamal Jyoti; Dikshit, Anil Kumar and Despande, Ashok. 2016. 'Human health risk assessment due to air pollution in 10 urban cities in Maharashtra, India.' Cogent Environmental Science. Volume 2, 1-16.
- Hiremath, R; Kattumuri, R; Kumar, B and Hiremath, G. 2014. 'Health and safety aspects of textile workers from Solapur (India) textile industries.' Indian Journal of Community Health. Volume 26, Issue 4, 364-369.

2. Cost benefits of mitigating air pollution assessed: None

3. Studies that monitor/assess extent of air pollution:

- Ministry of Environment, Forests and Climate Change, Government of India. 2015. Status of Pollution Generated from Road Transport in Six Mega Cities. GOI

Good Practices

- Compliance with air quality requirements are monitored.

Overall Scorecard Score

Overall Structure of the Clean Air Scorecard

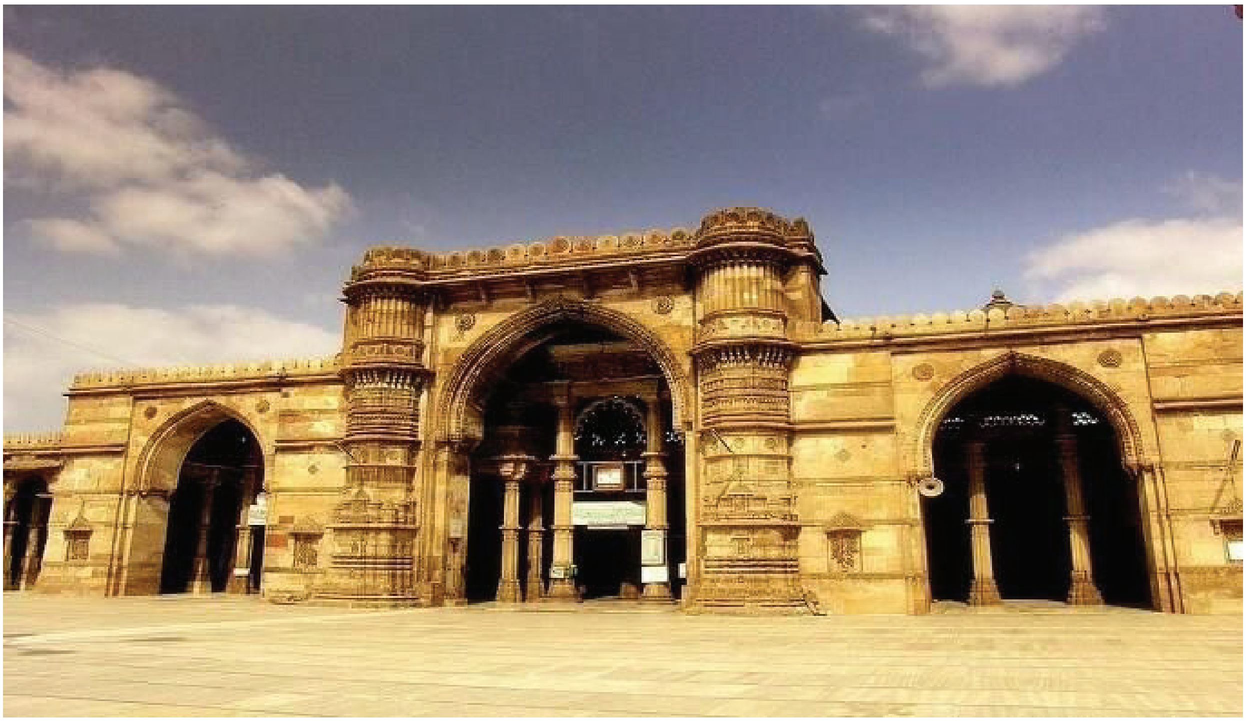
Air Pollution and Health Index (APHI) 33.33%	Clean Air Management Capacity Index (CAMC) 33.33%	Clean Air Policies and Actions Index (CAPA) 33.33%	Overall Clean Air Score 100%

Clean Air Scorecard Results

Overall Clean Air Score: 41.1 | Emerging

	Final Weighted Score	Band Category
Index 1 - Air Quality and Health Index	12.38	Poor
Index 2 - Clean Air Management Capacity	11.95L	imited
Index 3 - Clean Air Policies and Actions	16.79	Moderate

6.28 SURAT



Demographic	
Population	4 million
Area	
Total Land Area	334 sq. km

Monitoring Statistics	
Number of Monitoring Stations	10
Type of Monitoring Stations	Manual Air Quality Monitoring Systems
Pollutants Monitored	PM 2.5, PM10, SO2, NO2, O3, CO
Pollutant of Concern	PM10

Monitoring Stations	
Need for Monitoring Stations	11

Capacity to estimate impact of Air Pollution

1. Health Impact Studies Available :

- Guttikunda, Sarath and Jawahar, Puja. 2011. 'Urban Air Pollution Analysis in India. Pune (Mahrashtra), Chennai (Tamil Nadu), Indore (Madhya Pradesh), Ahmedabad (Gujarat), Surat (Gujarat), Rajkot (Gujarat)'. Urbanemissions.info. New Delhi, India.
- Hiremath, R; Kattumuri, R; Kumar, B and Hiremath, G. 2014. 'Health and safety aspects of textile workers from Solapur (India) textile industries.' Indian Journal of Community Health. Volume 26, Issue 4, 364-369.

2. Cost benefits of mitigating air pollution assessed: None

3. Studies that monitor/assess extent of air pollution:

- Ministry of Environment, Forests and Climate Change, Government of India. 2015. Status of Pollution Generated from Road Transport in Six Mega Cities. GOI

Good Practices

- Compliance with air quality requirements are monitored.

Overall Scorecard Score

Overall Structure of the Clean Air Scorecard

Air Pollution and Health Index (APHI) 33.33%	+	Clean Air Management Capacity Index (CAMC) 33.33%	+	Clean Air Policies and Actions Index (CAPA) 33.33%	=	Overall Clean Air Score 100%

Clean Air Scorecard Results

Overall Clean Air Score: 39.9 | Developing

	Final Weighted Score	Band Category
Index 1 - Air Quality and Health Index	7.33	Poor
Index 2 - Clean Air Management Capacity	13.95	Moderate
Index 3 - Clean Air Policies and Actions	18.64	Moderate

6.29 UDAIPUR

Demographic	
Population	0.45 million
Area	
Total Land Area	57 sq. km

Monitoring Statistics	
Number of Monitoring Stations	3
Type of Monitoring Stations	Manual Air Quality Monitoring Systems
Pollutants Monitored	PM10, SO2, NO2
Pollutant of Concern	PM10

Monitoring Stations	
Need for Monitoring Stations	3

Capacity to estimate impact of Air Pollution

1. Health Impact Studies Available :

- Rumana et al., 2014. 'A retrospective approach to assess human health risks associated with growing air pollution in urbanized area of Thar Desert, western Rajasthan, India.' Journal of Environmental Health Science and Engineering. Volume 12, Issue 23, 1-9.

2. Cost benefits of mitigating air pollution assessed: None

3. Studies that monitor/assess extent of air pollution:

- Kapoor, Chandra Shekhar; Kapasya, Vidhya; BR, Bamniya and Kapoor, K. 2009. 'Studies on the quality of ambient air in the Udaipur city (Rajasthan).'Current Journal of Current
- Neelima, Nair; B.R, Bamniya; G.S., Mahecha and Dhavan, Saini. 2014. 'Analysis of Ambient Air Pollution and Determination of Air Quality Status of Udaipur, Rajasthan, India.' International Research Journal of Environment Sciences. Volume 3, Issue 6, 5-10.
- Kapoor, C.S.; Bamniyal, B.R.; Jain, Smita and Kapoor, K. 2013. "Status and Monitoring of Ambient Air Quality of 'City of Lakes' Udaipur, (Raj.) India Ambient Air Quality of Udaipur City." Research in Health and Nutrition (RHN). Volume 1, Issue 1, 1-6.

Good Practices

- State sponsored mobile application called RajVayu that shows AQI for the city.
- Compliance with air quality requirements are monitored.
- City Development Plan includes section on air pollution prevention.

Overall Scorecard Score

Overall Structure of the Clean Air Scorecard

Air Pollution and Health Index (APHI) 33.33%	Clean Air Management Capacity Index (CAMC) 33.33%	Clean Air Policies and Actions Index (CAPA) 33.33%	Overall Clean Air Score 100%

Clean Air Scorecard Results

Overall Clean Air Score: 32.5 | Developing

	Final Weighted Score	Band Category
Index 1 - Air Quality and Health Index	3.33	Critical
Index 2 - Clean Air Management Capacity	12.36	Limited
Index 3 - Clean Air Policies and Actions	16.81	Moderate

\+ + =

6.30 VARANASI

Demographic	
Population	1 million
Area	
Total Land Area	82 sq. km

Monitoring Statistics	
Number of Monitoring Stations	5
Type of Monitoring Stations	Continuous and Manual Air Quality Monitoring Systems
Pollutants Monitored	PM10, SO2, NO2
Pollutant of Concern	PM10

Monitoring Stations	
Need for Monitoring Stations	6

Capacity to estimate impact of Air Pollution

1. Health Impact Studies Available :

- Madineni, Aishwarya. 2016. Varanasi Chokes! Particulate Matter Trends and Increasing Respiratory Ailments. IndiaSpend, CEED and Care4Air.

2. Cost benefits of mitigating air pollution assessed: None

3. Studies that monitor/assess extent of air pollution: None

Good Practices

- Compliance with air quality requirements are monitored.
- City Development Plan includes section on air pollution prevention.
- Varanasi city is included in a district environment action plan of Mirzapur.

Overall Scorecard Score

Overall Structure of the Clean Air Scorecard

Air Pollution and Health Index (APHI) 33.33%	+	Clean Air Management Capacity Index (CAMC) 33.33%	+	Clean Air Policies and Actions Index (CAPA) 33.33%	=	Overall Clean Air Score 100%

Clean Air Scorecard Results

Overall Clean Air Score: 30.9 | Developing

	Final Weighted Score	Band Category
Index 1 - Air Quality and Health Index	3.33	Critical
Index 2 - Clean Air Management Capacity	10.67	Limited
Index 3 - Clean Air Policies and Actions	16.94	Moderate

6.31 VIZAG (VISAKHAPATNAM)

Demographic	
Population	2 million
Area	
Total Land Area	544 sq. km

Monitoring Statistics	
Number of Monitoring Stations	10
Type of Monitoring Stations	Continuous and Manual Air Quality Monitoring Systems
Pollutants Monitored	PM 2.5, PM10, SO2, NO2, O3, CO
Pollutant of Concern	PM10

Monitoring Stations	
Need for Monitoring Stations	7

Capacity to estimate impact of Air Pollution

1. Health Impact Studies Available : None

2. Cost benefits of mitigating air pollution assessed: None

3. Studies that monitor/assess extent of air pollution:

- Kumar, Anil Boni; Sagar, Vinay B and Kumar, B. Prasana. 2015. 'Assessment of Air quality index of Visakhapatnam urban area Andhra Pradesh.' International Journal of Innovative Research and Creative Technology. Volume 1, Issue 4, 434-436.
- Guttikunda,Sarath K.;Goel, Rahul; Mohan, Dinesh; Tiwari, Geetam and Gadepalli, Ravi. 2014. 'Particulate and gaseous emissions in two coastal cities—Chennai and Vishakhapatnam, India.' Air QualAtmos Health. Volume 11.

- Krishna, Rama TVBPS; Reddy, MK; Reddy, RC; Singh, RN and Devotta, S. 2006. 'Modelling of Ambient Air Quality Over Visakhapatnam Bowl Area.' Proc Indian NatnSciAcad, Volume 72, No.1, 55-61.
- Kulkarni, K.S;Sahu, S.K.; Vaikunta, Rao L;Pandit, G.G. and Das, N. Lakshmana. 2014. 'Characterization and Source identification of Atmospheric Polycyclic Aromatic Hydrocarbons in Visakhapatnam, India.' International Research Journal of Environment Sciences. Vol. 3, Issue 11, 57-64.

Good Practices

- Compliance with air quality requirements are monitored.
- City Development Plan includes section on air pollution prevention.
- Has an air action plan for critically polluted parts of the city.

Overall Scorecard Score

Overall Structure of the Clean Air Scorecard

Air Pollution and Health Index (APHI) 33.33%	+	**Clean Air Management Capacity Index (CAMC) 33.33%**	+	**Clean Air Policies and Actions Index (CAPA) 33.33%**	=	**Overall Clean Air Score 100%**

Clean Air Scorecard Results

Overall Clean Air Score: 36.8 | Developing

	Final Weighted Score	Band Category
Index 1 - Air Quality and Health Index	3.33	Critical
Index 2 - Clean Air Management Capacity	14.80	Moderate
Index 3 - Clean Air Policies and Actions	18.71	Moderate

7

Challenges, Limitations and Learnings

Any exercise that involves the collection of primary and secondary data over an extended period of time is not without limitations. This report as mentioned earlier is built on information not only obtained through meticulous desk research but also through discussions with key officials, stakeholders and pollution control board officials. However, this report is based on data collected up to the period of June 2017 and therefore is limited by the fact that it does not reflect data that has been made available after that. It may therefore not show the present picture. But in the absence of any other compilation of this sort that gives an overview of air pollution management capacity of cities, this report gives an overall profile of Indian cities in the context of their air quality management capacity defined by international standards.

The Clean Air Scorecard tool assesses air quality management of a city based on three indices, the first of which is the Air Pollution and Health Index which talks both about the air quality monitoring system in the city and information on health-related data. Within this index, therefore, the monitoring framework, prevalence of health studies and the health framework is considered. If we put this in the context of something like the Air Quality Index, this is a very relevant and apt way of communicating AQ data. The second index is on Air quality management capacity which includes cross-sectoral information that impacts city's air pollution levels such as transport related information, information on industry regulations and other information that can be linked to the source/capacity/extent of air pollution. The third index is on AQ policies prevalent in the city and gives an indication of how much national policy has percolated to the city level. During our assessment, we did feel the need that we could have assessed the health index separately from the AQ monitoring and where there is adequate data available on health unlike in the case of the Indian cities it could lead to a more detailed analysis of information. However, since health data related to air pollution in India is a huge gap it was easier to club it with AQ monitoring data. Also, the clean air scorecard tool in its present version clubs air quality monitoring with health merely because there is a need to humanize data if we want it to reach the masses.

Selection of cities for this assessment was based on criteria like the Central Pollution Control Board's listing of non-attainment cities. It may be mentioned here that the same criteria have been used by the Ministry of Environment, Forest and Climate Change to identify and direct cities to prepare air action plans following the announcement of the National Clean Air Action Programme in April 2018. Standard criteria like high population density, the presence of air action plan, city development plan etc. were used to shortlist cities as well as not so standard criteria like smart city status and a regional variation to ensure cities from different geographical regions and meteorological conditions were accounted for.

In addition, it includes institutional arrangements for conducting health impact assessments and developed the capacity for conducting such assessments.

As with health impact assessment, there are criteria defined within the Clean Air Scorecard tool for the other indices- like AQ management capacity and AQ policy interventions, which define the rating of a city as underdeveloped, emerging, maturing or fully developed. In the present study, from among the 30 cities, none can be considered in the fully developed category.

For most countries where cities are considered to have good air action plans, these are aligned with other national development/economic plans (e.g. energy, transportation, climate, health, etc.) The plans also provide guidance on institutional coordination among relevant ministries/ departments to achieve air quality goals, safeguarding public health and the environment. In addition, the plans are science-based and stakeholder inclusive with instruments and strategies to comply with air quality and emission standards. There are also specific directives for adoption and implementation of control measures and continuous improvement after compliance. For a clean air action plan in a city that is considered in the fully developed category, the plan needs to be regularly improvised upon with tightening air quality improvement targets, linking with socio-economic plans and Climate Change Mitigation. It requires to specify a clear framework for implementation and enforcement and support public participation. In addition, there needs to be secured financial support for the development of the plan as well as an ensured budget for implementation. For continued engagement it requires a regular evaluation of technical feasibility and implementation strategies and systematic reporting of implementation results. In comparison a city like New Delhi which is in the maturing category according to the Clean Air Scorecard tool, will be in a position of defining the scope of the Clean Air Action Plan, reviewing the state of air quality and emission sources in the area, assessing actual and/or potential health and environmental impacts, preparing the list of control options, evaluating control options for efficacy, defining monitoring and evaluation mechanism, adopting the plan and integrating into other sector plans and issuing regular early warning system and emergency response plan as is being done during the emergency situations like the winter smog.

It may be mentioned here that the study does have its limitations as does any study that is conducted over a long period of time. From the period of collection of data to the period of publishing, there has been a long gap and there may be a shift in the trends for data collection as well as methodologies used for studies. Under such circumstances, one cannot delay air quality action by waiting for results from such studies. Also. an important area in the context of India will be education and awareness and this needs to be considered while taking into consideration air quality action. While a numeric score is often good for rating or getting a bird's eye view of a problem, a qualitative assessment may be required when individually working with each of these cities.

Clean Air Asia's strategy is to use these city assessments as a base paper for initiating air quality action. However, it may be mentioned here that the study in itself is not enough to compare or provide for corrective action. The Clean Air Asia strategy is to take the results of this study to cities and create a basis for discussion of policy action.

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8

Way Forward

This assessment has been a means to understand the status of Air Quality Management across cities in India. This is an important step in developing a roadmap for future steps to improve the air quality in Indian cities. Without a doubt, there are measures in place and additional steps are being taken at the city level to work towards improving air quality management. The intent, however, is to systematically work towards the long-term vision on Air Quality Management as outlined in the Guidance Framework for Better Air Quality in Asian Cities. The Guidance Framework is a voluntary and non-binding guidance document developed as an outcome of the biennial Governmental Meetings on Urban Air Quality in Asia, co-organized by Clean Air Asia and United Nations Environment Programme Regional Office for the Asia Pacific. It is an outcome of an extensive development process, which began in 2006 when the Long-Term Vision for Urban Air Quality in Asia was envisioned by representatives of environment ministries in the region. The long-term vision is "Healthy people in healthy cities, which puts emphasis on the prevention of air pollution, and which implements effective strategies for the abatement of air pollution (Clean Air Asia 2016)." The long-term vision describes the desired state of urban air quality in Asian cities by 2030; the Guidance Framework serves as a guide for cities and counties to achieve this vision. In 2016, the Guidance Framework was launched as a pioneering approach to resolve air pollution challenges at the local- and national levels. Centered on identified priority areas of concern in air quality management in the region, the Guidance Framework provides cities and countries with development capacity indicators and recommended steps and actions to improve air quality (ibid). Thus, there is a need to systematically work on air quality to achieve this end in Indian cities. Since the current state of AQM varies widely in Asian cities, the Fourth Governmental Meeting identified priority areas for concern for Asia, which were then translated into six guidance areas, which are given in figure 50. The intent is that sustained AQM is the result of an all-around approach that ties in policy, outreach, city level implementation and engagement across different sectors. Without doubt, the government in India in the recent past is taking an active role in improving the AQM of Indian cities, which can be seen in the increased number of plans, recommendations and initiatives being undertaken; to name three there is the NitiAayog's 'Three Year Action Agenda' (2017-19), which has a clearly defined section on abating urban air pollution.

Overall Clean Air Score		
Category	**Score Band**	**Description**
Fully Developed	81-100	Key components of clean air management complete. Strong mandate for air pollution and GHG management and strong sector-based and integrated policies, regulations and institutions to address major sources of pollution (e.g., transport, industry, energy and area sources). Policies and actions contribute to achieving levels equivalent to prescribed WHO guidelines and interim targets for air pollution.
Maturing	61-80	Key components of clean air management complete and some integration with other major sectors (e.g., transport, health and energy sectors). Policies and actions have achieved some success in reducing AP/GHG emissions but air quality levels still exceed healthy levels prescribed by the WHO. Management efforts in all sector sources need to be intensified to bring emissions further.
Emerging	41-60	Majority of key components of clean air management in place. Policies and actions to reduce emissions from identified major sources need to be enhanced. Sector-based institutions need to upgrade technical and management capacity.
Developing	21-40	GHG and AP emissions are increasing and air quality declining. Clean air management activities are scattered in different organizations with limited collaboration. Need to invest in strengthening components of basic air quality management and collaboration between stakeholders.
Underdeveloped	1-20	Ad hoc clean air management; lack in emissions and ambient air quality standards; Needs to build capacity for basic air quality and GHG emissions management.

Figure 50: Six Guidance Areas in the Guidance Framework

Secondly, the central government's 12-point draft action plan to combat air pollution. A team appointed by the Prime Minister's office drafted and launched this plan in December 2017. Lastly, the Comprehensive Action Plan: for Air Pollution Control in Delhi &NCR. This plan is a comprehensive policy document to reduce air pollution in the Delhi NCR area. It clearly defines short, medium and long-term measures. The Supreme Court has stated that such a plan must not only be made for a city like Delhi, but other Indian cities must get similar plans as the problem of air pollution is not a Delhi only phenomenon. In order to see the positive effects of these initiatives, it is important to systematically work at the city level towards an all-round development of AQM. The six areas of the guidance framework provide an authoritative roadmap to achieve this end. Undoubtedly, the initiatives being taken at the national and city level are well-intentioned steps to ensure 'liveable cities' in India and the need of the hour is for relevant stakeholders to come together to aid cities in their efforts towards this goal. This assessment report has been an endeavour to identify strengths and gaps at the city level for Air Quality Management so that support and technical assistance can be provided to enhance the steps being taken to develop Indian cities without comprising the state of air and hence life quality in them.

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Organisation for Economic Co-operation and Development. 2001. Glossary of statistical terms – emissions inventory. Retrieved from https://stats.oecd.org/glossary/detail.asp?ID=762

Stockholm Environment Institute. 2008. Emission. In Haq, G. &Schwela, D. (Eds.) Foundation course on air quality management in Asia. Retrieved from http://www.sei.se/Clean Air/modules.html

World Health Organization. 2016. WHO's Urban Ambient Air Pollution database - Update 2016. http://www.who.int/phe/health_topics/outdoorair/databases/AAP_database_summary_results_2016_v02.pdf. Accessed on November 5th, 2017.

APPENDIX 2

रजिस्ट्री सं॰ डी॰ एल॰-33004/99 REGD. NO. D. L.-33004/99

भारत का राजपत्र
The Gazette of India

असाधारण
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PART III—Section 4
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PUBLISHED BY AUTHORITY

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राष्ट्रीय परिवेशी वायु गुणवत्ता मानक

केन्द्रीय प्रदूषण नियंत्रण बोर्ड

अधिसूचना

नई दिल्ली, 18 नवम्बर, 2009

सं. बी-29016/20/90/पी.सी.आई.-I.—वायु (प्रदूषण निवारण एवं नियंत्रण) अधिनियम, 1981 (1981 का 14) की धारा 16 की उपधारा (2) (एच) द्वारा प्रदत्त शक्तियों का प्रयोग करते हुए तथा अधिसूचना संख्या का.आ. 384(ई), दिनांक 11 अप्रैल, 1994 और का.आ. 935 (ई) दिनांक 14 अक्टूबर, 1998 के अधिक्रमण में केन्द्रीय प्रदूषण नियंत्रण बोर्ड इसके द्वारा तत्काल प्रभाव से राष्ट्रीय परिवेशी वायु गुणवत्ता मानक अधिसूचित करता है, जो इस प्रकार है-

राष्ट्रीय परिवेशी वायु गुणवत्ता मानक

क्र. सं.	प्रदूषक	समय आधारित औसत	परिवेशी वायु में सान्द्रण		
			औद्योगिक, रिहायशी, ग्रामीण और अन्य क्षेत्र	पारिस्थितिकीय संवेदनशील क्षेत्र (केन्द्र सरकार द्वारा अधिसूचित)	प्रबोधन की पद्धति
(1)	(2)	(3)	(4)	(5)	(6)
1	सल्फर डाई आक्साइड (SO_2), µg/m³	वार्षिक* 24 घंटे**	50 80	20 80	-उन्नत वैस्ट और गाईक -पराबैंगनी परिदीप्ती
2	नाइट्रोजन डाई आक्साइड (NO_2), µg/m³	वार्षिक* 24 घंटे**	40 80	30 80	-उपांतरित जैकब और हॉचाइजर (सोडियम-आर्सेनाईट) -रासायनिक संदीप्ति
3	विविक्त पदार्थ (10माइक्रान से कम आकार)या PM_{10}, µg/m³	वार्षिक* 24 घंटे**	60 100	60 100	-हरात्मक विश्लेषण -टेयम -बीटा तनुकरण पद्धति

4187 GI/2009 (1)

4	विविक्त पदार्थ (2.5 माइक्रान से कम आकार या $PM_{2.5}$, $\mu g/m^3$	वार्षिक* 24 घंटे**	40 60	40 60	-हरात्मक विश्लेषण -टोयम -बीटा तनुकरण पद्धति
5	ओजोन (O_3) $\mu g/m^3$	8 घंटे** 1 घंटा**	100 180	100 180	-पराबैंगनी द्वीप्तिकाल -रासायनिक संदीप्ति -रासायनिक पद्धति
6	सीसा (Pb) $\mu g/m^3$	वार्षिक* 24 घंटे**	0.50 1.0	0.50 1.0	ई.पी.एम 2000 या समरूप फिल्टर पेपर का प्रयोग करके AAS/ICP पद्धति -टेफलॉन फिल्टर पेपर का प्रयोग करते हुए ED-XRF
7	कार्बन मोनोक्साइड (CO) mg/m^3	8 घंटे** 1 घंटा**	02 04	02 04	-अविपेक्षी अवरक्त (NDIR) स्पैक्ट्रम मापन
8	अमोनिया (NH_3) $\mu g/m^3$	वार्षिक* 24 घंटे**	100 400	100 400	-रासायनिक संद्वीप्ती -इण्डोफिनॉल ब्ल्यू पद्धति
9	बैन्जीन (C_6H_6) $\mu g/m^3$	वार्षिक*	05	05	- गैस क्रोमेटोग्राफी आधारित सतत् विश्लेषक -अधिशोषण तथा निशोषण के बाद गैस क्रोमेटोग्राफी
10	बैन्जो (ए) पाईरीन (BaP) केवल विविक्त कण, ng/m^3	वार्षिक*	01	01	-विलायक निष्कर्षण के बाद HPLC/GC द्वारा विश्लेषण
11	आर्सेनिक (As) ng/m^3	वार्षिक*	06	06	-असंवितरक अवरक्त स्पैक्ट्रामिती ई.पी.एम. 2000 या समरूप फिल्टर पेपर का प्रयोग करके ICP/AAS पद्धति
12	निकिल (Ni) ng/m^3	वार्षिक*	20	20	ई.पी.एम. 2000 या समरूप फिल्टर पेपर का प्रयोग करके ICP/AAS पद्धति

* वर्ष में एक समान अंतरालों पर सप्ताह में दो बार प्रति 24 घंटे तक किसी एक स्थान विशेष पर लिये गये न्यूनतम 104 मापों का वार्षिक अंकगणीतीय औसत ।

** वर्ष में 98 प्रतिशत समय पर 24 घंटे या 8 घंटे या 1 घंटा के मानीटर मापमान, जो लागू हो , अनुपालन कये जाएंगे । दो प्रतिशत समय पर यह मापमान अधिक हो सकता है, किन्तु क्रमिक दो मानीटर करने के दिनों पर नहीं ।

टिप्पणीः

1. जब कभी और जहां भी किसी अपने-अपने प्रवर्ग के लिये दो क्रमिक प्रबोधन दिनों पर मापित मूल्य, ऊपर विनिर्दिष्ट सीमा से अधिक हो तो इसे नियमित या निरंतर प्रबोधन तथा अतिरिक्त अन्वेषण करवाने के लिये पर्याप्त कारण समझा जायेगा ।

संत प्रसाद गौतम, अध्यक्ष

[विज्ञापन-III/4/184/09/असा.]

टिप्पणीः राष्ट्रीय परिवेशी वायु गुणवत्ता मानक संबंधी अधिसूचनाएँ, केन्द्रीय प्रदूषण नियंत्रण बोर्ड द्वारा भारत के राजपत्र आसाधरण में अधिसूचना संख्या का.आ. 384 (ई), दिनांक 11 अप्रैल, 1994 एवं का. आ. 935 (ई), दिनांक 14 अक्टूबर, 1998 द्वारा प्रकाशित की गयी थी ।

LIST OF FIGURES