# Pune
# Air Information and Response (AIR) Plan

October 2020



NRDC

CEE
Centre for Environment Education

phfi
INDIAN INSTITUTE OF PUBLIC HEALTH GANDHINAGAR

SAFAR

# Table of Contents

# Introduction

Air pollution is a major public health challenge around the world. Outdoor air pollution is a growing health threat in developing countries, such as India.[1] Pune is one of the largest and fastest growing cities in India, with a population of nearly seven million.[2] Pune has ranked among the most polluted cities in the world, and pollutant levels regularly exceed both Indian and World Health Organization (WHO) guidelines.[3] With the COVID-19 pandemic, the urgency to protect communities from air pollution is even greater.[4]

To protect local communities from rising air pollution, the Pune Municipal Corporation (PMC) and partners uses two interlinked tools: an air quality index (AQI) and the Air Information and Response (AIR) Plan. The AQI and AIR plan are connected to the Pune Clean Air Plan (CAP), as part of the National Clean Air Plan (NCAP).

The Pune AIR Plan is a health-based program designed to protect residents and increase awareness on the impacts of air pollution. The AQI and AIR Plan focus on health-risk communication with short and long-term actions to increase preparedness, information-sharing. and response coordination to protect vulnerable populations.

The PMC needs dedicated budgetary allocations and enhanced human resources to maximize the effectiveness of these interconnected air quality plans. AQI-based alert systems operate in major international cities, and four leading Indian cities, Ahmedabad, Delhi, Mumbai, and Pune.

# Purpose of the Pune AIR Plan

The AIR Plan aims to reduce the exposure of dangerous air pollution to vulnerable communities and support healthier and prosperous communities in Pune. The AQI and AIR Plan, along with the CAP, work to reduce air pollution.

**The Pune AIR Plan has five key strategies:**

I. **Health-Based Air Quality Risk Communication and Interagency Coordination** - to reduce health-risks by strengthening city-level interagency coordination and the air quality alert system.

II. **Set City Priorities to Improve Air Quality** - work with local experts to identify key interventions for air pollution reduction and exposure control and incorporate international best practices.

III. **Public Awareness and Community Outreach** - update the PMC website with the AQI and AIR Plan, engage the media, and develop and broadly disseminate information, education, and communication (IEC) materials.

IV. **Focus Activities on the Vulnerable** - tailor IEC materials to vulnerable groups, such as children, the elderly, and people with respiratory health problems. The School Flags Program, for example, will display colored flags that correspond to the AQI at schools.

V. **Build Capacity Among Medical Professionals** - engage with private and public medical professionals to build awareness and protection strategies against air pollution.

# Organization and Implementation of the Pune AIR Plan

As the lead agency, the PMC Environment Department is responsible for the coordination of the AQI and AIR Plan and additional staff resources will be needed as the plan matures. This includes monitoring the daily AQI and alerts, and disseminating public health messages to local departments, community service providers, and the Maharashtra Pollution Control Board (MPCB). The PMC Environment Department works with the public relations office to increase media coverage in the local language and on social media.

The AIR Plan focuses on vulnerable groups, such as people with respiratory or heart conditions, children, pregnant women, outdoor workers, and the elderly, who are most at risk from air pollution. The Plan also creates awareness among individuals and organizations, such as Urban Health Centers (UHCs) and link workers, who frequently work with at-risk populations, and can provide early diagnosis of asthma and other respiratory illnesses.

Support from individuals and community groups is essential to fight air pollution. Individuals can take steps to protect themselves, families, and communities from harmful air pollution. These steps include learning about the early signs of respiratory and cardiovascular illness, limiting outdoor activities as needed, and using masks and air filters. Media support is vital in spreading the word and increasing awareness on air pollution. Media can share news about health threats and run ads to provide local information.

# Key Stakeholders of the Pune AIR Plan

The Pune AQI is supported by technical expertise of the Ministry of Earth Sciences (MoES), Indian Institute of Tropical Meteorology, Pune (IITM) and Indian Meteorological Department's System of Air Quality and Weather Forecasting and Research (SAFAR) program, as well as the initiatives by the MPCB, the Central Pollution Control Board (CPCB), and the Ministry of Environment, Forests and Climate Change (MoEF&CC).

The Pune AIR Plan is part of a broader collaboration between the PMC and experts at the Indian Institute of Public Health, Gandhinagar (IIPH-G), Natural Resources Defense Council (NRDC), Centre for Environment Education (CEE), as well as IITM's SAFAR project.

The MPCB was also critical in the development of the plan, as were key local researchers and civil society groups. The combined efforts of government agencies, health professionals, and community leaders can serve to effectively inform the public about the health-risks from air pollution and the steps they can take to protect community and individual health.

The Pune AIR Plan is based on extensive engagement by the PMC and its partners through a series of stakeholder discussions on air pollution in Pune and India.

# Air Pollution Levels and Health Effects in Pune

Sulfur dioxide ($SO_2$), nitrogen oxides ($NO_X$), ozone ($O_3$), ammonia ($NH_3$), carbon monoxide (CO), coarser particles ($PM_{10}$), fine particles ($PM_{2.5}$), lead (Pb), arsenic, nickel, benzene and benzo-a-pyrene are all health-harming pollutants. $PM_{10}$ and $PM_{2.5}$ are the most frequently monitored in Pune and pose the biggest health concern because these particles can travel deep into the respiratory tract.

Over the past five years, air quality in Pune remains below the national standards. The average annual concentration of $PM_{2.5}$ increased by about 60% over the past twenty years, jumping from 29 µg/m$^3$ in 2013 to 47 µg/m$^3$ in 2018 (Figure 1), now exceeding the country's national ambient air quality standard of 40 µg/m$^3$.[5] In 2018, the director of the Pune-based Chest Research Foundation commented on air quality in Pune:

"The rise in chronic lung diseases is tremendous over the last few years and the major reason is rising levels of air pollution. The deteriorating quality of air has led to rise in the number of lung diseases specifically chronic obstructive pulmonary disorder and asthma and in winter air pollution levels increase more compared to other days."[6]

Analysis of air quality trends in Pune shows that the annual levels of $PM_{2.5}$ air pollution consistently exceed both the Indian standards and corresponding WHO guidelines.

**Figure 1: Satellite-derived annual surface PM$_{2.5}$ concentrations for Pune from 1998-2014**.[7]
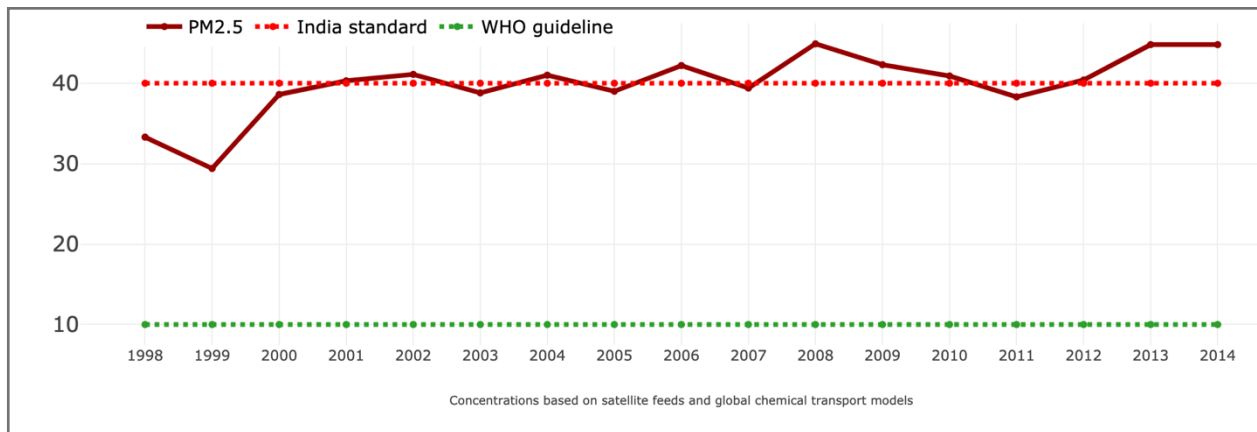


There are 19 monitoring stations in Pune, both manual and continuous ambient air quality monitoring stations (CAAQMS), operated by two separate systems. The manual stations include two MPCB stations, three CPCB stations, and three PMC locations. The CAAQMS include one MPCB station in operation and ten SAFAR stations in operation.

The eight manual station locations are PMC - Navipeth, Mandai, Hadapsar; MPCB (operated by Pune University) - Nalstop, Swargate, Bhosari, Pimpri Chinchwad; and IITM - Bhumkar Chowk.

The 11 CAAQMS locations are MPCB - Kothrud; and IITM-SAFAR - Pashan (IITM), Shivajinagar (India Meteorological Department (IMD)), Pune Airport (air force base), Alandi, Katraj, Hadapsar, Bhosari, Nigdi, and Manjri Kothrud.

The CPCB and MPCB operate a system of monitoring stations, and IITM through SAFAR performs separate monitoring (Figure 2). The MPCB station is operated in partnership with the CPCB, and in this system there is one CAAQMS station located at Karve Road.[8] There are also two manual air quality monitoring stations that provide observations on $PM_{10}$, $SO_2$, and $NO_2$ twice a week.

**Figure 2: Air quality monitoring stations in Pune** (Source: IITM, 2020).
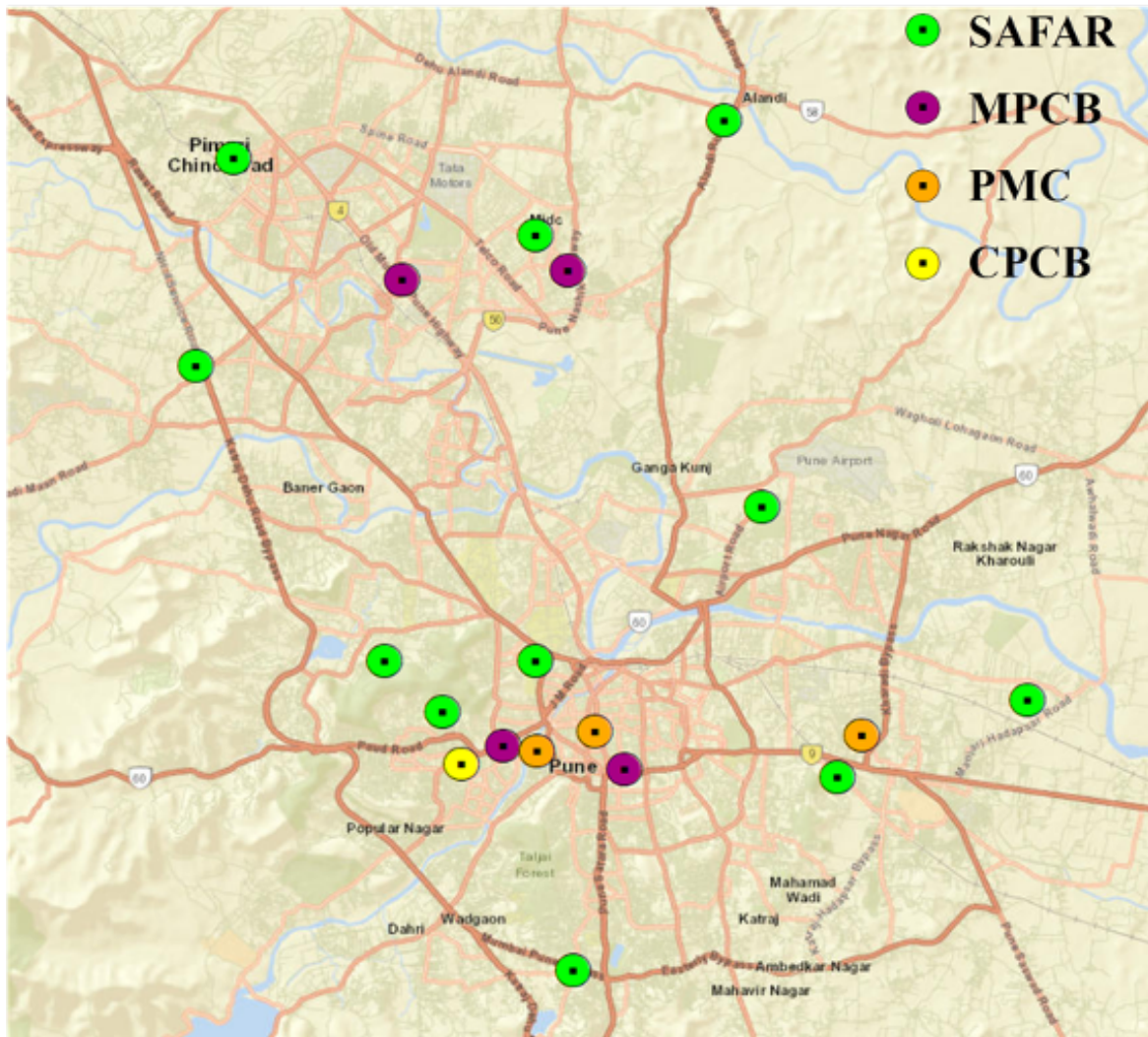


IITM and the IMD developed SAFAR in 2013. The system provides a location specific daily AQI, as well as near real-time air pollutant concentrations at a 15 minute interval, and forecasts the daily AQI up to two days in advance.[9] IITM-SAFAR was conceived as a major national initiative for greater metropolitan cities to provide local information on air quality, in collaboration with the National Centre for Medium Range Weather Forecasting.[10] IITM-SAFAR monitors are deployed in accordance with CPCB and World Meteorological Organization (WMO) standards and continuously collect data at five-minute intervals. IITM-SAFAR adopted the U.S. Environmental Protection Agency (U.S. EPA) Standard Operating Procedures for instrument calibration and maintenance and deploys state-of-the-art monitoring instruments.[11]

IITM-SAFAR monitors represent the first network in India to continuously monitor and forecast air pollution levels. The monitors sample air at a height of three meters from the ground and characterize air quality for the entire city by incorporating information from sites in industrial corridors, residential areas, urban centers, agricultural zones, and areas that represent background level concentrations. The monitors measure particulate matter ($PM_{2.5}$ and $PM_{10}$), $O_3$, nitrogen dioxide ($NO_2$), and CO. The stations also monitor key meteorological parameters (e.g. UV radiation, rainfall, temperature, humidity, wind speed, and direction).

IITM-SAFAR publishes an AQI based on the raw monitoring data, which largely corresponds to the CPCB AQI calculation methodology.[12]

## Pune Emissions Inventory - Understanding Air Pollution Sources

Many sectors, such as transportation, power generation, agriculture, and solid waste burning, contribute to air pollution. Quantifying the relative contributions of each sector is key to shape efforts to reduce emissions at the local level.[13] An emissions inventory is a comprehensive list, by source, of the amount of air pollution emitted in a particular area over a specified time period. It is representative of the long-term average conditions.

In 2020, IITM-SAFAR conducted an updated emissions inventory. The inventory is currently under review and the results should be released in late 2020.

In 2016, IITM-SAFAR updated a comprehensive emissions inventory for Pune. The inventory covered the metropolitan region for key health-damaging pollutants like $PM_{2.5}$ and $PM_{10}$, ozone precursors ($NO_X$ and volatile organic compounds (VOCs)), CO, and $SO_2$.

**Figure 3: 2015 emissions inventory for $PM_{2.5}$ in Pune** (Source: IITM-SAFAR, 2015).[14]



Biofuel 5%
Industry 17%
Other 29%
Transport 49%
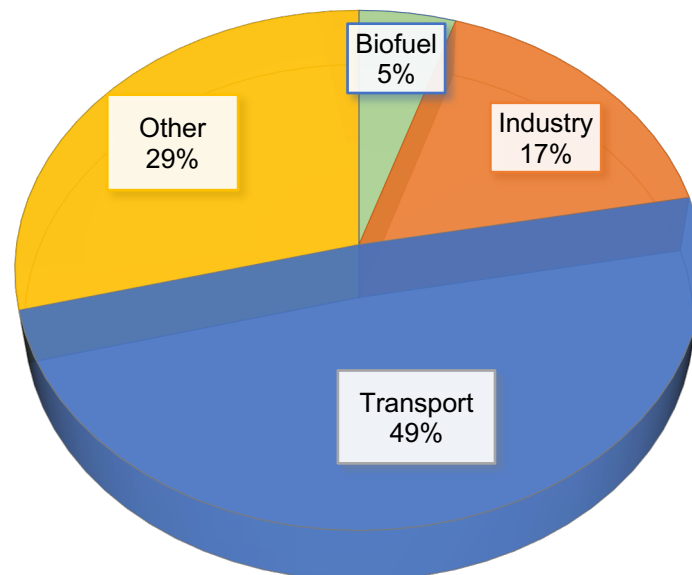
The emissions inventory collected data from direct sources through on-the-ground field surveys, and indirect sources from reviews of government and industry records. Researchers retrieved data from local authorities such as the PMC, MPCB, and individual industrial site operators.

The results from Pune's emissions inventory (Figure 3) for small particles ($PM_{2.5}$) indicate that transportation was responsible for almost half of primary emissions. Other sources included resuspended road dust (29%), industrial operations (17%), and solid fuel combustion (5%). The emissions inventory includes a sectoral breakdown for each pollutant of concern, to allow for a detailed understanding of local conditions.[15] While particulate matter (PM) remains a concern, a report highlighting the state of Pune's environment indicates a rising trend in the annual concentrations of $NO_2$ and $SO_2$.[16]

**Table 1: Sources of air pollution and related activities considered for the IITM emissions inventory** (Source: IITM-SAFAR, 2015).[17]

| Sectors | Source of pollution | Data collected for |
|---|---|---|
| **Transport** | On road vehicles | Number of vehicles, existing vehicle technology or age of vehicle, vehicle density on road, vehicle kilometers travelled (km/day), traffic composition, fuel type & quantity used, use of vehicle (hour/day or month or year) |
| | Paved and unpaved roads | Number of wet days, road surface silt loading surface material silt content, mean vehicle speed, & mean weight of vehicle on road |
| **Residential sector** | Cooking and heating | Total area – slum or other residential, number of households & slum pockets in the area, number of families and size, type of fuel used and quantity required for cooking or heating purposes, time for cooking/heating, & stove type used |
| **Commercial sector** | Cooking & heating activity in hotels, restaurants; street vendors; generators | Number of hotels & restaurants, street vendors, time for cooking / heating practices, stove type used, and type and quantity of fuel used |
| **Industrial sector** | Use of fossil fuel | Type of industry located in study area - industrial location, number of industrial zones, fuel type used & consumption (daily/monthly), details of installed emission control devices, operation type (days), & production capacity |
| **Agricultural sector** | Crop production, agricultural burning, agricultural pumps | Type of crop cultivated, area under production crop yield, type of land & mode of irrigation, use of fertilizer & pesticide, quantity of waste burned, composition of waste burned, hours of usage of pumps, number & size of pumps |
| **Waste** | Solid waste burning, solid waste disposal sites | Composition of waste, quantity of Municipal Solid Waste (MSW) generated, quantity of waste burned & mode of burning, & fraction of MSW disposed to sites |
| **Other sources** | Commercial or industrial generators | Hours of power cut off, number & capacity of generators |

# Adverse Health Impacts of Air Pollution in Pune

Pollution related health effects are well documented in Pune. One study estimated 733 excess deaths annually due to cardiovascular disease, 901 annual hospital admissions for respiratory disease due to polluted air, and 348 hospital admissions for cardiovascular disease.[18] Another study estimated that $PM_{10}$ caused 3,600 premature deaths in 2010.[19]

Evidence on the health effects of air pollution in Pune and India is limited, due to a lack of comprehensive, transparent data. Improved integration of air quality monitoring and data reporting with public health research can clarify the present-day health burden.[20]

# Links Between COVID-19 and Air Quality

COVID-19 has caused rapid and widespread damage to human health around the world. The toll has been especially heavy on nurses, doctors, and other frontline health professionals. Other populations that are particularly vulnerable to severe complications from COVID-19 include older adults, people such as asthma patients who have compromised immune systems, and people with chronic heart and lung disease. Exposure to air pollution worsens many of these pre-existing health problems, compounding the public health risks from the pandemic.[21]

Preliminary research in the U.S. indicates that long-term exposure to air pollution, even at relatively low levels, is associated with higher COVID-19 death rates because exposure to air pollution impairs health.[22]

While country-wide lockdowns achieved some short-term improvements in air quality, these benefits are not universally detected and do not compensate for the significant damage to lives and livelihoods by the pandemic.[23] Actions to improve air quality can protect respiratory health during this historic global crisis.

# Air Quality Index Scale and Color-Coded System

The AQI is a key tool used to communicate data that summarizes air quality conditions in a single metric and distills information on associated health risks in a way that is accessible to the public. The Pune AQI, as operated by SAFAR, summarizes air quality conditions for eight key pollutants with sub-indices and health breakpoints calculated for each: $PM_{10}$, $PM_{2.5}$, $NO_2$, $SO_2$, $CO$, $O_3$, $NH_3$, and Pb.

The raw concentration measurements from monitoring stations are translated into separate AQI sub-index values for each of the pollutants that make up the AQI. The highest of these sub-index AQI values determines the overall AQI value for the day. AQI sub-indices and health relevant breakpoints for critical pollutants are shown (Table 2).[24]

**Table 2: AQI sub-index and pollutant concentration breakpoints** (Source: SAFAR, 2016).[25]

| AQI category (range) | | | PM$_{2.5}$ 24-hr (µg/m$^3$) | | PM$_{10}$ 24-hr (µg/m$^3$) | | NO$_2$ 24-hr (ppb) | | O$_3$ 8-hr (ppb) | | CO 8-hr (ppm) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | I low | I high | C low | C high | C low | C high | C low | C high | C low | C high | C low | C high |
| Good | 0 | 50 | 0 | 30 | 0 | 50 | 0 | 21 | 0 | 25 | 0.0 | 0.9 |
| Satisfactory | 50 | 100 | 30 | 60 | 50 | 100 | 22 | 43 | 26 | 51 | 1.0 | 1.7 |
| Moderate | 100 | 200 | 60 | 90 | 100 | 250 | 44 | 96 | 52 | 86 | 1.8 | 8.7 |
| Poor | 200 | 300 | 90 | 120 | 250 | 350 | 97 | 149 | 87 | 106 | 8.8 | 14.8 |
| Very Poor | 300 | 400 | 120 | 250 | 350 | 430 | 150 | 213 | 107 | 381 | 14.9 | 29.7 |
| Severe | 400 | 500 | 250 | 380 | 430 | 700 | 214 | 750 | 382 | 450 | 29.8 | 40.0 |

To relate air quality to health risks, the Pune AQI uses six AQI categories: Good, Satisfactory, Moderate, Poor, Very Poor, and Severe. Each category is based on outdoor (ambient) concentration values of air pollutants and their likely health impacts.[26]

The Pune AQI uses a system in which SAFAR calculates its AQI in two parts. First, by forming sub-indices and individual AQI readings for each air pollutant, and second, by determining the health-relevant breakpoints of these sub-indices. Breakpoints are decided by the national ambient air quality standards (NAAQS), in conjunction with epidemiological studies on air pollution exposures and adverse health risks.

AQI values at or below 100 are generally thought of as satisfactory. When AQI values are above 100, air quality is unhealthy: at first for certain sensitive groups of people, then for everyone as AQI values get higher.[27] If two or more air pollutants have AQI values over 100, all sensitive groups are reported. For example, if the AQI is 140 for particle pollution and 105 for ozone, the AQI value that day would be announced as 140 for particle pollution, and note that ozone smog levels are high to alert sensitive groups.[28] Some countries also provide information on the AQI forecast for the next day, which can help people plan their outdoor activities.

The Pune AQI and forecasts will be made available on the PMC website as part of the Pune AIR Plan. The SAFAR website provides the daily AQI and the associated health impacts for the cities of Delhi, Pune, Mumbai, and Ahmedabad, along with the next day's forecast.[29] People can download the SAFAR-Air app on their smart phones. Pune also has a Digital Display Board System, which shows the air quality data, and AQI information is available on the SAFAR Air Health Alert System (SAHAS).

# AQI Color Signal System for AIR Health Alerts and Health Warnings

The PMC will issue AQI alerts, as an additional means of communication by using the following color signal system (Table 3).

**Table 3: AQI value ranges and associated health impacts** (Source: IITM-SAFAR, 2020).[30]

| Air Quality Index (AQI) | PM$_{2.5}$ Health Advisory | PM$_{2.5}$ Health Effect Statement |
|---|---|---|
| **Good (0-50)** | No cautionary action required | Air pollution poses little or no risk |
| **Satisfactory (51-100)** | Unusually sensitive people should consider restricting prolonged or heavy exertion & heavy outdoor work. | Air quality may cause minor breathing discomfort to sensitive people. |
| **Moderate (101-200)** | Sensitive people & individuals with history of respiratory disease should reduce prolonged or heavy exertion & outdoor exposure. | Air quality may cause moderate health concern for sensitive people. |
| **Poor (201-300) Triggers "Health Advisory"** | Children & adults with heart or lung disease, should reduce prolonged or heavy exertion & limit outdoor activity. | Children & adults at risk. More chances of precipitating respiratory symptoms in sensitive individuals. |
| **Very Poor (301-400) Triggers "Health Alert"** | Everyone should reduce prolonged or heavy exertion. More caution for children & adults with heart or lung disease. | Triggers health alert. Everyone may experience more health effects. Significant increase in respiratory effects in general population. |
| **Severe (401-500) Triggers "Health Warning"** | Everyone should avoid all outdoor physical activity. Sensitive individuals should remain indoor with minimal activity. | Should be declared as emergency condition. Serious risk of respiratory effect in general population as high risk. |

# Pune Air Information and Response Strategies

***Health-Based Air Quality Risk Communication and Interagency Coordination*** - reduce health risks by enhancing city-level interagency coordination and air quality alert system.

### Alerts and Advisories

As part of the Air Information and Response (AIR) Plan, the PMC will issue a series of health advisories, alerts, and warnings linked to the AQI, as well as the air quality forecast. These alerts will depend on the AQI category (Table 3).

**A Health Advisory** (AQI Poor 201-300) is issued when the air quality index is forecast to be "Poor" (levels 201 to 300) in the next 24 hours. Information about alerts will be shared with the MPCB. The nodal officer alerts relevant city departments, medical facilities, and instruct schools to hoist "orange" colored flags.

**A Health Alert** (AQI Very Poor 301-400) is issued when AQI levels are forecast to be "Very Poor" (levels 301 to 400) in the next 24 hours. In addition to city departments, medical facilities, and schools, the nodal officer alerts urban health centers, as well as private medical practitioners, including pulmonologists and pediatricians, to expect and prepare for more cases of respiratory health effects.

**A Severe Health Warning** (AQI Severe 401-500) an AIR health warning would be called when AQI levels are forecast to be "Severe" (levels 401 to 500) in the next 24 hours. The nodal officer alerts 1) urban health centers and private medical practitioners, including pulmonologists and pediatricians to expect and prepare for more cases of respiratory health effects; 2) 108 EMRI Ambulance Service that air pollution levels are forecast at "Severe"; 3) other PMC departments including transport, traffic police, estate, schools and colleges, and environmental management. The nodal officer and PMC media department work with local media to publish AIR Health Warning in print and broadcast media, including newspapers, radio and television, provide dedicated budgetary allocations for these activities.

No matter the AQI level, the PMC will inform, rather than warn, residents of the daily AQI and associated health risk through regular interagency coordination and community updates.

### Interagency Coordination

Successful implementation of the Plan requires coordinated action between many stakeholders, including the PMC government and line departments, health care professionals, emergency medical personnel, hospital staff, and community groups.

The AIR Plan includes an information dissemination flowchart that includes the PMC line departments. All health-based AQI alerts will be disseminated through the PMC by the nodal officer for the AIR Plan (Figure 4). Alerts will further trigger corresponding actions for PMC departments, targeted at specific stakeholders relevant to each department. For example, the PMC health department communicates with primary and community healthcare centers, state and private hospitals, and associations of doctors and private practitioners. The health department will provide alerts/ advisories based on the air quality forecast for the stakeholders.

A parallel information dissemination flowchart exists for government departments operating outside the PMC, within Pune's metropolitan limits (Figure 5). This includes the district administration, the Pune Metropolitan Region Development Authority (PMRDA), educational institutions - schools, colleges and universities, and the Maharashtra Industrial Development Corporation (MIDC), which regulates industrial areas in the Pune metropolitan area. The Plan coordinates with the MPCB, through its regional office.

**Figure 4: PMC AIR Plan interagency coordination and AQI dissemination plan**
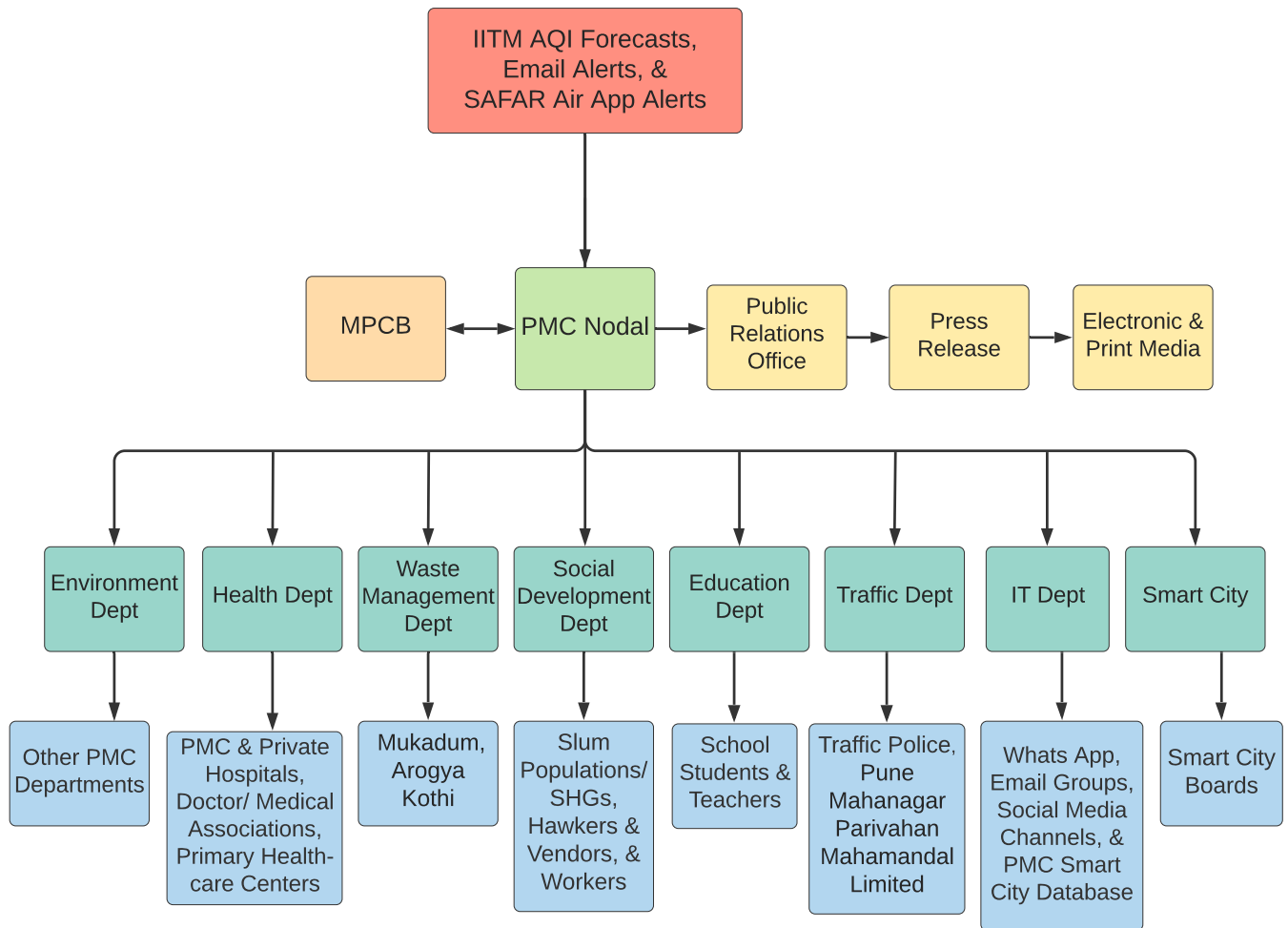
**Figure 5: Interagency coordination & dissemination of IITM AQI for other groups in Pune**
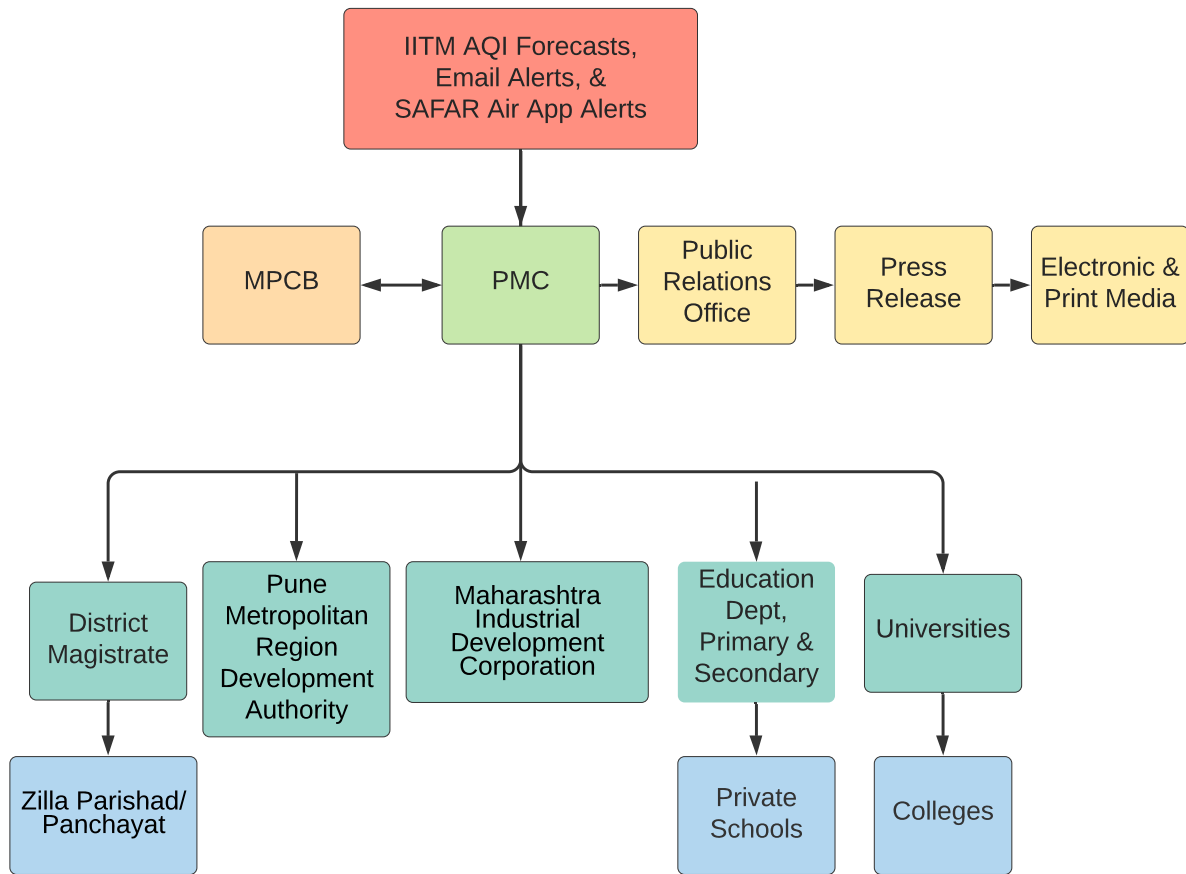


***Set City Priorities to Improve Air Quality*** - Mitigation is critical to improve the air quality in Pune (Table 1). Working closely with the MPCB, the PMC, and the institutional and expert members of the city-level supervisory committee under the NCAP, NRDC, and partners will:

- Engage and draw upon local institutions and experts to develop air quality improvement recommendations for the city.
- Analyze 1-2 key sectors in depth and identify interventions required to reduce pollution.
- Analyze and develop a compendium of best practices based on national and international experiences of other cities.

***Public Awareness and Community Outreach*** - update the PMC website with the AQI and AIR Plan, engage the media, and develop and broadly disseminate IEC materials (Figure 6).

Under the AIR Plan, the PMC will update their website with daily information about the AQI alerts as well as the forecasts. The AIR Plan and its components will be available, and the public dissemination framework has been developed to include various stakeholders (target groups for communication of AQI). The PMC and stakeholders will develop additional IEC materials for community outreach.

The key organizations and departments involved in the public awareness and community outreach component of the Pune AIR Plan include the following: IITM, MPCB, and the following PMC Departments - Environment, Health (hospitals and medical doctors); Waste Management; Education (schools); Traffic; Social Development Department (slum communities; outdoor workers); IT (manage website, social media page, email groups, WhatsApp groups); Public Relations Office (press release, print and electronic media), and Smart City (Smart City boards).

The PMC and partners will:
- Disseminate and update IEC materials (Marathi and English) for hoardings, pamphlets and videos for general public awareness, provided dedicated budgetary allocations.
- Update the PMC website with the AQI and AIR Plan and provide access to useful FAQs.
- Engage the media on the AQI and AIR Plan for regular broadcast of the AQI in newspapers and associated health advisories when issued by the PMC.

To maximize the impact of public awareness and community outreach, target groups have been identified for dissemination of AQI communication for health risk mitigation.

**Target groups for communication of AQI**

| | | |
|---|---|---|
| Young children in schools & Anganwadi | Elderly people | Slum population |
| Colleges and universities | Hospitals of PMC | Press media |
| PMC staff members | Private hospitals | Electronic media |
| Class 3 and 4 staff | Medical doctors | Hawkers and vendors |
| Sanitary inspector | Traffic police | Mazdoor Adda |
| Mukadam and sanitary workers | PMPML drivers | Workers |
| General Public | PMC drivers | |

**Channels for communicating the AQI and health precautions**

| | |
|---|---|
| PMC website | SAFAR/ SAMIR mobile App |
| Email groups | Media and press release |
| WhatsApp groups (PMC and external) | Smart City boards |
| Facebook page | IITM LED boards |
| Twitter | |

**Figure 6: PMC air quality communication materials in Marathi**



The PMC air quality communication materials in English are on the last page.

An Information Dissemination Matrix was created for public awareness and community outreach (Appendix). Although similar to the PMC interdepartmental communication framework, the matrix delivers targeted health risk communication around air quality to key groups (Appendix). These groups were identified through a consultative process with the PMC and partners.

The AIR plan includes two kinds of messages for public awareness and community outreach. *Regular daily messages*: regular messages about the current and forecast AQI, which can be sent to daily dissemination channels, targeting selected target groups. These messages include AQI health advisories and include preventive messaging when the AQI is "Good," "Satisfactory," "Moderate," and "Poor."

*Critical warning messages*: critical messages which are to be sent in case of AQI health alerts as well as warnings. These include preventive and critical messaging when the AQI is "Very Poor" and "Severe," or worse. Additionally, the AIR Plan allows specific stakeholders - individual doctors, media as well as academia, researchers and civil society groups to subscribe to these alerts. A database of vulnerable groups will be developed for targeted information dissemination.

***Focus Activities on Vulnerable Groups*** - tailor IEC materials for vulnerable groups, such as children, the elderly, and those with respiratory problems (Figure 6). For example, expanding the School Flags Program to display colored flags at schools, which correspond to the AQI.

The PMC will disseminate and update pamphlets, hoardings, videos, SMSs to increase awareness of vulnerable groups, and continue to implement the School Flags Program.

*Students at Zebar School point to an orange flag hoisted on school campus denoting a local IITM-SAFAR forecast for "Poor" air quality in January 2018 (Photo: NRDC).*



The PMC and partners will:
- Enact the School Flags Program to display colored flags that correspond to the daily AQI.
- Study chronic respiratory illness patients and children sensitization programs with the help of government and private doctors, based on partnerships with research institutions.
- Develop specific sensitization programs for communities living in high AQI localities.
- Conduct asthma clinics and pulmonary health promotion programs.
- Messages & alerts to those with asthma/ Chronic Obstructive Pulmonary Disease (COPD).

*Pilot of Pune School Flags Program launch by the Hon. Mayor, PMC, July 2019 (Photo: NRDC).*



***Build Capacity among Medical Professionals*** - engage with private and public medical professionals to build awareness and protection strategies against air pollution.

The PMC and partners will engage with private and public medical professionals to build health awareness and protective strategies against air pollution.

The PMC and partners will:
- Train the medical and paramedical workforce to build capacity on air pollution, health risk, and mitigations measures.
- Engage with private and public medical professionals to build health awareness and protection strategies on air pollution.
- Work with institutions specializing in public health and medical sciences to conduct epidemiological studies to establish impact of air pollution on health.
- Orientation can be done for class 3 and 4 staff of PMC like sanitary inspector, mukadam, sanitary workers, sweepers, and waste collectors.

# Appendix

## *Roles of PMC Departments for Information Dissemination and Outreach*

The roles and responsibilities of the key components of the public awareness and community outreach dissemination framework under the AIR Plan for the PMC Departments.

**Step 1:** The AQI for Pune city is released every day by IITM through SAFAR Air App and email group (sample SAFAR AQI email alert for Pune below).

**Step 2:** This information in email will be received by PMC IT Department under the guidance of the AIR Plan nodal officer from the Environment Department and partners. This information will be redistributed to the other channels of PMC. Environment Department indicates to the IT Department the type of the information. This will follow the Information Dissemination Matrix.

    a. Regular message and health advisories which are to be sent to daily dissemination channel. These include preventive messaging when the current and forecast AQI is "Good," "Satisfactory," "Moderate," and "Poor".

    b. Critical messages, as well health alerts and warnings are to be sent in case of warning. These include preventive and critical messaging when the current and forecast AQI is "Very Poor" and "Severe."

Sample SAFAR AQI email alert for Pune

| SAFAR-Pune | | |
|---|---|---|
| **PM$_{2.5}$** | **AQI** | **Description** |
| **Today** | 147 | Moderate |
| *Health Advisory* | Sensitive people should consider reducing longer /heavy exertion and heavy outdoor work. | |
| *Health Impact* | Minor health issues for sensitive people, no health concern to general public. | |
| **Tomorrow** | 130 | Moderate |
| *Health Advisory* | Sensitive people should consider reducing longer /heavy exertion and heavy outdoor work. | |
| *Health Impact* | Minor health issues for sensitive people, no health concern to general public. | |

*As on 17-02-2020         SAFAR@MoES-IITM-IMD

| Good (0-50) | Satisfactory (51-100) | Moderate (101-200) | Poor (201-300) | Very Poor (301-400) | Severe (401-500) |
|---|---|---|---|---|---|

**Step 3:** IT department will disseminate this information through different channels. Information will be sent to different PMC Departments:

| Emails to the groups | WhatsApp groups | Social media pages | PMC/ Smart City database |
|---|---|---|---|
| School headmaster groups | Schools group | Facebook | Email to website database |
| College principal groups | PMC staff internal groups | Twitter | PMC App database |
| Hospitals & medical doctor group | | PMC website | |
| PMC department heads/ nodal persons | | | |

**Step 4:** Other departments of PMC will disseminate this information in their network:

| Health department | PMC hospitals | Other hospitals | Medical doctors | Pathological laboratories |
|---|---|---|---|---|
| Waste management | Arogya Kothi | Mukadums | | |
| Social development department | SHGs | Slum community | Hawkers & vendors | Workers |
| Traffic department | Pune traffic police | Road department | PMPML drivers | PMC drivers |
| Education | School headmasters | School modal teachers | | |
| PRO | Press release to print and electronic media | | | |
| Smart City | Smart City boards | | | |

**Step 5:** Creation of a sensitive and vulnerable groups database, with the help of the PMC. The vulnerable groups are:
- Children in schools, colleges, and Anganwadi
- Elderly people
- Sensitive people – pregnant women, or people with allergy-related ailments, respiratory, or cardiovascular diseases; the information can be collected via medical practitioners and pathological laboratories
- Hospitals and medical doctors, PMC primary health centers
- People working in traffic and roadsides - traffic police and public transport drivers (PMPML, PMC drivers)
- General public through indirect modes to information dissemination

## Responsibilities for Information Dissemination by Pune Entities

The table below identifies the Pune entities (such as PMC and IITM) and the form of communication (such as emails and LED boards) responsible for disseminating AIR and AQI alerts to stakeholder groups.

| Target group | IITM-SAFAR email | IITM-SAFAR WhatsApp | PMC social media | IITM-SAFAR website | IITM-SAFAR App | PMC press release | Smart City board (VMD) | PMC/ Smart City database | IITM-SAFAR LED board |
|---|---|---|---|---|---|---|---|---|---|
| School children | Daily | Daily | | Subscription | Daily | | | | |
| College/ university | Daily | Daily | | Subscription | Daily | | | | |
| Elderly people | | | Critical | | | Critical | Critical | Critical | Daily |
| Elected representative | Daily | Daily | | | | | | | |
| Political officials (committee members) | Daily | Daily | | | | | | | |
| PMC staff members | | Daily PMC Internal | | | | | | | |
| Class 3 and 4 staff | | Daily PMC Internal | | | | | | | |
| PMC hospitals | Daily | Daily | | | | | | Critical | |
| Other hospitals | Daily | Daily | | | | | | Critical | |
| Medical doctors | Critical | Critical | Critical | Subscription | | | | Critical | |
| Traffic police | Daily | | Critical | | | | | | |
| PMPML drivers | Daily | Daily | | | | | | | |
| PMC drivers | Daily | Daily | | | | | | | |
| Slum population | | | | | | | | | |
| Press media | | | | Subscription | Daily | Critical | | | |
| Electronic media | | | | | Daily | Critical | | | |
| Hawkers & vendors | | | | | | | | | |
| Mazdoor Adda | | | | | | | | | |
| Workers | | | | | | | | | |
| General public | | | Critical | | Daily | Critical | Critical | Critical | Daily |

## Suggested AIR and AQI Messages for Specific Target Groups

Target groups may need specific advice in order to minimize health impacts of poor air quality if any. The messages need to be integrated to fit the groups' routine and lifestyle.

| AQI | School children | Medical professionals | Sensitive people | Elderly people | Vulnerable people | General public |
|---|---|---|---|---|---|---|
| **Good (0-50)** | No health risk | No health risk | No health risk | No health risk | No health risk | No health risk |
| **Satisfactory (51-100)** | No health risk | No health risk | No health risk | No health risk | No health risk | No health risk |
| **Moderate (101-200)** | No health risk, be watchful | Very sensitive people may experience problem | Reduce outdoor activity like travel, jogging | Reduce outdoor activity like jogging | Protect yourself, use mask | No health risk |
| **Poor (201-300)** | Reduce outdoor activity like exercise, jogging, outdoor game period | Sensitive people should be advised to reduce outdoor & heavy activity like exercise, jogging | Reduce outdoor & heavy activity like exercise, jogging, travel | Reduce outdoor & heavy activity like exercise, jogging, travel, morning walk | Reduce outdoor & heavy activity, use masks | Reduce outdoor activity, use masks |
| **Very Poor (301-400)** | Reduce heavy exertion, stop game, outdoor activity, jogging | Advice people to take precaution, be alert, avoid exposure | Reduce heavy exercise, take precautions, reduce exposure | Reduce heavy exercise & outdoor activity, stop walking & jogging | Use masks, remain away from visible source like smoke, etc. | Reduce heavy exercise, remain indoor, use mask |
| **Severe (401-500)** | Avoid all outdoor & physical activity, no game, jogging | Advice people to avoid all outdoor & physical activity, be alert, consult doctor if face any medical problem | Avoid all outdoor & physical activity, be alert, consult doctor if face any medical problem | Avoid all outdoor & physical activity, no walking or jogging, be alert, consult doctor if needed | Reduce outdoor & physical activity, use mask, be alert, consult doctor if face any medical problem | Avoid all outdoor & physical activity, use mask, consult doctor if needed |

*Note:*

- ▪ Sensitive people include - pregnant women; people with allergies, asthma, bronchitis; and people with respiratory, cardiovascular, and skin diseases.
- ▪ Vulnerable people include - traffic police on road, PMPML and PMC drivers, slum population, hawkers and vendors, and workers.
- ▪ General public include - college youth, healthy adults, media, and all other people.

| Air Pollution Level | Actions Suggested | Agency Responsible |
|---|---|---|
| **Poor (201-300)** | Activate response system - inform all relevant departments | AIR Plan nodal officer |
| | Alert schools to raise "orange" flags to inform children of pollution risk, alert vulnerable groups via emails, WhatsApp groups | AIR Plan nodal officer |
| | Mobilize media to disseminate warnings on air pollution | PMC publicity department |
| | Inform hospitals to be prepared for higher cases of respiratory illness | PMC health department |
| **Very Poor (301-400) Triggers "Health Alert"** | Activate health "alert" and response system - inform all relevant departments | Air Plan nodal officer |
| | Alert schools to raise 'red' flags to inform children of high pollution risk, alert vulnerable patient group via emails, WhatsApp groups | AIR Plan nodal officer |
| | Alert newspapers/ TV/ radio/ FM stations to advise people with respiratory and cardiac illnesses to avoid polluted areas and restrict outdoor movement | PMC publicity department |
| | Inform hospitals to be prepared for higher cases of respiratory illness, ensure adequate supply of oxygen and medicines | PMC health department |
| | Inform outside workers and laborers about air pollution risk | PMC estate/ building, & ward offices, & community development departments |
| | Strict vigilance and no tolerance for visible emissions - stop plying of visibly polluting vehicles by impounding or heavy fine | Transport department, traffic police |
| | Deploy traffic police for smooth traffic flow in areas likely to have congestion | Traffic police |
| | Issue alerts highlighting heavy fines on garbage burning in landfills & other places and prosecution of persons responsible | Director solid waste management |

| Severe (401-500) Triggers "Health Warning" | Activate alert "warning" and response system - inform all relevant departments | AIR Plan nodal officer |
|---|---|---|
| | Alert schools to raise 'maroon' flags to inform children of severely high pollution risk, alert vulnerable group via emails, WhatsApp | AIR Plan nodal officer |
| | Alert newspapers/ TV/ radio/ FM stations to advise people with respiratory or cardiac illnesses to avoid polluted areas & restrict outdoor activity | PMC publicity department |
| | Ensure hospitals are prepared for higher cases of respiratory illness, ensure adequate supply of oxygen and medicines | PMC health department |
| | Inform outside workers about air pollution risk, stop outside work & ensure outdoor workers use masks | PMC estate department |
| | Strict vigilance and no tolerance for visible emissions - stop plying of visibly polluting vehicles by impounding or heavy fine | Transport department, traffic police |
| | Deploy traffic police for smooth traffic flow in areas likely to have congestion | Traffic police |
| | Issue alerts highlighting heavy fines on garbage burning in landfills & other places & prosecution of persons responsible | Director solid waste management |
| | Order schools to shut down if Severe pollution persists for two consecutive days | Education department in consultation with boards |

# Endnotes

[1] WHO, "Ambient air pollution - a major threat to health and climate," www.who.int/airpollution/ambient/en/ (accessed September 22, 2020).

[2] Pune Smart City, "Explore Pune," https://punesmartcity.in/explore-pune/ (accessed September 22, 2020).

[3] Times of India, "Pune's air quality continues to worsen over the years," February 2019, https://timesofindia.indiatimes.com/city/pune/air-quality-continues-to-worsen-over-the-years/articleshow/68086815.cms (accessed September 22, 2020); Sakal Times, "Mumbai most polluted city in State," March 2019, www.sakaltimes.com/pune/mumbai-most-polluted-city-state-32522 (accessed September 22, 2020).

[4] Climate & Clean Air Coalition, "Scientists probe link between Covid-19 and deadly air pollution," August 2020, www.ccacoalition.org/en/news/scientists-probe-link-between-covid-19-and-deadly-air-pollution (accessed September 23, 2020).

[5] Times of India, "Pune's air quality continues to worsen over the years," February 2019, timesofindia.indiatimes.com/city/pune/air-quality-continues-to-worsen-over-the-years/articleshow/68086815.cms (accessed September 22, 2020).

[6] Hindustan Times, "Pollutants in Pune cross permissible limits", October 2018, www.hindustantimes.com/pune-news/pune-s-air-quality-crosses-permissible-limit-of-pollutants/story-KiTBvwXiCbJy3z4cWCRuXM.html (accessed September 22, 2020).

[7] Urban Emissions, "Satellite-derived Surface $PM_{2.5}$ Concentrations for Pune from 1998-2014," http://urbanemissions.info/india-%20apna/pune-india/ (accessed September 12, 2020); Satellite derived emissions is on the basis of modelling that incorporates satellite derived aerosol optical depth (AOD) with prevalent meteorological conditions.

[8] CPCB, "List of Air Quality Stations," https://app.cpcbccr.com/ccr/#/loginwww.cpcb.gov.in/caaqm/frmStationdetails.aspx?cityID=312.

[9] S. Patil and S. Gawande, "Ambient Air Quality Monitoring in Pune City," International Journal of Science and Research, www.ijsr.net/search_index_results_paperid.php?id=SUB154902 (May 2015): Volume 4 Issue 5, 2909 - 2913.

[10] G. Beig, "WMO Global Atmosphere Watch (GAW) Report No. 217," SAFAR-India, https://mce2.org/wmogurme/images/reports/GAW_217%20(SAFAR).pdf (2015)

[11] SAFAR-India, "Forecast Modelling and Supercomputing," IITM-Pune, http://safar.tropmet.res.in/FORECASTING-46-4-Details (accessed September 12, 2020).

[12] CPCB, "About National Air Quality Index," https://app.cpcbccr.com/ccr_docs/About_AQI.pdf.

[13] WHO, "Ambient air pollution: Interventions & tools," www.who.int/airpollution/ambient/interventions/en/ (accessed September 23, 2020).

[14] IITM, publication pending, (2015).

[15] G. Beig, "WMO GAW Report No. 217," SAFAR-India, https://mce2.org/wmogurme/images/reports/GAW_217%20(SAFAR).pdf (2015).

[16] PMC, "Environment Status Report 2018-19," www.pmc.gov.in/sites/default/files/reports_dpr/ESR-2018-19.pdf

[17] IITM, publication pending, (2015).

[18] K. Joyti et al., "Human health risk assessment due to air pollution in 10 urban cities in Maharashtra, India," Cogent Environmental Science, www.tandfonline.com/doi/full/10.1080/23311843.2016.1193110 (May 2016): Volume 2 Issue 1.

[19] S. K. Guttikunda and P. Jawahar, "Application of SIM-air modeling tools to assess air quality in Indian cities," Atmospheric Environment, doi.org/10.1016/j.atmosenv.2012.08.074 (December 2012): Volume 62, 551-561.

[20] T. Gordon et al.," Air pollution health research priorities for India: Perspectives of the Indo-U.S. Communities of Researchers," Environment International, https://pubmed.ncbi.nlm.nih.gov/29944987/ (October 2018): Volume 119, 100-108; V. Limaye et al., "Development of Ahmedabad's Air Information and Response (AIR) Plan to Protect Public Health," International Journal of Environmental Research and Public Health, doi.org/10.3390/ijerph15071460 (July 2018): 15, 1460.

[21] V. Limaye, "Polluted Air Makes the Coronavirus Even Deadlier," NRDC, www.nrdc.org/experts/vijay-limaye/polluted-air-makes-coronavirus-even-deadlier (April 2020).

[22] X. Wu et al., "Exposure to Air Pollution and COVID-19 Mortality in the United States: A Nationwide Cross-Sectional Study," Epidemiology, medRxiv: the preprint server for health sciences, doi.org/10.1101/2020.04.05.20054502 (Preprint April 2020).

[23] Q. Schiermeier, "Why Pollution Is Plummeting in Some Cities - but Not Others." Nature, https://doi.org/10.1038/d41586-020-01049-6 (April 2020): Volume 580, 313.

[24] G. Beig, "WMO GAW Report No. 217," SAFAR-India, https://mce2.org/wmogurme/images/reports/GAW_217%20(SAFAR).pdf (2015).

[25] IITM, SAFAR-India, "SAFAR Monitoring Network," 2016, safar.tropmet.res.in/MONITORING%20SYSTEM-10-3-Details (accessed July 28, 2020).

[26] SAFAR uses a segmented linear function to relate the actual concentrations of each pollutant to a non-dimensional number (the AQI). A linear segmented function uses straight-line segments to join discrete coordinates. In this case, the discrete coordinates are the AQI breakpoints. The following equation converts the concentration of key air pollutants to its respective AQI value:

$$I = \frac{I_{high} - I_{low}}{C_{high} - C_{low}}(C - C_{low}) + I_{low}$$

where,
I is the (Air Quality) index,
C is the pollutant concentration,
$C_{low}$ is the concentration breakpoint that is ≤ C,
$C_{high}$ is the concentration breakpoint that is ≥ C,
$I_{low}$ is the index breakpoint corresponding to $C_{low}$,
$I_{high}$ is the index breakpoint corresponding to $C_{high}$.

This equation, used to convert measured pollutant concentration data to its corresponding AQI, is taken from G. Beig, "WMO GAW Report No. 217," SAFAR-India, https://mce2.org/wmogurme/images/reports/GAW_217%20(SAFAR).pdf (2015).

[27] Air Now, "AQI Basics," www.airnow.gov/aqi/aqi-basics/ (accessed October 7, 2020).

[28] IITM Meteorology, SAFAR-India, "Air Quality Index," 2016, safar.tropmet.res.in/AQI-47-12-Details (accessed July 28, 2020).

[29] IITM, SAFAR-India, "SAFAR Monitoring Network," 2016, http://safar.tropmet.res.in/MONITORING%20SYSTEM-10-3-Details (accessed July 28, 2020).

[30] IITM Meteorology, SAFAR-India, "Air Quality Index," 2016, safar.tropmet.res.in/AQI-47-12-Details (accessed July 28, 2020).

# Pune AIR Plan IEC Material Developed in English



**Steps you can take to help improve air quality**

- Instead of using a car, consider taking public modes like buses and trains.
- Avoid highly trafficked roads during rush hour. More congestion means more pollution.
- Avoid highly trafficked roads during rush hour. More congestion means more pollution.
- Don't burntrash, outdoors or indoors, because harmful air pollutants are released by burning

**Air pollution is bad for your health**

- Protect your lungs, heart, and brain. By reducing exposure to air pollution, you can live longer.
- Air pollution harms children more than adults. Because children's bodies and brains are still developing, the air pollution that children inhale has an especially harmful effect on them
- Air pollution is a threat to many systems within the body. Small particles can enter the bloodstream from the lungs, and harm the heart and brain as well as lungs.
- Eat healthy food and drink plenty of water to build your body's natura defense against harmful air pollution.

**Take precautions to protect yourself from air pollution**

- Check SAFAR website (www http://safaz.tropmet.res.in) and download the SAFAR Air Quality Index (AQI) On mobile app to keep a daily check on air pollution levels
- Limit outdoor activity during high air pollution episodes.
- Before any strenuous physical activity or work outdoors, check the current AQI level
- If you have respiratory ailments, like bronchitis or asthma, keep your medications handy.
- If you're having trouble breathing, see a health professional Take advic from health professionals about opting for protective gear.

# Resources and Issue Briefs