

INTRODUCTION

Air pollution is a major public health threat in cities across the world. Air pollution is one of the highest ranking environmental and public health challenges globally, and especially in Southeast Asia. This project covers air pollution levels and source in Ahmedabad, India, the Air Quality Index (AQI) best practices, and identifies the elements of applying a successful AQI, including effective health risk communication. To protect local communities from rising air pollution levels, the Ahmedabad Municipal Corporation (AMC) is developing an AQI. AMC is working with the Indian Institute of Tropical Meteorology using a monitoring network called SAFAR (System of Air Quality and Weather Forecasting And Research). The Natural Resources Defense Council (NRDC) is working with the AMC on information, education, and communication strategies for the AQI being launched in Ahmedabad.

In 2010, the Indian government found that, average concentrations of particulate matter (PM) in the air of 180 Indian cities was about six times higher than World Health Organization (WHO) standards¹. In the most recent WHO assessment in 2014, 13 Indian cities ranked in the top 20 in the world for the worst fine particulate air pollution². The 2012 Global Burden of Disease assessment led by the WHO, identified the top priority air pollutants in India as PM, nitrogen oxides, ground-level ozone smog, and sulfur dioxide. Exposure to each of these air pollutants is associated with considerable risks to respiratory health. By reducing local air pollution, cities can reduce the burden of disease from stroke, heart disease, lung cancer, and both chronic and acute respiratory diseases, including asthma³. Furthermore, the lower the levels of air pollution, the better the cardiovascular and respiratory health of the population will be, both long-term and short-term⁴.

AQI systems already operate in key cities in India, including Pune, Delhi, and Mumbai, among others, as well as internationally. The AQI not only informs people about air pollution, but also provides detailed data on how to protect health and to guide pollution reducing policies and regulations. Many people and organizations support the effectiveness of the AQI for informing city residents about the health threats of air pollution.

Many people support the effectiveness of the AQI for its ability to inform residents about the levels and health threats of air pollution. With the AQI as the base, Ahmedabad's Air Information & Response (AIR) Plan⁵, in conjunction with the NRDC and the Indian Institute of Public Health Gandhinagar, focuses on health risk communication. The AIR Plan creates immediate and longer-term actions to increase preparedness, information-sharing, and response coordination to reduce the health impacts on vulnerable populations like children.

¹ Michael Greenstone and Rohini Pande, "India's particulate problem." *New York Times*, February 9, 2014, <http://www.nytimes.com/2014/02/10/opinion/indias-particulate-problem.html> Accessed December 2, 2016.

² World Health Organization, Global Health Observatory Data Repository, *Ambient (Outdoor) Air Pollution Database, by Country and City*, 2014. http://www.who.int/gho/phe/outdoor_air_pollution/en/ Accessed December 1, 2016.

³ Climate & Clean Air Coalition. www.ccacoalition.org Accessed December 2, 2016.

⁴ World Health Organization, *Ambient (outdoor) air quality and health*, 2016.

<http://www.who.int/mediacentre/factsheets/fs313/en/> Accessed December 2, 2016.

⁵ NRDC. https://www.nrdc.org/sites/default/files/ahmedabad_air_plan_feb_2017_final_pdf.pdf Accessed February 17, 2017.

AIR POLLUTION IN AHMEDABAD

Ahmedabad is one of India's largest cities with a population over seven million and lists as one of the cities with the worst air pollution in the world, along with New Delhi and Beijing. In 2010, Ahmedabad experienced approximately 4,900 premature deaths attributed to excessive ambient air pollution⁶. Worsening air quality in Ahmedabad has resulted in serious health concerns, including increased morbidity, especially in vulnerable populations⁷.

Particulate Matter

Research in air pollution epidemiology has increasingly focused on the harmful effects of exposure to particulate matter (PM). PM is the primary pollutant of concern and most frequently monitored in Ahmedabad because it can penetrate deeply into the respiratory tract, posing serious health risks. PM₁₀ is made up of coarse particles that are 2.5 to 10 micrometers in diameter. PM_{2.5} is made up of finer particles that are 2.5 micrometers in diameter or smaller. Because of its tiny size, PM_{2.5} can penetrate deep into airways, lungs and the respiratory system causing adverse health effects, even in low pollutant concentrations. Exposure to PM_{2.5} is linked to heart and lung disease and heart attacks. Other health effects associated with exposure to PM_{2.5} are increased respiratory symptoms, irregular heartbeat, non-fatal heart attacks, development of chronic bronchitis, and decreased lung function⁸. The most vulnerable populations to air pollution are the very young, the elderly, and those with preexisting cardiovascular conditions and asthma, and air pollution affects lung development⁹. A prominent study conducted in North American cities showed that a 10 µg/m³ increase in PM₁₀ was associated with an increase in all-cause mortality of about 0.3% to 0.5%¹⁰.

Ahmedabad has exceeded both WHO standards and India's air quality standards for particulate matter since at least 2008. The WHO interactive map reports annual mean air pollution concentrations for Ahmedabad of 100 µg/m³ for PM_{2.5} and 83 µg/m³ for PM₁₀, for 2013 and 2012, respectively¹¹. PM₁₀ levels in Ahmedabad exceeded permissible limits for all

⁶ WHO, *Global Ambient Air Interactive Map*, 2016.<http://maps.who.int/airpollution/> (accessed December 2, 2016)

⁷Guttikunda, S.K. and P. Jawahar, "Application of SIM-Air Modeling Tools to Assess Air Quality in Indian Cities," *Atmospheric Environment* 62 (2012); Pathak and Shukla. Co-benefits of low carbon passenger transport actions in Indian cities: Case study of Ahmedabad. Transportation Research Part D: Transport and Environment. Volume 44, May 2016, 303–316.

⁸ C. A. Pope III et al., "Lung Cancer, Cardiopulmonary Mortality, and Long-Term Exposure to Fine Particulate Air Pollution," *JAMA: The Journal of the American Medical Association* 287, no. 9 (2002): 1132–41.

⁹ Hassan N.A. et al., "Impact of climate change on air quality and public health in urban areas," *Asia Pac Journal of Public Health* (2015); Public Health Foundation of India, *Ambient Air Pollution and Public Health: A Call to Action*, March 2014.

¹⁰ C. A. Pope III et al., "Lung Cancer, Cardiopulmonary Mortality, and Long-Term Exposure to Fine Particulate Air Pollution," *JAMA: The Journal of the American Medical Association* 287, no. 9 (2002): 1132–41; Samet J.M. et al, "Morbidity and mortality from air pollution in the United States," The National Morbidity, Mortality, and Air Pollution Study, Research Report 94, Health Effects Institute, Cambridge, MA (2000).

¹¹ World Health Organization, *Global Ambient Air Interactive Map*, 2016, <http://maps.who.int/airpollution/> Accessed December 2, 2016; Ahmedabad's yearly averages for PM for 2014-15: state program (SAMP), S. No. 14-15; national program (NAMP), S. No. 22-18.

five years between 2008 and 2012, exceeding by 30–50% the national standards in India, which are less restrictive than the WHO guidelines¹². Studies also show that PM_{2.5} levels in Ahmedabad exceed national standards¹³.

Pollution Sources

Air pollution comes from several sources. PM is a mixture of solids and liquids in the air that can be emitted directly or formed by chemical reactions in the atmosphere. PM₁₀ comes primarily from motor vehicles, dust and construction and PM_{2.5} comes from many types of combustion, including vehicles, power plants, industry, waste burning, agricultural burning and cooking. A 2012 emissions study examined air pollution levels and sources and then modeled emissions. The study found that the major sources for PM₁₀ in Ahmedabad are: 30% road dust; 25% power plants; 20% vehicle exhaust; 15% industry; 5% domestic cooking and heating; 2% diesel generator sets; 2% waste burning and 1% construction activities¹⁴. Ahmedabad has two thermal coal- fired power stations: the 800MW Gandhinagar power plant and the 400MW Sabarmati power plant, which is one of the oldest in India. The surrounding low-efficiency brick kilns and trash burning also contribute to air pollution.

Ahmedabad's rapid growth, including increased vehicle-related emissions and stationary sources are two of the major sources of pollution. Direct vehicle exhaust is a dominant source of air pollution. From 2001 to 2011, vehicles, including motorcycles and scooters, doubled in Ahmedabad, while the population grew at a rate of 58%¹⁵. Vehicles, especially two-wheelers and diesel- based trucks, account for over 20% of PM₁₀ levels in Ahmedabad¹⁶. The number of two-wheelers (mopeds, scooters, motorcycles, all with a mix of 2 and 4 stroke engines) has grown rapidly in Ahmedabad. Compared to 2-wheelers, 4 stroke models are considered more fuel-efficient; an estimated 30-40% of 2-wheelers have 2 stroke engines. As in Ahmedabad, most cities ban heavy-duty vehicles during daytime. However, the number of light-duty vehicles increased during the daytime and a greater number of heavy-duty vehicles are on the roadways at night. Road dust from automobiles, 2-wheelers, trucks and other vehicles is a major problem in Ahmedabad, and other cities. Road dust accounts for over 25% of PM₁₀ levels in Ahmedabad and road dust is the largest contributor for PM₁₀ and direct vehicle exhaust is the largest contributor of PM_{2.5}¹⁷.

¹² WHO, *Global Urban Ambient Air Pollution Database*, 2016, http://www.who.int/phe/health_topics/outdoorair/databases/cities/en/ Accessed September 27, 2016; Pathak and Shukla. Co-benefits of low carbon passenger transport actions in Indian cities: Case study of Ahmedabad. *Transportation Research Part D: Transport and Environment*. Volume 44, May 2016, 303–316.

¹³ WHO, *Global Urban Ambient Air Pollution Database*, 2016, http://www.who.int/phe/health_topics/outdoorair/databases/cities/en/ Accessed September 27, 2016; Dey, S. et al., "Variability of outdoor fine particulate (PM_{2.5}) concentration in the Indian Subcontinent," *Remote Sensing of Environment* (2012): 153–161. Pathak and Shukla. Co-benefits of low carbon passenger transport actions in Indian cities: Case study of Ahmedabad. *Transportation Research Part D: Transport and Environment*. Volume 44, May 2016, 303–316.

¹⁴ Guttikunda, S.K. and P. Jawahar, "Application of SIM-Air Modeling Tools to Assess Air Quality in Indian Cities," *Atmospheric Environment* 62 (2012).

¹⁵ Parth Shastri, "Vehicle population grew at double the rate than human population in Ahmedabad," *Economic Times*, January 15, 2014, <http://economictimes.indiatimes.com/industry/auto/news/industry/vehicle-population-grew-at-double-the-rate-than-human-population-in-ahmedabad/articleshow/28827664.cms> Accessed December 2, 2016.

¹⁶ Guttikunda, S.K. and P. Jawahar, "Application of SIM-Air Modeling Tools to Assess Air Quality in Indian Cities," *Atmospheric Environment* 62 (2012).

¹⁷ Ibid; Urban Emissions, *Urban Air Pollution Analysis in India*, September 2011.

Ahmedabad's electricity grid is supplied by two thermal power stations, both coal-fired, and are major sources of emissions¹⁸. One is plant is near the Sabarmati River, the Sabarmati 400 MW power station, with a second, larger 800MW power station in Gandhinagar. The Sabarmati plant is one of the oldest power stations in India, operating since 1934. The Sabarmati power plant is in the city and can directly impact air quality while the Gandhinagar power plant is on the located on the northeastern edge of Ahmedabad. Dispersion models have found high emissions levels related to the plants for PM₁₀ and PM_{2.5}. Communities living near thermal plants experience higher rates of chronic respiratory illness, asthma, cancer and premature death¹⁹. Brick kilns surrounding Ahmedabad and diesel generators, which are often used for back-up power and for telecom towers, are other sources of pollution. Waste burning, is another major source of pollution. Domestic cooking and heating emissions, especially from low-income communities that use coal, biomass, and biofuels can contribute to outdoor air pollution.

AIR QUALITY INDEX

An AQI is a tool employed by cities, states, and countries around to the world to communicate present and future health risks of air pollution to residents. The AQI provides an index number for reporting daily air quality, on a scale from 0 to 500. The higher the AQI numerical value, the higher the level of air pollution that day. Additionally, the greater the potential health concerns. Typically, AQI values of 100 correspond to the national air quality standard for each pollutant, so AQI values of 100 or less are generally considered satisfactory. An AQI value of 50 would represent good air quality with low risks to public health, but an AQI value of 300 would represent air quality so hazardous that even healthy people may feel its respiratory effects²⁰. The AQI serves as a communication bridge to members of the public that can summarize complex air quality information in a single number and associated color code. Most AQI systems have two common characteristics: a table with different levels of air pollution and health risks, ranging from minimal to severe, and color-coding to distinguish these levels, also known as breakpoints. The breakpoints distinguishing different AQI levels

<http://shaktifoundation.in/wp-content/uploads/2014/02/urban%20air%20pollution%20analysis%20-%20india%206%20cities%202011%2009%2013.pdf> Accessed December 1, 2016.

¹⁸ Guttikunda, S.K. and P. Jawahar, "Application of SIM-Air Modeling Tools to Assess Air Quality in Indian Cities," *Atmospheric Environment* 62 (2012).

¹⁹ Guttikunda S.K. and R. Goel, "Health Impacts of Particulate Pollution in a Megacity—Delhi, India." *Environmental Development* 6 (2013): 8-20; WHO, Air Quality Standards Report

<http://www.who.int/mediacentre/factsheets/fs313/en/> Accessed February 27, 2017; WHO, Quantification of the Health Effects of Exposure to Air Pollution, 2000; Analitis, A., et al., "Short-term Effects of Ambient Particles on Cardiovascular and Respiratory Mortality," *Epidemiology* 17, no. 2 (2006): 230-3; Health Effects Institute, *Outdoor Air Pollution and Health in the Developing Countries of Asia: A Comprehensive Review*, 2010; WHO, "Seven Million Premature Deaths Annually Linked to Air Pollution," News Release, March 25, 2014. <http://www.who.int/mediacentre/news/releases/2014/air-pollution/en/> Accessed December 2, 2016.

²⁰ United States Environmental Protection Agency, AQI: A Guide to Air Quality and Your Health, EPA-456/F-14-002, February 2014, https://www3.epa.gov/airnow/aqi_brochure_02_14.pdf Accessed December 2, 2016.

are tied to scientific and epidemiologic evidence that links air pollution to adverse health effects among specific vulnerable populations. As such, the communication of AQI information to members of the public also depends on the identification of specific target audiences that are especially vulnerable to air pollution.

An AQI summarizes a rating for the quality of the air city residents are breathing, and an associated level of potential health impacts. In situations where multiple air pollutants are monitored concurrently, the AQI typically reflects the air quality and associated health effects for the most dominant pollutant. The AQI is calculated through an analysis of local weather and outdoor air pollution data, and values tend to vary seasonally, and on the time of day.

Ahmedabad's Air Pollution Monitoring

In India, the air quality monitoring network is coordinated on the national level by the Central Pollution Control Board (CPCB) and the Indian Institute of Tropical Meteorology (IITM) network, which is called SAFAR (System of Air Quality and Weather Forecasting And Research)²¹. Several entities operate about 20 monitoring stations in Ahmedabad, including the Gujarat State Pollution Control Board (GPCB), Gujarat Environmental Management Institute (GEMI), and new stations installed by the AMC and the IITM. The monitoring stations in Ahmedabad report results after 7 -10 days of monitoring, but periodically the monitoring results are unavailable because of technical difficulties. CPCB monitoring stations record data twice a week, for at least 104 samples per year, per their guidelines. Ambient air and meteorological data are submitted by the local meteorological department to the CPCB for compilation and reporting. GPCB also collects ambient air pollution data from all stations once each week for 12 hours, and calculates annual air pollution averages for each year from that data. Multiple monitoring systems provide complementary methods and more information to help evaluate future meteorological or air quality conditions, and health risks.

To protect public health and improve air quality the Ahmedabad Municipal Corporation is partnering with IITM to develop a new AQI for the city. Currently, SAFAR's AQI operates in New Delhi, Pune, and Mumbai with plans to expand to Ahmedabad. SAFAR provides location - specific information on air quality in near real-time and forecasts 1-2 days in advance²². This information is combined with an early warning system of weather parameters. The purpose of SAFAR is public engagement to increase people's awareness of local air quality issues. SAFAR is designed to provide useful for informing locally- appropriate air pollution control measures and systematic actions to reduce health risks associated with air pollution exposure. SAFAR systems monitor several pollutants and sensors should always operational and record data in 5 minute intervals²³. SAFAR currently uses multiple approaches to reach the public with their AQI alerts, including its website, SAFAR-app for smart phones, email alerts, and digital display boards.

²¹ Central Pollution Control Board, About National Air Quality Index, 2008, http://cpcb.nic.in/About_AQI.pdf Accessed September 28, 2016; Indian Institute of Tropical Meteorology, SAFAR Monitoring Network, <http://safar.tropmet.res.in> Accessed September 27, 2016.

²² Indian Institute of Tropical Meteorology, SAFAR Monitoring Network, 2016, <http://safar.tropmet.res.in> Accessed September 27, 2016; Indian Institute of Tropical Meteorology, SAFAR Forecast Modelling and Supercomputing, <http://safar.tropmet.res.in/FORECASTING-46-4-Details> Accessed December 2, 2016.

²³ Dr. Gufran Beig, *GAW Report No. 217, System of Air Quality Forecasting and Research (SAFAR-INDIA)*, Annual Report, Geneva: World Meteorological Organization, 2015.

SAFAR's AQI Scale

SAFAR uses an AQI system in which the reported AQI is the highest AQI value from among the criteria pollutants being measured and reported for the time-period in question. 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. 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, the AQI breakpoints²⁴. Breakpoints are decided by each country's national ambient air quality standards, in conjunction with epidemiological studies describing the relation between air pollution exposures and adverse health risks.

Different air pollutants pose health risks to different sensitive groups, when their AQI exceeds 100. The raw concentration measurements from monitoring stations are converted into separate AQI sub-index values for each air pollutants that comprise the AQI. The highest of these sub-index AQI values determines the overall AQI value for the day. When the AQI is above 100, in some countries' agencies also report which groups are especially vulnerable or sensitive to that pollutant—for example, children, or people with asthma or heart disease. If two or more individual air pollutants have AQI values over 100, all sensitive groups should be reported²⁵.

The AQI categories and health breakpoints for the pollutants that comprise SAFAR's AQI are shown in the table below²⁶. Eight pollutants go into SAFAR's AQI: PM10, PM2.5, NO2, SO2, CO, O3, NH3, and Pb. These eight have short- term (up to 24-hours) India National Ambient Air Quality Standards²⁷. However, breakpoints are only established for the five main pollutants: PM10, PM2.5, NO2, CO, and O3. SAFAR uses six AQI categories.

Description	AQI	PM10 µg/m ³ 24 hr avg	PM2.5 µg/m ³ 24 hr avg	CO ppm 8 hr avg	O3 ppb 24 hr avg	NO2 ppb 24 hr avg
Good + Satisfactory	0-100	0-100	0-60	0-1.7	0-50	0-43
Moderate	101-200	101-250	61-90	1.8-8.7	51-84	44-96
Poor	201-300	251-350	91-120	8.8-14.8	85-104	97-149
Very Poor	301-400	351-430	121-250	14.9-29.7	105-374	150-213
Severe	401-500	431-550	251-350	29.8-40	375-450	214-750

Table 1: The different AQI tiers for the five air pollutants comprise SAFAR's AQI.

²⁴ Ibid.

²⁵ United States Environmental Protection Agency, *AQI: A Guide to Air Quality and Your Health*, February 2014, https://www3.epa.gov/airnow/aqi_brochure_02_14.pdf Accessed December 2, 2016.

²⁶ Indian Institute of Tropical Meteorology, *SAFAR Monitoring Network*, 2016, <http://safar.tropmet.res.in> Accessed December 2, 2016; Indian Institute of Tropical Meteorology, *SAFAR Air Quality Index*, 2016 <http://safar.tropmet.res.in/AQI-47-12-Details> Accessed December 2, 2016.

²⁷ Ibid.

ELEMENTS OF EFFECTIVE AQI SYSTEMS

AQI systems that have been effectively communicated to air pollution-affected communities are based on a strong foundation of scientific evidence on air pollution-health effects, well-designed monitoring programs, and agency and public coordination that communicates the evidence base to affected communities. The dual goals of protecting public health from air pollution and improving air quality are strengthened by effective AQI systems, which provide the evidence base for municipal or state agencies to act on air pollution.

From the evidence base provided by AQI systems in India and globally, six of the key elements of successful, effective AQI systems include: 1. Robust, streamlined interagency coordination; 2. Strong communication channels and direct involvement with the general public, and with communities vulnerable to air pollution's effects: schoolchildren, older adults, people with respiratory or cardiovascular ailments, outdoor workers, people who engage in sports outdoors; 3. Range of different policy interventions that can reduce air pollution from its sources; 4. Scientific studies that expand local air pollution-health evidence base; 5. Media engagement and outreach; 6. Build capacity among health professionals on air pollution and health.

Interagency Coordination

Air pollution is not a localized problem, especially since pollutants and emissions are affected by regional and long-range transport. Since air pollution can affect large geographic areas as well as concern many different sectors, state-wide coordination of agencies is an effective mechanism to combat air pollution. Combating air pollution requires professionals and experts in many areas such as scientists, data analysts, engineers, law makers, politicians, economists, health officials, accountants, and more. Furthermore, the fact that air pollution can arise from many different sources such as industry, transportation, and agriculture, makes it an interagency issue. International experiences show that interagency coordination is a pivotal part in reducing air pollution, as well as informing and protecting the public from its effects.

Interagency coordination is a necessary and productive tool to address the broad problem of air pollution. Agencies have found that collaborative efforts have helped in other ways than combating air pollution, such as 1) fostered positive interagency coordination, cooperation and consultation 2) created a functional framework for improving working relationships for better understanding the work of other agencies 3) stressed the importance of environmental concerns earlier in the project development process 4) built trust and understanding amongst agencies 5) increased the credibility and support of projects and programs by involving affected agencies in the planning process 6) streamlined the conformity analysis by getting interagency groups to an early agreement on technical and procedural requirements.

Strong communication channels to reach air pollution-affected communities

An AQI is a tool to disseminate information on air quality in qualitative terms (good, satisfactory, moderate, poor, very poor, severe) with corresponding color codes²⁸. The AQI should be easy to associate with health effects and provide additional information relating to potential health symptoms and advice as to what action to take. Improvements in air quality depend on the support of citizens who are well-informed about local and national air pollution problems and about the progress of mitigation efforts. Many air pollution guidelines consider the importance of alerts when air pollution becomes serious and action needs to be taken²⁹. The public should be involved in developing risk communication from the outset and can contribute to the assessment and management of risk. Essential elements for effective risk communication are information quality, transparency, the simplicity and coherence of the message, receptivity to public concerns and timing. Communication approaches should be participatory and integrate sociological methods into traditional public health-oriented ones. While this may increase effort and cost, it is useful in managing controversy, when and if it develops during high air pollution emergencies.

Involving the public as stakeholders helps establish effective communication and reciprocal exchange of information and is conducive to finding innovative solutions, thus moving away from one-way communication models³⁰.

Develop a range of possible policy interventions to reduce air pollution at its sources

As the local scientific evidence base concerning the health harms from air pollution grows, so will the need for a range of possible policy interventions to reduce air pollution sources. Plans to reduce vehicle, industrial, construction, agricultural and other air pollution sources will be a necessary complement to air pollution monitoring and health risk communication, under systems like the AQI. Other plans like planting trees to reduce fine particulate air pollution show promising results. By combining several approaches, air pollution sources can be reduced while AQI programs help people adjust their behavior to protect themselves from current levels of air pollution.

Scientific studies can expand local air pollution-health evidence base

An evidence base provides the foundation for acting. Examples of the types of scientific studies that could serve to build this evidence base include: epidemiologic studies to examine possible relationships between levels of daily air pollution and respiratory hospitalizations or emergency department visits in Ahmedabad or describing the range of air pollution exposures among highly-exposed outdoor workers.

Media engagement and outreach

The media in India has been covering the nation's deteriorating air quality, and has a very critical role to play in raising public awareness of air pollution's effects on health. Moving

²⁸ Central Pollution Control Board. http://www.cpcb.nic.in/FINAL-REPORT_AQI_.pdf

²⁹ Shooter, D. and P. Brimblecombe, "Air quality indexing," *Int. J. Environment and Pollution* 36 (2009): 305–323.

³⁰ WHO Regional Office for Europe, *Health and environment: communicating the risks*, 2013, http://www.euro.who.int/_data/assets/pdf_file/0011/233759/e96930.pdf Accessed December 2, 2016.

forward, continuing to involve the media in efforts to raise public awareness and reduce air pollution is essential. The media provide expert points of view on what could be some of the tough questions in the minds of a wide range of local stakeholders, from air pollution-vulnerable city residents to local businesspeople to local policymakers.

Build capacity and engagement among health professionals on air pollution-health

AQI reporting to the public provides important information about potentially unhealthy air pollution days, and gives people ways to reduce their air pollution exposures. Health professionals can provide specific information on personal health risks of air pollution information and can encourage vulnerable people to take health-protective actions.

Medical and health professionals should consider routinely advising patients, especially those with asthma and other respiratory or cardiovascular illness, to avoid strenuous outdoor activity when the AQI is high. Besides advocating for individual patients' health, the same health professionals have the expertise that informs local interventions and policy strategies to reduce air pollution. Building capacity, advocacy, and engagement among health professionals benefits everyone.

Discussion

Ahmedabad's Communication and Outreach Plans and Experiences

An AQI would not be very effective without proper community outreach, and the message must reach the intended audience. The Ahmedabad AIR Plan³¹, in development with the NRDC and Public Health Foundation of India, is a health-based program designed to protect and increase awareness among residents on air pollution. The AIR Plan creates immediate and longer-term actions to increase preparedness, information-sharing, and response coordination to reduce the health impacts of air pollution on vulnerable populations. As part of the AIR Plan, the Ahmedabad AQI and air quality forecasts will be available on the AMC website. The website will also provide access to useful information on air quality related FAQs. Ahmedabad is also planning to use a Digital Display Board System that displays current air quality data to citizens by setting up large LED screens in populated areas in the city. Public awareness and outreach includes engaging media on the AQI and AIR Plan and developing information, education, and communication materials. Social media can be used to reach large masses of people.

Also, including organizations who advocate for the health of people with illnesses can help reach some of the most health-vulnerable people. The AIR Plan is also proposing a school flag program that would coordinate with schools to display colored flags corresponding to the daily AQI. Media engagement includes regular broadcast of AQI in newspapers and associated health advisories whenever issued by AMC. Moving forward, continuing to involve the media in efforts to raise public awareness and reduce air pollution is essential.

Ahmedabad is the economic center of the state of Gujarat. Ahmedabad includes the surrounding suburban and rural areas, and is predicted to be one of the world's fastest-growing urban areas in the coming decade³². However almost two million residents live in slums. In 2013, the city of

³¹ NRDC. https://www.nrdc.org/sites/default/files/ahmedabad_air_plan_feb_2017_final_pdf.pdf Accessed February 27, 2017.

³² Joel Kotkin. Forbes.com. October 7, 2010. <https://www.forbes.com/2010/10/07/cities-china-chicago-opinions-columnists-joel-kotkin.html> Accessed December 1, 2016.

Ahmedabad through the AMC, the NRDC and others, became the first Indian city to create a comprehensive early warning system and heat preparedness plan.³³ The goal of which was to protect the public's health and save lives. This plan has provided valuable information on how to reach Ahmedabad's vulnerable populations. For example, slum residents lack access to (or cannot afford) reliable electricity, transportation, and/ or health care. Slum residents that lack access to information (or do not seek out information) are less able to prepare or modify behavior.

The heat plan shows that effective communication to vulnerable populations should include displaying the information and forecast, early warnings, media campaigns, and distributing informational pamphlets³⁴. Ahmedabad should publicly display air quality and forecasts in high-traffic locations where many people can view the information and at vulnerable sites (schools, slums). As with the heat plan, even rickshaws were used to spread awareness. Forecasts enable people to plan to avoid unnecessary outdoor travel/work on poor air quality predicted days. Ahmedabad can identify neighborhood unofficial leaders to disseminate air quality warnings and information to slum areas, and these individuals could help activate community networks to spread the word. AMC and partner stakeholders can promote and coordinate public service announcements via television, radio, newspapers, and text messages. Telephone companies can play an important role in sending text messages as alerts. AMC can work with the health department to create pamphlets on air pollution in English, Gujarati, and Hindi to distribute to hospital staff, community groups, and schools.

These communication and outreach strategies have been very effective in Ahmedabad's heat plan. Ahmedabad's heat action plan is now used as a model for other cities in India looking to become more heat resilient. Success will hopefully continue with Ahmedabad's air quality plan.

³³ NRDC. <https://www.nrdc.org/resources/rising-temperatures-deadly-threat-preparing-communities-india-extreme-heat-events> Accessed December 1, 2016.

³⁴ NRDC. <https://www.nrdc.org/sites/default/files/india-heat-slum-communities-IB.pdf> Accessed December 1, 2016.