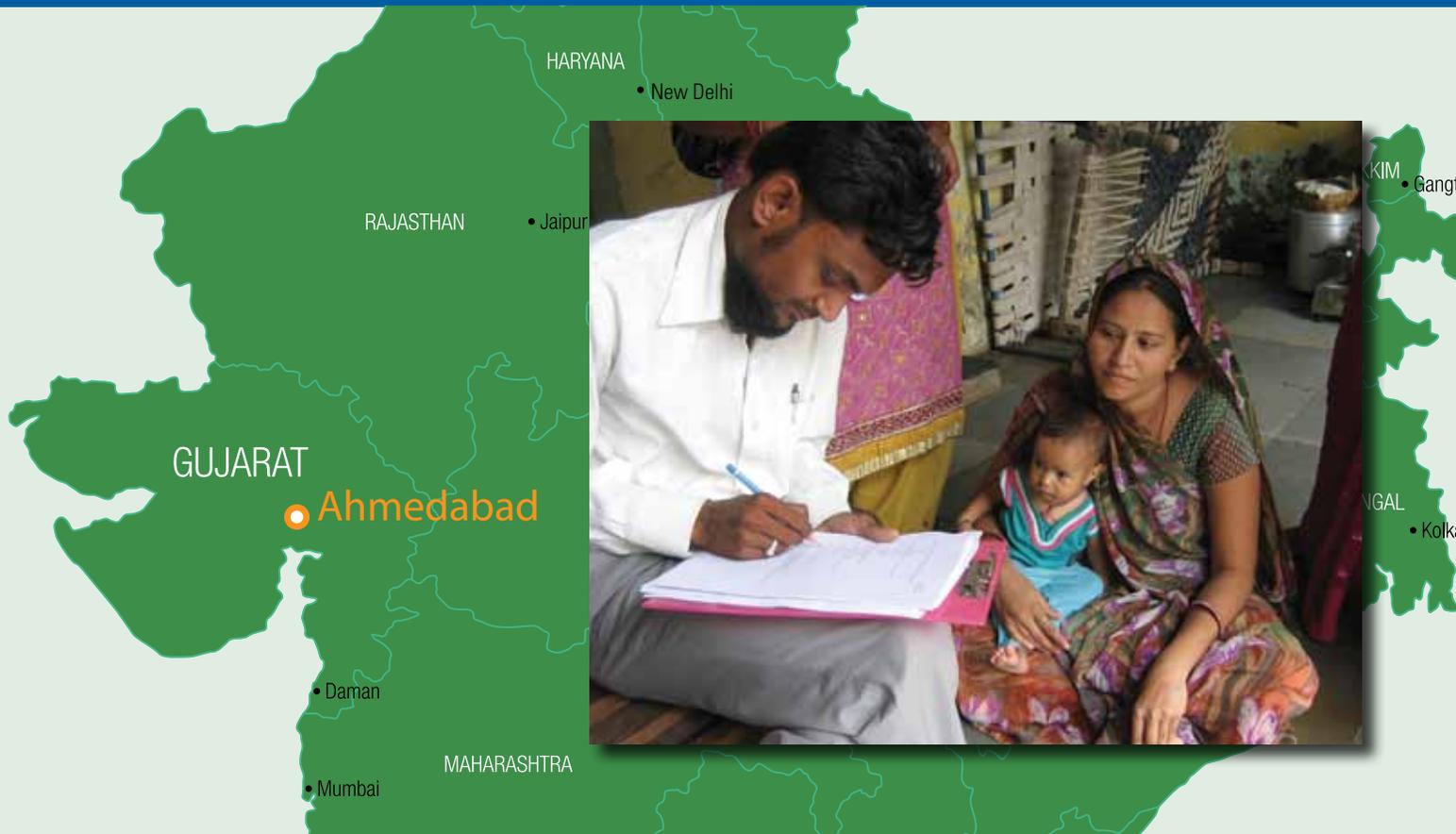


# Rising Temperatures, Deadly Threat:

## Recommendations for Ahmedabad's Government Officials



Supported in part by:



## Partnering Organizations

### *Ahmedabad Municipal Corporation*

The Ahmedabad Municipal Corporation (AMC) is the municipal governing body of Ahmedabad, responsible for the city's civic infrastructure and administration. Led by its mayor and commissioner, AMC has pioneered the development of heat vulnerability reduction strategies and an early warning system for extreme heat events to protect its residents.

[www.egovamc.com/](http://www.egovamc.com/)

### *Climate & Development Knowledge Network*

This publication was supported in part by the Climate & Development Knowledge Network (CDKN), which is supported by the UK Department for International Development (DFID) and the Netherlands Directorate-General for International Cooperation (DGIS) for the benefit of developing countries. CDKN supports and promotes innovative thinking and innovative action on climate change and development issues.

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The Indian Institute of Public Health, Gandhinagar (IIPH) was launched by the Public Health Foundation of India (PHFI), and is a leader on public health education, advocacy and research on public health. IIPH pushes the mandate of equity in public health, applying strategy, resources and networks to the issues and practice of public health in India. IIPH's programs aim to make education and research activities relevant to India in content and context.

[www.phfi.org](http://www.phfi.org)

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### *Rollins School of Public Health of Emory University*

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[www.sph.emory.edu](http://www.sph.emory.edu)

*Key researchers and authors:* Dr. Jeremy Hess, Kathy Van Tran

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The Natural Resources Defense Council (NRDC) is one of the most effective environmental groups, combining 1.3 million members and online activists with the expertise of more than 350 scientists and other professionals. NRDC is a leader in public health research, policy, and advocacy—including building resilience in local communities and fighting climate change. In 2009, we launched our India Initiative focused on climate change and clean energy with projects on climate adaptation and energy efficiency. With our partners, we advocate for increased policy development and implementation to protect communities from environmental threats.

[www.nrdc.org](http://www.nrdc.org)

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Cover image: Summer 2011 survey administrator and respondents in Ahmedabad.

Credit: Kathy Tran/Gulrez Azhar.

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## INTRODUCTION

Higher daily peak temperatures and longer, more intense heat waves are becoming increasingly frequent globally due to climate change.<sup>1</sup> Extreme heat events already have had a significant impact in India, where summer temperatures are historically high. National programs in India exist to address many effects of climate change; nonetheless, the country has yet to implement strategies to adapt to increasing heat.<sup>2</sup> On the municipal level, more coordinated action is needed among the many government departments and organizations to reduce the devastating health effects of heat stress on the local population. Targeted policy interventions that increase information sharing, communication, preparedness, and response coordination can be implemented to improve vulnerable populations' resilience to rising temperatures.

Through the Ahmedabad Municipal Corporation (AMC), Ahmedabad is leading as the first Indian city to create a comprehensive early warning system and preparedness plan for extreme heat events. The Indian Institute of Public Health (IIPH), Public Health Foundation of India (PHFI), Natural Resources Defense Council (NRDC), Mount Sinai School of Medicine, and Rollins School of Public Health at Emory University have partnered with the AMC to protect and prepare Ahmedabad for extreme heat events. This brief is one of four published to provide specific recommendations for leading stakeholders and the most vulnerable residents who will be impacted by extreme heat: key government agencies, health care professionals, outdoor workers, and slum communities.

### Ahmedabad Snapshot

One of India's fastest-growing cities, Ahmedabad is the economic center of the state of Gujarat. The Ahmedabad district, including the surrounding suburban and rural areas, is home to 7.2 million people.<sup>3</sup> Ahmedabad is predicted to be one of the world's 19 fastest-growing urban areas in the coming decade, according to *Forbes* magazine.<sup>4</sup>

The city is located in the arid northwest region of India, where warm, dry conditions are conducive to heat waves. While summer is defined as spanning March, April, and May, Ahmedabad's hottest temperatures can run from March through June, with temperatures generally peaking in May and warm days through November.<sup>5</sup> Ahmedabad's average monthly maximum summer temperature from March through June is 38.8°C (101.8°F); in winter, November through February, the average monthly high is 28°C (82°F). The average monthly minimum temperature is 24°C (75°F) in the summertime and 15°C (59°F) in the winter.<sup>6</sup> Temperature peaks in Ahmedabad can be extreme, as experienced during the May 2010 heat wave when the temperature spiked to 46.8°C (116°F).

### REDUCING EXTREME HEAT VULNERABILITY IN AHMEDABAD

During the historic May 2010 heat wave in Ahmedabad, temperatures reached 46.8°C (116°F). Estimated daily mortality rates increased substantially during the heat wave.<sup>7</sup> IIPH and NRDC are further investigating this extreme heat period to better understand its effects on the health of Ahmedabad's population. With climate change fueling higher temperatures in Ahmedabad and elsewhere, a new scale of coordinated action among municipal and other government agencies is needed to address and prevent the harmful health effects of heat stress. It is critical to first identify which populations are most vulnerable to extreme heat, including their places of residence and work. It is also necessary to identify and prioritize policies and programs to address current and projected future health risks. In addition to these assessment steps, creating and maintaining collaborative systems within the different government departments (e.g., emergency response, emergency management, health agencies, and meteorological services) is essential to ensure streamlined coordination of existing services, create successful early warning communications, promote data sharing and health education, and identify service gaps, as a foundation for an effective early warning system before extreme heat events.

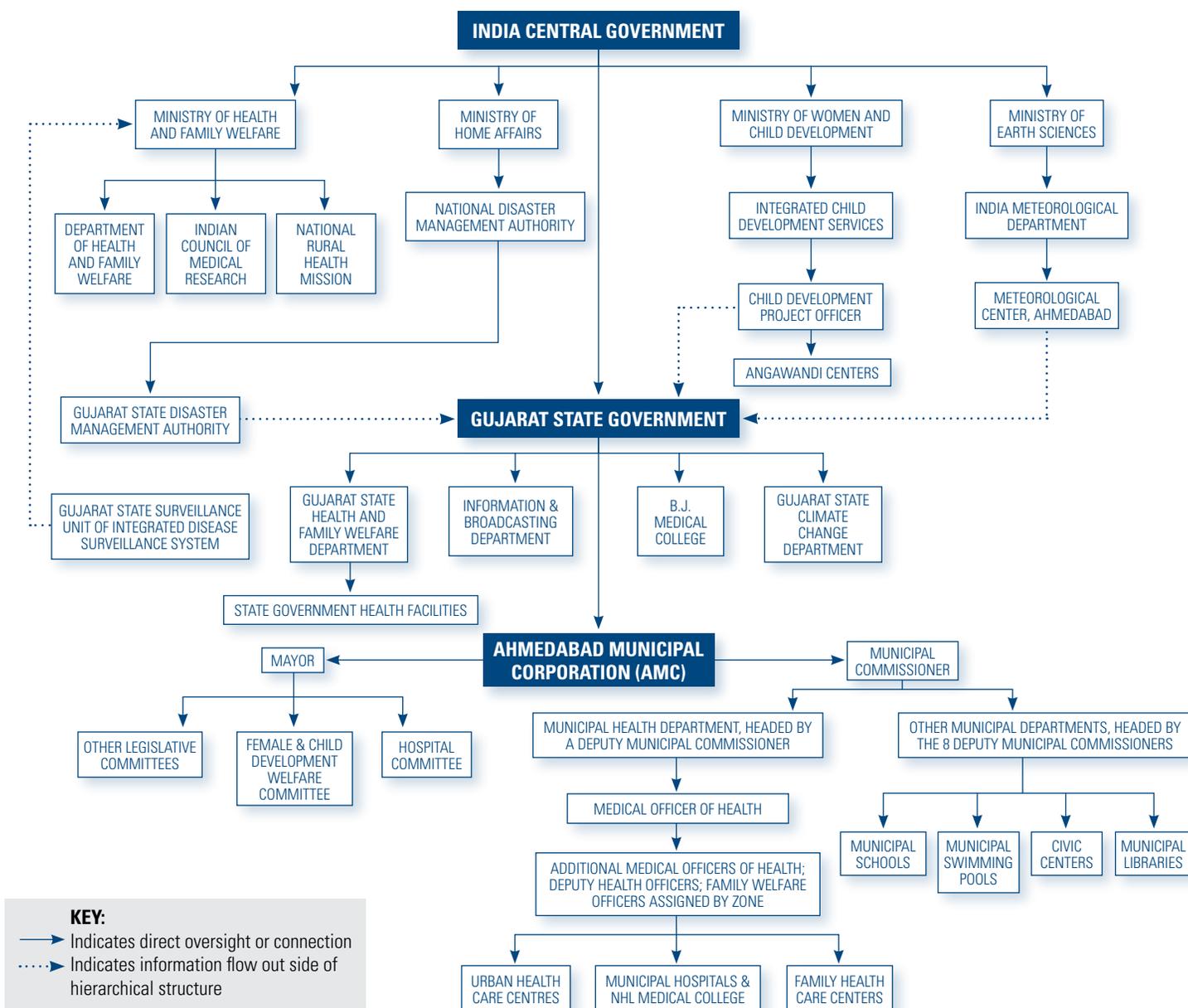


Rickshaw driver in Ahmedabad, March 2012

## KEY STAKEHOLDERS

Actions by government departments, formal and informal organizations, and professionals at multiple levels of the Indian government are necessary to prepare Ahmedabad residents for extreme heat. Despite initial steps by the AMC and the government of Gujarat, more remains to be done to achieve this important objective. Coordinated stakeholder action by the groups listed in Figure 1 and described below is essential to develop and communicate prevention messages and alerts related to extreme heat and heat illness, prepare for extreme heat events and their health impacts, and identify and stabilize patients with heat illness.

Figure 1: Ahmedabad Extreme Heat Early Warning System and Adaptation Network Stakeholders



Source: Information collected from personal interviews and data available at the following websites: Health and Family Welfare Department, government of Gujarat, available at [india.gov.in/outerwin.php?id=http://mohfw.nic.in/](http://india.gov.in/outerwin.php?id=http://mohfw.nic.in/). Ahmedabad Municipal Corporation, available at [www.egovamc.com/home.aspx](http://www.egovamc.com/home.aspx).

## Stakeholders at the Central Government Level

### ■ Ministry of Health and Family Welfare<sup>8</sup>

This ministry provides technical advice on medical and public health matters and implements various health services. Existing programs can be expanded to include activities that address the health impacts of extreme heat and climate change:

- *Department of Health and Family Welfare*. Responsible for health-related issues such as emergency medical relief, health research, hospitals, and public health.<sup>9</sup> Central government health facilities include a general hospital, a hospital for chest diseases, and 42 dispensaries in Ahmedabad.
- *National Rural Health Mission*. Facilitates integrated comprehensive primary health care services, especially to vulnerable communities. The mission includes developing District Health Action Plans and could be extended to implementing a heat-health early warning system in Ahmedabad.<sup>10</sup> The Rural Health Mission along with a proposed National Urban Health Mission has the potential to bring about fundamental changes to the country's health care system.
- *Indian Council of Medical Research*. Coordinates and promotes biomedical research throughout India and sponsors workshops on climate change and health.<sup>11</sup>

### ■ Ministry of Home Affairs

This ministry hosts and oversees disaster management authorities. Extreme heat and its health impacts are not currently considered within its purview, but it could be relevant to responding to extreme heat events moving forward:

- *National Disaster Management Authority (NDMA)*.<sup>12</sup> Oversees policies, programs, and guidelines for disaster response and risk mitigation projects for chemical, flood, and river erosion; avalanches; and urban flooding. Currently, heat waves are not one of NDMA's national disaster categories.<sup>13</sup>
- *Gujarat State Disaster Management Authority*.<sup>14</sup> Oversees the state's preparedness and response to natural disasters, and manages the State Disaster Resource Network, a database containing local disaster preparedness plans and contact information.<sup>15</sup> Heat waves are currently not part of the database.

### ■ Ministry of Women and Child Development

The ministry has responsibility for several state programs and stakeholder groups that could be integrated in a plan to mitigate the health impacts of heat, including:<sup>16</sup>

- *Integrated Child Development Services (ICDS)*.<sup>17</sup> Provides health care and supplemental nutrition to children under the age of 6 and expectant and nursing mothers through a national network of centers.
- *Child Development Project Officers*.<sup>18</sup> Lead ICDS projects at the state level, oversee the running of Anganwadi Centers, and report progress to the Gujarat state government.
- *Anganwadi Centers*.<sup>19</sup> Offer health care and nutritional supplements to young children and expectant mothers.

### ■ Ministry of Earth Sciences

This ministry is responsible for providing national forecasts and projections using global circulation models of monsoons, weather and climate cycles, the ocean's current state, earthquakes, tsunamis, and other earth system phenomena.<sup>20</sup> The ministry includes:

- *Indian Meteorological Department*.<sup>21</sup> Provides current and forecast weather information and warnings of severe weather phenomena including tropical cyclones, dust storms, heavy rains and snow, and cold and heat waves. The Department oversees Meteorological Centres in state capitals, including the center in Ahmedabad.<sup>22</sup>
- *Meteorological Centre, Ahmedabad (Met Centre)*.<sup>23</sup> Provides periodic climatological services, weather forecasts, and warnings for the general public and government agencies in Ahmedabad. Currently, temperature measurements are continuously monitored in only two locations, an observatory and the automatic weather station at Ahmedabad airport; daily temperature data exist for most of the past 100 years. Temperature records are confirmed by the Indian Meteorological Department in Delhi and shared with *National Oceanic and Atmospheric Administration* in the United States.

### ■ Ministry of Environment and Forests

The ministry is responsible for planning, promoting, coordinating, and overseeing the implementation of environmental and forestry programs and the administration of India's national parks.<sup>24</sup> Its primary activities include conservation and survey of India's flora, fauna, forests, and other wilderness areas; prevention and control of pollution; tree planting, and mitigation of land degradation.



Meteorological Centre, Ahmedabad, March 2012

### What Defines a Heat Wave in Ahmedabad?

The Met Centre currently determines whether to declare a heat wave once the daily maximum temperature exceeds 40°C (104°F).<sup>25</sup> A heat wave is declared if the normal maximum temperature should be 40°C or lower and the forecast maximum temperature is actually 5°C to 6°C above normal; it is also declared if the forecast maximum is higher than 45°C (113°F) regardless of the normal maximum. A severe heat wave is declared if the forecast maximum temperature is 7°C higher than the normal maximum.<sup>26</sup> A heat wave is forecast 48 hours in advance and can be declared for a single day.<sup>27</sup>

### Stakeholders at the Gujarat State Government Level

#### ■ Gujarat State Health and Family Welfare Department<sup>28</sup>

This department oversees a network of health and medical facilities throughout Gujarat. These facilities include a civil hospital, an oncological (cancer) hospital, a nephrological (kidney ailments) hospital, and a cardiac (heart ailments) hospital.<sup>29</sup>

#### ■ Gujarat State Climate Change Department

In 2009, the Gujarat government established a separate department to coordinate with government agencies in addressing climate change mitigation and adaptation, the first of its kind in India.<sup>30</sup> The department aims to conduct research and to promote partnership among communities to become active agents of sustainable development. The department includes 39 initiatives on energy and petrochemicals, urban transportation, forest and environment, rural and industrial development, and mines.

■ **Gujarat Energy Development Authority (GEDA)**

GEDA is the state nodal agency for the Ministry of New and Renewable Energy and the state-designated agency for the Bureau of Energy Efficiency. It develops long-term renewables policy and implements sustainable energy programs across the state.<sup>31</sup>

■ **Gujarat State Surveillance Unit of the Integrated Disease Surveillance System**

The Gujarat State Surveillance Unit is an integrated disease-reporting system launched by the Ministry of Health and Family Welfare that operates at the state and district levels.<sup>32</sup> The system sets up a flow of information between district hospitals, medical colleges, and other health care facilities. These facilities collect and report information to a District Surveillance Unit, which reports to the State Surveillance Unit, and then to the Central Surveillance Unit.<sup>33</sup> Through the system, hospitals and other medical providers submit weekly reports on confirmed, probable, and suspected cases of specific diseases, such as malaria, dengue, dysentery, and cholera.<sup>34</sup> The existing communication protocols for disease outbreaks could be replicated as part of an early warning system for extreme heat events.

■ **Byramjee Jeejeebhoy (B.J.) Medical College**

The college is associated with Gujarat University and is partnering with PHFI, IIPH, and NRDC to research and develop a pilot early warning system for extreme heat in Ahmedabad.<sup>35</sup>

■ **Gujarat Public Works Department**

This department is the state agency in charge of construction and maintenance of buildings for most of the state departments and public undertakings. It also performs maintenance of road works, including highways.

**Stakeholders at the Ahmedabad Municipal Government Level**

■ **Ahmedabad Municipal Corporation (AMC)**

The AMC is the municipal governing body of Ahmedabad.<sup>37</sup> Its administration is shared by a mayor and a commissioner. The municipal commissioner implements policies and has deputy commissioners for city zones (Central, East, West, North, New West, and South).<sup>38</sup> The zones are divided into a total of 64 wards within the AMC for administrative purposes. The AMC is partnering with PHFI, IIPH, and NRDC to take a leading role in adopting an early warning system for extreme heat in Ahmedabad.

■ **Municipal Health Department**

This department is a central agency within the AMC.<sup>39</sup> It comprises a network of medical officers, family welfare officers, and health officers for each zone.<sup>40</sup> AMC health facilities include 3 hospitals, 23 dispensaries, 8 maternity homes, 37 family welfare centers,<sup>41</sup> an ophthalmological hospital (specializing in treatment of the eye), and an infectious disease hospital (see Figure 2 below).<sup>42</sup>

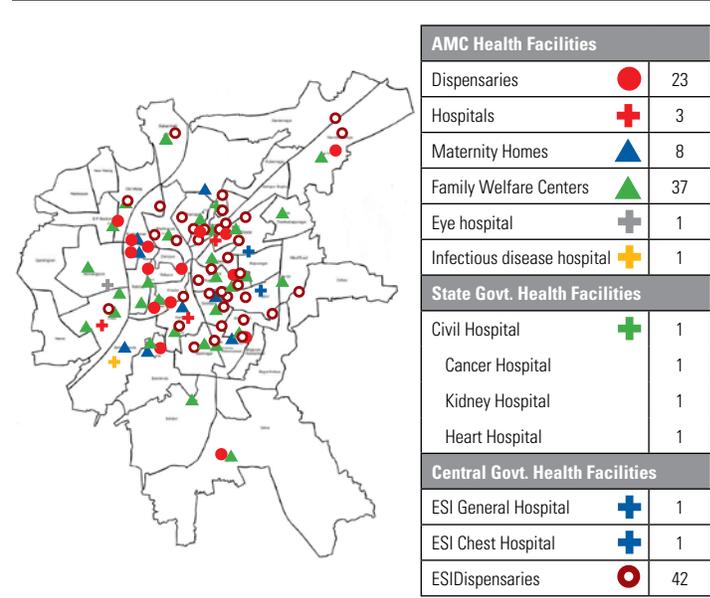
■ **Other Municipal Departments**

The AMC provides and administers a number of other institutions that are relevant to a heat adaption system, including the Ahmedabad Urban Development Authority, Municipal Transport Services, Labor and Employment Department, and Municipal Corporation Water Project Department. The AMC also operates civic centers where citizens can transact business with government entities, municipal libraries, swimming pools, and schools.<sup>43</sup>

**Lessons From California’s Experience: Improving Government Response to Climate Change<sup>36</sup>**

The California Energy Commission investigated the challenges faced by climate change adaptation efforts in the San Francisco Bay Area. Institutional governance concerns, such as legal obstacles and limited jurisdictions, were identified as the most prevalent barriers to implementation of climate adaptation measures. Other barriers to self-organizing to initiate adaptive change included attitudes, values, and motivations among the population. Resources and funding issues were also identified as barriers, even in relatively affluent areas. Last, politics and leadership play a critical role in moving adaptation forward, and inadequate leadership was found to be a hindrance to progress.

**Figure 2: Locations of AMC Health Facilities**



Source: Graphic and data from the Ahmedavad Municipal Corporation website: [www.egovamc.com/home.aspx](http://www.egovamc.com/home.aspx).

## CURRENT OR POTENTIAL DISASTER RELIEF AND ADAPTATION INITIATIVES IN AHMEDABAD

Initial strategies are being formulated both to improve general disaster preparedness and specifically to protect Ahmedabad residents from extreme heat. Building on these preliminary efforts and existing protocols will help develop an effective early warning system for the city. Enhancing interdisciplinary coordination among the various stakeholders is essential to the success of preparing local communities for extreme heat.

### Initiatives at the Central Government Level

■ **Severe Weather Warning System:** The Met Centre is responsible for issuing severe weather warnings to the general public, the press, and the concerned departments of central and state governments including the departments of Agriculture, Power, Irrigation, Roadways and Railways, Aviation, Ports and Fisheries, Sport and Tourism, and Industries. The Met Centre periodically disseminates forecasts through local radio and media.<sup>44</sup> It currently does not systematically notify local government officials and agencies, hospitals, or community groups of severe weather warnings. In order to expand the reach of extreme weather warnings, the Met Centre plans to create a dedicated weather channel that would disseminate weather forecasts and warnings, but such a channel has not been established to date.<sup>45</sup>

■ **Heat Wave Warning System:** The Met Centre is required to notify the state government of a predicted heat wave (via fax and text message) two days prior to its occurrence, along with a 96-hour outlook for temperatures. Protocol requires that a relief commissioner be notified at the state-level control room and a press bulletin be sent to the local media. The alerts that are sent from the Met Centre to the state government are then forwarded to the local news media and the AMC. A service to receive the daily weather forecast from the Met Centre via text message and email is also available for a fee, but the AMC currently is not enrolled. Municipal hospitals are also not currently notified of heat wave warnings, either by the Met Centre or the AMC.

■ **Weather Gauges:** In 2011, working with the Gujarat Climate Change Department, the AMC and the Met Centre announced plans to install several new weather gauges to supplement the one that the city currently uses (see Figure 3, below). The plans have yet to be implemented and depend on the availability of financial resources in the coming years. The planned temperature gauges would enable scientists to examine historical weather trends, determine high-risk areas, and develop a better understanding of how temperature varies within the city. This information will help the Met Centre and AMC to warn local communities about impending heat waves, which is critical to protecting vulnerable residents from heat exhaustion, heat stroke, and other heat-related illnesses, some of which can be fatal.

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Automatic (right) and manual (left) weather gauges at Met Centre, Ahmedabad

Figure 3: Proposed Sites for Weather Gauges in Ahmedabad



In addition to the city's one weather gauge, Ahmedabad officials are proposing the following locations for 10 more, as shown on the map below: Sarkhej (A), Ognaj (B), Chandkheda (C), Astodia (D), Vasna (E), Narod (F), Memco (G), Odhav (H), Bapunagar (I), and Vatva (J).

Source: Google Maps.

## Initiatives at the State Government Level

■ **Gujarat Action Plan on Climate Change:** In 2011, Gujarat officials started developing a climate change state action plan, which focuses on areas of the National Missions on Solar, Energy Efficiency, Sustainable Habitat, Sustainable Agriculture, and Water.<sup>46</sup> This action plan includes proposals for additional research on climate adaptation for extreme heat events.

■ **Heat-Related Emergency Data Collection:** The GVK Emergency Management Research Institute (EMRI) and the Gujarat Department of Health signed a memorandum of understanding to provide around-the-clock emergency medical services, including for heat-related emergencies, to the entire state through a “108 Emergency Response Service.”<sup>47</sup> Those needing assistance can call a toll-free number, accessible from a landline or mobile phone. EMRI is currently building a database of heat-related emergencies in Ahmedabad to inform the development of the city’s early warning system.

■ **Gujarat State Integrated Disease Surveillance Program (IDSP):** The IDSP is intended for integrated paper-based and electronic reporting of diseases, with a flow of information between district hospitals, medical colleges, other health care facilities, the State Surveillance Unit, and the Central Surveillance Unit.<sup>48</sup> Gujarat’s state-level unit of the IDSP collects and analyzes weekly data regarding disease outbreaks in Ahmedabad and across the state, and monitors major urban areas for signs of disease outbreaks including malaria, dengue, dysentery, and cholera. Once a disease outbreak is expected, warnings are circulated directly from IDSP to the appropriate commissioners, health officers, and chief district health officers, and predetermined rapid response teams visit the outbreak areas for immediate intervention. Currently there are three ways to report an epidemic: syndromic, presumptive, and laboratory.

■ **Gujarat State Disaster Resource Network (SDRN):**<sup>49</sup> Following the 2001 earthquake, the Gujarat State Disaster Management Authority was created to better prepare for future disasters. The authority, in turn, established the SDRN to create a database of disaster management plans and contact information at the state, district, and village levels.<sup>50</sup> Although the database is not publicly accessible, it includes information on past disasters and the emergency contacts of disaster management committees at various administrative levels.<sup>51</sup> Heat waves are currently not included in the database.



Dr. Perry Sheffield of Mount Sinai School of Medicine leads a focus group discussion with local medical professionals at the March 2012 “Health Effects of Heat in Relation to Climate Change” workshop in Ahmedabad

© Anthony Berger

## Initiatives at the Municipal Government Level

■ **Ahmedabad Heat Adaptation Discussions:** In March 2011, AMC partnered with NRDC, PHFI, and IIPH to bring together leading experts from India and the United States to kick off discussions about heat adaptation strategies in Ahmedabad. More than 40 expert scientists, municipal and state administrators, and health officials collaborated to develop recommendations addressing heat-related health vulnerability for the city. In March 2012, the AMC hosted a workshop on “Health Effects of Heat in Relation to Climate Change: Building Resilience to, and Protecting Local Residents From, Increasing Extreme Heat in Ahmedabad,” with PHFI, IIPH, NRDC, and the Mount Sinai School of Medicine. At the workshop, city leaders, medical professionals, and leading experts discussed the role of health professionals in improving preparedness for extreme heat events.

■ **Heat Vulnerability Assessment:** During the summer of 2011, AMC, PHFI, IIPH, NRDC, and the School of Public Health at Emory University conducted one of the first heat vulnerability assessments. The survey examined household health history, heat susceptibility, heat stress knowledge, heat exposure adaptation, and access to resources in slum communities. The project involved educating and distributing an informational pamphlet on reducing extreme heat’s health risks to the elderly and families with young children living in slum communities. AMC is continuing to partner with the joint Indo-U.S. team to launch an early warning system for extreme heat in 2013.



Smt. Shardaben General Hospital in Ahmedabad



Close-up of the white china mosaic tiles on the hospital's roof

■ **AMC Hospital Changes:** The AMC-run Smt. Shardaben General Hospital serves some of the poorest slum communities of Ahmedabad. As a result of the discussions at the March 2011 Indo-U.S. heat-health workshop, the hospital took scalable actions to begin mitigating the effect of extreme heat on patients:

- The AMC has replaced the black tar roof of the government hospital, which treats mostly children, with a reflective white china mosaic roof—providing for cooler indoor temperatures. About seven of the 64 urban health centers have now installed china mosaic roofs.
- The hospital moved the maternity ward from the top floor to the ground floor during the summer to reduce exposure to extreme temperatures for vulnerable newborns and new mothers. Doctors observed noticeably cooler temperatures on the top ward and lower infant mortality rates after these changes.<sup>52</sup>

■ **Control Rooms for Monsoon Preparation:**<sup>53</sup> The AMC has created special control rooms in its main and zonal offices to prepare for and serve as centers for solving citizen problems during the heavy monsoon season. The control rooms are staffed 24 hours a day, and citizens can utilize them to file monsoon-related complaints. The control rooms currently do not serve the community for extreme heat warnings and assistance.

■ **All India Disaster Mitigation Institute (AIDMI):** AIDMI is a community-based action research and advocacy organization working on disaster management and mitigation since 1995.<sup>54</sup> AIDMI conducted a risk assessment in AMC schools to evaluate the understanding of disaster preparedness among staff and students, current disaster mitigation practices, and the structural safety of schools.<sup>55</sup>

■ **Tree Census and Planting:** The AMC in conjunction with Gujarat University and the State Forest Department is conducting a tree census to determine current green cover as part of a digital database to inform efforts on increasing the city's urban green space.<sup>56</sup> Starting in 2010, the AMC organized one of the world's largest tree planting drives to counter the negative effects of climate change. More than 29,000 people planted 848,301 saplings in 400 preselected sites, and 500,000 seedlings were distributed throughout Ahmedabad.<sup>57</sup> These greening efforts support heat preparedness and climate mitigation efforts.

## **POLICY RECOMMENDATIONS: BUILDING RESILIENCE TO EXTREME HEAT IN AHMEDABAD**

While basic institutional infrastructure exists and initial activities supporting public health preparedness for extreme heat in Ahmedabad are under way, much more needs to be done to improve interdisciplinary communication, collaboration, and project implementation. Coordinated early action by municipalities, health officials, and other stakeholders to prepare for extreme heat events is one of the most effective ways to build resilience and protect resident health.<sup>58</sup>

## **Best Practices for Extreme Heat Preparedness Programs**

Experience in Ahmedabad and elsewhere in the world shows that an effective preparedness program for the health impacts of severe heat incorporates:<sup>59</sup>

- A designated nodal agency or steering committee to coordinate reliable communication, timely dissemination of health-relevant information, and strong working relationships among various government agencies.
- A reliable, calibrated early warning system that highlights dangerous exposures to heat and outlines measures to reduce risk and prepare for heat illness. Such a warning system should 1) have clear activation thresholds, 2) set out the types of action to be taken when a threshold is met, and 3) designate who is responsible for each action.
- Identify vulnerable populations (e.g., young children, the elderly, people with heart or lung illnesses, families living in poverty, and workers in high-risk occupations), where they are located, factors that increase their vulnerability, factors that could be capitalized on to increase their resilience, and appropriate communication strategies.
- Monitoring and tracking heat health threats and appropriate responses, in order to build an accessible and rigorous database that can be used to assess risk and evaluate interventions.
- Educational outreach to health care practitioners and community members, as well as public awareness campaigns that incorporate clear action statements. These campaigns should be launched prior to each summer season and repeated periodically throughout the season, particularly at the onset of a heat wave event.
- Creation of emergency response plans that are integrated into broad, multi-disease surveillance and warning systems.

## Spotlight: Toronto's Heat-Health Alert System

The city of Toronto, Canada, has a fully operational heat-health warning system.<sup>60</sup> From May 15 to September 30, when temperatures rise, Toronto Public Health staff monitor the Heat-Health Alert System to determine when the Medical Officer of Health should declare a heat alert or extreme heat alert. Using spatial synoptic classification, the Heat-Health Alert System compares forecast data to historical meteorological conditions that have led to increased mortality in Toronto. Forecast data include temperature, dew point, humidity, cloud cover, wind speed and direction, and the number of consecutive days on which oppressive conditions occurred. Toronto declares a heat alert when forecasts suggest a level of mortality between 25 and 50 percent greater than what would be expected on a typical summer day. An extreme heat alert is declared when forecasts suggest a level of daily mortality at least 50 percent greater than what would typically be expected. If a heat alert is declared, the Health Department notifies key response partners, community agencies, and the public. Hot weather response activities focus on protecting vulnerable groups at increased risk for heat-related illness. In addition, the city opens seven cooling centers, with water and snacks available;<sup>61</sup> Parks, Forestry, and Recreation departments extend the operating hours of city pools;<sup>62</sup> and the city's updated Hot Weather Response Plan is available to everyone online, disclosing the framework of the governmental and nongovernmental members of the response team and plans for communication of extreme heat conditions.<sup>63</sup>

Increased adaptive capacities and integrated coordination of key partners are needed to implement an effective heat-health early warning system in Ahmedabad. The following recommendations, based on IIPH's and NRDC's work with partners and public health experts in Ahmedabad and the U.S. over the past two years, are organized into short- and long-term action steps for the different stakeholders best suited to contribute to an early warning and public protection system to reduce the health-related impacts of extreme heat in Ahmedabad.

## AHMEDABAD MUNICIPAL CORPORATION (AMC)

### Immediate Opportunities

- *Create a Heat-Health Nodal Office within AMC to pilot the heat-health early warning system.* Appoint an AMC officer to head the new early warning system and be responsible to coordinate and communicate ahead of, and during, extreme heat events; and provide support staff as necessary. Among other duties identified below, the nodal office should organize preventive training and outreach efforts for health workers, link workers, schoolchildren, and the local community. The office should also coordinate communication internally and externally among the relevant departments and organizations, including the Met Centre, hospitals and health centers, and media outlets, ahead of forecast heat waves, and organize interventions such as providing tankers of water and keeping parks open later to protect residents during extreme heat events.
- *Improve internal communication among state and local agencies.* Create formal and efficient communication channels among the AMC, the Met Centre, health officials and hospitals, and emergency response communities to warn of arriving heat waves. The AMC should directly receive heat wave warning information from the Met Centre and formalize the process to notify the Health Department, which in turn should notify hospitals, health centers, and link workers of an upcoming heat wave.
- *Increase heat- and health-related information dissemination:*
  - Work with the Health Department to create a multilingual pamphlet, in English, Gujarati, and Hindi, to distribute to hospital workers, labor unions and professional associations serving at-risk occupations, community groups (with a focus on vulnerable neighborhoods), and schools on heat stress prevention and tips to prevent heat stress.<sup>64</sup> An initial pamphlet for the general public with tips and illustrations was circulated in English and Gujarati during Ahmedabad's hottest months in 2012 (see Figure 4).
  - Train community leaders to help the elderly and children during heat waves, and create a buddy system in which neighbors check on each other during heat waves.
  - Create a free "heat line" call center to provide public support during heat waves, and publicize the service within slum communities. The heat line could have an information system to provide guidance to heat stroke victims and tips on heat stress prevention. The Met Centre currently has a phone line that periodically provides temperature information, but it is not widely operational.

Figure 4: Informational pamphlets with tips on keeping cool in Gujarati (left) and English (right), circulated to the public during Ahmedabad's hottest months in 2012



■ Work with local press and media outlets, including newspapers, radio, and television, to publicize heat warnings and produce ads on heat-health awareness, protection strategies, and the availability of the heat line. The media should be encouraged to provide low- or no cost-space in their venue for public interest announcements.

■ Develop Heat Vulnerability Reduction Communication Strategies for the community, informed by the heat vulnerability assessments. The communication strategies should identify the cooperating agencies, which agency will take the lead, which heat-vulnerable communities to target, and which materials to distribute. Mobile phone operators can play an important role in sending text messages as alerts.<sup>65</sup>

■ Work with the Information Department of the government of Gujarat to reach all communities and equip them with information to prepare for upcoming heat waves.<sup>66</sup>

■ *Assess and prioritize heat-vulnerable communities.* Identify the most heat-vulnerable neighborhoods in Ahmedabad by assessing heat risk factors, such as high numbers of elderly residents, limited water service, and high incidence of heat-related illness in the past. Prioritize these locations for educational outreach by link workers and implementation of heat vulnerability reduction measures.

■ *Issue public service announcements and health warnings* as soon as a heat wave is anticipated—and ideally at least two to five days in advance of a heat wave—on the radio and in newspapers, in coordination with the Met Centre and the AMC Health Department.<sup>67</sup> Set up email listservs to notify relevant stakeholders, and work with private-sector telecom companies on text alerts to circulate warnings.

■ *Use AMC-run night shelters* in the city as daytime shelters for protection against extreme heat during heat waves.

## Longer-term Opportunities

### ■ *Form partnerships and heat-health preparedness networks:*

Deepen engagement with local stakeholders and develop a network of multidisciplinary professionals, including public health professionals, clinical medical specialists, urban planners, environmental experts, occupational health experts, and administrators, locally and internationally, to develop actionable heat-health programs.

- Work with other cities and states to build a heat-health preparedness network.

- Integrate the heat early warning systems into India's Integrated Disease Surveillance System.

### ■ *Pilot green projects in government buildings.* The AMC should showcase the benefits of heat mitigation efforts in government buildings and popularize passive cooling design elements by kicking off a cool roofs initiative with the Ahmedabad Urban Development Authority.

- Conduct a pilot project to assess the efficacy and cost-effectiveness of painting a building roof white.

- Assuming the pilot is successful, develop an initiative to paint all municipal buildings' roofs white, and provide incentives to local businesses and residents to do the same.

- Implement rainwater harvesting at all government buildings, both as a passive cooling technique and to increase water supply in times of extreme heat.

### ■ *Work with the state government to issue heat-related illness warnings and increase preparedness to treat patients during heat waves.* Develop hospital staffing plans and protocols to treat an increased number of patients during heat waves. Currently, the state government issues a circular to the municipal hospitals with disease epidemic warnings and sends a special team to the hospitals in the event of an epidemic, but heat-related illnesses are not included. For certain epidemics and diseases, the State Health Department creates an epidemic wing. AMC should work with the state government to include heat-related illnesses among the epidemics for which it issues warnings.

### ■ *Create incentives and requirements for local businesses employing outdoor workers to provide cool water, shade, and rest periods in cool areas.*<sup>68</sup>

### ■ *Complete the 2012 Inventory of Canopy Cover* to fulfill AMC's obligations for urban tree canopy cover under the Urban Environmental Accords, and publish the results of the 2012 tree census. Use this documentation of the number and types of trees to inform implementation of the Accord's goals for canopy cover and urban green space, and expand tree canopy, particularly in slum communities, to help alleviate the impacts of the urban heat island effect, especially on vulnerable populations.<sup>69</sup>

## METEOROLOGICAL CENTRE

### Immediate Opportunities

### ■ *Increase communication channels between the Met Centre, AMC, and the Health Department* to institute heat-related health alerts and deepen network collaboration to share data on impending extreme heat events and resulting health effects. Ensure that the channels of communication are operational for the duration of the heat wave warnings issued by the Met Centre.

### ■ *Implement plans to create a dedicated weather channel* to share information on extreme weather and provide access to online sources of Met Centre data to help inform the public of forecast extreme heat events.<sup>70</sup>

### ■ *Revise the current heat wave advisory threshold definition* after consultation with the Health Department about what temperatures trigger mortality and morbidity in Ahmedabad. A process of yearly reevaluation of the heat wave advisory threshold should be established based on the mortality and morbidity data collected as part of the heat early warning system.

### Longer-term Opportunities

### ■ *Work with the AMC and state government* to publicly display temperature and weather forecasts so unessential travel or work can be avoided on the hottest predicted days. Priority should be given to high-traffic locations where many people can view the information, and to highly vulnerable sites where the possibility of the heat island effect is magnified due to lack of trees, dense vehicle traffic, large amounts of paved area, and local heat-generating sources.

### ■ *Install additional temperature gauges across the city* to collect temperature and humidity data on different wards' microclimates (see Figure 3). Coordinate with the Department of Climate Change to achieve this goal.

### ■ *Extend the mandate and capacity of the special control rooms* created for relief during the heavy monsoon season to handle heat waves as well. The Met Centre currently sends monsoon forecasts to the state-level control rooms, which then send the information and high-rainfall alerts to concerned commissioners and district officials across the state. The Met Centre and state government can follow a similar forecast dissemination process for extreme heat warnings to inform concerned health officials and commissioners.

### ■ *Measure air pollution and air quality* in conjunction with extreme temperatures to test for, and forecast, the cumulative negative health effects of extreme heat and associated air pollution.

- *Conduct geomapping and spatial analysis* of the ongoing summer heat-related deaths and illness cases, which started being tracked in 2010, to give the Health Department information to conduct descriptive epidemiological studies.
- *Analyze historical data available for the past 100 years*, and work with the Indian Meteorological Department to determine the local trend in daily maximum, minimum, and average temperatures for Ahmedabad to create a rigorous database for city temperature variations, which will inform the heat wave threshold advisory definition.

## HEALTH DEPARTMENT, AHMEDABAD MUNICIPAL CORPORATION

### Immediate Opportunities

- *Conduct heat vulnerability reduction training to increase awareness and diagnosis of heat illnesses:*
  - Provide a train-the-trainers session for primary medical officers so they can offer heat-specific advice (symptoms, diagnosis, and treatment including self-monitoring hydration) to their medical staff.
  - Create a training program or multiday workshop for health care providers, ward leaders, and paramedics on extreme heat and health, including specifics on heat case diagnosis and management, especially during heat waves.<sup>72</sup> Also, conduct training programs for link workers for outreach and community-based surveillance of heat illness in slum communities. Training should include information on how to counsel patients, what threshold temperatures apply for different levels of treatment, when to increase staffing to handle hospital capacity, and surveillance protocols.
  - Work with the GVK Emergency Management and Research Institute (EMRI) to train emergency service professionals on responding to extreme heat emergency cases.<sup>73</sup>
  - Increase heat stress outreach and education for women in maternity wards before they leave the hospital, since newborns make up a high proportion of heat-related deaths.
  - Identify and relocate the most vulnerable patient wards (such as the neonatal ward) from the top floor of hospitals, where the temperatures are highest, to cooler parts of the building. Measure the morbidity and mortality outcomes before and after location change to evaluate the effectiveness of intervention.



Smt. Shardaben General Hospital, Ahmedabad, March 2012

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- *Undertake data collection to create a robust heat-health database:*
  - Work with urban health centers, which collect daily case data at the household level for patients who do not go to the public hospitals, to collect data on heat-related illnesses.
  - Update hospital admission and emergency-case records to add information regarding the patient's occupation and locality within the city to correlate these with heat stress.
  - Work with private hospitals, where most residents go for medical services, to collect data prospectively on heat-related cases.<sup>71</sup>
  - Work with medical colleges to share and correlate data on morbidity, mortality, ambulance use, and weather.
  - Conduct studies from 2013 onwards of heat-related illness and death, setting up systems to gather information from the AMC's emergency medical service calls, clinic visits, hospital emergency departments, hospital admissions, and labor and neonatal wards.
- *Create and implement guidelines on diagnosis and treatment of heat stress, heat exhaustion, and heat stroke* to reduce and prevent mortality and morbidity. Use materials extensively for training and communication, including informing patients via posters and pamphlets about upcoming heat warnings and providing tips to prevent heat stress.
- *Adopt heat-focused examination procedures at local hospitals and urban health centers.* Examination of admitted patients for signs and symptoms of heat-related illnesses could become routine, adding a brief procedure during the peak-heat summer months at a minimum. The basic statistics of such patients should also be recorded to identify the locations, occupations, and sociodemographics of Ahmedabad's residents most vulnerable to heat stress and illness.

## Longer-term Opportunities

- *Establish an air-conditioned treatment room or ward in each hospital, and measure its effects in both patient and health care worker populations. Collect before- and after-installation data to determine if having one to two hours per day of cool air improves health care worker productivity.*
- *Conduct an in-hospital drill of a simultaneous heat wave and disease outbreak scenario after completing heat-health training to ensure proper preparation among hospital workers.*
- *Conduct epidemiological case reviews to link heat death, risk factors, and cases of illness to daily and weekly temperatures, based on general hospital and emergency room admission information and neonatal care records.*

## GUJARAT CLIMATE CHANGE DEPARTMENT

### Immediate Opportunities

- *Incorporate adaptation to extreme heat as a key component of the state's climate change plan, including increased coordination between the Met Centre, AMC, and Health Department to enhance preparedness for extreme heat events.*
- *Include heat waves under the category of disasters set by the State Disaster Management Authority and as part of the State Disaster Resource Network. Expand the Integrated Disease Surveillance System to include reporting of heat-related symptoms.*

### Longer-term Opportunity

- *Ensure sufficient funding to the AMC, Met Centre, Health Department, and other stakeholders to enhance their initiatives on extreme heat preparedness.*

## GUJARAT ENERGY DEVELOPMENT AUTHORITY

### Immediate Opportunities

- *Implement building codes that entail passive cooling practices such as increased reflectivity of building roofs, green roofs, increased natural ventilation, and rainwater harvesting to increase the thermal comfort of interior living and work spaces. Incentive mechanisms (such as reduced taxes) can be used to accelerate green infrastructure development.*
- *Provide additional incentives for implementing passive cooling techniques in areas that are used for shelter from extreme heat, such as hospitals, clinics, homeless shelters, and public areas.*

## AHMEDABAD URBAN DEVELOPMENT AUTHORITY

### Immediate Opportunities

- *Create a map of community resources including public parks and other green space, health centers and hospitals, homeless shelters, temples, Bus Rapid Transit System (BRTS) routes, and public libraries, to increase awareness of extreme heat safety resources and adaptation strategies for vulnerable communities.*
- *Increase access to places to cool off throughout the city. Currently, most parks, lakes, swimming pools, public libraries, shopping malls, and the BRTS routes are concentrated in the northwest part of Ahmedabad, which is not easily accessible to the poorer populations who do not live there. Cooling spaces should be extended throughout the city.*
- *Keep large public parks open later during the summer to provide cool spaces for the public.<sup>74</sup>*

### Longer-term Opportunities

- *Create more park space with trees and other green cover to provide cool spaces and shade for residents. This initiative can be part of Ahmedabad's participation in the Urban Environmental Accords, which is focused on increasing green cover in the city.<sup>75</sup> Vacant areas such as side lots, parking medians, and spaces between buildings and roads can be used to create small, accessible green spaces.*
- *Implement urban planning programs such as a cool roofs initiative to paint roofs white, create green roofs and walls, and plant trees in neighborhoods to keep them cool. Incentive mechanisms can be implemented to accelerate green urban planning initiatives. Develop a strategy to evaluate the efficacy of these initiatives and the highest-priority locations for intervention.*

## AHMEDABAD MUNICIPAL TRANSPORT SERVICES

### Immediate Opportunities

- *Install additional traffic booths or covered boxes for traffic police to stand in during their shifts in hot weather, and equip traffic police with oxygen to help reduce their exposure to poor air quality at the street level.<sup>76</sup>*
- *Implement shorter and flexible shift times for traffic officers to protect them from exposure to extreme heat. Use cameras for stringent enforcement of rules at traffic signals to reduce the number of police who must regulate traffic at road intersections.*



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Covered booth for traffic police in Ahmedabad, March 2012

### Longer-term Opportunities

- *Provide safe drinking-water fountains*, preferably with cold water, at bus stops near major crossroads, in gardens, and in other public places.
- *Install shaded bus stops* that protect riders from the heat, and extend the bus route eastward to areas where more vulnerable populations reside.

### AHMEDABAD MUNICIPAL CORPORATION WATER PROJECT DEPARTMENT<sup>77</sup>

#### Immediate Opportunities

- *Commit tankers solely to deliver drinking water* to ensure that no other materials compromise the safety of the drinking water. Perform periodic inspections of tanked-in drinking water.<sup>78</sup>
- *Implement protocol for termination of all nonessential use of water* in the event of water shortages at public and private swimming pools, water fountains, and/or water parks.

### Longer-term Opportunity

- *Ensure uninterrupted safe drinking water supply* to the city residents during the summer, using water tankers when necessary.

### AHMEDABAD LABOUR AND EMPLOYMENT DEPARTMENT<sup>79</sup>

#### Immediate Opportunity

- *Improve labor law enforcement and coordination.* Construction workers, factory laborers, manual laborers who work outdoors, and individuals, often women, working in poorly ventilated indoor kitchens are very vulnerable to heat stress. Although some labor laws and other safeguards currently exist to protect workers, including site visits from labor officers and sanitary inspectors, the number of inspectors and protections is inadequate. The department should coordinate enforcement between the state and central government jurisdictions that share responsibility for labor law implementation to help alleviate heat stress on workers, particularly in periods of heat waves.

## Longer-term Opportunities

- *Work with the AMC to educate laborers and workers whose occupations require intensive work outdoors during extreme heat events (e.g., rickshaw drivers, street vendors, traffic police, construction workers, and kiln and quarry workers). Incentivize local businesses to provide cool water to occupationally at-risk workers and shift times of work to cooler hours, and organize a training and educational workshop so business owners are able to recognize and react to extreme heat, using AMC's Heat Vulnerability Reduction Communication Strategies.*
- *Increase the number of government officials and inspectors overseeing construction sites, quarries, factories, and other vulnerable work sites, particularly during high-temperature periods, to enforce labor laws related to heat safety.*

## CONCLUSION

Located in the arid northwest region of India, extreme heat events already have had a deadly impact on Ahmedabad's population. With peak daily temperatures and the frequency and intensity of heat waves predicted to increase with climate change, targeted policy interventions coordinated across multiple levels are needed to reduce the devastating health effects of heat stress in India. Under the Ahmedabad Municipal Corporation, Ahmedabad is leading as the first Indian city to create a comprehensive early warning system and preparedness plan for extreme heat events, but more remains to be done. This report's recommendations aim to identify tangible short-term and longer-term actions the AMC and other key government departments and organizations can take to increase residents' resilience to rising temperatures in Ahmedabad, including increasing information-sharing, communication, preparedness, and coordination. Looking ahead, these strategies for mitigating the effects of extreme heat can be adjusted for application in other at-risk regions within and beyond India, to help protect people from the increasingly severe effects of climate change.

## Endnotes

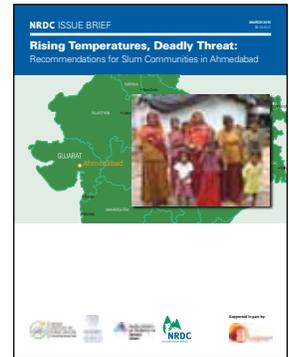
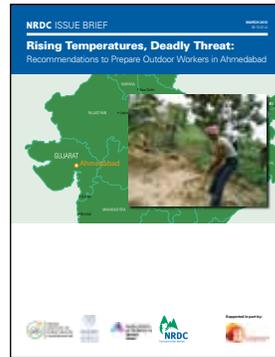
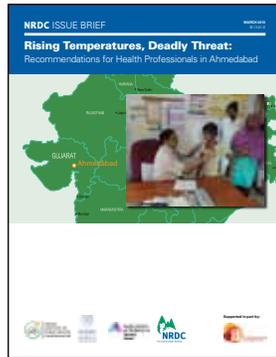
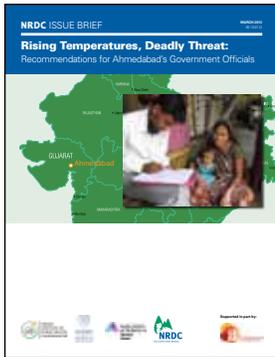
- 1 Intergovernmental Panel on Climate Change, "Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation," March 8, 2012. [www.ipcc-wg2.gov/SREX/](http://www.ipcc-wg2.gov/SREX/).
- 2 See NRDC's Fact Sheet, "India: Addressing Climate Change and Moving Towards a Low-Carbon Future," updated November 2012, for several examples of India's domestic actions and programs to address climate change. [www.nrdc.org/international/india/lowcarbonfuture-fs.asp](http://www.nrdc.org/international/india/lowcarbonfuture-fs.asp).
- 3 Office of the Registrar General & Census Commissioner, "Census of India 2011: Provisional Population Totals, Ranking of Population Districts, 2001–2011," Government of India: [www.censusindia.gov.in/2011-prov-results/prov\\_data\\_products\\_gujarat.html](http://www.censusindia.gov.in/2011-prov-results/prov_data_products_gujarat.html).
- 4 Kotkin, Joel. "The World's Fastest-Growing Cities," *Forbes*, October 7, 2010. [www.forbes.com/2010/10/07/cities-china-chicago-opinions-columnists-joel-kotkin.html](http://www.forbes.com/2010/10/07/cities-china-chicago-opinions-columnists-joel-kotkin.html).
- 5 See "Weather and Climate in Ahmedabad," Maps of India. [www.mapsofahmedabad.com/general-information/weather.html](http://www.mapsofahmedabad.com/general-information/weather.html).
- 6 Hong Kong Observatory. "Climatological Information for Ahmedabad, India." [www.hko.gov.hk/wxinfo/climat/world/eng/asia/india/ahmedabad\\_e.htm](http://www.hko.gov.hk/wxinfo/climat/world/eng/asia/india/ahmedabad_e.htm). Weatherbase.com. Weather for Ahmadabad, India. [www.weatherbase.com/weather/weatherall.php3?s=74624&refer=&units=metric&cityname=A Ahmedabad-Bihar-India](http://www.weatherbase.com/weather/weatherall.php3?s=74624&refer=&units=metric&cityname=A Ahmedabad-Bihar-India).
- 7 Calculations based on Ahmedabad's daily mortality data during May 2010, received by IIPH and NRDC from the AMC.
- 8 Ministry of Health and Family Welfare, "Introduction," [mohfw.nic.in/index1.php?lang=1&level=1&sublinkid=1&lid=13](http://mohfw.nic.in/index1.php?lang=1&level=1&sublinkid=1&lid=13).
- 9 Department of Health and Family Welfare, Ministry of Health and Family Welfare. [india.gov.in/outerwin.php?id=http://mohfw.nic.in/](http://india.gov.in/outerwin.php?id=http://mohfw.nic.in/).
- 10 See District Health Action Plans, Gujarat, Ahmedabad, National Rural Health Mission. [mohfw.nic.in/NRHM/DHAP/DHAP.htm](http://mohfw.nic.in/NRHM/DHAP/DHAP.htm).
- 11 Background, Indian Council of Medical Research. [icmr.nic.in/About\\_Us/About\\_ICMR.html](http://icmr.nic.in/About_Us/About_ICMR.html).
- 12 Roles and Responsibilities, National Disaster Management Authority. [ndma.gov.in/ndma/rolesrespons.html](http://ndma.gov.in/ndma/rolesrespons.html).
- 13 National Disaster Management Authority. [ndma.gov.in/ndma/organisation.html](http://ndma.gov.in/ndma/organisation.html).
- 14 Profile, Gujarat Disaster Management Authority. [www.gsdma.org/profile.htm](http://www.gsdma.org/profile.htm).  
Ministry of Earth Sciences. [dod.nic.in/](http://dod.nic.in/).
- 15 State Disaster Resource Network Home, Gujarat State Disaster Management Authority. [203.77.202.117/sdrnguj/index.htm](http://203.77.202.117/sdrnguj/index.htm).
- 16 Ministry of Women and Child Development. [wcd.nic.in](http://wcd.nic.in).
- 17 Integrated Child Development Services Scheme. [wcd.nic.in/icds.htm](http://wcd.nic.in/icds.htm).
- 18 Ibid.
- 19 Ibid.
- 20 Ministry of Earth Sciences. [dod.nic.in/](http://dod.nic.in/).
- 21 IMD's Mandate, India Meteorological Department. [www.imd.gov.in/doc/mandate.htm](http://www.imd.gov.in/doc/mandate.htm).
- 22 India Meteorological Department, "Organisation" website. [www.imd.gov.in/doc/organization.htm](http://www.imd.gov.in/doc/organization.htm).
- 23 Meteorological Centre, Ahmedabad. [www.imdahm.gov.in/#](http://www.imdahm.gov.in/#) ("About MC" tab).
- 24 Ministry of Environment and Forests. [envfor.nic.in/](http://envfor.nic.in/).
- 25 India Meteorological Department, Terminologies and Glossary. [www.imd.gov.in/doc/termglossary.pdf](http://www.imd.gov.in/doc/termglossary.pdf).
- 26 In seasons when normal maximum temperature exceeds 40° C, a heat wave is declared upon a departure from the normal maximum of 4°C to 5°C. If the forecast maximum temperature is 6° C (or more) higher than the normal maximum, a severe heat wave is declared. For additional information, contact: Director Meteorological Centre, RS/RW Building, Airport Colony, Ahmedabad; Toll free number:1-800-180-1717; email: [mcahm@rediffmail.com](mailto:mcahm@rediffmail.com).
- 27 Discussion at the Heat-Health Roundtable with representatives from the Met Centre, NHL Municipal Medical College, Health and Family Welfare Department, IIPH, and NRDC, Ahmedabad, September 2012.
- 28 Health and Family Welfare Department, Government of Gujarat, Introduction. [www.gujhealth.gov.in/about-introduction.htm](http://www.gujhealth.gov.in/about-introduction.htm).
- 29 Ramanj, K.V., et al. "Urban Health Status in Ahmedabad City: GIS Based Study of Baherampura, Kubernagar, and Vasna Wards," p. 36. [www.iimahd.ernet.in/publications/data/2005-03-05ramani.pdf](http://www.iimahd.ernet.in/publications/data/2005-03-05ramani.pdf).
- 30 Gujarat State Climate Change Initiatives. [www.gujaratindia.com/initiatives/initiatives.htm?enc=TEnmka18rLd9cWRBUEX85lswwfZZ+o8b+w+YfQPy7dU93tk/rntr0H+OnwOK0bubl3+goYyJYyk1/dBRv+06CbmqSVNPGxGVsK14u4slibrqAnIU6NnDw0tj6RQxr6WY2kLs1KAPRYw6nzEy3BJww==](http://www.gujaratindia.com/initiatives/initiatives.htm?enc=TEnmka18rLd9cWRBUEX85lswwfZZ+o8b+w+YfQPy7dU93tk/rntr0H+OnwOK0bubl3+goYyJYyk1/dBRv+06CbmqSVNPGxGVsK14u4slibrqAnIU6NnDw0tj6RQxr6WY2kLs1KAPRYw6nzEy3BJww==).
- 31 Gujarat Energy Development Authority. [geda.gujarat.gov.in/background.php](http://geda.gujarat.gov.in/background.php).
- 32 Indian Integrated Disease Surveillance Program, PowerPoint, presentation, slide 2 (2010). [rs.rtiitn.in/BioSurvey/doc/Workshop/Indian%20Integrated%20Disease%20Surveillance%20Program.pdf](http://rs.rtiitn.in/BioSurvey/doc/Workshop/Indian%20Integrated%20Disease%20Surveillance%20Program.pdf).
- 33 Ibid. at slide 8.
- 34 Ibid.
- 35 B.J. Medical College. "About BJMC." [www.bjmc.org/](http://www.bjmc.org/).
- 36 Moser, Susanne, and Ekstrom, Julia. "Identifying and Overcoming Barriers to Climate Change Adaptation in San Francisco Bay," Public Interest Energy Research (PIER) Program White Paper, July 2012.
- 37 Gujarat 2013, District Profiles, Ahmedabad. [www.vibrantgujarat.com/dist-profile-ahmedabad.htm](http://www.vibrantgujarat.com/dist-profile-ahmedabad.htm).
- 38 Ramanj K.V., et al. "Urban Health Status in Ahmedabad City: GIS Based Study of Baherampura, Kubernagar, and Vasna Wards," p. 2. [www.iimahd.ernet.in/publications/data/2005-03-05ramani.pdf](http://www.iimahd.ernet.in/publications/data/2005-03-05ramani.pdf).
- 39 Ibid. at 2.
- 40 Ibid.
- 41 The centers provide primary health care services and focus on problems with childbirth, malnutrition, water, and airborne illness. <http://proceedings.informingscience.org/IS2002Proceedings/papers/raman054egov.pdf>.
- 42 Ibid. at 36.
- 43 Ahmedavad Municipal Corporation. [www.egovamc.com/home.aspx](http://www.egovamc.com/home.aspx) ("Citizens" tab).
- 44 Interactive Voice Response System. [imdahm.gov.in/ivrs.htm](http://imdahm.gov.in/ivrs.htm). The Met Centre also has a toll-free number for temperature updates, 1-800-180-1717. However, the number is only periodically functional.
- 45 Meteorological Centre, Ahmedabad, "Welcome" pamphlet, p. 4. [www.imdahm.gov.in/#](http://www.imdahm.gov.in/#) ("About MC" tab).
- 46 Gujarat Action Plan on Climate Change: <http://moef.nic.in/downloads/others/States-SAPCC-gujarat.pdf>.
- 47 Memorandum of understanding between EMRI and the Gujarat government. [www.emri.in/images/stories/MOU\\_pdf/Gujarat%20MOU.pdf](http://www.emri.in/images/stories/MOU_pdf/Gujarat%20MOU.pdf).

- 48 Indian Integrated Disease Surveillance Program, PowerPoint presentation, slide 2 (2010). [rs.rti-iitm.in/BioSurvey/doc/Workshop/Indian%20Integrated%20Disease%20Surveillance%20Program.pdf](http://rs.rti-iitm.in/BioSurvey/doc/Workshop/Indian%20Integrated%20Disease%20Surveillance%20Program.pdf).
- 49 Contact information for the SDRN: Gujarat State Disaster Management Authority, 5th floor, Block No-11, Udyog Bhavan, Sector-11, Gandhinagar-382017. SDRN helpline numbers: +91 79-23259596; +91 9427307853. Email: [sdrnhelpline@gsdma.org](mailto:sdrnhelpline@gsdma.org).
- 50 Gujarat State Disaster Management Authority, "Creation of Authority." [www.gsdma.org/profile.htm](http://www.gsdma.org/profile.htm). Gujarat State Disaster Management Authority, State Disaster Resource Network home page. 203.77.202.117/sdrnguj/index.htm.
- 51 Gujarat State Disaster Management Authority, State Disaster Resource Network: Comprehensive Repository for Gujarat State, PowerPoint presentation, slide 7. 203.77.202.117/sdrnguj/systemflow.htm ("SDRN Presentation" link).
- 52 Such medical perceptions have yet to be scientifically studied.
- 53 Ahmedabad News4Gujarat. "AMC Operates Control Room for Monsoon," June 13, 2012. [news4gujarat.com/2012/06/13/amc-operates-control-room-for-monsoon-ahmedabad/](http://news4gujarat.com/2012/06/13/amc-operates-control-room-for-monsoon-ahmedabad/).
- 54 Child's Right to Safer Schools Campaign, "About Us." [schoolsafety.aidmi.org/aboutus.aspx](http://schoolsafety.aidmi.org/aboutus.aspx).
- 55 All India Disaster Mitigation Institute, "Reducing Risks Through Community-Based Disaster Risk Reduction: Enhancing Disaster Resilience of At Risk Communities." [schoolsafety.aidmi.org/](http://schoolsafety.aidmi.org/).
- 56 Chaudry, P.; K. Bagra, K.; and Singh, B. "Urban Greenery Status of Some Indian Cities: A Short Communication," *International Journal of Environmental Science and Development*, Vol. 2, No. 2 (2011).
- 57 Green Ahmedabad Campaign. [gujaratforest.org/Portal/News/4\\_1\\_green-ahd-campaign.pdf](http://gujaratforest.org/Portal/News/4_1_green-ahd-campaign.pdf).
- 58 Ebi, Kris, and Knowlton, Kim, summary of presentation, March 2011 Kickoff Workshop, Ahmedabad, India. Workshop presentation data included in IIPH, NRDC report, "Climate Change and Health Preparedness in India: Protecting Local Communities in Ahmedabad, Gujarat From Extreme Heat," March 2012. [www.nrdc.org/international/india/india-health-report.asp](http://www.nrdc.org/international/india/india-health-report.asp).
- 59 World Meteorological Organization and World Health Organization, "Heat Waves and Health: Guidance on Warning System Development," 2010.
- 60 Toronto Public Health, "The Heat Alert System," [www.toronto.ca/health/heatalerts/alertsystem.htm](http://www.toronto.ca/health/heatalerts/alertsystem.htm). Toronto has a population of 2.6 million, according to the 2011 Canada census.
- 61 Ibid.
- 62 Ibid.
- 63 Toronto Public Health, "Hot Weather Response Plan" (2012). [www.toronto.ca/health/heatalerts/pdf/hwr\\_plan\\_2012.pdf](http://www.toronto.ca/health/heatalerts/pdf/hwr_plan_2012.pdf).
- 64 Providing written materials raises literacy issues. Developing alternative approaches to communicate with the illiterate population warrants further discussion, but this issue is beyond the scope of this report.
- 65 Some AMC agencies have used text message alerts in the past for special health campaigns run by the AMC.
- 66 Gujarat Information, Government of Gujarat. [gujaratinformation.net/](http://gujaratinformation.net/).
- 67 Currently, Ahmedabad has a weather forecast capability of 48 hours. For medium range forecast ability, the National Center for Medium Range Weather Forecast will need to be involved.
- 68 See the related Issue Brief, "Rising Temperatures, Deadly Threat: Recommendations to Prepare Outdoor Workers in Ahmedabad," for a detailed analysis and recommendations for construction workers and other outdoor laborers affected by extreme heat in Ahmedabad.
- 69 "Enumerators take Stock of Ahmedabad's Green Quotient," *DNA India*, February 6, 2012. [www.dnaindia.com/india/report\\_enumerators-take-stock-of-ahmedabad-s-green-quotient\\_1646508](http://www.dnaindia.com/india/report_enumerators-take-stock-of-ahmedabad-s-green-quotient_1646508).
- 70 Meteorological Centre, Ahmedabad, "Welcome" pamphlet, p. 4: [www.imdahm.gov.in/#](http://www.imdahm.gov.in/#) ("About MC" tab).
- 71 Further investigation is needed to determine what percentage of Ahmedabad's residents use private hospitals rather than urban health centers, and why.
- 72 Link workers are employees contracted by Ahmedabad's health department to provide visiting or in-home nursing care. Link workers' duties include visiting individual homes to administer medicines to patients and carrying out door-to-door surveys to monitor the city's health.
- 73 GVK EMRI Emergency Management and Research Institute. [www.emri.in/index.php?option=com\\_content&task=view&id=42&Itemid=65](http://www.emri.in/index.php?option=com_content&task=view&id=42&Itemid=65).
- 74 Currently, the larger parks close at 7 p.m. in the city. The smaller parks are not staffed and are open 24 hours a day.
- 75 The goals of the Accords are to "to ensure accessible park or recreational open space within half a kilometer of each resident by 2015; complete a canopy cover and adopt policies to establish goals based on ecological and community considerations to plant and maintain canopy coverage in not less than 50 percent of available sidewalk planting sites; or pass meaningful legislation that protects critical habitat corridors and other habitat characteristics (e.g., water features, food-bearing plants, shelter for wildlife, use of native species) from unsustainable development." See Urban Environmental Accords, [www.sfenvironment.org/downloads/library/accords.pdf](http://www.sfenvironment.org/downloads/library/accords.pdf).
- 76 Higher temperatures can dramatically worsen ground-level ozone smog concentrations, especially for traffic police who work in high-ozone areas.
- 77 The state's Department of Electricity and Power to ensure implementation of initiatives with implication on usage of electricity.
- 78 In the past, there have been instances in which tankers that previously transported hazardous chemical compounds were later used for delivery of drinking water, which was contaminated.
- 79 See the related Issue Brief, "Rising Temperatures, Deadly Threat: Recommendations to Prepare Outdoor Workers in Ahmedabad," for a detailed analysis and recommendations for workers affected by extreme heat stress in Ahmedabad.









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