Addressing vulnerability to the health risks of extreme heat in urbanising Ahmedabad, India

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Doctor diagnosing a patient at an urban health centre in Ahmedabad.

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Key messages

- Climate change is fuelling more intense and frequent heat waves in India. A new scale of coordinated action is essential to protect communities, especially their most vulnerable members, from the dangerous health effects of extreme heat.
- In Ahmedabad, western India, strong local government leadership enabled the highly effective implementation of a pilot Heat Action Plan – the first of its kind in South Asia – and its continuation following completion of the pilot project.
- The Plan, which is based on robust scientific research, builds public awareness of the risks of extreme heat, trains medical and community workers to prevent and respond to heat-related illnesses, and coordinates an interagency emergency response effort when heat waves hit.
- Sharing international experiences and best practices helped change the perception among project stakeholders that heat was not a significant health threat. However, further awareness-raising is still necessary to convince the general public.

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1. Introduction

Higher daily peak temperatures and longer, more intense heat waves are becoming increasingly frequent globally due to climate change.[1] Coordinated action is needed on a greater scale to minimise the dangerous health effects of heat stress. Extreme heat events are having a significant impact in India, where summer temperatures are historically high.[2] In Gujarat, a coalition of academic, health and environmental groups, led by the Natural Resources Defense Council (NRDC) and the Indian Institute of Public Health (IIPH), worked together with the Ahmedabad Municipal Corporation (AMC) to prepare people for increasingly extreme heat in the city of Ahmedabad, through activities including an early warning system and heat preparedness plan. This coalition is also referred to as the team of project partners.

Ahmedabad is the first city in South Asia to comprehensively address the health threats of extreme heat (see Box 1). India, like many countries, does not have national heat wave policies in place. However, the model described in this paper can be adapted by other cities to prepare for heat waves, as well as other extreme weather events, such as flooding and cyclones.

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Box 1: Heat stress impacts on health

Heat waves have devastating impacts on human health within the Indian subcontinent. A direct relationship exists between increased temperatures and increased mortality and morbidity caused by heat stress.

Extreme heat, heat waves and drought cause many severe direct and indirect health effects, including:
- malnutrition
- a rise in climate-sensitive diseases like diarrhoeal illnesses, dengue fever, chikungunya and malaria
- dehydration
- heat cramps
- oedema (swelling)
- heat exhaustion
- heat syncope (fainting)
- heat stroke.

Severe long-term health impacts of heat stroke include:
- renal insufficiency, kidney malfunction and failure
- neurological defects, headaches and blurred vision
- cardiac ailments, chest pain and heart attacks
- increased mortality risk for the years following heat stroke for those who survive.

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2. Developing Ahmedabad's Heat Action Plan

With climate change exacerbating heat waves, and the devastation caused by the 2010 heat wave still fresh in people's minds (see Figure 1), the AMC recognised that coordinated action on a greater scale was essential to protect local people and minimise the dangerous health effects of heat stress. Although no national policy existed to address extreme heat, the state of Gujarat and the city of Ahmedabad wanted to prepare for the rising threat of heat as part of their broader climate adaptation efforts. For background on Ahmedabad's vulnerability to heat waves, see Box 2.

In early 2011, several organisations[8] formed a coalition (a team of partners) to address heat-induced health threats by creating an early warning system and a heat-preparedness plan, collaborating with international public health and forecasting experts to strengthen the project's scientific foundation and outreach capacity. These actions led to the city's Heat Action Plan.[9]

2.1 Purpose

The key purpose of developing the Heat Action Plan was to prepare the city for future heat waves and protect people from heat-related illness and death. The Plan aims to build resilience to, and reduce the impacts of, heat waves on Ahmedabad's residents, with a particular focus on protecting the most vulnerable.

The project team focused on improving the capacity of the AMC to protect its people when heat waves hit the city. This included:
- improved planning for responding to heat disasters at local and state levels
- training medical response professionals to tend to affected people
- improving communication within the government and with the public ahead of extreme heat events by issuing advance warnings to agencies and through the media.

The team aimed to increase the resilience of vulnerable populations through community outreach and education. Training sessions and communications materials were adapted for slum communities, urban health centres and schools by incorporating visual graphics to describe ways to protect oneself from heat. The team also aimed to improve worker safety protocols during heat waves through specific policy

Figure 1. Temperatures recorded during the deadly May 2010 heat wave in Ahmedabad

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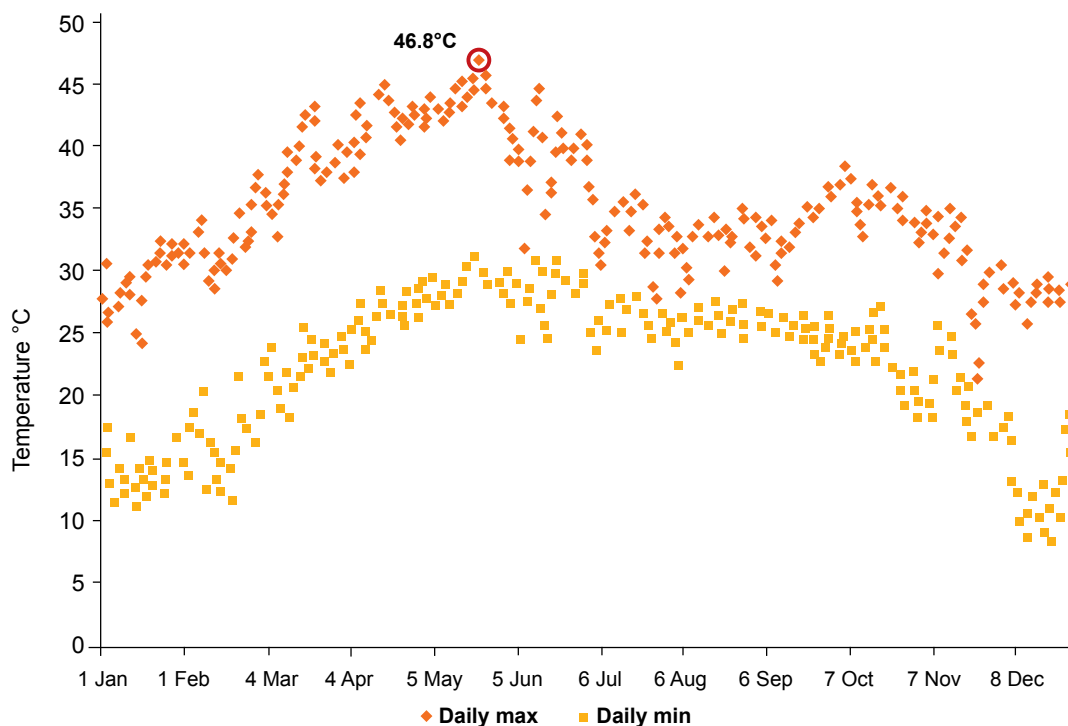
Box 2: Ahmedabad's increasing vulnerability to heat waves

India's National Disaster Management Agency defines heat waves as periods of abnormally high temperatures, above the normal maximum temperatures that occur during the summer season in the north-western parts of India. India has national programmes to address many effects of climate change, but the country has yet to implement strategies to adapt to increasing heat. Even at the city level, heat waves and their impacts have been largely overlooked in disaster preparedness policies. Until recently, no city in South Asia had a comprehensive early warning system for extreme heat in place.

Ahmedabad is the economic centre of Gujarat and is predicted to be one of the world's 19 fastest-growing urban areas in the coming decade.[3] The Ahmedabad district, including the surrounding suburban and rural areas, is home to 7.2 million people.[4] It is also a very hot place, located in India's arid north-west region where warm, dry conditions are conducive to heat waves.

As a rapidly urbanising city with an expanding population in this hot and semi-arid climate, Ahmedabad faces multiple stresses that increase its vulnerability and exacerbate the impact of deadly heat waves. Additionally, the city houses large migrant and slum populations from neighbouring states, other parts of India and abroad, and attracts construction and other outdoor workers who are more susceptible to heat.[5]

Ahmedabad's hottest temperatures occur in the summer months, from March to June, with temperatures generally peaking in May. Days remain warm through to November.[6] The average monthly maximum summer temperature from March to June is 38.8°C (101.8°F); in winter (November to February) the average monthly maximum temperature is 28°C (82°F). The average monthly minimum temperature is 24°C (75°F) in the summer and 15°C (59°F) in the winter.[7]

While the averages are high enough, the peaks can be extreme. During the heat wave that occurred on 20–23 May 2010, the temperature spiked at 46.8°C (116°F) (see Figure 1). This massive heat wave and its devastating death toll served as a wake-up call to the AMC, alerting the Corporation to the urgent need for action to protect its residents. Although Ahmedabad had experienced regional heat waves in 1981 and 1998, the 2010 heat wave raised flags for officials about the health threats of extreme heat.

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recommendations and awareness-raising activities. The AMC adopted the Heat Action Plan ahead of the 2013 heat season – becoming the first city in South Asia to implement such a plan.

2.2 Approach

The approach to developing the Heat Action Plan had three pivotal components. First, the process aimed to create strong partnerships among local-level stakeholders such as the AMC and hospitals, academic institutions, international organisations and health organisations. This coalition provided a strong and effective base and ensured technical, social, political and administrative support for the project. Further, bringing key stakeholders on board early on enabled the project team to promote collaborative efforts towards a common goal.

Second, the process was built on sound scientific research and outreach. This enabled the project team to back up their recommendations with trustworthy data throughout the process. Using these data and communicating findings within the Ahmedabad community served as a useful outreach mechanism to generate awareness about the health risks of extreme heat.

Third, assessing which populations were most vulnerable to heat waves and heat-related health impacts within Ahmedabad enabled the team to tailor strategic interventions to reach those most at risk. The results of this vulnerability assessment, along with research findings, shaped the recommendations of the Heat Action Plan. These components are explained in more detail below and shown as a timeline in Figure 2.

Building strong partnerships

Building a strong relationship between the city's leaders and the project partners was an essential first step to ensure the success of the Heat Action Plan. The IIPH and the NRDC reached out to several city and state leaders, and the AMC was the most eager to address heat waves at a municipal level due to the deadly 2010 heat wave that had inundated its hospital wards.

The IIPH and the NRDC then coordinated with the state of Gujarat, which was also keen to expand its climate adaptation efforts. The partnership connected city officials with international experts in the project

Figure 2. Heat adaptation project components (2009–2013)
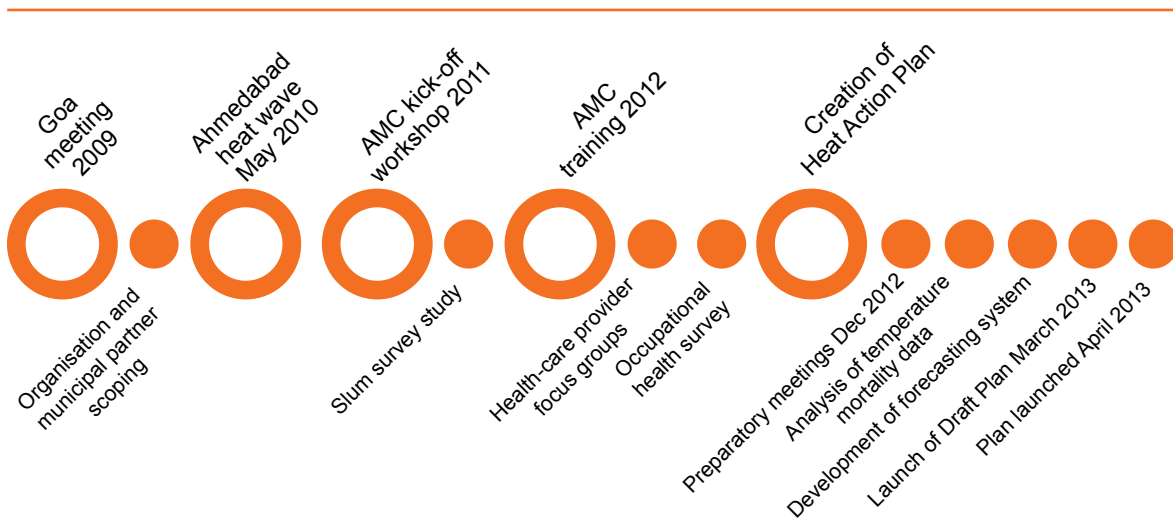
Source: IJERPH [© Ahmedabad Heat and Climate Study Group]

team, and IIPH provided strong leadership, a local network and public health resources for on-the-ground activities.

The project partners provided the expertise needed to develop Ahmedabad's Heat Action Plan. The combination of local, national and international partners was imperative: it helped to ensure that the Heat Action Plan was robust, integrating expert insights from many different perspectives. The international perspectives also helped to make the Plan easier to replicate in cities elsewhere. The strong and adept team enabled the project to connect with local people, ensured scientific proficiency, included expertise from the health sector and provided international competence.

The knowledge provided by the project partners to the municipal government built trust and confidence, and fostered the political will required for action. For example, the team engaged medical professionals from Ahmedabad to explain to municipal leaders the dangers that extreme heat posed for the city's communities. The team also highlighted how government leadership and action could save lives at a low cost. Working with multiple levels of the government, from the health department to the mayor's and commissioner's offices, expanded government support and political will for action.

A foundation for scientific research and outreach

To kick off the project, the team held a workshop with medical and government officials, during which they mapped the city's existing public health infrastructure to deal with heat stress, and sensitised the stakeholders present to the health dangers of extreme heat. This workshop, along with the whole project, was based on extensive scientific research.

The team's research comprised several activities. They compiled temperature and mortality data and conducted heat vulnerability surveys. They also held focus group discussions with health-care professionals and roundtables with international experts (see Box 3). Participants in the focus groups were not surprised to hear the climate change projections as they were already experiencing increasing temperatures first-hand. The partners worked with public health and policy experts to analyse response plans to heat-related health issues around the world. Realising that inter-governmental communication regarding weather forecasts could be improved, they explored longer-term forecasting options to provide earlier warnings of heat waves.

The project team also interviewed several hundred people who were identified as being most vulnerable to extreme heat (see next section). Because age, chronic disease and working conditions exacerbate heat vulnerability, these groups included children, elderly, slum communities and outdoor workers (such as

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Box 3: Challenges for local health-care professionals: Recognising heat illness

In March 2012, the coalition of partners held two focus group discussions with health care professionals in Ahmedabad. They discussed the effects of climate change, available resources to treat heat-related illnesses and the heat stress advice delivered to patients. They also identified the most heat-vulnerable groups within the city.[11] During these focus group discussions, medical professionals in Ahmedabad identified three related layers of challenges to addressing the health impacts of extreme heat:

1. diagnosing heat-related illness like heat stroke, in part because examination of patients for signs and symptoms of heat illness is not a routine procedure

2. having the equipment and facilities necessary to triage patients quickly, such as ice or an air-conditioned 'cool room'

3. treating heat-related illness with hydration, ice packs and 'cool rooms', and counselling patients with heat-specific advice.

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construction workers). From this research, the team produced four policy briefs to summarise and share the findings and recommendations for these groups in a series entitled 'Rising temperatures, deadly threat'.[10] While this extensive scientific research was integral to developing the pilot plan in Ahmedabad, other cities across India and South Asia can build on this research, modifying Ahmedabad's Heat Action Plan and planning how to protect their own communities from the effects of extreme heat.

The briefs were aimed at a range of key stakeholders, including decision-makers. Summarising the science behind the identification of those most vulnerable to extreme heat and the actions needed on the part of municipal and private sector groups, these briefs increased confidence among local officials and key stakeholders to take action on the recommended strategies and policy interventions in the Heat Action Plan.

As well as government and local communities, the project team engaged the private sector in the Heat Action Plan. Organisations like the GVK Emergency Management and Research Institute (GVK EMRI, a local professional emergency response group operating through a public–private partnership) now include heat warnings in internal communications to their employees and train them to recognise the signs of heat illness. The team is continuing outreach activities to local employers of outdoor workers, with such recommendations as changing work shift patterns to times of non-peak temperatures and providing better heat stress protection through ample water, shade and break-times.

Identifying at-risk people
Increased urbanisation is associated with rising urban poverty. People living in slums are vulnerable to extreme climatic conditions because of their low and unstable incomes, limited access to basic services, poor sanitation and lack of resources. These communities are particularly vulnerable to climate-related health hazards, having limited resources with which to cope or adapt.

In 2011, the project team conducted a cross-sectional randomised cluster sample survey of household vulnerability to extreme heat among Ahmedabad's slum populations. The survey questionnaire, written in English and Gujarati, focused on health, heat waves, heat exposure and existing measures to combat heat waves. The process targeted the female heads of household, who were often home and could report on the entire family's well-being, to gather information about the health of the whole family. In total, 300 households were interviewed, with information collected for about 1,650 individuals.[12] This provided information about heat-related symptoms and heat-related illness among slum populations over time, which helped to identify the factors behind their vulnerability and what resources are already in place to reach these at-risk communities.[13]

The survey results showed that age, chronic disease and working conditions all exacerbated vulnerability to heat waves (see Box 4). As protective measures, raising awareness and building capacity were effective tools for reducing heat-related health impacts. This research, including the vulnerability assessment, formed a key component of the Heat Action Plan and helped to create the political will necessary to develop the Plan.

Box 4: Who is most vulnerable to extreme heat: Eight key factors based on initial survey results[14]

Age – For every 5 years a slum resident ages, their odds of experiencing heat-related symptoms and/or illnesses increases by more than 20%. The elderly reported having the most pre-existing conditions, increasing their vulnerability.

Income – The average slum resident lives below the poverty line, has poor access (physical and financial) to potable water and medical care, and is likely to work in the direct sun.

Pre-existing conditions – The likelihood of suffering from heat-related illness increases strongly if the slum resident has a pre-existing chronic, diarrhoeal or infectious condition. An average of three members per surveyed household had pre-existing conditions, primarily the elderly.

Work location – 90% of respondents worked outdoors during the summer and 74% walked as their main mode of transport. Working in direct sun greatly increases the risk of heat-related illness.

Drinking water – Most residents had limited access to water and 70% of respondents drank tap water.

Access to doctors – All households reported that seeing a doctor was convenient, but many residents said they do not see a doctor for heat-related symptoms and illnesses.

Access to information – Those households who did not seek information on heat-related illnesses during heat waves were much more at risk. All households reported hearing about heat warnings during summer 2011, with 53% hearing from other people and 46% through the media (primarily TV, with newspapers second).

Social connectedness – 97% of respondents reported feeling safe in their community due to good neighbour relations. Such strong social connectedness can be useful during heat waves.

2.3 Turning recommendations into action

The scientific research, desktop research, vulnerability assessments and roundtables with stakeholders described above and encapsulated in the policy brief series 'Rising Temperatures, Deadly Threat' enabled the project team to make recommendations to the city officials about how to better prepare for and reduce the impact of the increasingly extreme heat waves. Working closely with the city's key stakeholders, the project team helped them prepare to act upon the recommendations set out in the Ahmedabad Heat Action Plan.

The Plan is a resource for various stakeholders, especially city government officials and health workers. As described in detail below, it provides guidelines and well-defined actions for each player in a heat emergency. It outlines how to operate an early warning system for heat waves and contains a community outreach strategy, as well as preventative measures including building awareness. The Plan also provides strategies for coordinated action by different government agencies. These include immediate and longer-term actions to increase preparedness, share information and coordinate responses.

3. Implementing Ahmedabad's Heat Action Plan

Interacting with many different stakeholders during a heat emergency – while remaining efficient and effective – is one of the most challenging components of a heat-related emergency, and is tackled by the Heat Action Plan. The communication strategy in the Plan has two prongs. First, communicating information within local government agencies during an emergency is important. To ensure departments interact, the project raised awareness within the local government about the need to collaborate. Second, the Plan identifies the need for clear external communication with the public, especially those most at risk. Educating the public ahead of an emergency, for example on how to protect themselves from heat-related illness, and warning them when extreme heat is forecast are the main aspects of external communication efforts.

Figure 3 shows the heat wave communication plan proposed in the Heat Action Plan. The lead officer (locally called the 'nodal' officer) within the AMC health department is responsible for overseeing the Plan's implementation. Once a heat warning is received, the nodal officer issues a corresponding heat alert email, phone and fax message to the relevant governmental and non-governmental agencies, and to the media and the public, to kick-start protective actions. The details on how this was developed are explained below.

Figure 3. The heat wave communication plan for Ahmedabad
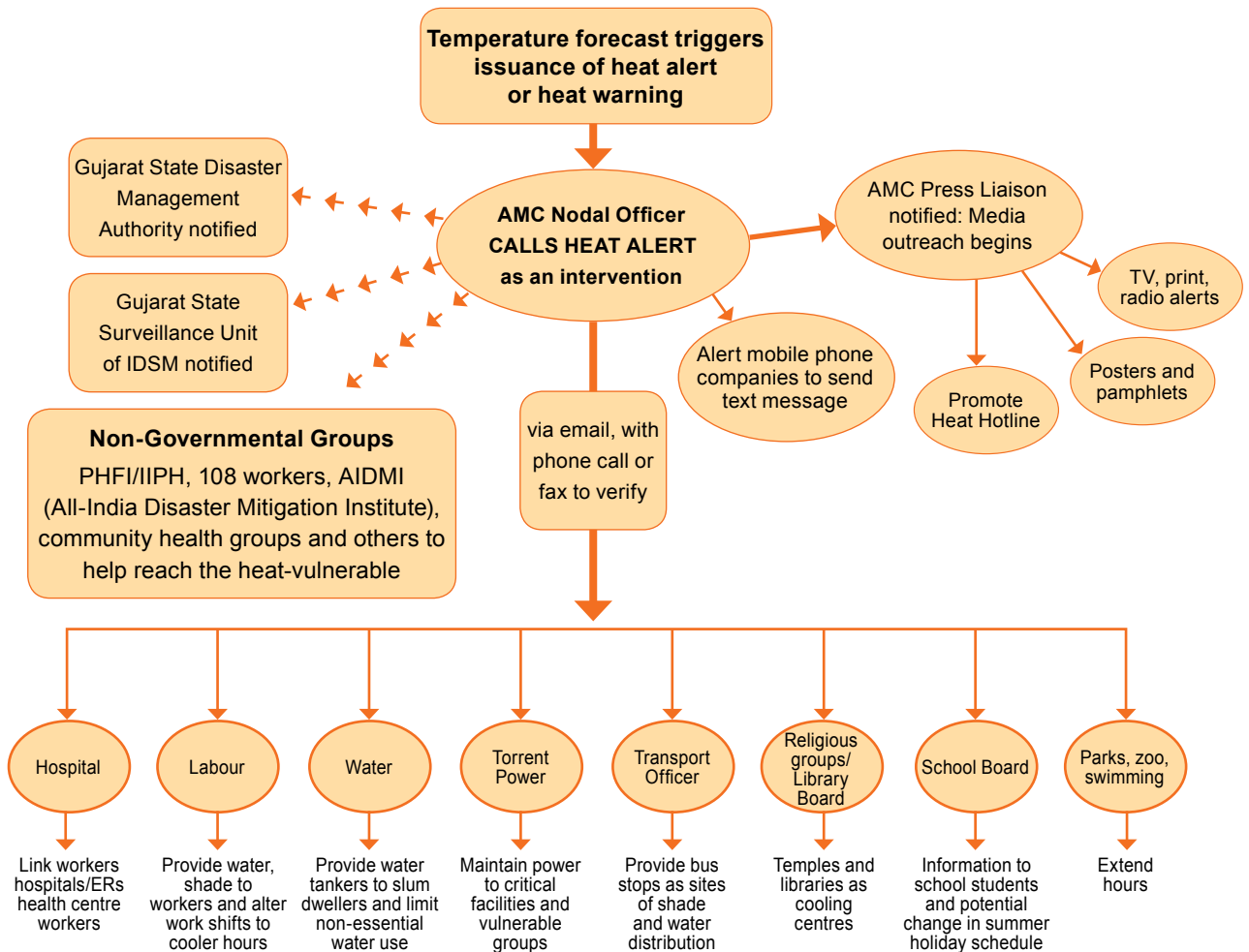
Source: Ahmedabad's Heat Action Plan (2013)[15]

3.1 Communicating within local government

Before the Heat Action Plan was created, there were few methods available for the exchange of relevant information between the various local government departments and other state government agencies and institutions. The city did not have a channel for sending warnings of heat waves or preparing the public. For example, the AMC was not being warned of predicted extreme heat in a systematic way by the meteorological department, and so could not pass on warnings to the public or the health department.

To remedy this, the project team developed an internal communication tree (see Figure 3) to formalise communication channels and issue heat alerts during heat waves as part of the Heat Action Plan. To develop this communication tree, the team identified the agencies and institutions involved and the best means of communicating with them. Then the team worked with the AMC to designate a lead officer within the AMC Health Department who would receive the daily forecast and subsequently coordinate declaration and issuance of the heat alert through multiple means (phone, email, text messages) to the rest of the involved agencies and other stakeholders.

The AMC appointed a senior medical officer within its health department as the nodal officer with the overarching responsibility for coordinating all municipal activities related to the Heat Action Plan. Buy-in from the AMC to appoint an existing officer to this role helped to organise the internal communication channels. The team also crafted draft notifications in the form of internal communication emails and texts and official

heat alerts to be sent when a heat alert was declared to ensure smooth rollout of the early warning system. The health department now receives daily temperature forecasts and sends alerts about heat risks to local government departments when extreme heat is forecast, while also disseminating public health messages and working to increase media preparedness prior to and during the hotter months. As extreme temperatures can be forecast many times during the heat season, multiple heat alerts may be issued per year.

The coalition hosted training workshops with municipal medical officers, health department professionals, the meteorological department, the media and civil society to build capacity and educate them about the new communications system. To ensure the communication tree and priority early warning interventions were ready for the launch in 2013, the project team simulated a heat event with government agencies. They then gathered feedback and made modifications to the communication tree and heat alerts to ensure it was effective and ready to be deployed when extreme heat was forecast during the 2013 heat season.

3.2 Communicating with the public

A series of outreach activities was then organised as part of the Heat Action Plan launch in 2013 to increase public awareness and improve community outreach. The project team designed public hoardings (billboards), advertisements and pamphlets in English and Gujarati. These publications use simple text coupled with illustrations describing symptoms of heat stress and how to protect oneself during extreme heat events (for example, drink water and stay in the shade). The use of local language and many visuals were conscious steps to ensure outreach to a wide proportion of Ahmedabad's residents, many of whom do not speak English and are illiterate. The AMC then displayed 10 hoardings across the city and fixed 150 banners to buses and rickshaws at the commencement of the 2013 heat season. The AMC also published and distributed 6,000 pamphlets in Gujarati and English (see Figure 4) through schools, hospitals and urban health centres throughout the 2013 heat season.

The media was also used to alert the public to an extreme heat forecast. This included a radio campaign in Gujarati and advertisements in the local papers. In addition, heat alerts are announced on the radio and television and the ambient temperature is posted in public places on scrolling screens. Moving forward, the team aims to encourage the use of SMS text alerts sent to mobile phones and web postings on the AMC website and social media sites (like Facebook and Twitter) to reach even more residents.

Figure 4. Public information pamphlets

4. Key strategies in the Heat Action Plan

The Heat Action Plan outlines strategic interventions for a wide variety of stakeholders.[16] To enable quick adoption, the project team focused on three key activities. Given budgetary and timing constraints, the coalition of partners worked with the AMC to identify which policies and programmes could have the biggest impact for the most vulnerable residents in the Plan's inaugural year. Prioritising three initial measures helped ensure the first Plan was cost-effective and adopted quickly by the local government ahead of the 2013 heat season. Because the Plan is reviewed each year, it can be updated and/or expanded each subsequent year. The three key activities (divided into pre-, during and post-heat season, see Box 5) were as follows:

1. Build public awareness and community outreach. This activity focused on the risks of heat waves and practices that can prevent heat-related illnesses and deaths. Key tasks included disseminating public messages on heat-stress prevention through media outlets, information materials and advertisements (see section 3.2).

2. Initiate a simple early warning system. This is needed to alert residents to predicted high temperatures and involves an interagency response effort. The AMC has created formal communication channels among governmental agencies, health officials, hospitals, emergency responders, local community groups and media outlets ahead of forecast high temperatures to alert them and coordinate their responses to extreme heat events (see Figure 3).

3. Capacity building among health-care professionals. This helps professionals to recognise and respond to heat-related illnesses, particularly during extreme heat events. The training is aimed at primary care (including general practitioners and nurses) so they can offer heat-specific advice, diagnose symptoms and recommend treatment (including self-monitoring and rehydration). They can also subsequently train their own staff on how to counsel patients and thereby prevent and reduce mortality and morbidity, when to increase staffing to handle a potential rise in patient demand, and how to develop tracking protocols to report heat-related illnesses and deaths. Link workers and other community health workers are also trained to recognise heat-related dangers and offer prevention tips for outreach and community-based tracking of heat-related illness in slum communities.

5. Key drivers of and barriers to the development of the Heat Action Plan

The process of developing Ahmedabad's Heat Action Plan was supported by several drivers but also encountered some obstacles.

5.1 Main drivers of the project

Government support and political will. Gaining strong local government support from the beginning enabled the project to take advantage of and build upon existing government protocols and agency structures. This enabled the Heat Action Plan to be established quickly and effectively, and to continue to develop after its rollout in 2013. Making use of available resources and community eagerness to participate also expanded the project's impact. The IIPH and the NRDC signed a memorandum of understanding (MOU) with the Gujarat state government, Gujarat University and BJ Medical College and a separate MOU with the Commissioner for the AMC to ensure government support and mutual agreement from the beginning. Since then, the city's leaders have taken ownership of the project and are continuing to lead the early warning system, even after the project ended.

Early stakeholder engagement. A stakeholder group comprising the city's key personnel and local groups was formed during the initial workshop in 2011. From early on, the project team imparted the urgency of action to combat heat waves in the city and the future threat from climate change. Constant stakeholder engagement and public education about the impact of heat waves helped the project gain public support and identify the challenges facing the city. The local stakeholder group provided input and guidance to the Heat Action Plan throughout its development in the form of participation in workshops, providing suggestions and recommendations on how to cope with heat-related impacts, representing the local population in project meetings and implementing protective measures. However, reaching the general public, particularly at-risk communities, remains an ongoing challenge.

Strategic partners. The project team comprised diverse partners, who together provided comprehensive expertise. These included experts in public health, heat forecasting, policy development and administration,

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Box 5: Heat Action Plan strategies in Ahmedabad during the 2013 heat season

The following activities were carried out in Ahmedabad during the 2013 heat season as part of the initial Heat Action Plan and will be continued in the future. The entity responsible for each activity is flagged.

Pre-heat season:

- Organise workshops and meetings for officials from health and other key departments, including a mock heat alert (project team).
- Train urban health centre medical officers (project team).
- Sensitise hospital superintendents, physicians and '108' emergency services to heat-related health risks (project team).
- Prepare health facilities, for example through air-conditioned wards and supplying ice packs (AMC).
- Engage the media through workshops and meetings so they are ready to raise awareness of extreme heat through television, radio and print (AMC, project team).
- Instigate a public outreach campaign including displays and advertisements developed by the project team (AMC). This included:
  - 6,000 pamphlets distributed to school children and other vulnerable people
  - large billboards displayed at around 10 locations in Ahmedabad
  - banners attached to rickshaws and buses
  - digital screens displaying the temperature, information on heat-related illness symptoms and suggested precautions.

During the heat season:

- Disseminate regular heat alerts and information internally to local agencies and stakeholders through emails and text messages (AMC, project team).
- Disseminate 'red alert' emails to all government departments, including traffic and city police, the fire department and school authorities (AMC).
- Keep city gardens open during the afternoons to provide cool places (AMC).
- Continuously monitor heat-related illnesses and daily deaths (AMC).
- Issue heat alerts to the public through the media and continue the public outreach campaigns described above (AMC, project team).
- Conduct ongoing media engagement to keep the media up to date regarding heat season activities (AMC, project team).

Post-heat season:

- Analyse activities undertaken and data collected before and during the heat season (project team).
- Explore procurement of weather gauge instruments for better local monitoring of temperature and other weather parameters in coming years (AMC, project team).
- Hold follow-up training for medical and paramedical staff (AMC, project team).
- Disseminate pamphlets and information regarding how to protect oneself from extreme heat through the media ahead of the next heat season (AMC, project team).

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and local and international project implementation. This diversity in perspectives and abilities was crucial to the success of the Heat Action Plan in Ahmedabad. As the first Plan of its kind in South Asia, there were no precedents on which to build, so a wide range of opinions was valuable.

Nodal agency and nodal officer. The project team identified the municipal health department as the central point of contact for managing the project. Within this department, Dr Tejas Shah, AMC health officer, was appointed as lead nodal officer. Dr Shah now serves as the central point of contact and information exchange regarding the Heat Action Plan. He is responsible for ensuring consistent project progress and is in charge of initiating the early warning system. Appointing a current municipal agency and officer, with established communication channels that already had procedures in place to coordinate the city's public health efforts, meant the Heat Action Plan could make use of the city's existing communications infrastructure. This enabled the Plan to be adopted before the 2013 heat season.

5.2 Main barriers to success

Recognising heat as a disaster and growing health threat. Although extreme heat events had already created severe health impacts in Ahmedabad, government officials and the public did not consider heat waves as disasters like monsoons and earthquakes, nor was there a general appreciation that heat waves will intensify because of climate change and therefore require a high level of preparation. This lack of awareness included the health sector, where it was not routine procedure to examine patients for signs and symptoms of heat-related illness upon admission. Sharing information on heat wave mortality and preparation plans from Europe, the USA and elsewhere helped to change this perception among government officials and others involved in the Heat Action Plan. Specifically, heat adaptation plans adopted by other cities offered best practices that could be adapted for Ahmedabad. Training to improve diagnosis and treatment and record protocols among health professionals also addressed this barrier. However, a general lack of knowledge about the health impacts of heat and how to prepare continues to pervade the general public. It has proved difficult to reach some of the most at-risk populations, such as slum residents, to communicate health information and heat alerts. Raising awareness through education campaigns is, therefore, an ongoing effort to encourage the public to take additional steps to protect themselves from extreme heat.

Data collection. Collecting temperature and mortality data was more challenging than expected, in part because extreme heat vulnerability was not recognised previously as a public health hazard that could be reduced. Implementation of the Heat Action Plan increased the visibility of the project team's efforts and role as a non-governmental third party. This helped the team develop trust and build stronger relationships. Although hospitals are starting to monitor heat-related illnesses and deaths, lack of capacity and budget prevented the team integrating the use of many tools to monitor heat-related health threats and evaluate the effectiveness of interventions during the 2013 heat season. This will limit some of the team's tracking of the Heat Action Plan's effects and data collection, delaying the development of baseline data against which progress can be monitored.

Time and budget constraints. As in many cities, resources in Ahmedabad are scarce and must be allocated judiciously. Responding to budgetary and timing constraints, project partners worked with the AMC to identify the policies and programmes that would have the greatest impact for the most at-risk groups. The team prioritised short-term and long-term recommendations for vulnerable populations in the briefing series and the Heat Action Plan. This helped to ensure that initial measures were cost-effective and adopted quickly by the local government ahead of the 2013 heat season. Being flexible about implementation efforts and making use of existing resources also helped to keep the overall project on track. For example, the team designed the outreach campaign to take advantage of low-cost or free media outlets, such as adverts on rickshaws. They also persuaded graduate students to undertake scientific research as part of their theses, under the supervision of the team's senior experts, to keep costs down. Now that Ahmedabad has rolled out these first-tier programmes, the project team is working with the local government to increase the interventions employed in the years to come in a cost-effective manner.

Interagency communication and coordination. At the beginning of the project, weather warnings were not communicated widely to the local government and hospitals, and the general public was not alerted about heat waves. It quickly became clear that enhancing inter-governmental coordination and communication and providing public warnings were essential elements to prepare local communities to deal with extreme heat. The team tried to identify preliminary efforts and existing protocols to build on, such as appointing a lead officer within the municipal health department and using established emergency procedures and low-cost media outlets to reach the public. Using national, state and local programmes and infrastructure already in place facilitated a faster and smoother implementation of the Plan. Improving formal communication channels, developing longer-term forecasting tools and designating a lead officer within the city government to direct heat-related efforts became key components of the Plan. More remains to be done to improve and expand communication channels among the governmental agencies moving forward, however, as the Plan expands and becomes more wide-reaching.

6. Impacts of the Heat Action Plan

The Heat Action Plan aimed to increase Ahmedabad's resilience to heat waves by increasing its awareness, preparedness and preventive measures. Although the Heat Action Plan was launched only in 2013, the project team has already achieved several notable successes.

Adoption of the Heat Action Plan. Implementation of the Heat Action Plan was a major success. The AMC adopted it quickly as a part of its annual disaster preparation plan for Ahmedabad, and appointed a nodal officer and agency to oversee its implementation. This enabled interventions on a broad scale across the city's municipal agencies. The AMC also dedicated funds for the Heat Action Plan to cover its inaugural actions, demonstrating the government's recognition of the need for intervention.

Interest in other cities. Heat waves are a threat for many cities across the world, particularly in South Asia and other hot, arid regions that are on the front line of climate change. Following the successful pilot in Ahmedabad, additional cities and states within India and in other countries have shown interest in adopting a similar initiative.

The 2014 Heat Action Plan. The Heat Action Plan was adopted as a continually renewing adaptation plan and early warning system for the city of Ahmedabad, which could be updated and/or expanded each subsequent year. Ahead of the 2014 heat season, the coalition worked with city officials to evaluate and assess the effectiveness of the inaugural 2013 Heat Action Plan and improve it ahead of the 2014 heat season. Responses from the AMC indicate that awareness of heat-related health impacts has improved among residents, and support for the continuance and expansion of the Heat Action Plan within the AMC and with other stakeholders remains strong. An annual review and update of the Plan, to continuously improve its effectiveness and respond to changing circumstances, will allow the city to continue to address heat waves. The coalition is also now undergoing a quantitative and qualitative evaluation of the 2014 Heat Action Plan, and working with the AMC to update the Plan ahead of the 2015 heat season.

7. Lessons learned

As natural disasters continue to break records in terms of their severity, wreaking devastation among communities around the world, so awareness of climate change and the importance of adaptation efforts is rising. Harnessing this increasing recognition can support the implementation of new adaptation projects. The experience in Ahmedabad provides several lessons about how to achieve this.

The key messages for policy-makers are:
- Coordinated action at a greater scale is essential to protect communities, especially the most vulnerable, from the dangerous health effects of extreme heat. With climate change fuelling more intense and frequent heat waves in many parts of the world, this action is urgent.
- To tailor an early warning system and preparation plan to a specific community, it is important to identify and map vulnerable communities, identify the factors that increase their vulnerability and their resilience, and develop appropriate communication strategies to reach them. Using tools to monitor heat-related health threats and evaluate the effectiveness of interventions is also important to assess risk and continuously improve plans.
- Gaining strong government buy-in and support from the beginning enabled this project to build on existing protocols and agency structures to successfully enact a Heat Action Plan rapidly and effectively.
- Sharing international experiences and best practices helped to change the general perception among key official stakeholders in Ahmedabad that heat was not a significant health threat. However, ongoing efforts to build awareness, for example through education campaigns, were necessary to convince the general public.

Endnotes

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8   Project partners included: public health, environmental and academic groups, led by the AMC, the IIPH, the Public Health Foundation of India and the NRDC, in partnership with Emory University's Rollins School of Public Health, Icahn School of Medicine at Mount Sinai, Georgia Institute of Technology, and Sri Ramachandra University, as well as the Climate Development and Knowledge Network (CDKN) and the Indo-U.S. Science and Technology Forum.

9   AMC (2013) *Ahmedabad Heat Action Plan 2013: Guide to extreme heat planning in Ahmedabad, India*. Easy read version. Ahmedabad: Ahmedabad Municipal Corporation (www.egovamc.com/downloads/healthcare/healthpdf/heat_action_plan.pdf).

10 NRDC (2013) 'Rising temperatures, deadly threat: recommendations for Ahmedabad's government officials'. NRDC Briefings Series. Ahmedabad: Natural Resources Defense Council (www.nrdc.org/international/india/extreme-heat-preparedness/files/india-heat-government-officials-IB.pdf). All briefs available at: www.nrdc.org/international/india/extreme-heat-preparedness.

11 Ibid.

12 Ibid.

13 Tran, K., Azhar, G., Nair, R., Knowlton, K., Jaiswal, A., Sheffield, P., Mavalankar, D. and Hess, J. (2013) 'A cross-sectional, randomized cluster sample survey of household vulnerability to extreme heat among slum dwellers in Ahmedabad, India'. *International Journal of Environmental Research and Public Health* 10(6): 2515–2543 (www.mdpi.com/1660-4601/10/6/2515).

14 Scientific methodology for heat health assessment: The assessment of the slum communities was conducted by IIPH and as part of a master's thesis at Emory University Rollins School of Public Health in April 2012 by Kathy Tran, advised by Dr Jeremy Hess. The study was done in collaboration with Mt Sinai School of Medicine and NRDC after a March 2011 heat and health vulnerability workshop with local and state officials in Gujarat. The survey used randomised sampling to identify target households located in 13 urban slum communities in Ahmedabad, which were identified by local public health authorities as having greater susceptibility and less resilience to extreme heat exposure. The study focused on factors that affect heat exposure, susceptibility to heat-related illness and adaptive capacity, all of which feed into vulnerability to heat. These factors' indicators were identified through literature review and expert opinion, and assessed through a cross-sectional household survey. Survey questions included demographics, occupational conditions, housing conditions that might confer heat exposure, coping methods, access to heat/health information, and social connectedness. A total of 300 respondents (primarily female heads of household) provided information on behalf of their households for a total of 1,650 individuals.

15 AMC (2013) *Ahmedabad Heat Action Plan 2013: Guide to extreme heat planning in Ahmedabad, India*. Easy read version. Ahmedabad: Ahmedabad Municipal Corporation (http://www.egovamc.com/downloads/HealthCare/healthpdf/heat_action_plan.pdf).

16 These include the AMC (including its meteorological department and health department), Gujarat Climate Change Department, Gujarat Energy Development Authority, Ahmedabad Urban Development Authority, Ahmedabad Municipal Transport Services, Ahmedabad Municipal Corporation Water Project Department and Ahmedabad Labour and Employment Department.

About this Background Paper

The authors have produced this paper as part of a learning programme managed by the Climate and Development Knowledge Network (CDKN) and ICLEI-Local Governments for Sustainability. The programme captures lessons learned, and seeks to enrich understanding of what makes low-carbon and climate-resilient development efforts work well at the subnational level. For more papers in the series, visit www.cdkn.org/resources.

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