



Evaluation of Ahmedabad's Heat Action Plan: Assessing India's First Climate Adaptation and Early Warning System for Extreme Heat

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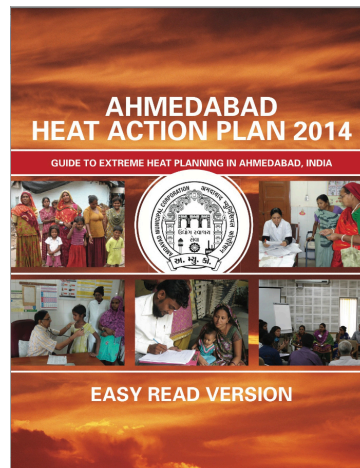
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EXECUTIVE SUMMARY

Located in the sweltering northwestern region of India, residents of the rapidly urbanizing city of Ahmedabad cope with soaring temperatures, and occasionally, with deadly heat waves. Rising to the challenge of climate change, the Ahmedabad Municipal Corporation (AMC) has piloted an innovative plan to prepare its people against dangerous heat waves. Ahmedabad's 2013 Heat Action Plan was the first comprehensive early warning system and preparedness plan for extreme heat events in South Asia. The Plan describes agency and community actions to increase preparedness, information-sharing, and response coordination to protect vulnerable populations from extreme heat.



Now that the Plan has been enacted for two of Ahmedabad's scorching heat seasons (2013 and 2014), this issue brief offers the first evaluation of the Plan's early effects in reducing heat-related health impacts and saving lives in the face of extreme temperatures. The coalition of partners that created the Heat Action Plan led this evaluation effort. Following the 2008 World Health Organization's Guidance on evaluations of heat-health action plans, the team evaluated *Structural*, *Process*, and *Outcome* considerations of the Plan.

The following three different aspects were analyzed to assess the Plan's effectiveness:

- whether city residents' illnesses and deaths during the heat season decreased after Plan implementation;
- whether accurate weather and temperature forecasts and corresponding heat alerts were issued before heat waves hit; and
- whether stakeholders believe the Plan was successfully administered, and effectively reached vulnerable populations with preparatory materials and heat alerts.

Based on this initial assessment of the climate adaptation plan in action, the team of partners is now planning to revise and enhance the 2015 Heat Action Plan's strategies and interventions to increase its overall ability to better prepare Ahmedabad's residents for rising heat fueled by climate change.

This deeper look at the innovative Heat Action Plan's first two years in action resulted in five key takeaways:

- **Overall, Ahmedabad is much more prepared for heat waves than it was in 2010.** The Heat Action Plan has been effective at increasing awareness on the dangers of heat waves, disaster risk management, and climate change in Ahmedabad.
- **The Heat Action Plan was successfully implemented and administered** by the city's nodal (head) agency in 2013 and 2014. The Plan created better awareness of the health dangers of extreme heat among stakeholders through trainings and capacity building, especially among government, health and emergency response professionals. Given early hesitations about the success of an early warning system

and preparedness plan for heat in India – where such a plan had never been implemented previously – the inaugural 2013 Heat Action Plan in Ahmedabad exceeded expectations.

- **There have been fewer city-reported deaths during Ahmedabad’s annual heat season in the years since the Heat Action Plan was launched.** In other words, the Plan may already be saving lives since its implementation in 2013, and it continues to protect more residents each year as the Plan’s activities and impact expand.
- **Temperature forecasts and corresponding heat alerts have been accurate,** building confidence for longer-term forecasts and an early warning system that can offer residents and the government agencies involved in the Heat Action Plan more time to prepare before heat waves hit.
- **The Heat Action Plan has strong potential to increase its effectiveness and reach more vulnerable populations in the community** to protect their health and save lives as temperatures continue to rise to dangerous levels. Continuing to expand the Plan’s future outreach activities to reach the wider public would help protect the city’s most at-risk groups, including slum communities, school children, and outdoor workers.

Looking ahead, this evaluation aims to help refine and improve all stages of planning, development, and implementation of Ahmedabad’s Heat Action Plan for future heat seasons. This evaluation also hopes to offer instructive feedback to guide other Indian cities and states’ development of their own heat adaptation plans. The Ahmedabad Heat Action Plan offers a replicable model of practical interventions that can be implemented immediately to protect public health in other regions suffering from extreme heat. With an efficient and effective heat preparedness and early warning system in place, heat adaptation plans can help vulnerable populations prepare for extreme heat today, and rising temperatures fueled by climate change.



AMC’s Release of the 2014 Heat Action Plan in Ahmedabad.

1 INTRODUCTION: EVALUATING A HEAT ACTION PLAN

Creating a climate adaptation plan, tailored to a specific locale to help prepare and protect its people from natural disasters fueled by climate change, is a challenging process. After it is developed through local conversations and scientific research, piloted, and then implemented, a new set of challenges awaits: evaluating the plan in action to determine whether it is successfully achieving its goals, and then fine-tuning the plan to improve its effectiveness.

The Heat Action Plan (the “Plan,” or “HAP”), adopted by the city of Ahmedabad in April 2013 will embark on its third heat season in early 2015. It aims to reduce heat waves’ deadly impacts on health and save lives. This Plan and the city’s nodal (head) officer in charge orchestrate many varied activities during the heat season, including interventions such as trainings and outreach to the most heat-vulnerable groups on how to protect themselves from heat stress, and an early warning system to notify the public and government agencies when extreme heat is forecast.

To achieve its overall goal of reducing heat-related health impacts and saving lives in the face of rising temperatures, the Plan primarily aims to implement three key strategies:

- **Build public awareness about the health risks of heat waves through community outreach;**
- **Initiate an early warning system with a 7-day forecast that provides advance notice to the public about predicted high temperatures and impending heat waves; and**
- **Increase capacity among Ahmedabad’s health care professionals for treating people with heat-related illnesses.**

Following Ahmedabad’s inaugural two heat seasons with the Heat Action Plan in place, this issue brief attempts to assess the Plan’s progress towards accomplishing its goals. The lessons gleaned from this assessment are offered with the hope that future heat adaptation plans both in Ahmedabad and elsewhere can improve in efficiency and effectiveness, protecting at-risk populations in the face of rising temperatures.



Patients at an Urban Health Centre in Ahmedabad, 2013

1.1 PROJECT CONTEXT AND HISTORY

“Our first priority is the people of Ahmedabad, and they need to be protected from the impacts of climate change. Our Heat Action Plan provides the roadmap we need to save lives when the next dangerous heat wave hits.”

~ Former AMC Commissioner Shri Guruprasad Mohapatra

Ahmedabad’s effort to undertake disaster preparedness for high temperatures was prompted in part by a deadly heat wave that hit the city in northwestern Gujarat in May 2010. Peak temperatures of 46.8°C (116°F) caused a spike in reported heat-related illness and death; 1,344 more deaths occurred among resident (a 43% increase) as compared to the same time period in prior years.¹ With climate change fueling more frequent and more intense heat waves, the local government recognized the need for a plan to protect local communities from escalating dangerous health effects of heat stress.



Urban Health Centre in Ahmedabad, 2013.

Despite the lack of a national policy on extreme heat, the State of Gujarat and the city of Ahmedabad wanted to prepare for this rising threat as part of their broader climate adaptation efforts. Public health, environmental and academic groups, led by the Ahmedabad Municipal Corporation (AMC), IIPH-Gandhinagar (IIPH-G), the Public Health Foundation of India (PHFI), and the Natural Resources Defense Council (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, formed a coalition in order to address these heat-induced health threats.² The coalition’s goal was to develop an early warning system and heat preparedness plan – the first plan of its kind for any city in South Asia.

The team aimed to improve heat disaster response planning at local and state levels by crafting an interagency heat action plan and related strategies, and by increasing related capacities in local health centers. The HAP functions as an administrative tool that defines different levels of

¹ According to our research developed over the course of this project, during Ahmedabad’s May 2010 heat wave, 4,462 people died, comprising an excess of 1,344 deaths (43.1% increase) when compared to a corresponding reference period in prior years (when 3,118 deaths occurred in May). For more information on our methodology and these findings, please see Azhar GS, Mavalankar D, Nori-Sarma A, Rajiva A, Dutta P, et al. 2014. Heat-Related Mortality in India: Excess All-Cause Mortality Associated with the 2010 Ahmedabad Heat Wave. *PLoS ONE* 9(3): e91831. doi:10.1371/journal.pone.0091831 (Azhar et al., 2014).

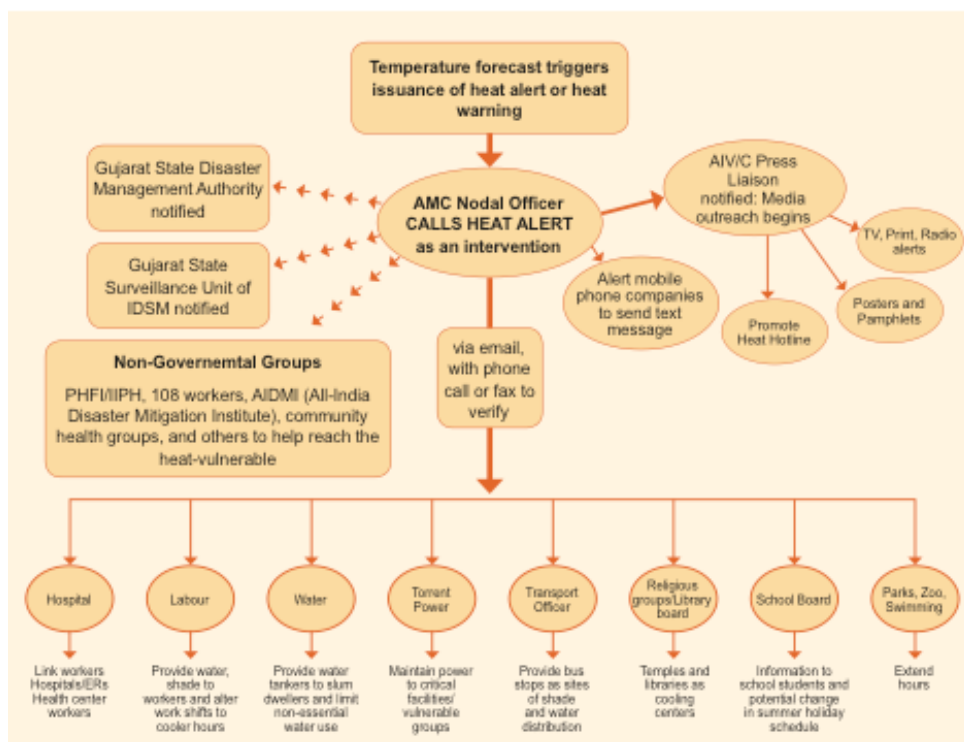
² Leading this broader coalition is the Ahmedabad Heat and Climate Study Group, which consists of (in alphabetical order): Dileep Andhare (IIPH-G), Gulrez Shah Azhar (IIPH-G), Meredith Connolly (NRDC), Bhaskar Deol (NRDC), Priya Dutta (IIPH-G), Partha Sarthi Ganguly (IIPH-G), Jeremy Hess (Emory University), Anjali Jaiswal (NRDC), Nehmat Kaur (NRDC), Radhika Khosla (NRDC), Kim Knowlton (NRDC and Mailman SPH, Columbia University), Dileep Mavalankar (IIPH-G), Ajit Rajiva (IIPH-G), Abhiyant Tiwari (IIPH-G), Amruta Sarma (Fulbright Student Research Scholar), and Perry Sheffield (Icahn SOM at Mount Sinai). Funding for the group was provided, in part, by the Climate Development and Knowledge Network (CDKN) and the Indo-US Science and Technology Forum (IUSSTF).

heat emergency for the city and coordinates activities among the diverse plan participants depending on the declared level of heat emergency.

To more efficiently communicate and respond during extreme heat events, the AMC has created formal communication channels among governmental agencies, meteorological forecasters, health officials and hospitals, emergency responders, local community groups, and media outlets ahead of forecasted high temperatures (see **Figure 1 below**).³ To improve communication within the government and with the public ahead of extreme heat events, the AMC appointed a nodal officer who issues advance warnings among agencies and through the media, and coordinates the Plan’s activities. The media also has a critical role in public education and outreach, and their buy-in and interest in the novel early warning system has helped provide momentum for the public to take notice of warnings.

Another primary focus of the Plan was capacity building and training for health care professionals in order to improve medical officers’ overall ability to recognize and respond to heat-related illnesses. The team also aimed to increase resilience among vulnerable populations in Ahmedabad through community outreach and education, using training and communication materials developed for health centers and schools. Finally, the coalition hoped to improve worker safety protocols during heat waves through awareness-raising activities.

Figure 1. Communications Chart for Ahmedabad Heat Action Plan (HAP)



³ There are alternative sources for daily temperature forecasts in Ahmedabad, each with different lead times that can provide several days’ advance notice of temperatures before they occur. For this project, two potential sources for forecasts were the India Meteorological Department (IMD) and the Climate Forecast Application Network at Georgia Tech.

1.2 CHALLENGES IN EVALUATING HEAT ACTION PLANS

Evaluating the effectiveness of the Heat Action Plan is no easy task. In addition to little international precedence as to how to assess its efficacy (see side bar), heat waves are sporadic and their resulting adverse health impacts on people can be challenging to distinguish and identify.

Although climate change is predicted to increase the frequency, duration, and intensity of heat waves globally, including in India, long-lasting intense heat waves are still relatively rare events in Ahmedabad. Additionally, individual heat waves vary greatly in severity and length, making it difficult to compare effects of different heat waves on the population within even the same heat season, let alone in different years. For example, the 2013 heat season – the inaugural year of the Heat Action Plan – was not as extremely hot as compared to recent heat seasons, with no official heat waves declared that year.

Side Bar: Assessing Heat Action Plans Around the World

Few studies have successfully evaluated the efficacy of heat action plans.⁴ As a result, research in this area is limited, and there is little agreement on how best to assess the effectiveness of systems as a whole or of individual intervention measures. In England, an evaluation of the heat action plan surveyed five types of health and social care organizations through a mix of self-completed and telephone questionnaires to explore awareness of the heat wave plan and their responses to it.⁵ A study in Canada and the United States has shown while the heat-vulnerable elderly population appears to be aware of imminent hot weather, information and certainty about what to do is less known.⁶ Despite these examples, HAP program evaluations remain few and far between.

The spectrum of heat-related health problems is broad ranging as well, from simple rashes to life threatening heat stroke. Many serious consequences can stem from the thermal stress experienced while working physically demanding jobs and/or working in hot environments. Many health issues caused by heat are not diagnosed or attributed to other causes, limiting medical staff's ability to account for them in an official and consistent way.

Finally, the Heat Action Plan enacted in Ahmedabad involves a variety of agencies and utilizes many diverse interventions both before and during the heat season and during a declared heat wave. Tracking and assessing the impact of many of the individual efforts remains challenging. Measuring the overall ability of the Heat Action Plan to accurately predict heat waves, educate and warn the public, and to inform behavior or save lives is more feasible using a scientific

⁴ Toloo G, FitzGerald G, Aitken P, Verrall K, Tong S. 2013. Evaluating the effectiveness of heat warning systems: systematic review of epidemiological evidence. *Int J Public Health* 58:667-681 (Toloo et al., 2013); White-Newsome JL, McCormick S, Sampson N, Buxton MA, O'Neill MS, Gronlund CJ, Catalano L, Conlon KC, Parker EA. 2014. Strategies to reduce the harmful effects of extreme heat events: a four-city study. *Int J Environ Res Public Health* 11:1960-1988 (White-Newsome et al., 2014); Sheridan S. 2007. A survey of public perception and response to heat warnings across four North American cities: an evaluation of municipal effectiveness. *Int J Biometeorol* 52(1):3-15 (Sheridan, 2007).

⁵ Matthies F, Bickler G, Marin NC, Hales S. 2008. *Heat health action plans: Guidance*. World Health Organization (WHO), Regional Office for Europe (Matthies et al., 2008).

⁶ Sheridan, 2007.

quantitative approach. However, interviews and questionnaires completed by involved stakeholders have also provided some qualitative feedback about how effective the Plan's individual strategies and interventions have been (see **Attachment 3**).

The World Health Organization (WHO) issued a Guidance in 2008 that describes some general elements of heat-health action plans around the world, including some of the types of evaluation efforts that have been undertaken so far.⁷ Key considerations include: monitoring and evaluating whether HAP communications helped raise awareness in advance of heat waves, made measurable differences in heat-avoidance behavior among city residents or helped improve health outcomes, and were appropriately targeted to the most heat-vulnerable groups. To accomplish this for Ahmedabad, we used a broad evaluation framework with a range of short-, medium-, and longer-term indicators of these types of potential success for the HAP.

Little relevant recent data was available on several other determinants of health besides extreme heat, such as daily air pollution conditions; recent changes in socio-economic opportunities that could affect access to heat-adaptive measures like air-conditioning; and local-scale population changes among heat-vulnerable groups (e.g., age 65 and older, Ahmedabad's slum dwellers, and very young children).⁸ With these limitations in mind, the project developed a variety of methods to evaluate the effects of the Heat Action Plan in action during 2013 and 2014, including qualitative surveys of HAP stakeholders, quantitative analytics of the temperature forecasts and reported mortalities, and expert opinion.

Following the 2008 WHO Guidance on evaluations of heat-health action plans, this issue brief describes three different aspects of the Ahmedabad HAP, and evaluate **Structural**, **Process**, and **Outcome** considerations.

2 STRUCTURAL CONSIDERATIONS

Structural considerations relate to the larger context in which a city-level heat action plan is developed. For example, they examine whether a national climate adaptation plan is in place. At the national scale, India does have a National Action Plan on Climate Change, which is now in the process of implementation at the subnational and local levels.⁹ However, specific climate-health adaptation strategies are not an explicit part of the plan. Local knowledge and traditional practices on ways to reduce heat stress are important and widely used; these include drinking *chaas*, a thin buttermilk-like beverage, eating raw sour mangoes on hot days, and donning light colored clothing and head coverings. Access to air-conditioning remains unavailable for many local residents. Long-standing cultural traditions have often viewed extreme heat as a necessary way of life in India, rather than as a specific – albeit seasonal – public health hazard.

Other structural considerations included developing ways to work towards achieving the three main components or strategies to be applied in the HAP. For Ahmedabad, these were: (1) building public awareness of heat as a public health threat through community outreach; (2) initiating a simple early warning system with staged heat action levels based on temperature

⁷ Matthies et al., 2008.

⁸ Analitis A, Michelozzi P, D'Ippoliti D, et al. 2014. Effects of heat waves on mortality: effect modification and confounding by air pollutants. *Epidemiology* 25(1):15-22 (Analitis et al., 2014).

⁹ Dhanapal G. 2014. Climate adaptation in India. *Nature Climate Change* 4:232-233 (April 2014).

forecasts; and (3) building capacity among health care professionals to better recognize and treat heat illness and vulnerability before they can progress to heat-related death.

The objectives of each of these three elements were described in the 2013 Heat Action Plan and 2014 Plan, which updated and expanded upon the 2013 pilot. Both of these documents were shared and widely discussed before being shared with the city government, key health agencies, and the media. Upon official release, the HAP was posted on the AMC website, at:

http://www.egovamc.com/downloads/HealthCare/healthpdf/heat_action_plan.pdf

The parties responsible for enacting specific steps within each of these three components are described in the original 2013 HAP in detail. A “nodal officer” in the city health department has the key responsibility for coordinating heat preparation activities, calling heat action alert levels and dismissing alerts as part of the early warning system, and serving as a local emissary to groups outside of the city who are interested in learning about Ahmedabad’s HAP development. Different individuals within a variety of city agencies are notified and launch coordinated action when an alert is called, in accordance with **Figure 1** above.

The four key audiences identified early on for the heat adaptation work in Ahmedabad were: (1) health professionals; (2) government officials; (3) outdoor workers; and (4) slum communities. These vulnerable populations were identified through on-the-ground studies, focus groups, interviews, and workshops that considered factors affecting heat exposure, susceptibility to heat-related illness, and adaptive capacity. Four NRDC Issue Briefs were developed to speak to the needs and concerns of each of these groups.¹⁰ Initial recommendations were developed as part of these Issue Briefs in the first year of the HAP, based on analysis of temperature data, mortality data from city hospitals, emergency ambulance call records, heat vulnerability surveys, focus group results, and interviews with government officials. See the series of issue briefs for specific information on each subset.¹¹

The HAP also included development of early warnings for extreme heat. Prior to this early warning system, the local office of the India Meteorological Department (IMD) in Ahmedabad issued forecasts of extreme heat two days in advance. In examining other international early warning systems for extreme heat, the project team, along with Ahmedabad government officials, determined that developing a pilot for longer-term forecasts would prove useful in preparing for heat waves. The 7-day pilot forecasts were generated through an innovative hybrid dynamical-statistical temperature forecast system developed by the Georgia Institute of Technology (Georgia Tech) and the Climate Forecast Applications Network (CFAN).¹²

¹⁰ Natural Resources Defense Council Issue Brief Series (4). 2013. *Rising Temperatures, Deadly threat: Recommendations for Health Professionals, Government Officials, Outdoor Workers, and Slum Communities*. All 4 briefs available at: <http://www.nrdc.org/international/india/extreme-heat-preparedness/>.

¹¹ See id.

¹² The hybrid model uses the European Center for Medium- Range Weather Forecast (ECMWF) Variable Ensemble Prediction System (VarEPS) that is statistically post-processed and calibrated to adjust for model bias in a manner similar to previous work conducted at Georgia Tech. The visual format of the daily warnings, their content, and the threshold values for various alert levels were developed in early 2013 through in-depth collaborative conversations among the AMC, Georgia Tech/CFAN experts, the AMC, and project partners from IIPH/PHFI and NRDC who comprised the Ahmedabad Heat and Climate Study Group. See the CFAN website at: <http://www.cfanclimate.com/>.

3 PROCESS CONSIDERATIONS

“You cannot build the well once the fire starts. You need to have already dug the well, bought the pump, and put everything in place beforehand. By planning ahead, we can prepare for heat waves before they hit and save many more lives.”

~ Dr. Dileep Mavalankar, Director, Indian Institute of Public Health-Gandhinagar

3.1 THE FIRST YEARS OF HAP LAUNCH IN CONTEXT: PROCESSES FROM 2011-2014

To create a *process* to advance the project’s three overarching goals in Ahmedabad, the coalition first developed an evidence-based heat preparedness plan and early warning system. The initial phase focused on evidence accumulation, including extensive literature review, analysis of local temperature and mortality data, surveys with heat-vulnerable populations, focus groups with health care professionals, and expert consultation. The findings and recommendations are encapsulated in the series of policy briefs developed in 2011-2012 for key government agencies, health care professionals, outdoor workers, and slum communities, and synthesized in the heat preparedness plan.

When the project began in 2011, communication of impending extreme heat was limited among municipal agencies. At the time, the IMD issued 2-day forecasts daily, but the AMC and other experts indicated a need for forecasts with a longer lead-time and coordinated action to alert the local government, health care centers, and the public of forecasted heat waves with formal communication channels to disseminate these warnings. A 7-day probabilistic weather forecast was thus developed from 2012-2013 to work alongside the government temperature forecasts and trigger the plan’s heat alert system in advance of dangerous heat waves.

To develop the priority early warning interventions for the inaugural 2013 launch, the project team conducted a “table top exercise” with government agencies to simulate a heat event. During this “table top” exercise, each government official with a role in the heat action plan walked through what they would do if a heat alert was issued. Based on feedback from this workshop, the team activities were considered realistic and effective. The Ahmedabad Municipal Corporation appointed its Health Department as the nodal agency with the overarching responsibility of coordinating all municipal activities. This agency monitors daily temperature forecasts, sends heat-health alerts, and disseminates public health messages to local government



HAP training workshops held with medical professionals in 2013 (left) and traffic police in 2014 (right).

departments when extreme heat days are forecast, as well as works to increase media awareness regarding preparedness.

During both 2013 and 2014, as part of planned activities both before the heat season (December through February) and during the heat season (March through June), the coalition hosted separate training workshops with municipal officers, medical professionals, the meteorological department, the media, and civil society. For community outreach, the team designed hoardings (billboards), which the government planned to display in prominent locations across the city; designed banners for auto-rickshaws to promote heat protection behavior; and developed pamphlets in English and Gujarati (the primary local language) for distribution to school children and other heat-vulnerable populations. These simple publications applied straightforward text, sometimes coupled with illustrations, listing the symptoms of heat stress and how to protect oneself during extreme heat events. The coalition also engaged with the private sector, including the paramedic/emergency response organization GVK regarding their internal communications to employees during heat waves.

Sidebar: Journal Articles Stemming from Heat Health Research in Ahmedabad

The project also expanded the body of science on the effects of heat waves, publishing four journal articles between 2013 and 2014:

1. Tran K, Azhar GS, Nair R, Knowlton K, Jaiswal A, Sheffield P, Mavalankar D, Hess J. 2013. A cross-sectional, randomized cluster sample survey of household vulnerability to extreme heat among slum dwellers in Ahmedabad, India. *Int J Environ Res Public Health* 10(6): 2515-2543.
2. Azhar GS, Mavalankar D, Nori-Sarma A, Rajiva A, Dutta P, et al. 2014. Heat-related mortality in India: excess all-cause mortality associated with the 2010 Ahmedabad heat wave. *PLoS ONE* 9(3):e91831.
3. Knowlton K, Kulkarni SP, Azhar GS, Mavalankar D, Jaiswal A, et al. 2014. Development and implementation of South Asia's first heat-health action plan in Ahmedabad. *Int J Environ Res Public Health* 11(4):3473-3492.
4. Kakkad K, Barzaga M, Wallenstein S, Azhar GS, Sheffield P. 2014. Neonates in Ahmedabad, India during the 2010 heat wave: a climate change adaptation study. *Journal of Environmental and Public Health*, vol. 2014, Article ID 946875.

Given initial hesitations about the success of an early warning system and preparedness plan for heat in India – where such a plan had never been implemented – the inaugural 2013 Heat Action Plan in Ahmedabad exceeded early expectations. An expert committee of international and local experts who are part of the Ahmedabad Heat and Climate Study Group had developed an initial list of recommended heat adaptation actions. The nodal officer from Ahmedabad's Health Department worked with the Ahmedabad Heat and Climate Study Group project partners to identify and prioritize Plan policies and programs that would have the largest impact on the most vulnerable groups. This selection process, based in part on the AMC's budget, bandwidth, and structures in place, helped tailored the Plan to ensure cost-effective and expedient adoption of initial measures by AMC. It also ensured that those strategies selected could be successfully implemented ahead of the 2013 heat season.

Building upon the 2013 activities, the city and coalition stepped up outreach activities in 2014. The coalition conducted workshops with an expanded focus, reaching out to highly heat-exposed vulnerable groups including traffic police, women's groups, rag pickers and other outdoor workers. The city and its partners also explored broader applications of multimedia tools, such as email and text alerts, in continuing outreach.

3.2 STAKEHOLDER EVALUATIONS, 2013-2014

Evaluating these efforts in a scientific, data-driven way is challenging. Accurate forecasting and reduced heat-related mortality and morbidity are good general indicators that alerts were sent out ahead of extreme heat days and that the government, health professionals, and the public were prepared to protect themselves from the heat. However, these quantitative measures are not determinative of which individual interventions were successful. A qualitative stakeholder questionnaire and roundtable discussion conducted after the 2013 and 2014 heat season provides feedback on the communication plans, community outreach, and advanced warnings administered through the Heat Action Plan.

The team conducted questionnaire-based interviews of involved stakeholders in both 2013 and 2014. The interviewees offered their thoughts on the efficacy of the existing Plan's programs and contemplated future updates for the following year.

The following evaluation questions framed the stakeholder questionnaire:

1. Major role and involvement in launching the Heat Action Plan;
2. Resources provided by the stakeholder;
3. Their aspirations for the program's effects;
4. Their perspectives on the actual impacts and what aspects were critical; and
5. Their future plans and considerations for the next iteration of the Heat Action Plan.

Given the extensive engagement of local stakeholders in developing the Plan, the coalition has built interest in the evaluation and feedback process within several government agencies and among community members. As part of the evaluation process for 2013 and 2014, the research team conducted semi-structured interviews with questionnaires and surveys. The evaluation was conducted during the fall of each year, following the heat and monsoon seasons.

The stakeholders who participated in the questionnaire were identified based on their involvement in the Plan or agency responsibilities. The project partners targeted and interviewed the top management authority responsible for surveillance activities. The Health Department, as nodal agency, was surveyed, as was the AMC press office, who works to increase media communication regarding preparedness and warnings. Organizations who executed the Plan's programs and/or actively supported ground activities were also surveyed. **Appendix 3** provides detailed results from the 2013 and 2014 stakeholder surveys, as well as the survey's limitations.

Sidebar: Stakeholders Identified to Participate in the Survey Questionnaire

1. Local municipal government officials involved in the Plan's control and administration. This category includes the AMC Nodal Officer, AMC media department, AMC health department and medical officer, and hospital administrators.
2. Those heads of organizations involved in the on-the-ground execution of the program.

3. Partner organizations and collaborators actively supporting ground activities or involved in data processing and sharing.

3.3 FORECAST EVALUATIONS - *WERE HEAT WARNINGS ISSUED AT THE RIGHT TIME?*

To determine the early warning system's effectiveness, i.e., whether heat warnings were issued at the right time, the team compared the predicted values generated by the CFAN forecasts seven days in advance to the actual temperatures later observed at the local Ahmedabad weather station. The analysis included:

- Evaluation of quantitative differences between forecast temperatures and observed temperatures in 2013 and 2014;
- Assessment of the forecasts' utility in predicting and calling various alert levels in 2013 and 2014.

Overall, the observed temperatures closely matched the CFAN forecasts, which provided several days' advance notice to the Ahmedabad community utilizing the heat action plan's early warning system. The next-day forecast seemed to be the most accurate, with less than a degree of difference relative to actual observed temperatures. Longer-term forecasts were also accurate and reliable, though decreasing in accuracy with each additional lead day. **Appendix Section I** offers more detailed analysis, utilizing two methods of data comparisons.

Side Bar: Heat Action Plan's Temperature Alert Thresholds for 2013 and 2014:

The following temperature thresholds corresponded with color-coded heat alerts, issued by the nodal officer and triggering the early warning system's activities in Ahmedabad:

RED ALERT	Extreme Heat Alert Day
ORANGE ALERT	Heat Alert Day
YELLOW ALERT	Hot Day
WHITE	No Alert

- **2013:**
 - WHITE NO-ALERT: No Alert Day (<41°C)
 - YELLOW ALERT: Hot Day (41.2- 43.4°C)
 - ORANGE ALERT: Heat Alert Day (43.5-45°C)
 - RED ALERT: Extreme Heat Alert Day (>45°C)
- **2014:**
 - WHITE NO-ALERT: No Alert Day (<41°C)
 - YELLOW ALERT: Hot Day (41-42.9°C)
 - ORANGE ALERT: Heat Alert Day (43-44.9°C)
 - RED ALERT: Extreme Heat Alert Day (≥45°C)

4 OUTCOME CONSIDERATIONS

4.1 HEALTH OUTCOMES – WERE LIVES SAVED AFTER THE HAP WAS IMPLEMENTED?

The team performed a quantitative mortality outcome evaluation of possible effects of the HAP launch in April 2013 based on daily mortality data from the heat season in the years before and after the Heat Action Plan was launched (March-May are typically the hottest months in Ahmedabad).¹³ Studies in other global cities have varied in their determination of how best to identify those days most dangerous to health as a result of extreme heat.¹⁴



Members of Ahmedabad community, 2012

The 2013 heat season was less severe than in 2010 with maximum temperatures consistently below 45°C.¹⁵

The combined 2013 temperature and mortality data shows on the relatively high heat days, mortalities were low and not correlated with temperatures. Although awareness of the Plan was high among the implementing groups, fewer heat alert warnings issued in 2013 meant that evaluation of the HAP's effect was challenging.

While the heat seasons in both 2013 and 2014 were less severe than during in the 2010 heat wave, the 2014 temperatures were much higher. The 2013 temperature data showed daily maximum temperatures ranged as high as 44.3°C on one day that year, while the 2014 temperature data shows maximum temperatures ranged up to 46°C, exceeding the ≥45°C “extreme heat” threshold temperature on 10 days.¹⁶

A preliminary health outcome evaluation analysis suggests there was at least a 25% decrease in May's excess all-cause mortality in the two years since the HAP was launched. In both 2013 and 2014, estimated May excess mortality was lower than 2010, as methods described in detail in **Appendix Section II** suggest. Considering just May, typically the hottest month, excess mortality was 24% lower in the 2014 summer than in the historic 2010 heat wave, and 52% lower in the less extreme 2013.¹⁷

In other words, **since the Heat Action Plan was enacted, fewer deaths have been reported during Ahmedabad's hottest months** than before the Plan was in place. Building awareness of and preparing medical workers, municipal agencies, and vulnerable communities for the health threats of extreme heat, in addition to providing early warnings and interventions when heat waves hit, may have already saved lives in Ahmedabad.

¹³ Gender stratified mortality data from ward crematoriums was obtained from AMC records provided by Dr. Amit Begda (SVRBD & Nodal Officer-NUHM). Data was provided up to May 2013 and is accurate as of Oct 10th, 2013.

¹⁴ Hajat S, Sheridan SC, Allen MJ, et al. 2010. Heat-health warning systems: a comparison of the predictive capacity of different approaches to identifying dangerous hot days. *Am J Public Health* 100(6):1137-1144.

¹⁵ IMD's automated METAR station monitors daily temperatures and shares the data with the National Climatic Data Center (NCDC) in the U.S.

¹⁶ In 2013, on May 21 daily maximum temperature reached 44.3°C (acc. to NCDC). In 2014, daily max. temperature was ≥45°C on 10 days: April 28, 29; May 27, 28, 29; June 3, 4, 5, 6, 7 (according to Weather Underground).

¹⁷ Initial results from an alternative analysis (manuscript in preparation) suggest hundreds fewer died in 2014 post-HAP than in 2010.

4.2 COMMUNITY OUTREACH OUTCOMES

A key feature of the Heat Action Plan was community outreach to build public awareness of the risks of heat waves and best practices for residents to prevent heat-related deaths and illnesses. The project team designed hoardings (billboards) and published advertisements and pamphlets in both English and Gujarati (the primary local language). The informational materials used straightforward text and illustrations listing the symptoms of heat stress and how to protect oneself during extreme heat events.



HAP hoarding in Gujarati posted in Ahmedabad, May 2014.

A series of outreach activities were then organized as part of the Heat Action Plan launch in 2013, including AMC's health and publicity departments displaying the hoardings around the city and on rickshaws with instructions on how to "Save Yourself from Heat," and distributing thousands of pamphlets at schools with heat-illness prevention tips. A radio campaign was developed in local languages and press notes were published in the local papers.

Sidebar: Community outreach by the numbers: Awareness-building materials disseminated in 2013-2014

- 6,000 heat health warning pamphlets for schools in Gujarati and English
- 150 Auto rickshaw banners in Gujarati and English
- 15 big hoardings around the city in Gujarati and English
- Heat awareness press notes published in local newspapers in Gujarati and English (1 in 2013, 3 in 2014).
- Extensive media coverage through newspaper articles, radio broadcasts and television features

Additionally, advance warnings ahead of forecasted extreme heat days were communicated as part of the Plan. Prior to the Plan's launch, the Meteorological Department did not share temperature data directly with city health departments and only one weather gauge read the temperature near Ahmedabad's airport, out of the city's hot core. Through the Plan, advance warnings are now given by the nodal officer to hospitals, urban health centers, and other municipal agencies through an internal communication plan and disseminated to the general public – particularly to at-risk residents – through the city government's media channels and other mediums including newspaper, radio, and TV. The Ahmedabad Municipal Corporation also installed a large public electronic LED temperature forecast display, one of the first in India, to alert communities of the current temperature and to allow residents to prepare for the heat ahead.

Ahead of the heat season (December through February), training programs for medical professionals, link workers, and other community outreach groups were organized with a focus on diagnosing heat-related illnesses and teaching patients how to recognize and treat the symptoms.¹⁸ Additional trainings focused on recommended interventions for vulnerable slum dwellers and outdoor workers were also held to sensitize government officials and medical professionals.¹⁹

4.2.1 Outcomes from 2013 Stakeholder Feedback on HAP

According to stakeholders' responses in the 2013 questionnaire, **the 2013 Heat Action Plan created better awareness of the health dangers of extreme heat among stakeholders through trainings and capacity building, especially among government, health and emergency response professionals.** However, this awareness has not yet reached the majority of the ground-level public, particularly slum communities, school children, outdoor workers and other vulnerable groups. Stakeholders also noted that the Plan was able to communicate early warnings before extreme heat days within the government in accordance to its internal communication plan, but again, it was difficult to ascertain whether those alerts reached the public. The participation of the AMC Commissioner and a full time nodal officer to monitor the program were also described as successes, but a lack of involvement and interest by government departments beyond the AMC Health Department was highlighted as a concern.

To improve the Plan, stakeholders proposed instituting more official protocols in hospitals and urban health centers and increasing access to cooling resources. Enhancing media presence and increasing temperature displays in public places were suggested for future heat seasons. Finally, although the public-private partnership emergency ambulance service group, GVK-EMRI 108, participated in the evaluation and indicated their plan to continue participation next year, a lack of general participation by corporate groups, NGOs, senior citizen groups and others was flagged as an untapped resource.

At the end of the 2013 heat season, the partners convened meetings in Ahmedabad to recap how the Plan succeeded in action and to develop a strategy to improve the Plan looking ahead to the 2014 heat season. Feedback from the stakeholder questionnaires was taken into account to evaluate the 2013 Plan and improve upon it. Multi-agency seminars were organized with stakeholders involved with the Plan along with additional public health experts to weigh in on what was effective and feasible to incorporate into the 2014 Heat Action Plan.

Although the 2013 Plan created better awareness of the health dangers of extreme heat among stakeholders, there was no official heat wave in 2013. Hence there was not as much public participation and action on the administrative side. Despite the success of the HAP's early efforts, stakeholders and other related agencies admit that heat waves were still not considered a major issue in many government and non-government agencies, making it difficult to initiate

¹⁸ A workshop training for medical officers & community best practices discussion on extreme heat was held in Ahmedabad on 11 December 2012.

¹⁹ A workshop training on vulnerability of, and recommendations to help protect, slum communities and occupational workers from heat-related health issues held in Ahmedabad on 13 December 2012.

valid interests. **Appendix Section III** provides detailed suggestions that stakeholders made to enhance both the 2013 and 2014 Heat Action Plans, as well as limitations of the surveys.

4.2.2 Outcomes from 2014 Stakeholder Feedback on HAP

Building upon the 2013 activities, the city and coalition stepped up outreach activities in 2014. Stakeholders noted that community-level awareness regarding heat-related resources substantially increased. The city and its partners strengthened efforts to reach vulnerable groups in 2014 through an additional series of workshops with traffic police, women's groups, rag pickers, and outdoor workers as well as via multimedia tools including email and text alerts. Several goals from the prior year's evaluation were achieved including the installation of a scrolling LED screen with temperature forecasts and newspaper inclusion of heat alerts.

Survey results in 2014 showed stakeholders reporting a higher level of engagement and satisfaction with the Heat Action Plan. Specifically, stakeholders remarked on the accuracy of longer-term forecasts, which improved public trust in heat alerts. Respondents also felt outreach efforts improved, including greater media coverage and efficiency of daily updates. Internally, the AMC utilized new communication tools such as WhatsApp, a popular smart phone application that enables free SMS-like messaging. These group messages – including early warnings of forecast heat waves – sent via WhatsApp were then disseminated publicly; stakeholders believe this may be a better means of broadcasting heat alerts and health protection tips than via bulk emails. The level of involvement of different departments in 2014 impressed stakeholders, but stronger coordination between agencies is still a priority. Stakeholders also suggest greater capacity building among medical personnel at the grassroots level.

Continued scaling of outreach efforts to better prepare and warn Ahmedabad's most vulnerable groups remains a challenge. Although some grassroots groups such as the Indian-based NGO Self-Employed Women's Association (SEWA) received HAP notifications, other at-risk groups including highly heat-exposed traffic police and construction workers require more attention. Improvements to the materials such as animations, posters, videos, and Hindi translations were suggested to disseminate heat protection strategies to a broader audience. Outreach material could also specifically target women since they are particularly vulnerable to heat stress. Recommendations shaped in part by these suggestions and the evaluation are now being incorporated into the 2015 Heat Action Plan to increase the Plan's reach and impact among the city's at-risk residents. **Appendix Section IV** contains potential recommendations to improve the 2015 Heat Action Plan.

Sidebar: Addressing Gender Disparities Associated with Climate Change

Climate change fuels hotter, more frequent heat waves, posing significant threats to women, especially those women residing in urban slums and working outdoors. A variety of interrelated factors increase women's susceptibility to heat-related illnesses, including:

- Traditional gender roles place daily cooking responsibility on women, which often takes place on open fires indoors, exacerbating heat exposure during the scorching heat season and due to poor ventilation.
- Poor women often are often illiterate and lack access to technology and important tools for adaptive capacity and heat awareness.
- Heat waves cause widespread shortages in safe drinking water and food for resource-limited urban slum dwellers. Women, as primary collectors, must work harder during the heat season to secure potable water, firewood, and food for their families.
- Many women in outdoor occupational settings e.g., construction and agricultural workers, wear shirts over their saris, hindering the cooling effect of sweat evaporation.

Ahmedabad's HAP recognizes the importance of incorporating women into its climate adaptation strategies. Because at-risk women often head their household's resource collection and protect their families' health, they are key agents for community engagement and behavioral change.

Proposed gender-related protection activities for the HAP 2015 include:

- Targeted distribution of pamphlets with heat protection tips in places where women often congregate, like markets and watering holes.
- Training workshops with community groups (e.g., Self-Employed Women's Association (SEWA) to increase awareness and warnings among at-risk communities and increase participation of women in decisions related to climate adaptation.
- Encourage employers to enable female workers to wear light, breathable cotton clothing and/or uniforms.

5 CONCLUSION

Despite the challenges of conducting evaluation and assessment studies, the Ahmedabad coalition considered whether the Plan met its goals, identified gaps and improvements, and assessed impacts. Our results show that overall, the Plan has been effective at increasing awareness of the dangers of heat waves, disaster risk management, and climate change in Ahmedabad. The city is much more prepared for heat waves than it was in 2010.

The innovative forecasting system along with outreach activities have proven beneficial in efforts to save lives. The 2-day forecast seems to be the most accurate, with less than a degree of difference relative to actual observed temperatures. Longer-term forecasts were also accurate and reliable overall, and provided more notice to the government and residents of impending extreme heat.

There were fewer city-reported deaths during Ahmedabad's annual heat season in the years since the Plan was launched. Stakeholder evaluations suggest that the HAP may have already helped diminished heat-related illnesses and save lives during periods of extreme heat, and it continues to protect more residents each year as the Plan's activities and impact expand.

Looking ahead, greater resources must be committed to increasing awareness in vulnerable communities and capacity building among medical professionals. A key to expanding activities is increased interagency communication as well as community outreach with media, civil society groups, schools, and business. The team will next be working with the AMC to enhance the 2015 Heat Action Plan, thereby expanding its reach and impact.

The Ahmedabad Heat Action Plan offers a replicable model of practical interventions that can be taken immediately to start saving lives and protecting health in other regions suffering from extreme heat. With an efficient and effective heat preparedness and early warning system in place, heat adaptation plans can help vulnerable populations prepare for extreme, and rising temperatures fueled by climate change.

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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. <http://www.egovamc.com/>

Indian Institute of Public Health, Gandhinagar - Public Health Foundation of India

The Indian Institute of Public Health, Gandhinagar (IIPH) 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. The Public Health Foundation of India (PHFI) is a public-private partnership structured as an independent foundation. PHFI is the hub of teaching, research, sharing knowledge and experiences in areas at the cutting-edge of public health in India. PHFI has launched four institutes of public health, including IIPH- Gandhinagar. <http://www.phfi.org>

Natural Resources Defense Council

The Natural Resources Defense Council (NRDC) is an international nonprofit environmental organization with more than 1.4 million members and online activists. Since 1970, our lawyers, scientists, and other environmental specialists have worked to protect the world's natural resources, public health, and the environment. Since 2009, NRDC's India Initiative on Climate Change and Clean Energy has worked with partners in India to help build a low-carbon, sustainable economy. <http://www.nrdc.org/international/india>

Rollins School of Public Health of Emory University

Founded in 1990, the Rollins School of Public Health is one of the United States' top public health schools and offers 22 degree programs in a wide range of health areas including Global Environmental Health. Rollins benefits greatly from its location in Atlanta, Georgia, home to the Centers for Disease Control and Prevention and several other organizations that work in the public health space. The School strives to educate the world's future public health leaders and offers students unique opportunities to gain practical experience and work in the field during their coursework. <http://www.sph.emory.edu/cms/index.html>

Icahn School of Medicine at Mount Sinai

The Icahn School of Medicine at Mount Sinai is internationally recognized as a leader in groundbreaking clinical and basic science research and is known for its innovative approach to medical education. With a faculty of more than 3,400 in 38 clinical and basic science departments and centers, Mount Sinai is a top-ranked medical school based in New York City. <http://www.mssm.edu/>

Georgia Institute of Technology

The Georgia Institute of Technology is one of the United States' top research universities, distinguished by its commitment to improving the human condition through advanced science and technology. Located in Atlanta, Georgia, more than 20,000 undergraduate and graduate students receive a focused, technologically-based education. The School of Earth and Atmospheric Sciences leads innovative research for the 21st century within the context of a premier technological research university. <http://www.eas.gatech.edu/>

Climate & Development Knowledge Network

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6 APPENDIX

The following Appendix provides a detailed description of the quantitative and qualitative measurement tools utilized in this stakeholder evaluation. The sections are as follows:

Section I: *Forecast Evaluations* describes how the accuracy of temperature forecasts were calculated

Section II: *Mortality Evaluation* highlights results for the mortality outcome evaluation and the methodology by which mortality data was analyzed

Section III: *2013 Stakeholder Evaluation* provides a summary of stakeholder responses from questionnaires administered in 2013 and 2014. It also includes survey limitations

Section IV: *Potential Recommendations for 2015 Heat Action Plan* highlights concrete steps from this assessment that will be incorporated into the 2015 HAP

SECTION I: FORECAST EVALUATIONS

Where heat warnings issued at the right time?

The team's evaluation of the early warning system compared the predicted values generated by the CFAN forecasts seven days in advance to the actual temperatures from the local Ahmedabad weather station.²⁰ The analysis included:

- Evaluation of quantitative differences between forecast temperatures and observed temperatures in 2013 and 2014;
- Assessment of the forecasts' utility in predicting and calling various alert levels in 2013 and 2014.

Evaluation of predicted versus actual (observed) daily maximum temperatures

Data on forecast temperatures were collected from CFAN website, and on observed daily maximum temperatures from weather stations at Ahmedabad airport via press releases from India Meteorological Department (IMD), and the international online National Climatic Data Center (NCDC) database, which corresponds to the Meteorological Terminal Aviation Routine (METAR) weather data (which is automatically monitors IMD's temperature daily). These data sets were labeled IMD and METAR, respectively. Probabilistic CFAN forecasts were first evaluated from March 23rd to June 4th, 2013.

Data comparisons for early warning system evaluation were done for using two different procedures:

1. Root mean square error (RMSE) of the CFAN predicted daily maximum temperatures, versus the observations from both datasets. RMSE is a widely used measure of the differences between values predicted by a model versus the values actually observed.²¹

²⁰ Local weather station ID 426470 (VAAH).

²¹ The formula for RMSE is: The formula for RMSE is given as $RMSE = \sqrt{\frac{1}{n} \sum_{i=0}^n x_i^2}$: where $x = (\text{forecast} - \text{actual})$

2. Comparison of the most likely forecast level against actual temperatures. This was established by comparing the forecasted level for each of the 7-day forecasts to the actual temperature threshold that was crossed.

The RMSE analysis conducted for each day of the extended forecast in 2013, compared with the actual temperatures from both the local weather stations, makes clear that the next-day forecast seems to be the most accurate. Verification analyses conducted in 2014 by Georgia Tech/CFAN support this finding. A manuscript on the two methods of advanced forecast and early warning system evaluation is in preparation and will provide more detailed analyses and findings.

Comparison of the most likely forecast/alert level, against actual temperatures

In 2013, only one “heat wave alert” was called via the HAP forecasts, which was from May 19-21, 2013, when 3 “very hot” days $\geq 43.5^{\circ}\text{C}$ were forecast, for May 19-21, 2013. The daily maximum temperatures later observed for May 19-21st were 44.2°C , 43.6°C , and 44.3°C respectively, according to the IMD data, which matched the CFAN forecast. In 2014, three “heat wave alerts” were called via the CFAN/HAP forecasts and there were ten “extreme heat” days. The observed temperatures matched the CFAN forecasts, which provided several days’ advance notice to the Ahmedabad community utilizing the heat action plan’s early warning system.

Based on the IMD observational records, Ahmedabad had only one “extremely hot” day $\geq 45^{\circ}\text{C}$ during the 2014 hot season; yet other data sources like Weather Underground show that 10 days were $\geq 45^{\circ}\text{C}$ in 2014. These disagreements between IMD and other data sources make absolute evaluation of the accuracy of forecasts challenging.

Comparison of the most likely forecast/alert level, against actual temperatures

Note that, between 2013 and 2014, the temperature alert thresholds were changed slightly:

- **2013:** Safe ($<41^{\circ}\text{C}$), Hot ($41.2-43.4^{\circ}\text{C}$), Very Hot ($43.5-45^{\circ}\text{C}$), Extreme Heat ($>45^{\circ}\text{C}$).
- **2014:** Safe ($<41^{\circ}\text{C}$), Hot ($41-42.9^{\circ}\text{C}$), Very Hot ($43-44.9^{\circ}\text{C}$), Extreme Heat ($\geq 45^{\circ}\text{C}$).

2013: Year 2013 saw only **one** “heat wave alert” called via the HAP forecasts, which was from May 19-21, 2013, when 3 “very hot” days $\geq 43.5^{\circ}\text{C}$ were forecast, for May 19-21, 2013. The daily maximum temperatures later observed for May 19-21st were 44.2°C , 43.6°C , and 44.3°C respectively, according to the IMD data, which matches the CFAN forecast.

2014: Year 2014 saw three “heat wave alerts” called via the CFAN/HAP forecasts:

- May 5-9 (“very hot” and “hot” days forecast)
- May 26-June 1 (“very hot” and “hot” days forecast)
- June 2-June 8 (“extreme heat” and “very hot” days forecast)

The observed daily maximum temperatures match the CFAN forecasts, which provided several days’ advance notice to the Ahmedabad community utilizing the heat action plan’s early warning system.

SECTION II: MORTALITY EVALUATION

Were lives saved after the Heat Action Plan was implemented?

In terms of a quantitative evaluation of possible effects of the HAP launch in April 2013 on health outcomes, daily mortality data from the 2005-2014 hot season (March-May) was available to the project team, providing an opportunity for mortality outcome evaluation.²² Studies in other world cities have varied in their determination of how best to identify those days most dangerous to health as a result of extreme heat.²³

Methodology: Heat and mortality in Ahmedabad, before and after the HAP

Another means to conduct this evaluation would be to establish a pre-HAP reference period, across the “summer” heat months of March-June, for years 2009 and 2011, similar to the Azhar et al. (2014) paper in PLOS ONE. By applying the May daily mortality counts for 2009 and 2011 combined, and comparing that to the mortality observed in the 2010 heat wave period, excess all-cause mortality during the historically hot season of 2010 can be estimated. Then the extreme heat of May 2010 provides a way to compare the observed 2013 and 2014 mortality, from years after the Heat Action Plan (HAP) was instituted, to estimate the difference in excess mortality relative to the 2010 heat wave period. The HAP was launched in April 2013, which would allow for further calculation and comparison of 2013 and 2014 May mortality, relative to the reference period.

Using the average of daily May all-cause mortality in the 2009 and 2011 reference period (100.6 mean daily May mortality), excess May mortality was compared in years 2010 (average daily mortality of 143.9 during the May 2010 historic heat wave)²⁴, then in 2013 (the 1st year post-HAP launch, with relatively cool temperatures), and 2014 (the 2nd year post-HAP launch, with relatively hot temperatures). Results show that average daily mortality in May 2013 was 120.5, and 133.0 in May 2014. While there were an estimated 1,344 excess deaths in 2010 relative to the reference period (2009 and 2011), in 2013 there were 617 excess deaths estimated by this method, and in 2014 there were 1,004. This suggests that, even in a very hot year like 2014, there was as much as a 25% decrease in May’s excess all-cause mortality after the launch of the HAP; and in a summer with less extreme heat events like 2013, which was the first year post-launch, a 54% decrease.

The same confounders as mentioned above hold true for this analysis, which also did not consider temperatures nor specific behavioral change since the HAP that may have diminished heat vulnerability and thus reduced mortality. **These methods suggest that daily all-cause summer mortality in Ahmedabad has dropped in the years since the HAP was launched.**

²² Gender stratified mortality data from ward crematoriums was obtained from AMC records provided by Dr. Amit Begda (SVRBD & Nodal Officer-NUHM). Data was provided up to May 2013 and is accurate as of Oct 10th, 2013.

²³ Hajat et al., 2010.

²⁴ As reported in Azhar et al. (2014).

It should be noted that there are several potential confounders that could also affect comparisons across different years of daily temperature-mortality relationships. These include:

- Population growth in the city at large, and specifically among the most heat-vulnerable groups
- Air pollution
- Outbreaks of infectious diseases or disasters that cause acute spikes in mortality
- Increased (or decreased) access to air-conditioning
- Changes in environmental heat exposure

In terms of municipal population growth trends in Ahmedabad, from 2001-2011 a 4.1% average annual growth rate has been reported.²⁵ If this growth rate remains stable to the present, one might assume that there could be a 4% increase in the numbers of municipal deaths each year, although deaths need not be on par with population growth. Yet in the absence of similar data on the possible effects of changing mortality rates in Ahmedabad, this provides a first approximation of how to account for this potential confounder.

SECTION III: 2013 AND 2014 STAKEHOLDER EVALUATION

The respondents to the 2013 Stakeholder Survey made several suggestions for the 2014 Heat Action Plan, including:

- ***For awareness***, the stakeholders recommended greater outreach to slum communities, focusing on increasing involvement of community outreach groups, such as link workers, schools, and worker groups to more directly reach vulnerable populations. Outreach could potentially be expanded through more grassroots distribution of materials and school lectures as well as better-tailored posters and pamphlets to audiences in easily communicated way, similar to successful tuberculosis pamphlets.
- ***For alerts***, the stakeholders noted that the early warnings being communicated before extreme heat days and having a full time nodal officer to monitor the program were effective strategies. However, increased media presence and temperature displays in public places were highlighted as necessary improvements.
- ***For interagency cooperation***, the stakeholders felt that the participation of the AMC commissioner and health department were strong, however, greater involvement by other government departments is needed.
- ***For medical professionals***, the respondents reported that the Plan successfully increased capacity building and preparation among health professionals through trainings, but putting more official protocols and increasing access to cooling resources are still needed. Other recommendations included increasing the availability of ice packs, medications for heat stress, and other cooling resources at hospitals, urban health centers, and for emergency personnel.
- ***For cooling opportunities***, stakeholders recommended the need for more public cooling facilities and water resources in addition to parks being kept open during the heat season. Others recommendations included increasing public park hours, water availability, and mobile water coolers to vulnerable neighborhoods during extreme heat days.

²⁵ As reported at: <http://www.citypopulation.de/India-Gujarat.html>

The following year, the respondents to the 2014 Stakeholder Survey made several suggestions for the 2015 Heat Action Plan, including:

- **For awareness**, more “train the trainer” sessions targeted to health care workers and school teachers were recommended. Existing community groups like the Self-Employed Women’s Association (SEWA), once trained in reducing heat-health vulnerability, can help reach vulnerable groups at the grassroots level. Further targeted outreach to workers’ groups for highly heat-exposed outdoor occupations like police and construction was recommended. Stakeholders felt that there was much more media coverage in 2014; newspapers, video alerts and radio were considered quite effective, while bulk emails were less successful. Respondents recommended utilizing smart phone applications like “WhatsApp” and local radio FM broadcasts like Radio Mirchi, as well as incorporating social media outlets to reach a wider audience. Stakeholders suggest creating a slum map that identifies high-risk areas to better target heat communication efforts.
- **For alerts**, the stakeholders affirmed their endorsement and trust in the accuracy and utility of the CFAN/HAP forecasts, with municipal officials confirming their excitement for a continued partnership in the 2015 heat season. The stakeholders recommended possibly installing more scrolling LED temperature postings, depending on funding. Also, newspapers can reserve space for posting forecast temperatures days ahead, so LED scrollers can provide updated daily forecasts. Mobile SMS texts can also be used to send alerts via agreements with mobile phone companies, who could distribute heat alert messages in bulk to public
- **For Interagency Communication/Cooperation**, the stakeholders suggested developing concrete distribution plans for supplies such as ice packs and drinking water. Holding weekly update meetings to increase coordination between departments was proposed.
- **For medical professionals**, the respondents reported that private hospitals could become more involved in outreach and tracking heat-related illnesses and mortality in order to address cases more comprehensively. An SMS alert system could direct messages regarding heat alerts to private practitioners. More training on prevention, emergency response, tracking, and surveillance would be useful for lower-level medical professionals, like nurses, paramedics, urban health center staff, the 1,100 community health workers, and link workers in Ahmedabad since “...these are often the medical people who interact with patients first.”
- **For cooling opportunities**, stakeholders advised that ice packs for critical patients (heat stroke) must be made more accessible, especially in urban health centres, ambulances, and hospitals. They also suggest expanding access to water sources and shaded areas in public spaces.
- **For stakeholder participation**, incorporation of other sectors such as Masters of Social Work students, local water-related NGOs, aanganwadis, and public staff e.g. construction workers, traffic police, and BRTS staff was recommended.

Limitations of the Stakeholder Surveys

To date, assessing stakeholder feedback through the semi-structured interviews has not included individual community members from the public, since the interviews have focused on the implementing stakeholders and partners, primarily working with the city government. Despite the Plan’s efforts, stakeholders and other related agencies have reiterated that heat waves are still

neglected as a major public health issue in many government and non-government agencies, as well as among many members of the public. It remains an ongoing challenge to stimulate widespread awareness and interest, especially among the most heat-vulnerable communities. Most of the stakeholder questions pertained to the amount of media coverage received rather than aiming to assess the penetration of the HAP into the community at the individual level.

SECTION IV: POTENTIAL RECOMMENDATIONS FOR 2015 HEAT ACTION PLAN

Based on the combined experiences of the project team and the responses from the 2013-2014 Stakeholder Evaluations, the following recommendations are being considered for the 2015 Heat Action Plan:

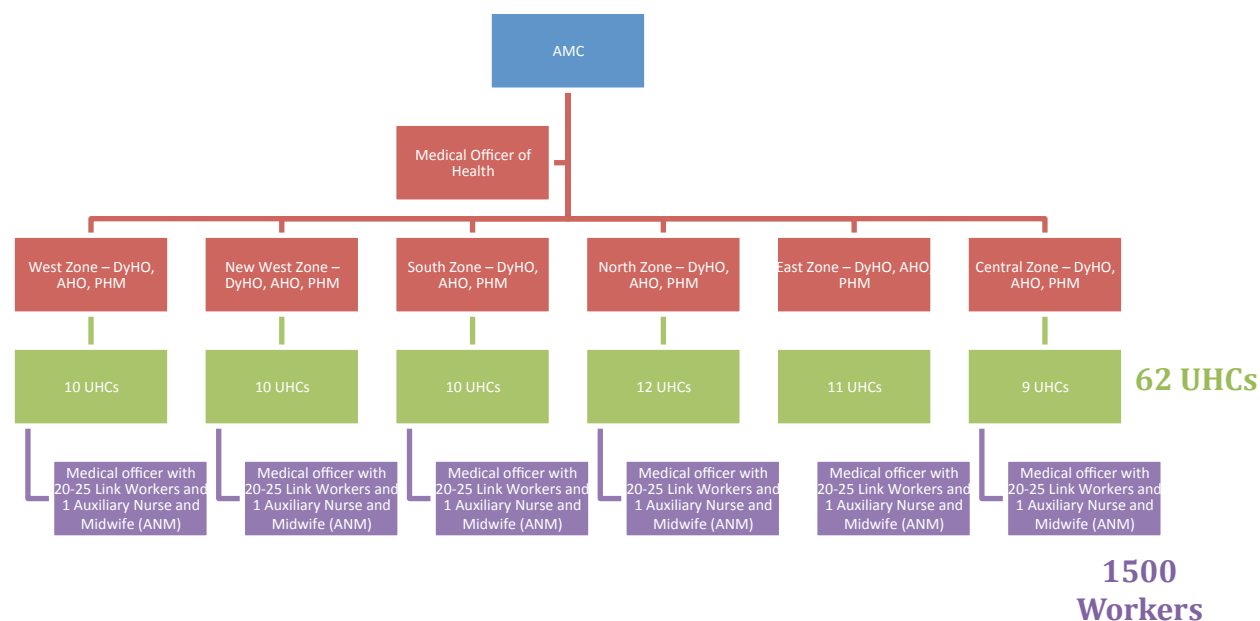
- Expand infrastructure to include:
 - Automated weather station
 - More temperature scrolls at public gathering & traffic square
 - A full time nodal officer for monitoring this program, or more staff support for the nodal officer
- Increase and improve IEC activities and ensure that the message is spread effectively to the entire community, especially those most heat-vulnerable
- Execute the program before school exams are held, to better reach families via students
- Update the alert system for broadcast on local Radio FM
- Increase distribution of pamphlets explaining how to diagnose and prevent heat illnesses
- Offer trainings to urban health centres and link workers in heat stress treatment standards and diagnosis guidelines
- Establish active heat-health hotline services
- Establish simple, user-friendly means to track heat-related illnesses and mortality daily
- Establish simple, user-friendly means to measure heat avoidance behaviors and their effects on health outcomes
- Improve early referral and detection capacity among health professionals for patients that are susceptible to dehydration. Create better identifying factors for why people are at risk for heat-related illnesses
- Expand to include different municipal and state-level agencies in involvement and participation
- Create and distribute a heat-themed video/poster, like the video launched at the International Meeting in Malaysia by IIPH's Dr. Abhiyant Tiwari in October 2014
- GVK-EMRI 108 sends SMS text messages to its drivers and staff in the street, warning them about hazardous conditions like extreme heat. This text messaging service could be combined with AMC's collection of residents' email and phone numbers, to possibly forward the heat warnings much more widely to the public
- Newspapers could reserve a space for heat wave alerts beyond the occasional press notes
- Increase HAP outreach to the grassroots-level in Ahmedabad
- Increase scientific research output on climate change related topics
- Add more gender dimensions as this project continues, since women may be disproportionately vulnerable to heat-health effects and not getting timely disaster preparedness information, owing to their time spent indoors in hot homes, and their

overall lower access to technology and literacy.²⁶ Develop outreach materials specifically targeted to women, potentially taking advantage of SMS text messages in local languages, and of places like markets and watering holes where women often congregate

- Implement similar HAP programs in other cities across South Asia
- Utilize medical professionals’ framework to coordinate communication of heat protection tips and early warnings of heat wave response among of medical workers and health clinics according to the most susceptible wards (see mapping below)

Sidebar: Framework of Ahmedabad’s Medical Professionals Working with the HAP

This organizational mapping serves as a framework to coordinate communication of heat protection tips and early warnings of heat wave response among of medical workers and health clinics involved in Ahmedabad’s Heat Action Plan. This framework shows the linkages between the Ahmedabad Municipal Corporation (AMC) as the nodal government institution down to grassroots-level response teams of medical officers, link workers, and auxiliary nurse and midwives in urban health clinics located in each of the six city’s geographic zones. This map of actors can help guide trainings and future action based on the susceptibility of particular wards.



²⁶ Leslie M. 2014. Weather forecasters predict better services for women. Reuters online (Wed. Nov.5, 2014), available at: <http://in.reuters.com/article/2014/11/05/disasters-women-idINKBN0IP0Y820141105>