CITY RESILIENCE TOOLKIT

Response to Deadly Heat Waves and
Preparing for Rising Temperatures

INDIAN INSTITUTE OF PUBLIC HEALTH GANDHINAGAR

phfi

NRDC

Mount Sinai

UNIVERSITY of WASHINGTON

CDKN Climate & Development Knowledge Network

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# INCREASING RESILIENCE TO EXTREME HEAT HEALTH RISKS ACROSS RAPIDLY URBANIZING INDIA

One of the world's deadliest heat waves devastated India in May 2015, killing more than 2,300 people. As climate change increases the frequency and severity of heat waves and the associated health risks, vulnerable, poor communities are often the hardest hit. In the face of these climate-fueled weather threats, early warning systems and preparedness plans can be adopted to protect health and lives within communities and increase resilience to rising temperatures.

Led by the city of Ahmedabad, Natural Resources Defense Council (NRDC), Public Health Foundation of India (PHFI)-Indian Institute of Public Health, Gandhinagar (IIPH-G), and a coalition of partners successfully implemented the first-ever early warning system and interagency disaster risk reduction plan for extreme heat in South Asia in 2013. Through raising awareness, increasing health care capacity, and issuing early heat alerts, the pioneering Ahmedabad Heat Action Plan increases preparedness and resilience to extreme heat and ultimately saves lives. Now the heat resilience efforts are poised to scale with heat action plans in new cities, including Nagpur, Surat, and Bhubaneswar.

Ahmedabad's Heat Action Plan

Heat waves are becoming increasingly severe, exacerbated by climate change. After a deadly heat wave hit the rapidly urbanizing city of Ahmedabad in 2010, the Ahmedabad Municipal Corporation (AMC) partnered with a coalition of academic, health, and environmental groups to improve the city's heat disaster response with a comprehensive early warning system and preparedness plan for extreme heat. Identifying the city's most heat-vulnerable residents (children, the elderly, slum communities, and outdoor workers), the Ahmedabad Heat Action Plan was launched in 2013 and deploys a three-pronged approach to reduce heat-related health risks:
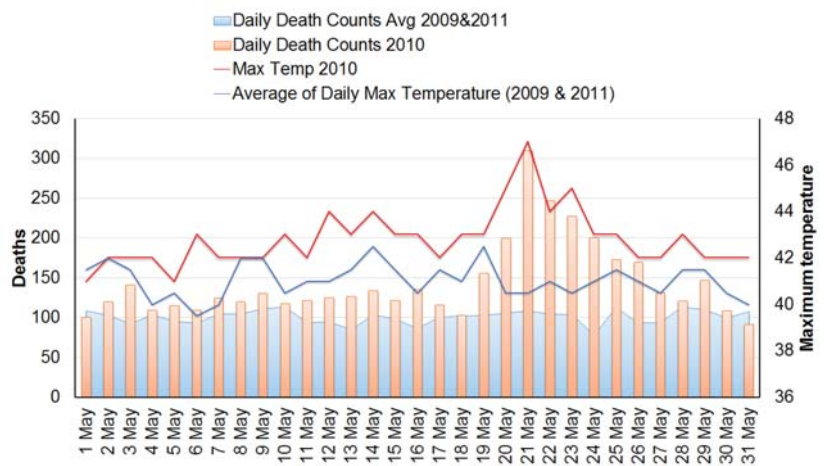
Deadly Threat: Ahmedabad 2010 Heat Wave Temperature and Death Count

1. Building public awareness of health risks through trainings, public advertisements, and community outreach.

2. Implementing an early warning system that coordinates government agencies, health officials, emergency response teams, and media outlets to alert the public of impending heat waves.

3. Increasing capacity among health care workers to recognize and treat heat-related illnesses.

Cutting-edge research - published in prominent scientific journals - is the foundation of the Ahmedabad Heat Action Plan and heat preparedness scaling efforts. Initial evaluation of the effectiveness of the Ahmedabad Heat Action Plan shows that the plan has saved numerous lives during its first three years of implementation, in addition to preparing the city's 7 million residents for future deadly heat waves.
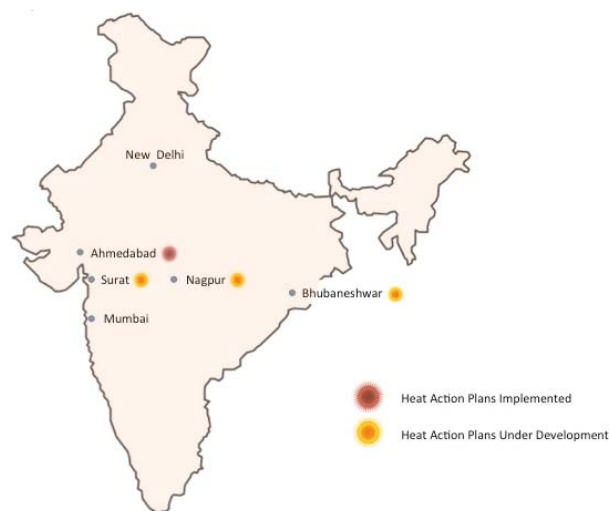
Scaling Heat Adaptation Plans Across India

Based on the Ahmedabad model, NRDC and IIPH are collaborating with leading cities and states in India to craft their own early warning systems and heat preparedness plans.

Nagpur, Maharashtra. In the heart of the subcontinent, the city of Nagpur and neighboring cities Chandrapur, Gondia, Akola, Nanded and Jalgaon are devising heat action plans to be adopted ahead of the 2016 heat season. For seven consecutive summers, the city has seen temperatures exceed 45°C (113°F). Through efforts led by the Maharashtra State Public Health Department and Nagpur Municipal Corporation, Nagpur is on track to become the second city and Maharashtra will become the first state to adopt regional heat preparedness plans in India.

Surat, Gujarat. Located along Gujarat's western coast, the city of Surat's high humidity compounds the health impacts of extreme temperatures each year. Surat's heat action plan could create the groundwork for a regional or state-level heat resilience plan in Gujarat.

Bhubaneswar, Odisha. The state of Odisha suffered an historic heat wave in 1998, with more than 2,000 people losing their lives. The city of Bhubaneswar, which also experiences high humidity, is working with the Odisha State Disaster Management Authority to expand its regional disaster planning based on the Ahmedabad model to prepare for rising temperatures.

Municipal Heat Action Plans in India

New Delhi

Ahmedabad
Surat • Nagpur
Mumbai • Bhubaneshwar

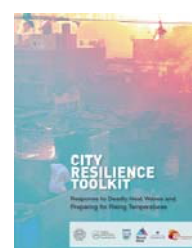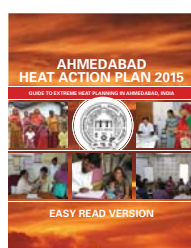Heat Action Plans Implemented
Heat Action Plans Under Development

National Heat Wave Planning

Key cities, NRDC and IIPH are also working with the Indian government to mainstream heat wave planning at the state and national levels. The Indian Meteorological Department (IMD) plays a critical role at the national and local level, providing cities with guidance on using weather forecasts and determining temperature thresholds to declare heat alerts. IMD supports the scaling up of heat action plans by strengthening and coordinating forecast communication to the cities. The National Disaster Management Authority has also started providing guidelines for heat-related disaster risk reduction plans to increase communities' resilience to extreme heat and overall capacity in climate adaptation efforts across India.

As temperatures continue to rise, pioneering heat wave preparedness efforts like the heat action plan in Ahmedabad are critical in protecting vulnerable communities from the increasingly deadly effects of a warming world.

Heat Health Preparedness Resource Page
http://www.nrdc.org/international/india/extreme-heat-preparedness/

AHMEDABAD
HEAT ACTION PLAN 2015
GUIDE TO EXTREME HEAT PLANNING IN AHMEDABAD, INDIA

EASY READ VERSION

A Cross-Sectional, Randomized Cluster Sample Survey of Household Vulnerability to Extreme Heat among Slum Dwellers in Ahmedabad, India

NRDC ISSUE BRIEF
Rising Temperatures, Deadly Threat:
Recommendations for Slum Communities in Ahmedabad

CITY
RESILIENCE
TOOLKIT

HOW-TO MANUAL

Steps to Develop an Urban Heat Action Plan
based on the Ahmedabad Experience

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INTRODUCTION

Climate change poses significant challenges to cities. As urban populations continue to grow, the need for cities and their residents to adapt to climate change and its impacts becomes increasingly urgent. Extreme heat is one of the health threats already challenging cities in India and around the world.

The second deadliest heat wave in India's recorded history devastated the country in May 2015, causing more than 2,300 deaths.[1] Temperatures soared, averaging more than 5.5°C (nearly 10°F) above average for two weeks, creating a relentless and dangerous heat crisis for people across the country.[2] Extreme heat events such as these have resulted in deaths, economic losses, power outages, and even riots and protests. Climate change is expected to fuel more intense, more frequent extreme heat events.[3]

More than 2,300 people died during India's second deadliest heat wave in history in May 2015. Extreme heat events such as these have resulted in deaths, economic losses, power outages, and even riots and protests.

Climate resilience and adaptation efforts in cities and states can reduce heat vulnerability, maintain economic stability, and protect people's health.

The consequences of extreme heat can clearly be dire. Cities and states—as drivers of national economic growth—therefore need to prepare for recurring heat waves. For many cities developing or improving their buildings, roadways, parks, and streets, preparing for extreme heat can be built into their planning and re-development processes, which will also enhance urban climate adaptation and resilience. Climate resilience and adaptation efforts in cities and states can reduce heat vulnerability, maintain economic stability, and protect people's health. As extreme heat continues to challenge cities—many of which already suffer from an urban heat island effect[4]—having a heat action plan helps to ensure economic and health resilience in the face of extreme heat. Heat action plans include early warning systems that alert citizens and organizations in advance of extreme heat, and enable them to respond effectively to save lives.

Ultimately, cities and states can reduce harm from extreme heat events by

1   CNN "India heat wave kills 2,330 people as millions wait for rain," 2 June 2015.
      http://www.cnn.com/2015/06/01/asia/india-heat-wave-deaths/
2   NASA Earth Observatory, "India Faces Deadly Heat Wave," 5 June 2015,
      http://earthobservatory.nasa.gov/IOTD/view.php?id=85986
3   Kamal Kumar Murari, Subimal Ghosh, Anand Patwardhan, Edoardo Daly, Kaustubh Salvi, Intensification
      of future severe heat waves in India and their effect on heat stress and mortality, Regional Environmental
      Change, 2015, 15, 4, 569
4   Many cities experiences warmer temperatures than surrounding rural areas as building materials and pave-
      ment absorb and later re-radiate the sun's energy, creating an "island" of heat. Many cities experience this
      "urban heat island" effect because their development and design replaced vegetation, permeable surfaces,
      and open land with buildings, roads, and impermeable surfaces – all of which absorb and re-radiate heat

preparing for them in advance. However, before developing a heat action plan, it is important to ensure the existence of the following elements:

- Detailed information regarding previous extreme heat events, including records of daily temperatures and possible health effects of heat

- Willing and interested municipal and state government leaders who are active on climate change adaptation and open to new collaborations

- Strong public health presence in government (at the city and state level)

- Strong public health presence in civil society (e.g. schools of public health)

Building on these elements, cities and states can follow a series of standardized steps to create their own heat action plans. These steps are included in this How-to Manual to guide development of a Heat Action Plan. It considers the experiences in developing the Ahmedabad Heat Action Plan as well as research and best practices from heat management strategies around the world. It consists of seven steps that outline key elements of planning for extreme heat. These steps include:

- City Engagement

- Vulnerability Assessment and Establishing Heat-Health Threshold Temperatures

- Developing a Heat Action Plan

- Team Preparation and Coordination

- Implementation and Monitoring

- Evaluating and Updating the Plan

- Strategies for Reducing Extreme Heat and Adapting to Climate Change

- Each step is supported with real-world examples from various cities. Finally, the manual also provides additional resources that a city can refer to in order to develop its Heat Action Plan.

THE PROCESS
Seven Steps

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1 City and State Engagement

The first step in planning for extreme heat management is to build strong city and/or state level engagement. This requires participation from government leaders, municipal health agencies, other key agencies and departments, and local partners. Ensuring strong engagement helps to identify key stakeholders and partners at the beginning of designing a heat action plan. During the implementation phase, strong engagement also brings the participation, resources, and skills of stakeholders and partners to local heat management activities. To make the planning process easier, it is important to meet with each of these agencies and partners and discuss the intent and process of developing a heat action plan.

As a part of the city or state engagement activities, the first step is identifying and forging relationships with key stakeholders. Getting buy-in from municipal leaders such as the mayor is essential to ensure the needed political will exists to provide strong leadership and eventually implement the plan. Engaging with the meteorological body that provides temperature and weather forecasts is necessary to predict when extreme heat will occur and warn the public accordingly. Developing relationships with the municipal press office and media can help to disseminate preventative information and heat warnings during extreme heat events.

Partnerships with groups such as public health universities can provide a local network, local expertise and public health resources for implementation on the ground. Municipal health agencies, emergency responders and other medical professionals are integral for trainings and capacity building as they can recognize and respond to heat-related illnesses, particularly during extreme heat events. Health professionals can also underscore to municipal leaders the dangers that extreme heat pose to local communities. Relationships with local community groups can provide outreach and communication on prevention methods to vulnerable communities.

- Identify and engage with the key municipal leaders
- Identify and engage with meteorological body
- Identify key municipal health agencies, emergency responders and other medical professionals
- Identify and engage with relevant partners, including public health universities and local community groups
- Develop relationship with the municipal press office and local media

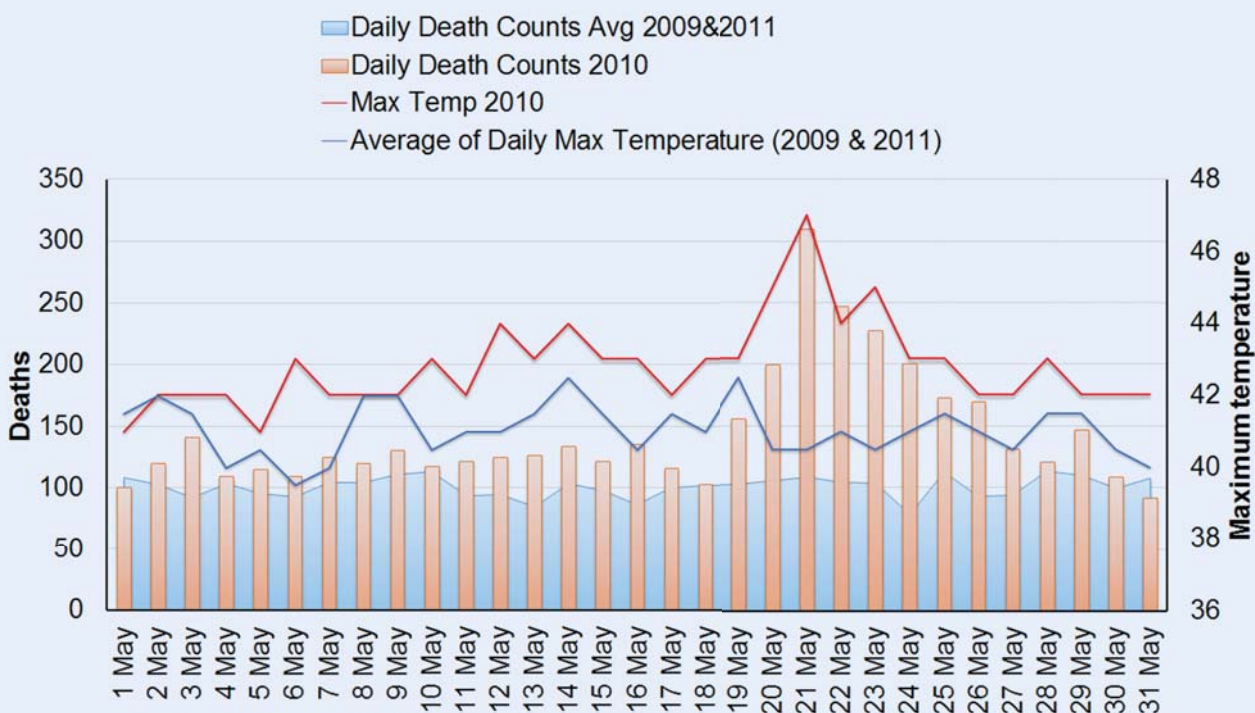| Case Study | Development of Ahmedabad Heat Action Plan, 2013 |

Figure 1: Ahmedabad 2010 Heat Wave Temperature and Death Count

The project team's public health and scientific experts performed robust scientific analysis of temperature data, mortality data from city hospitals, emergency ambulance call records, heat vulnerability surveys, focus group results, and interviews with government officials as a foundation of the Ahmedabad Heat Action Plan. This chart shows the correlation between peak temperatures and the high death counts during Ahmedabad's tragic 2010 heat wave.[5]

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5   NRDC, IIPH Resource Page, "Rising Temperatures, Deadly Threat," March 2013, http://www.nrdc.org/
     international/india/extreme-heat-preparedness/

2 Vulnerability Assessment and Establishing Heat-Health Threshold Temperatures

Extreme heat does not impact all people equally. Some people are more vulnerable to extreme heat and its impacts than others. It is important to identify the more vulnerable areas and populations of the city in order to establish priorities and minimum thresholds for heat alerts and activities. Incorporating information about vulnerable population groups within the city will help planners create effective, targeted strategies for reaching and protecting these groups. This will make the heat action plan more robust and equitable for all of the city's residents.

To create effective strategies for vulnerable groups and the rest of the city, stakeholders should collect firsthand information (such as historic extreme heat and mortality data) and assess the local impacts and nuances of extreme heat in the city. Heat island effects and other neighborhood-level "hot spots" can also be identified. Grassroots organizations might have data on heat-related morbidity and mortality that is not officially measured in surveillance and hospital records. This data can then be used to develop heat-health threshold temperatures and corresponding heat alerts.

Heat-health thresholds can be determined based on the city or district's heat wave definition, as well as on the assessment of historic mortality and temperature data. Heat alert levels should correspond to different heat-health thresholds.

Identifying intergovernmental and infrastructural challenges helps to anticipate and overcome them as the heat action plan is created. For example, a lack of interdepartmental communication can make the information flow slow within the government. Creating formal communication channels between relevant agencies ahead of a heat emergency can overcome that roadblock.

Step 2 | Checklist

- **Collect the historic extreme heat temperature and mortality data, and assess the impact of extreme heat events on the city**
  - Collect daily health data (e.g., total all-cause mortality numbers, and—if recorded—numbers of heat-related emergency room visits, heat-related hospital admissions, and heat-related deaths)
  - Gather daily temperature records and forecast information (e.g. daily temperature maximums, heat and humidity index, length of forecast, and methods of communicating temperature and weather forecasts)
- **Identify local heat-health thresholds & determine heat alert levels**
  - Decide on thresholds for heat alerts (i.e., what temperature range should correspond with which level of heat alert)
- **Identify current & future climate-health hazards, with a focus on extreme heat**
- **Identify intergovernmental and infrastructural vulnerabilities and assets that can impact heat resilience (using feedback and discussion from the stakeholder group)**
  - List existing intergovernmental vulnerabilities that may be impacted by extreme heat or hinder a heat action plan
  - List existing infrastructural vulnerabilities to extreme heat
  - List existing assets that can enhance heat resilience
- **Identify the vulnerable populations and health risks specific to each group**

Vulnerable population groups were identified through a vulnerability survey and assessment in Ahmedabad before preparing the Heat Action Plan. The health risks associated with each group were also determined through the survey and research. This process helped stakeholders and partners to develop targeted actions and recommendations for each at-risk group. See series of four issue briefs called "Rising Temperatures, Deadly Threat" for more information about the vulnerability assessment and tailored recommended actions for slum communities, outdoor workers, government officials and health professionals.[6]

Figure 2:   One of a series of four issue briefs, "Rising Temperatures, Deadly Threat: Recommendations to Prepare Outdoor Workers in Ahmedabad"

3 Developing a Heat Action Plan

The Heat Action Plan creates immediate and longer-term actions to increase preparedness, information-sharing, and response coordination to reduce the health impacts of extreme heat on vulnerable populations. Understanding the city's or state's heat vulnerabilities will help planners identify the key actions to take during the heat season to reduce heat-related illness and death. These actions should leverage existing infrastructure and cater to different subpopulations, particularly the vulnerable groups. Heat alerts should be communicated to relevant departments and the broader public, and participating groups should be responsible for actions corresponding to each heat alert level.

Key strategies to incorporate into the Heat Action Plan include:

- Building public awareness and community outreach to communicate the risks of heat waves and implement practices to prevent heat-related deaths and illnesses. Examples include disseminating public messages on how to protect people against extreme heat through media outlets and informational materials such as pamphlets and advertisements on heat stress prevention.

- Initiating an early warning system and inter-agency coordination to alert residents of predicted high and extreme temperatures. These efforts include creating formal communication channels to alert governmental agencies, health officials and hospitals, emergency responders, local community groups, and media outlets of forecasted extreme temperatures.

- Capacity building among health care professionals to recognize and respond to heat-related illnesses, particularly during extreme heat events. This can be achieved through targeted trainings for primary medical officers and other paramedical staff,

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6   NRDC, IIPH, "Rising Temperatures, Deadly Threat," March 2013, available at: http://www.nrdc.org/international/india/extreme-heat-preparedness/

and community health staff so they can effectively prevent and manage heat-related cases to reduce mortality and morbidity.

- Reducing heat exposure and promoting adaptive measures by mapping of high-risk areas of the city, increasing outreach and communication on prevention methods, access to potable drinking water and cooling spaces during extreme heat days. Collaboration with non-governmental organizations is another means to expand outreach and communication with the city's most at-risk communities.

See the attached Ahmedabad Heat Action Plan for more information and specific examples.

Step 3	Checklist

- Draft Heat Action Plan to include identified the before, during, and after summer season activities, such as:
  - Enhancing awareness, preparedness, and training (before the summer)
  - Establishing heat alerts, heat alert responses, actions for each heat alert level, early warning systems, and activities during periods of extreme heat (during the summer)
  - Preparing for next season through evaluating and improving the heat action plan (after the summer)
- Develop a clear communication plan that includes:
  - Intergovernmental communication and coordination of extreme heat awareness and response when a heat alert is declared
  - Communication with the public:
    - Public messages and information for building awareness before the heat season
    - Informational materials recommending preventative measures tailored for each sub-population (especially vulnerable groups)
    - Effective warning messages to convey heat alerts and heat wave early warning systems to the public

Case Study	Ahmedabad Heat Action Plan, 2014

WHITE	No Alert	< 41˚C
YELLOW ALERT	Hot Day Advisory	41˚C – 43.4˚C
ORANGE ALERT	Heat Alert Day	43.5˚C – 45˚C
RED ALERT	Extreme Heat Alert Day	> 45˚C

Figure 3:   Heat alert levels set for Ahmedabad[7]

The Ahmedabad Heat Action Plan established different heat alert levels corresponding to identified heat-health thresholds (Figure 3). The plan also created a communication plan among government departments to communicate internally and to alert the public when a heat alert was declared (Figure 4).

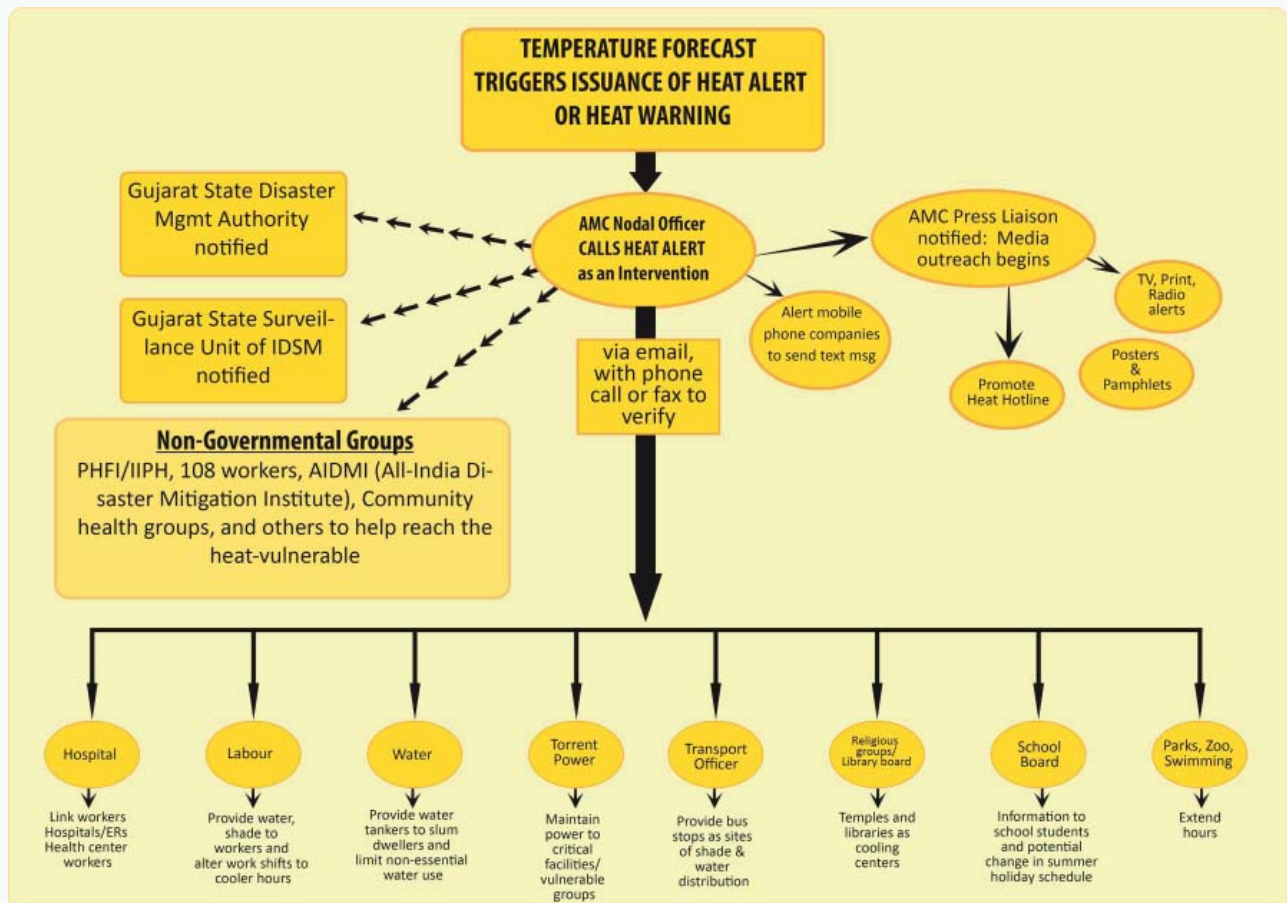7   User Guide: AMC's Early Warning System.

Figure 4: Intergovernmental communication strategy for heat alerts and warnings[8]

4 Team Preparation and Coordination

Before implementing a heat action plan, government leaders must ensure that key officials and agencies are well-prepared to handle the responsibilities. Key officials should receive training and information about activities before, during, and after the heat season. Organizing a "tabletop exercise" to stimulate a heat alert being declared can help test the plan's implementation and prepare the key players. These drills can also identify any weaknesses or problems in the plan to be resolved before heat season arrives. Effective implementation depends on efficient and clear communication among officials, departments, and the public. Officials should seek to streamline and improve communication among departments and between the government and the public. This includes broadly and effectively communicating warnings, forecasts, and advice to the public before, during, and after the heat season. Appointing a lead or "nodal" officer to head the Heat Action Plan and establishing effective communication practices in advance of heat season will prevent communication bottlenecks during extreme heat events. Creating a method to receive feedback, complaints, and questions from city residents can also help ensure the Plan's efficacy.

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8   Amdavad Municipal Corporation, "Ahmedabad Heat Action Plan 2014." http://switchboard.nrdc.org/blogs/ajaiswal/HAP%202014_FINAL.pdf

- ■ Appoint head or "nodal" officer and/or agency to oversee the Heat Action Plan
- ■ Build capacity of key officials and agencies
  - ● Conduct tabletop exercises, simulations, and drills
- ■ Identify and resolve communications gaps and weaknesses between participating departments, partners and the public

Case Study | **New York City, United States, 2014**

Figure 6: *New York City Mayor Bill de Blasio and other officials participate in a tabletop exercise for extreme heat at the Office of Emergency Management[9]*

New York City officials from the Mayor's office, the Department of Health and Mental Hygiene, the Office of Emergency Management, and over 30 other additional agencies conducted a tabletop exercise in August 2014. This simulated a 10-day heat wave and power outage affecting a population of 400,000 people.[10] As a result, the officials discovered weaknesses in the city's emergency response plan to extreme heat. They realized that the city needed to find new ways of rapidly delivering food and medicine to afflicted areas and vulnerable residents.[11]

5 Implementation and Monitoring

Effective implementation and monitoring of the heat action plan's activities during the hottest months should run smoothly both among government agencies and among the public. Government departments (and their potential non-governmental partners) are responsible for implementing many components of a heat action plan, but the public should also be aware of how to respond to extreme heat. Awareness building and training for the public should be conducted year-round, particularly ahead of the annual heat season. Clear, local language messages should be catered to different groups. Activities from the city or state's departments should be monitored continuously so that problems can be identified and addressed in a timely manner. This monitoring will also inform evaluation of the heat plan (see Step 6).

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9   Chayes, Matthew, "Exercise shows gaps in NYC emergency plan," Newsday, August 5, 2014: http://www.newsday.com/news/new-york/exercise-shows-gaps-in-nyc-emergency-plan-1.8972229?utm_medium=Email&utm_source=ExactTarget&utm_campaign=.

10 Puerini, Raymond, "Heat Wave Exercise Identifies Gaps to Improve NYC Emergency Plan," National Association of County & City Health Officials (NACCHO), August 15, 2014: http://nacchopreparedness.org/?p=2829.

11 Chayes, Matthew, "Exercise shows gaps in NYC emergency plan," Newsday, August 5, 2014: http://www.newsday.com/news/new-york/exercise-shows-gaps-in-nyc-emergency-plan-1.8972229?utm_medium=Email&utm_source=ExactTarget&utm_campaign=.

- ■ **Develop and widely disseminate key messages for communities**
  - • Conduct year-round awareness building and training workshops for the public
  - • Warn the public and raise interest in advance of heat season (e.g., through materials such as pamphlets, ads, pictures and videos)
  - • Cater messages to identified vulnerable groups (including recent mothers, parents, educators, the elderly, children, illiterate persons, outdoor workers, immigrants, and slum dwellers)
  - • Ensure that clear "Dos-and-Don'ts" during a Heat Wave are available in local languages in hot spots such as schools, hospitals, and religious centers. Disseminate through the media utilizing magazines, newspapers, websites, radio, television, and/or social media such as Facebook, Twitter, and WhatsApp)

- ■ **Continuous monitoring of the activities listed under the plan**
  - • Regularly update stakeholders and authorities on progress
  - • Identify any problems or bottlenecks
  - • Adjust practices as appropriate to resolve problems and ensure best outcomes

Case Study   **Ahmedabad Municipal Corporation, India, 2014**

NRDC and IIPH partnered with the Ahmedabad Municipal Corporation to distribute clear, local language posters with "Dos and "Don'ts" for dealing with extreme heat throughout the city of Ahmedabad in newspapers, buses, and rickshaws. The posters provided information that was relevant for city residents. Such advertisements could be available and modified on a year-round basis to enhance awareness and encourage preventive behaviors.

Figure 7:   *"Heat Alert: How to Save Yourself From Heat Waves" posters in English and Gujarati for Ahmedabad residents[12]*

12   Natural Resources Defense Council (NRDC), "Ahmedabad Heat Action Plan 2014: Guide to Extreme Heat Planning in Ahmedabad, India (EASY READ VERSION)," 2014: http://switchboard.nrdc.org/blogs/ajaiswal/HAP%202014_FINAL.pdf.

6 Evaluating and Updating the Plan

Strategies for extreme heat must be flexible and iterative. As government stakeholders accrue more experience, expertise, and data regarding extreme heat and heat action plans, they should be able to easily adjust, evaluate, and improve their strategies over time. After every heat season, the city or state must assess the efficacy of its heat action plan, including the processes, outcomes, and impacts. Stakeholders should then identify changes and improvements for the next heat season. The plan should ultimately be updated, and key officials and participants should be made aware of these changes.

See Appendix for more details on a recommended evaluation process.

Step 6	Checklist

- **Assess the efficacy of the heat action plan: processes, outcomes, and impacts**
  - Examine the processes (e.g. communications, logistics, and implementation) of the most recent plan. Questions might include:
    - o Which processes worked well?
    - o Which processes did not work well or as anticipated?
    - o What feedback was received from partners and participants?
    - o Was implementation cost-effective?
    - o Were there bottlenecks to communication and/or logistics?
  - Examine the outcomes and impact of the most recent plan. Questions might include:
    - o Did the plan work as anticipated?
    - o Were the most vulnerable populations well-served?
    - o What do scientific data and health records show regarding the impacts of the heat season? Did the heat plan make a difference?
    - o What feedback was received from residents and the media?
    - o Did awareness and behaviors improve?
    - o Did morbidity and mortality rates decline compared to previous heat seasons?
- **Identify changes to the plan for next year to improve outcomes and processes for the next heat season?**
- **Update the plan**
- **Disseminate updated plan to officials and participants**

Over 50 professionals from local health authorities, departments of Ahmedabad Municipal Corporation, and local emergency medical response services participated in an evaluation workshop for the Ahmedabad Heat Action Plan on December 11, 2014. They discussed the lessons learned and successes of the 2014 Heat Action Plan, and found ways to improve it in advance of the 2015 heat season. They found that they needed to increase community awareness and improve interagency communication for the 2015 Heat Action Plan.

Figure 8: AMC Heat Action Plan Evaluation Workshop[13]

7 Strategies for Reducing Extreme Heat and Adapting to Climate Change

As climate change fuels more intense, more frequent extreme heat, strategies that reduce the impact of heat waves become crucial. Cities and states can begin to enhance their own abilities to reduce heat-health threats far in advance of future heat seasons. Furthermore, strategies to reduce the urban heat island effect will help protect city residents from health risks before, during, and after heat waves. Cities can examine their own social, environmental, and economic circumstances to decide which strategies are most appropriate and cost-effective to develop.

Examples of strategies to mitigate the urban heat island effect and alleviate extreme heat include:

- City forestation[14] (favoring native trees and vegetation)

- Cool pavements[15]

- Cool roofs[16]

- Green roofs

- Land management policies and strategies[17]

- Traffic and congestion policies and strategies[18]

- Creating wind paths[19]

13   Climate & Development Knowledge Network (CDKN), "FEATURE: Vibrant Gujarat – Evaluating Ahmedabad's Action Plan," March 12, 2015: http://cdkn.org/2015/03/feature-vibrant-gujarat-evaluating-ahmedabads-heat-action-plan/.
14   United States Environmental Protection Agency (EPA), "Urban Heat Island Mitigation," August 29, 2013: http://www.epa.gov/heatislands/mitigation/index.htm.
15   Ibid.
16   Lawrence Berkeley National Laboratory (LBNL) and International Institute for Information Technology (IIIT), "Using Cool Roofs to Reduce Energy Use, Greenhouse Gas Emissions, and Urban Heat-Island Effects: Findings from an India Experiment," 2011: http://www.coolrooftoolkit.org/wp-content/uploads/2012/04/Satyam-project-in-India-IIIT.pdf.
17   Elsayed, Ilham S.M., "Mitigation of the Urban Heat Island in the City of Kuala Lumpur, Malaysia<" Middle-East Journal of Scientific Research 11 (11): 1602-1613, 2012: http://www.idosi.org/mejsr/mejsr11%2811%2912/19.pdf.
18   Ibid.
19   Akashi, Tatsuo, "Creating the 'Wind Paths' in the City to Mitigate Urban Heat Island Effects: A Case Study

- Enabling maximum air flow and reducing heat uptake in major buildings[20]

- Enhancing awareness

- Implementing relevant educational programs

Step 7	Checklist

- **Assess technologies and strategies for mitigating the urban heat island effect and alleviating extreme heat**

- **Determine which technologies and strategies are most appropriate and feasible**

- **Establish support to create longer-term mitigation and alleviation strategies, with partnerships that include government agencies, universities, private companies, non-governmental agencies, and the public**

- **Implement the longer-term alleviation strategies**

Case Study	Ahmedabad, India 2010

Shardaben General Hospital in Ahmedabad installed a white china mosaic "cool roof" to reduce internal hospital temperatures. The black tar roof had caused warmer indoor temperatures and spikes in heat-related illnesses. The neonatal ward on the top floor was closest to the black tar roof and experienced oven-like conditions, with newborn infants exposed to temperatures hotter than everywhere else in the hospital. The hospital moved the neonatal unit to the first floor, and replaced the black tar roof with a white china mosaic cool roof. These actions cooled indoor temperatures and reduced heat-related illness, particu-larly among newborn infants. Ahmedabad

Figure 11: Shardaben General Hospital's renovated white china mosaic roof (Photo by Nehmat Kaur)[21]

decided to apply this heat mitigation technique to all of its hospitals. Expansion of cool roofs and other heat mitigation techniques reduces the urban heat island effect, and should alleviate the health impacts of extreme heat while simultaneously saving costs on energy.

in Central District of Tokyo,"CIB-W101 (Spatial Planning and Infrastructure Development) Annual Meeting 2008: http://www.kenken.go.jp/japanese/contents/cib/w101/pdf/mtg/0809dublin/session01.pdf.

20 Health Canada, "Communicating the Health Risks of Extreme Heat Events: Toolkit for Public Health and Emergency Management Officials," 2011: http://www.hc-sc.gc.ca/ewh-semt/alt_formats/hecs-sesc/pdf/pubs/climat/heat-chaleur/heat-chaleur-eng.pdf.

21 Khosla, Radhika and Gulrez Shah Azhar, "The Opportunity of Cool Roofs to Mitigate the Heat/Health Impacts of Climate Change in Ahmedabad," Natural Resources Defense Council (NRDC), March 29, 2012: http://switchboard.nrdc.org/blogs/rkhosla/the_opportunity_of_cool_roofs.html. See also, Jaiswal, Anjali and Meredith Connolly, "Protecting Communities from Extreme Heat: 2014 Heat Action Plan Emphasizes Cutting-Edge Climate Adaptation Efforts in Ahmedabad, India," NRDC, March 10, 2014: http://switch-board.nrdc.org/blogs/ajaiswal/protecting_communities_from_ex.html.

Key Authors & Investigators:

Indian Institute of Public Health, Gandhinagar
Dr. Dileep Mavalankar, Dr. Partha Ganguly, Priya Dutta, Dr. ABhiyant Tiwari

Natural Resources Defense Council
Dr. Kim Knowlton, Anjali Jaiswal, Meredith Connolly, Nehmat Kaur, Bhaskar Deol

University of Washington Department of Medicine
Dr. Jeremy Hess

Icahn School of Medicine at Mount Sinai
Dr. Perry Sheffield

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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. The Public Health Foundation of India (PHFI) is a public-private partnership and 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 environ-mental organization with more than 2 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

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Appendix

Glossary

A   **Ahmedabad Heat Action Plan** – In 2013, Ahmedabad Municipal Corporation (AMC) collaborated with the Natural Resources Defense Council (NRDC), the Indian Institute of Public Health, Gandhinagar (IIPH), and other organizations to create the first comprehensive early warning system and preparedness plan for extreme heat events in South Asia. The plan has been updated annually.

C   **Cool roofs** – Roofs that use products and materials with high solar reflectance and thermal emittance properties. They prove cooler than roofs using conventional materials during the summer, and can mitigate the heat island effect in cities.

           Cool pavement – Pavement that uses materials and technology to reduce the amount of energy and heat absorbed, thus lowering surface temperatures for the pavement and mitigating the heat island effect in cities.

D   **Dos and Don'ts for Extreme Heat**– A guideline of actions that residents should and should not undertake in response to extreme heat.

E   **Early warning system** – A system that analyzes relevant data to forecast an impending hazard or disaster and warns the public in advance, thus allowing for timely responses that prevent deaths, morbidity, and economic loss.

           Extreme heat – Heat (and possibly humidity) conditions that substantially exceed summer norms at any given location.

G   **Green roofs** – Roofs that have vegetation. Vegetation on rooftops cools the surrounding air and the roof surface, thus helping to mitigate the urban heat island effect.

H   **Heat action plan** – A plan for responding to extreme heat conditions (including heat waves) and minimizing their impacts.

           Heat-health threshold – A threshold or boundary for temperature (and possibly humidity) conditions above which morbidity and mortality increase beyond baseline levels for a given location.

           Heat wave – A prolonged period of extreme heat.

U   **Urban heat island** –Many cities experiences warmer temperatures than surrounding rural areas as building materials and pavement absorb and later re-radiate the sun's energy, creating an "island" of heat. Many cities experience this "urban heat island" effect because their development and design replaced vegetation, permeable surfaces, and open land with buildings, roads, and impermeable surfaces – all of which absorb and re-radiate heat.

International Survey of State-Level Heat Action Plans

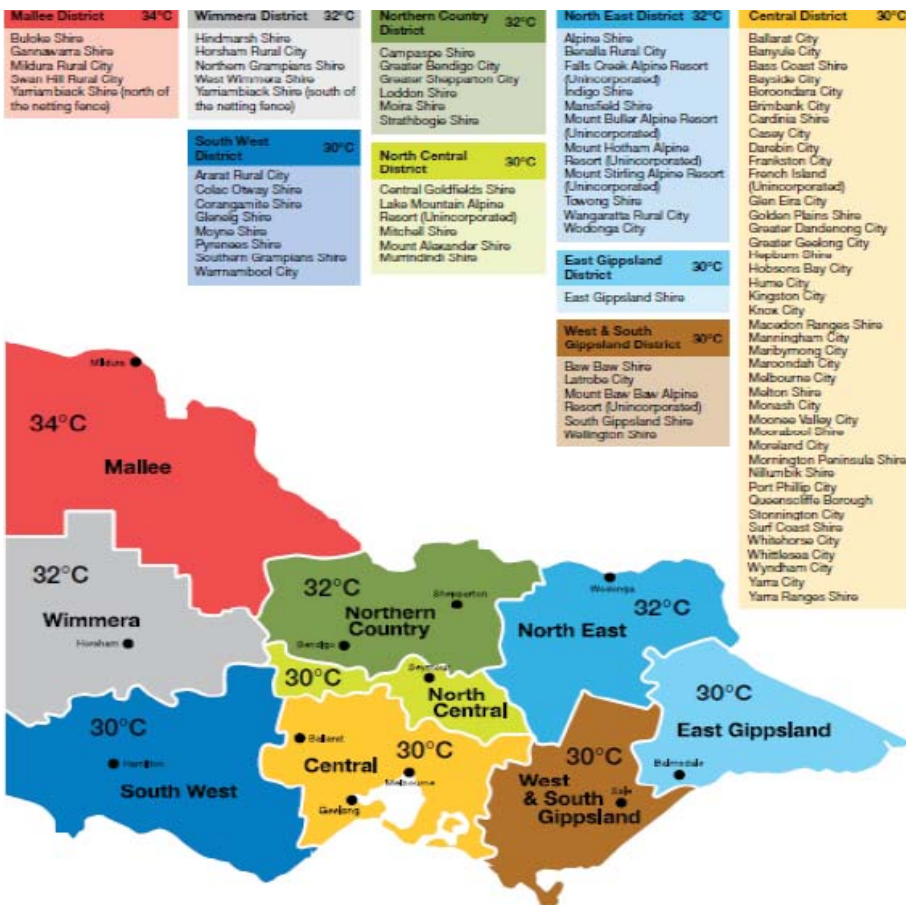## Victoria State Heat Plan - Emergency Management Victoria (EMV)

Warning and Alerts

The **Bureau of Meteorology** forecasts temperature 7 days in advance. The Bureau also has a pilot heat event product, which forecasts 3-day heatwaves.[1]

Based on the Bureau of Meteorology weather forecasts, the **Department of Health** issues heat health alerts to key stakeholders to notify them of an impending heat event and encourage them to activate their heatwave plans.

The Department of Health has identified heat health temperature thresholds for Victoria, above which heat-related illness and mortality increases substantially. A heat health threshold has been established for each of the nine weather forecast districts. The boundaries of weather forecast districts are determined by the Bureau of Meteorology. The thresholds differ across the state to recognize the higher temperatures experienced in northern parts of Victoria.

Figure 1: Weather forecast districts and corresponding heat health temperature thresholds[2]

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1   Emergency Management Victoria, State Heat Plan 2014, March 6 2015, http://fire-com-live-wp.
     s3.amazonaws.com/wp-content/uploads/State-Heat-Plan-2014_Bookmarked.pdf
2   Department of Health & Human Services (DHHS), Government of Victoria, Heat Health Alert System 2014-
     2015, Information and guidance for councils and stakeholders, March 6 2015, http://docs.health.vic.gov.
     au/docs/doc/479050E85C879831CA257D8C0015FD87/$FILE/Heat%20health%20alert%20system_guid-
     ance%202014%20-%202015.pdf

These thresholds are based on information including average summer temperatures and research conducted by Monash University. An assessment of the temperature threshold analysis conducted by Monash University indicates that thresholds were determined by assessing the relationships between maximum, minimum, and average temperature with total 2-day mortality and anomalous mortality.[3]

When forecast average temperatures are predicted to reach or exceed the heat health temperature threshold for a specific weather forecast district, the Chief Health Officer will issue a health alert for that district, available on the Chief Health Officer website.[4] Alerts may be issued several days prior to event. Heat health alerts are issued to government departments, health agencies, health service providers and local government.

Following notification, health agencies and service providers such as hospitals, local government, residential aged care facilities, and ambulances implement their plans and responses.[5]

Once a heat health alert has been issued, the Chief Health Officer, in conjunction with the Emergency Management Commissioner and agencies such as Ambulance Victoria, Victoria Police and the Bureau of Meteorology may provide information and warnings to the community through media releases and interviews.

Human Health

The Department of Health provides a comprehensive suite of resources for the community, such as brochures, posters and fact sheets, about staying healthy in the heat. They also provide heat health messages during the summer on social media. The Department's heatwave framework comprises Heatwave Plan for Victoria, Heat health alert system, Heatwave Planning Guide, Heatwave plan review tool, Heat Health Information Surveillance system.[6]

Strategic Coordination of Heat Event Management

The **Emergency Management Commissioner** is responsible for emergency response coordination of heat events at the state tier and ensures the coordination, control, consequence management, communications and recovery functions of these events are integrated and effective. The Emergency Management Commissioner works from the **State Control Centre** (SCC), which provides a range of services to assist with the coordination and control of emergencies and which has well-established protocols for working across all government agencies.[7]

The **Victoria Police** are responsible for emergency response coordination at the regional, municipal, and incident tiers of emergency response management and the Regional Emergency Coordinator (RERCs), Municipal Emergency Response Coordinators (MERCs) and Incident Emergency Response Coordinators (IERCs) undertake emergency response coordination in the region, municipality, and at the incident respectively.

3   Monash Climate School of Geography and Environmental Science, "Temperature thresholds associated with increased mortality in ten major population centres in rural Victoria, Australia". http://docs.health.vic. gov.au/docs/doc/73A9CA50F5A6672CCA257A36002451C5/$FILE/heatwaves_thresholds_report.pdf
4   Department of Health & Human Services (DHHS), Government of Victoria, Heat health alert system, March 6, 2015, http://www.health.vic.gov.au/environment/heatwaves-alert.htm
5   Ibid.
6   Emergency Management Victoria, State Heat Plan 2014, March 6 2015, http://fire-com-live-wp. s3.amazonaws.com/wp-content/uploads/State-Heat-Plan-2014_Bookmarked.pdf
7   Ibid.

Government Arrangements for heat event management

State Tier Governance: The Emergency Management Commissioner manages the State response to major emergencies including heat events, through the following five key teams: state coordinate team (SCOT), state control team (SCT), state emergency management team (SEMT), emergency management joint public information committee (EMJPIC) executive, and full EMJPIC. These teams are supported by State Crisis and Resilience Council (SCRC).

Emergency Management Teams

To organize a whole of government approach to the management of a heat event, Emergency Management Teams (EMTs) are convened as follows: State Emergency Management Team (SEMT), Regional Management Team (REMT), and Incident Emergency Management Team (IEMT). An EMT is the collaborative forum where agencies with roles and responsibilities during an emergency meet to discuss the risks and likely consequences of the heat event and plan a whole-of-government approach to the management of these risks and consequences at their respective tier.

Health and medical response coordination

The State Health and Medical Commander is responsible for the overall direction of the health and medical response to an emergency and represents the agencies in the SEMT. These include Department of Health, Ambulance Victoria, first aid providers, medical providers, health services, and relief agencies.

During a significant heat event:

- The Emergency Management Commissioner may engage the support of EMJPIC to ensure the state-level messages from all agencies with a role or responsibility in managing the heat event are included in the key messages to the public

- The Chief Health Officer, the Emergency Management Commissioner and Victoria Police are responsible for speaking to the media and the community regarding whole-of-government arrangements

- The Chief Health Officer and/or Ambulance Victoria are responsible for providing information about how the community can stay healthy in the heat

- AEMO is responsible for speaking on behalf of the Victorian Electricity supply industry when there are widespread and prolonged outages affecting the State.

- Individual agencies may speak to the media regarding their own activities, however this will be coordinated through EMJPIC at the regional tier, Victoria Police, the Department

Municipal Corporations

Because they are the closest tier of government to local communities, municipal councils have a central role in building community capacity and resilience to prepare and plan for, respond to and recover from emergencies. Each municipal council should have a heat-wave plan as a part of the Municipal Emergency Management Plan. The Department of Health provides guidance and support to municipal councils on developing these plans, including through their Heatwave Planning Guide – Development of heatwave plans in local councils in Victoria, which can be found on their website.

State of California Contingency Plan for Excessive Heat Emergencies

Using historical weather and mortality data, the National Weather Service and the California Department of Public Health have identified for each of the five major types of climate regions the conditions that constitute an excessive heat event within those specific regions. When temperatures "spike" for two or more consecutive days without an adequate drop in nighttime temperature to cool the outdoor and indoor environments, there is a significant increase in the risk to vulnerable populations. Therefore the definition of excessive heat events with the climate zones considers both daytime maximum temperatures and nighttime maximum low temperatures.[8]

Figure 3. State of California Organizational Structure and Basic Staffing
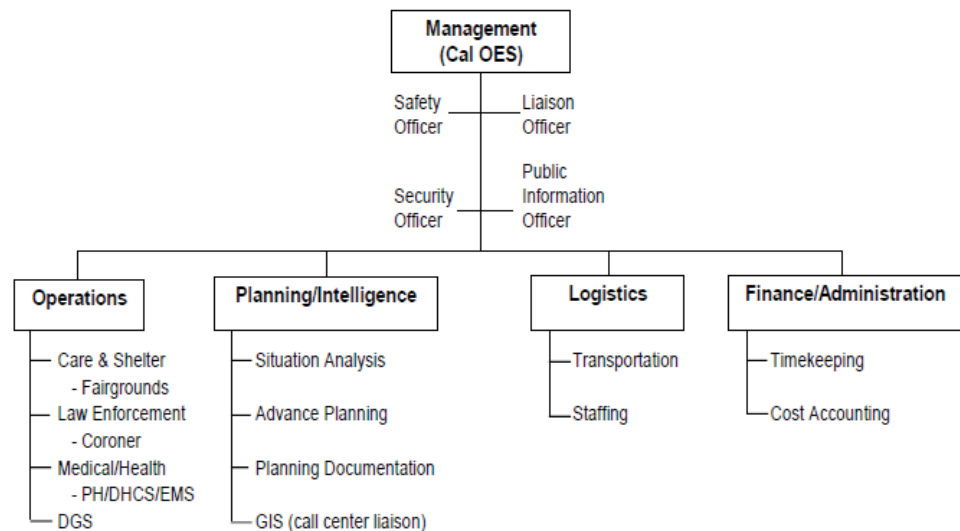
The state divides heat emergency planning into three phases:

(1) Seasonal Readiness

(2) Heat Alert

(3) Heat Emergency

For further details regarding responsible department/agency responsibility and activities, see pg. 12 – 28 of Heat Contingency Plan.[9]

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8   California Governor's Office of Emergency Services, Contingency Plan for Excessive Heat Emergencies, June 2014. www.calema.ca.gov/PlanningandPreparedness/Documents/Heat
9   Ibid.

In reviewing these activities, the nodal agencies for carrying out the plan are the Cal Office of Emergency Services and the California State Warning Center. The state also offers local government guidance and checklists for each of these phases.

Alerts and Warnings

The National Weather Service (NWS) will generally initiate its Heat Index Program Alert procedures when the heat index high is expected to exceed 105° - 110° (depending on local climate) for at least two consecutive days.

Based on climate-region-specific criteria, if NWS predicts excessive heat event, they issue alerts in form of a Special Weather Statement

- Excessive Heat Outlook (issued 3 – 7 days in advance)

- Excessive Heat Watch (issued 36 – 48 hours in advance)

- Excessive Heat Warning (issued 0 – 36 hours in advance of event expected to last 2 days or more)

The alert procedures include:

- Adding heat index (HI) values in zone and city forecasts;

- Issuing special weather statements and/or public information statements presenting a detailed discussion of (1) the extent of the hazard including HI values, (2) who is most at risk, (3) safety rules for reducing the risk;

- Assisting state and local health officials in preparing heat emergency messages in severe heat waves (meteorological information from special weather statements will be included as well as more detailed medical information, advice, and names and telephone numbers of heath officials); and,

- Release of all the above information to the media and over the National Oceanic and Atmospheric Administration's (NOAA) own weather radio.

State Dissemination of Public Information

- The state assumes **that local governments are the first responders** in emergencies

- Cal OES will mainly rely on the operational areas through their county health departments to determine the activation levels at which specific activities will be undertaken.

Steps to Determine Temperature Thresholds for Cities in India

The following set of steps are intended to aid cities in developing threshold temperatures for heat action plans.

Possible steps might be:

1. City: Gather daily all-cause mortality counts

   - If available, include data on age, gender, etc.

   - Include a notation of the Source of the Data and the date it was acquired

2. City: Gather daily maximum temperature (Tmax) and daily Heat Index (H.I.) max

   - Include a notation of the Source of the Data and the date it was acquired

   - METAR = hourly; Tmax and Tmin are from an Analog device

3. Create a Data Table summarizing the descriptive statistics for the City

   - For example: Date – Death Counts – H.I. Max

4. Plot graphs

   - Create descriptive stats for all data analyzed

   - To include: daily Tmin, Tmax, mean, median, 50th – 90th – 95th – 97th – 98th – 99th percentile values

   - PLOT: Mortality counts on vertical left Y-axis; Date on the main X axis; Temp on y=axis on R vertical]

   - PLOT: temp and HI vs. mortality counts

   - Select a possible couple of threshold temperatures, based on visual inspection of graphs

5. Calculate correlation coefficients for mortality & for 3 segments of time series:

   - All dates/temps

   - Temps < threshold

   - Temps ≥ threshold

6. Other questions to ask:
   To help determine the effects of possible confounders
   If any of these data are available, can add as columns on the data table

   - Changes in population size or demographics

   - Infectious disease outbreaks

   - Air pollution episodes

   - Accidents, disasters

   - Holidays

7. A discussion of health risk communication i.e. heat alerts will also be an important consideration in determining thresholds

8. What should we do about cities that lack mortality and/or morbidity data?

    •   Percentile Approach to Threshold Determination:

    •   Other cities, states, countries globally have used percentile values to determine thresholds

    •   "In situations where there is basic meteorological information but no health data, a percentile-based threshold (90th, 95th) could be contemplated as a warning trigger value."[10]

    •   Calculate the 90th (or 95, 97, 98, 99th) percent temperatures locally during summer months (March – June) over last 10 (minimum) years through Excel spreadsheets

    •   See how percentiles compare to heat-mortality plot, if one is available: is there a percentile value that coincides with a spike in temperatures?

    •   Ahmedabad's 90th percentile value (42.9 deg C) was super close to the 43 deg C used as threshold for Orange Heat Alert days

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10   2015 World Meteorological Organization and World Health Organization Report. *Heatwaves and Health: Guidance on Warning-System Development.* http://www.who.int/globalchange/publications/heatwaves-health-guidance/en/

Suggested Heat Action Plan Evaluation Methodology

- Heat action plans should be evaluated after every heat season. This will help cities to improve on their plans in advance of future extreme heat events. The following steps comprise a suggested framework for evaluating heat action plans.[22]

- Identify and engage stakeholders

- Develop evaluation questions

- Determine methods and procedures for collecting data

- Assess resources and establish a timeline, work plan, and budget

- Collect and analyze data

- Interpret results

- Communicate insights, findings, and lessons learned

- Update and improve the plan based on insights, findings, and lessons learned

Links for Reference

- Ahmedabad Heat Action Plan, 2015[23]

- Expert Committee Recommendations for a Heat Action Plan based on the Ahmedabad Experience, 2015[24]

- Heat Action Plan YouTube Video, 2014[25]

- CDKN Inside Story: Vibrant Gujarat – Evaluating Ahmedabad's Action Plan[26]

- "Rising Temperatures, Deadly Threat" Series of Four Issue Briefs of Recommendations for Heat Adaptation in Ahmedabad[27]

22   See Public Health Ontario, "Evaluating health promotion programs," November 1, 2012: http://www. publichealthontario.ca/en/eRepository/Evaluating_health_promotion_programs_2012.pdf. Also see W.K. Kellogg Foundation, "W. K. Kellogg Foundation Evaluation Handbook," January 1998: http://www.epa. gov/evaluate/pdf/eval-guides/evaluation-handbook.pdf.
23   NRDC, IIPH, AMC. 2015 Ahmedabad Heat Action Plan (2015): available at: http://www.nrdc.org/international/india/extreme-heat-preparedness/files/ahmedabad-heat-action-plan.pdf
24   NRDC, IIPH, Expert Committee Recommendations for a Heat Action PLan based on the Ahmedabad Experience (2015): available at: http://www.nrdc.org/international/india/extreme-heat-preparedness/files/ ahmedabad-expert-recommendations.pdf
25   HAP YouTube Video (2014) available here: http://youtu.be/mEZS_6rgi-Y
26   Climate & Development Knowledge Network (CDKN), "Inside Story: Addressing heat-related health risks in urban India: Ahmedabad's Heat Action Plan," May 2014: http://cdkn.org/wp-content/uploads/2014/05/ Ahmedebad_Inside_Story_final_web-res1.pdf
27   NRDC, IIPH, "Rising Temperatures, Deadly Threat" issue brief series, March 2013, available at: http:// www.nrdc.org/international/india/extreme-heat-preparedness/

List of Additional Scientific Journals and Resources

Scientific Journal Articles regarding the Ahmedabad Heat Action Plan:

- PlosOne: Heat-Related Mortality in India: Excess All-Cause Mortality Associated with the 2010 Ahmedabad Heat Wave (March 2014) http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0091831

- International Journal of Environmental Research and Public Health: Development and Implementation of South Asia's First Heat-Health Action Plan in Ahmedabad (Gujarat, India) (January 2014) http://www.mdpi.com/journal/ijerph/special_issues/weather-risks

- Journal of Environmental and Public Health: Neonates in Ahmedabad, India, during the 2010 Heat Wave: A Climate Change Adaptation Study (January 2014) http://www.hindawi.com/journals/jeph/2014/946875/

- A Cross-Sectional, Randomized Cluster Sample Survey of Household Vulnerability to Extreme Heat among Slum Dwellers in Ahmedabad, India (June 2013) http://www.mdpi.com/1660-4601/10/6/2515

Other Resources:

- Bernard, Susan M. and Michael A. McGeehin, Municipal Heat Wave Response Plans (http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1448486/)

- Communicating the Health Risks of Extreme Heat Events: Toolkit for Public Health and Emergency Management Officials (http://www.hc-sc.gc.ca/ewh-semt/pubs/climat/heat-chaleur/index-eng.php)

- Evaluating health promotion programs, 2012 (http://www.publichealthontario.ca/en/eRepository/Evaluating_health_promotion_programs_2012.pdf)

- Heatwave Planning Guide Development of heatwave plans in local councils in Victoria (http://docs.health.vic.gov.au/docs/doc/18BA71008326BA63CA257A360018513D/$FILE/planning-guide.pdf)

- Overview of Shanghai Multi-hazard Early Warning system and the role of Meteorological Services, 2010 (http://www.wmo.int/pages/prog/drr/events/MHEWSCostaRica/Docs/Session%202/Shanghai/Shanghai_MHEWS_CostaRica.pdf)

- Pyrenees Shire Council Heatwave Plan 2012 (http://www.pyrenees.vic.gov.au/files/7baa91d9-edd3-4daf-bc2e-9e480113cfd1/Pyrenees_Heatwave_plan_-_Adopted_21082012.pdf)

- Rogers, David and Vladimir Tsirkunov, Implementing Hazard Early Warning Systems, 2011 (http://www.gfdrr.org/sites/gfdrr.org/files/Implementing_Early_Warning_Systems.pdf)

- The Shanghai Multi-Hazard Early Warning System: Addressing the Challenge of Disaster Risk Reduction in an Urban Megalopolis, 2012 (http://link.springer.com/chapter/10.1007%2F978-3-642-25373-7_7)

- Urban Heat Island Mitigation, 2013 (http://www.epa.gov/heatislands/mitigation/index.htm)

- W. K. Kellogg Foundation Evaluation Handbook, 1998 (http://www.epa.gov/evaluate/pdf/eval-guides/evaluation-handbook.pdf)

Heat Action Plan Development
Chart and Checklist

(To be filled out by Nodal Officer or Local Knowledge Partner)

Activity	Deadline	Status with Date	Next Steps
Step One: Government and Stakeholder			
Identify and engage with the key leaders at different levels of the government (city, state, regional, central government)			
Appoint head or "nodal" officer and/or government agency to oversee the Heat Action Plan process			
Identify and engage key local knowledge partners to handhold with local government			
Identify and engage with meteorological body			
Identify key municipal health department other medical profes-sionals			
Identify emergency responders - EMRI			
Identify disaster management authority			
Identify public health universities and local community groups			
Identify key publicity department			
Identify press office and local media			
Draft and circulate background note on city (desktop research on city and background that includes the information above)			
Hold initial meeting or workshop, led by nodal officer, to bring all identified stakeholders together in the process to develop a heat action plan –			
Form Steering Committee Based on meeting			
Step Two: Vulnerability Assessment and Establishing Heat-Health Threshold Temperatures			
Collect the historic extreme heat temperature and mortality data, and assess the impact of extreme heat events on the city			
Collect daily health data (e.g., total all-cause mortality numbers, and—if recorded—numbers of heat-related emergency room visits, heat-related hospital admissions, and heat-related deaths)			
Gather daily temperature records and forecast information (e.g. daily temperature maximums, heat and humidity index, length of forecast, and methods of communicating temperature and weather forecasts)			
First draft of analysis on mortality and temperature and identify gaps			
Expert review and discussion of analysis on mortality and temps			
Second draft of analysis on mortality and temperature and iden-tify gaps			

Activity	Deadline	Status with Date	Next Steps
Discussion with experts on local heat-health thresholds & determine heat alert levels			
Discuss thresholds for heat alerts with key municipal government (i.e., what temperature range should correspond with which level of heat alert)			
Engage with local met department to ensure forecasts are being sent and received			
Identify intergovernmental and infrastructural challenges and assets that can impact heat resilience (using feedback and discussion from the stakeholder group)			
List existing intergovernmental coordination issues that could hinder heat action plan			
List existing characteristics of buildings, roadways, parks, etc. that could contribute to heat vulnerabilities			
List existing assets that can enhance coordination of alerts and heat resilience			
Identify the vulnerable populations and health risks specific to each group based on scientific analysis			
Draft and circulate note on mortality, temperature threshold analysis, forecasting system, interagency coordination, vulnerable groups			
Discuss note with IIPH-G experts, NRDC and other international and domestic experts			
Meet with Steering Committee, led by nodal officer, to discuss mortality, temperature, threshold vulnerable group – present note and powerpoint			
Step 3: Developing a Heat Action Plan			
Identify the before, during, and after summer heat season activities, such as:			
Awareness, preparedness, and training (before the summer)			
Establishing heat alerts, heat alert responses, actions for each heat alert level, early warning systems, and activities during periods of extreme heat (during the summer)			
Preparing for next season through evaluating and improving the heat action plan (after the summer)			
Draft heat action plan and clear communication plan that includes:			
Meteorological department should provide at least 5-day forecasts to the nodal officer, relevant stakeholders and the public, to provide lead time when a heat alert is declared to enact the heat action plan			
Intergovernmental communication and coordination of extreme heat awareness and response when a heat alert is declared			

Activity	Deadline	Status with Date	Next Steps
Communication with the public: Public messages and information for building awareness before the heat season			
Informational materials recommending preventative measures tailored for each sub-population (especially vulnerable groups)			
Draft and circulate note with Draft Heat Action Plan – on IEC, intergovernmental communication, elements of HAP			
Discuss note on IEC with IIPH-G experts, NRDC and other international and domestic experts			
Meet with Steering Committee, led by nodal officer, to draft HAP– present note and powerpoint			
Nodal officer, knowledge partners and relevant government officials and stakeholders should conduct tabletop exercises, simulations, and drills, practicing what to do when a heat alert is declared			
Identify and resolve communications gaps and weaknesses between participating departments, partners and the public			
Develop final HAP with inputs from meetings and stakeholder discussion and release			
Step Five: Implementation and Monitoring **Develop and widely disseminate key messages for communities**			
Conduct year-round awareness building and training workshops for the public			
Warn the public and raise interest in advance of heat season (e.g., through materials such as pamphlets, ads, pictures and videos)			
Cater messages to identified vulnerable groups (including recent mothers, parents, educators, the elderly, children, illiterate persons, outdoor workers, immigrants, and slum dwellers)			
Ensure that clear "Dos and Don'ts" during a Heat Wave are available in local languages in hot spots such as schools, hospitals, and religious centers. Disseminate through the media utilizing magazines, newspapers, websites, radio, television, and/or social media such as Facebook, Twitter, and WhatsApp)			
Continuous monitoring of the activities listed under the plan			
Regularly update stakeholders and authorities on progress			
Identify any problems or bottlenecks			
Adjust practices as appropriate to resolve problems and ensure best outcomes			

Article

Development and Implementation of South Asia's First Heat-Health Action Plan in Ahmedabad (Gujarat, India)

Kim Knowlton [1,2,3,*], **Suhas P. Kulkarni** [4], **Gulrez Shah Azhar** [3,5], **Dileep Mavalankar** [3,5],
Anjali Jaiswal [1,3], **Meredith Connolly** [1,3,] **Amruta Nori-Sarma** [2,3,5], **Ajit Rajiva** [3,5], **Priya Dutta** [3,5],
Bhaskar Deol [1,3], **Lauren Sanchez** [1,3], **Radhika Khosla** [1,3], **Peter J. Webster** [6], **Violeta E. Toma** [6],
Perry Sheffield [3,7], **Jeremy J. Hess** [3,8,9] and the Ahmedabad Heat and Climate Study Group [3]

[1] Natural Resources Defense Council, New York, NY 10011, USA; E-Mails: ajaiswal@nrdc.org (A.J.);
    bdeol@nrdc.org (B.D.); laurenksanchez@gmail.com (L.S.); radhika.khosla@gmail.com (R.K.);
    mconnolly@nrdc.org (M.C.)
[2] Department of Environmental Health Sciences, Mailman School of Public Health, Columbia University,
    New York, NY 10032, USA
[3] Ahmedabad Heat and Climate Study Group, Gandhinagar, Gujarat 380054, India
[4] Ahmedabad Municipal Corporation, Medical Officer of Health, Ahmedabad, Gujarat 380001, India;
    E-Mail: suhaspkulkarni@gmail.com
[5] Indian Institute of Public Health, Gandhinagar, Gujarat 380054, India;
    E-Mails: gsazhar@iiphg.org (G.S.A.); dmavalankar@iiphg.org (D.M.);
    amrutasri.nori-sarma@yale.edu (A.N.-S.); arajiva@iiphg.org (A.R.); priyadutta@iiphg.org (P.D.)
[6] School of Earth and Atmospheric Sciences, Georgia Institute of Technology, Atlanta, GA 30332, USA;
    E-Mails: pjw@eas.gatech.edu (P.J.W.); vt25@mail.gatech.edu (V.E.T.)
[7] Icahn School of Medicine at Mount Sinai, New York, NY 10029, USA;
    E-Mail: perry.sheffield@mssm.edu
[8] Department of Environmental Health, Rollins School of Public Health, Emory University, Atlanta,
    GA 30322, USA; E-Mail: jhess@emory.edu
[9] Department of Emergency Medicine, School of Medicine, Emory University, Atlanta, GA 30322, USA

* Author to whom correspondence should be addressed; E-Mail: kknowlton@nrdc.org;
   Tel.: +1-212-727-4579; Fax: +1-212-727-1773.

SCALING UP HEAT ACTION PLANS IN KEY CITIES AND STATES IN INDIA

Lessons from April 2015 Ahmedabad Workshop

In 2013, Ahmedabad Municipal Corporation (AMC) and partners including the Indian Institute of Public Health, Gandhi-nagar (IIPH) and Natural Resources Defense Council (NRDC) launched Ahmedabad's Heat Action Plan (HAP), the first comprehensive early warning system and preparedness plan for extreme heat events in South Asia. The Plan's activities have been implemented during each subsequent annual heat season to reduce heat-related health impacts. With rising temperatures and climate change impacts threatening residents' health and lives, several cities, state and central government officials, researchers and civil society groups have shown an interest in expanding heat wave preparedness and disaster planning in India.

NRDC and IIPH organized a workshop in Ahmedabad on April 15-16, 2015, bringing together about fifty public health, meteorological, disaster management, and medical professionals to share expertise on how heat action plans can be scaled and adopted by cities and states around India. The goals of the workshop included deepening heat health action in Ahmedabad, scaling heat preparedness activities to other cities and at the state-level in Gujarat and other states, and increasing involvement of the central government's disaster risk management authority. The workshop also featured the formal release of the 2015 Heat Action Plan by Municipal Commissioner of Ahmedabad, Smt. D Thara. The workshop was co-sponsored by the Climate and Development Knowledge Network (CDKN), the Indo-US Science and Technology Forum (IUSSTF), and the Government of Gujarat Climate Change Department.

AMC Commissioner Smt. D. Thara accepts Innovative Climate Action Leadership Award from NRDC and IIPH. Ahmedabad, April 15, 2015.

DAY 1: Cities' Experiences Addressing Heat Health and Climate Change

To kick off the workshop, representatives from Indian cities and states presented on heat waves' significant toll on local communities' lives and current activities to protect health from extreme heat. Participating city and state officials from Surat, Gujarat, Nagpur, Maharashtra, Bhubaneshwar, Odisha, Hyderabad and New Delhi shared heat experiences and key planning needs. NRDC senior scientist Dr. Kim Knowlton presented international best practices from heat health action plans implemented in New York City, California, and Abu Dhabi, among others. Discussions were then held on forecasting and thresholds and disaster management.

AMC nodal officer Dr. Tejas Shah presents at the workshop. Ahmedabad, April 15, 2015.

Forecast and Thresholds to Determine Heat Alerts

Temperature forecasting and thresholds are a critical component of developing an early warning system and heat emergency plan. Indian Meteorological Department (IMD) officials highlighted that temperature forecasts are improving each year, with aims of making stronger linkages to health-related data. IMD's support for heat action plans is increasing through continual improvements to the technical output of their data and strengthening their ability to coordinate extreme heat forecasts.

Participants emphasized that agencies should coordinate actions according to specific forecasts. IMD should decipher important knowledge from forecasting and inform the media accordingly. To help build public awareness, the media could improve its reporting of forecasts to the public. Other institutions can support IMD by linking forecasting to health impacts. In this way, forecasts and warnings will be taken seriously when agencies send concerted messaging.

Challenges in this type of risk-based warning include variability of vulnerability across regions and demographics, which would require city and district authorities to parse data to determine variations in on-the-grounds implementation.

Interagency Coordination on Heat and Disaster Risk Reduction and Management
Incorporating disaster risk management authorities in heat wave emergency preparedness is an important approach to effective government coordination during heat waves. The Gujarat State Disaster Management Authority (GSDMA) supports Ahmedabad's heat action plan and want to adopt these preparedness activities across the state, indicating promising opportunities for disaster management coordination in the state of Gujarat.

Disaster management authorities prioritize four key groups' buy-in to scale heat preparedness activities: the poor, civil society, private sector, and bureaucracy. Mapping the upward and downward linkages of heat and health in order to outline how each sector will impact and be impacted by heat is critical. In addition to addressing immediate needs that are achievable through adaptation efforts, urban planning is a longer-term component that can be encompassed a city's heat action plan activities to reduce the overall impact of heat.

AMC and NRDC representatives hold the award presented to the AMC. Ahmedabad, April 15, 2015.

DAY 2: Building Resilience Through Increased Medical Capacity and Public Communication Efforts

On the next day, discussions focused on medical professional capacity building and the role of media in information, education, and communication (IEC) efforts. Cities and state representatives then participated in interactive breakout sessions in which stakeholders from each city and/or state worked through the first three steps of NRDC's *How-to-Manual: Steps to Develop a Heat Action* and discussed questions and shared progress on achieving these steps. The workshop closed with an open discussion of next steps.

Enhancing Capacity of Medical Professionals, Urban Health Facilities, and Emergency Services to Deal with Health Effects

About eighty percent of heat illnesses cases are sent to the emergency department, underscoring the importance of emergency services in heat action plans. State representatives from Maharashtra and Odisha supported development of heat action plans by enhancing capacity-building efforts in health facilities and issuing heat-related guidelines and protocols. Collaboration between transportation, labor, and education departments as well as IMD and disaster management authorities is key to improve a city's emergency response. Stronger meteorological infrastructure and hospital surveillance could address existing research gaps on temperature and mortality. Variability in case definitions for heat illnesses and heat-related death could be addressed by heat health trainings among medical professionals, reinforcing more accurate identification and reporting of heat-related illness.

A standardized databank format to record each heat illness case, including age, sex, and cause of death, should be developed for health care facilities. Hospitals are so overburdened with patient management that data recording becomes difficult. Surveillance protocols could be strengthened through collaboration with relevant health institutes for use in a variety of care settings.

Information, Education, and Communication to Build Resilience

In addition to science and research, outreach is a key component of developing a heat action plan. As a result, improving media engagement and partnership to better target the most vulnerable communities is critical to save lives. As compared to other natural disasters, heat waves are known as silent killers since they may not be as visibly destructive or dramatic. For this reason, from a media perspective, writers try to make heat more engaging to the public.

Involving other stakeholders like graphic designers to create city-specific vulnerability maps that can be shared with the media could also be helpful. Heat health training for reporters would be useful in sensitizing them on what messages they should be publishing and what is new in weather and climate science. Involving local vernacular newspapers would ensure access among all demographics. Environmental institutes could also expand data and make sure it is creatively used and disseminated to the public in such a format that makes sure it incites a sense of urgency and hits close to home within at-risk communities. This type of initiative requires close collaboration between public health and communication experts.

Proposed Next Steps

Forecasts and Thresholds to Determine Heat Alerts
- Link air quality monitoring with weather data collection to further analyze the interaction of the urban heat island and air pollution.
- Improve linkages between meteorological and health data.
- Support interagency coordination between the IMD, media, health professionals, city planners, and end users. Explore holding a roundtable to analyze dissemination and communication of data through each of these stakeholders.

Interagency Coordination on Heat and Disaster Risk Reduction and Management
- Map upward and downward linkages of heat and health for four key sectors: poor communities, civil society, private sector, and bureaucracy.
- Include longer-term goals of urban planning and climate change resilience in heat action plans.
- Ensure periodic review and evaluation once action plans are crafted and implemented.

Enhancing Capacity of Medical Professionals, Urban Health Facilities, and Emergency Services
- Sensitize both public and private hospitals through modules on standardized case reporting by health professionals.
- Equip emergency professionals with heat response protocols.
- Improve resources and facilities for cooling in clinical settings.

Information, Education, and Communication to Build Resilience
- Collaborate with civil society to target outreach to vulnerable groups, i.e., women, industrial workers, and outdoor workers.
- Tap into community organizations and local government leadership to expand heat health communication.
- Use locally accessible language and graphic messaging to ensure accessibility.

NEW YORK CITY KNOWLEDGE FORUM

Sharing International Climate Resilience Experiences from India and the U.S.

"This two-way India-US dialogue on climate resilience forms a bridge between today and a safer, more healthy future."

– Dr. L S Rathore,
Director-General, Indian Meteorological Department

In a lead up to Climate Week NYC 2015, climate health leaders from four growing regions of India gathered in New York City for a week of peer-to-peer meetings and engagement on climate health preparedness and resilience. Indian government officials and public health experts from Gujarat, Maharashtra, New Delhi, and Odisha exchanged best practices with their New York counterparts on building community resilience and capacity to cope with the health effects of climate-related extreme weather events in India and the U.S. One major topic was the scaling of local climate adaptation efforts across cities based on the leading examples of Ahmedabad and New York City to protect vulnerable communities from extreme weather events including increasingly prevalent and severe heat waves and other impacts exacerbated by climate change.

The delegation gathered at NRDC for a tour of the office space's green building practices and cool roof. New York City, September 2015.

INDIA-US CLIMATE RESILIENCE PARTNERSHIP: HIGH-LEVEL KNOWLEDGE LEADERSHIP EXCHANGE FORUM ON HEAT-HEALTH AND CLIMATE PREPAREDNESS

The Forum was held in New York City from September 13th to 18th, 2015, and hosted by the Natural Resources Defense Council (NRDC), the Public Health Foundation of India-Indian Institute of Public Health, Gandhinagar (IIPH) and the Icahn School of Medicine at Mount Sinai, with support from the Indo-US Science & Technology Forum (IUSSTF).

India Knowledge Exchange Forum Delegates:

Dr. LS Rathore, *Director General of Meteorology, Indian Meteorological Department, New Delhi*

Ms. Sujata Saunik, *Principal Secretary, Public Health Department, Government of Maharashtra*

Dr. Muzaffar Ahmad Hakim, *Member, National Disaster Management Agency, New Delhi*

Dr. Kamal Mishra, *Deputy General Manager, Odisha State Disaster Management Authority*

Dr. Suresh Patel, *Superintendent of Hospitals, Ahmedabad Municipal Corporation*

Dr. Lipika Nanda, *Director, Indian Institute of Public Health, Bhubaneswar, Odisha*

Lead hosts included NRDC's Anjali Jaiswal, Dr. Kim Knowlton, Meredith Connolly and Sameer Kwatra, Mount Sinai's Dr. Perry Sheffield, and IIPH's Dr. Partha Ganguly, Dr. Priya Dutta and Dr. Abhiyant Tiwari.

The devastating heat wave that hit India in May 2015 and caused more than 2,300 deaths emphasizes the urgent need for greater climate change preparedness. In response to a deadly heat wave that hit Ahmedabad in 2010, local municipal officials, NRDC, IIPH and partners launched the Ahmedabad Heat Action Plan (HAP) in 2013, becoming the first early warning system and preparedness plan for extreme heat events in South Asia, and an example of local climate resilience in action. On the ground climate preparedness actions, like Ahmedabad's heat action plan, are crucial components to the global fight against climate change and are particularly focused on protecting the populations that are most vulnerable to the short and long term effects of climate change.

Through efforts to scale the successful Ahmedabad HAP, the delegation of climate health leaders are now supporting other cities and states' efforts to adopt heat action plans. Nagpur is on track to become the first city in Maharashtra (and second city in India) to adopt a heat early warning system and preparedness plan by Spring 2016. Odisha is also advancing a regional heat preparedness plan based on its existing state-level heat emergency planning activities. Leaders in the New York region are also working on climate action and resilience, preparing for extreme weather events in ways that better protect local communities.

The following events, site visits, and discussions were held as part of the Knowledge Exchange Leadership Forum from September 13-18, 2015:

Formal Welcome with New York City Mayor's Office and NRDC Director of Programs

- NRDC's Director of Programs, Dale Bryk (featured above) discussed NRDC's efforts to protect public health and fight climate change around the world.

- Dan Zarrilli, Director of New York City Mayor's Office of Recovery & Resiliency, offered a keynote address about the city's leadership on resilience and climate preparedness through the new One New York (One-NYC) plan. By 2050, the number of days in New York City above 90°F are expected to at least double due to climate change.

- While temperature extremes like heat waves are a major climate risk facing New York City, the devastation wrecked by Hurricane Sandy to NYC's coastlines, infrastructure, power grid and hospitals in 2012 was also discussed. This hurricane hit the city with very little warning and time to prepare, resulting in at least 149 deaths, destruction of thousands of homes and an estimated 250,000 vehicles, and economic losses across New York totaling at least $18 billion. Many New Yorkers described this "superstorm" as a wake up call that the city needed stronger resilience planning for climate-fueled disasters in the future.

New York City Department of Health & Mental Hygiene (NYCDOH) Meeting

- New York City's heat-health preparedness and climate disaster response was featured by the NYCDOH. NYCDOH's Katie Lane, Kaz Ito and Munerah Ahmed discussed the deadly threat of high temperatures in New York, preparedness efforts and communication outreach to the public and health providers, surveillance for heat-health planning, and development of temperature thresholds.

- Maharashtra State Public Health Secretary Sujata Saunik described the efforts in the city of Nagpur and surrounding areas to prepare for rising temperatures by enacting an early warning system and Heat Action Plan.

- Dr. Partha Ganguly of the Indian Institute of Public Health, Gandhinagar, described Ahmedabad's surveillance system and community health response structure to reach the city's most vulnerable residents.

New York City Emergency Management (NYCEM) Command Center Meeting and Site Tour

- In the NYCEM Situation Room, Assistant Commissioner of Planning and Preparedness, Megan Pribram, discussed New York City's risk landscape and the citywide management system, which is a model for interagency coordination when responding to hazards such as heat waves. Heat response is recognized as part of an all-hazards response, interagency coordination and communications during activations.

- Odisha State Disaster Management Authority's Dr. Kamal Mishra described state-level emergency preparedness in India, including his department's role in one of the largest evacuations in history ahead of Hurricane Phailin in 2013.

Icahn School of Medicine at Mount Sinai Meeting

- Dr. Phil Landrigan, Dean for Global Health at Mount Sinai's Icahn School of Medicine, underscored the need for the U.S. and India to share experiences and lessons from the pressing climate crisis, which transcends boundaries.

- NYC Health & Hospitals Corporation's Dr. Nick Cagliuso described New York City's approach to climate incident emergency management. Dr. Kevin Chason, Director of Mount Sinai Health System Emergency Planning, highlighted how Superstorm Sandy put the hospital's all-hazards preparations to the test in 2013.

- The enormous benefits of embedding emergency management into the public health system, ensuring effective preparation and a consistent flow of information were made clear.

- Asante Shipp Hilts from New York State's Department of Health's Office of Public Health Practice described her department's BRACE program, centered on "building resilience against climate events." Under this program, the state health department is developing toolkits for local county health departments to create their own climate-health awareness materials tailored to local constituents.

Meeting with National Oceanic and Atmospheric Administration (NOAA)

- NOAA officials Juli Trtanj and Michelle Hawkins shared expertise with delegates on climate forecasting and its intersections with protecting public health to scale heat alert systems and develop an integrated national heat health system. In preparation for increasing heat due to climate change, NOAA is developed a National Integrated Heat Health Information System to provide forecasting tools for the Center for Disease Control, public health officials and emergency management officials to inform early warnings and early action to protect people.

- Dr. L S Rathore, Director-General of Meteorology for the Indian Meteorological Department (IMD), described how health is one of the newest initiatives emerging from his 140 year old institution. One effort aimed at improving local data flow are "Nowcasts," which provide short range forecasts for 136 cities around the country.

Meeting at Mailman School of Public Health, Columbia University

- Delegates met with experts at Columbia University's Mailman School of Public Health, which created the nation's first academic program in climate and health.

- Mailman Dean Linda Fried explained how critical science and research are to understand the ways that climate change impacts human health, which can, in turn, inform well-informed policies. Enabling governments to tap into public health institutions' wealth of knowledge by incorporating them into the fabric of government processes can create better policies.

- Discussion centered on partnerships to leverage public health expertise and academic climate research, community leadership, and agencies' collaboration to foster community resilience and longer-term preparedness. Environmental justice group WE ACT's director Peggy Sheppard described organizing community roundtables to identify what the city could do to protect vulnerable, poor and disabled residents in NYC during extreme heat events.

- The urgency of addressing air pollution, which is tied to extreme heat events, was also raised. Unless proactive climate resilience work improves air quality, outdoor air pollution.is projected to cause six million premature deaths annually by 2050.

Historic Bellevue Hospital Site Visit

- Dr. Bill Rom, professor of medicine and environmental medicine at New York University School of Medicine, gave an in-depth tour of the historic Bellevue Hospital Center.

- Bellevue is the oldest hospital in the U.S. and the largest as well, serving many of New York's most vulnerable residents. Following the hospital's flooding, evacuation and other impacts of Superstorm Sandy, measures have been taken to make the hospital more resilient against future climate threats.

This forum for international exchange and focus on the need for climate adaptation measures was timely as the world prepares for the United Nations Framework Convention on Climate Change at the Conference of Parties in Paris in December 2015.

ONLINE RESOURCES

Ahmedabad Heat Action Plan and Research Materials are available at:
http://www.nrdc.org/international/india/extreme-heat-preparedness/
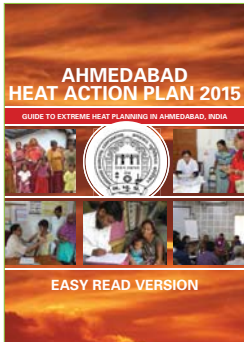
Ahmedabad's Heat Action Plan

How-to Manual: Steps to Develop a Heat Action Plan based on the Ahmedabad Experience

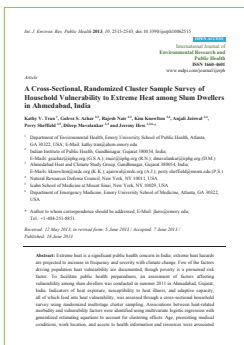Inside Story: Addressing heat-related health risks in urban India: Ahmedabad's Heat Action Plan

Expert Committee Recommendations for a Heat Action Plan based on the Ahmedabad Experience

Fact Sheet: Increasing Resilience to Extreme Heat Health Risks Across Rapidly Urbanizing India

Cutting Edge Scientific Research and Journal Articles

International Journal of Environmental Research and Public Health: A Cross-Sectional, Randomized Cluster Sample Survey of Household Vulnerability to Extreme Heat among Slum Dwellers in Ahmedabad, India (June 2013)
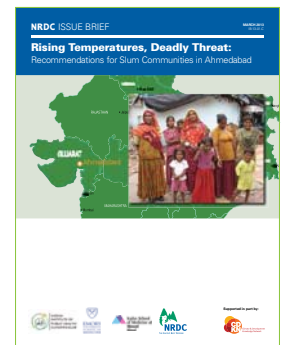
International Journal of Environmental Research and Public Health: Development and Implementation of South Asia's First Heat-Health Action Plan in Ahmedabad (Gujarat, India) (January 2014)

Journal of Environmental and Public Health: Neonates in Ahmedabad, India, during the 2010 Heat Wave: A Climate Change Adaptation Study (January 2014)

PlosOne: Heat-Related Mortality in India: Excess All-Cause Mortality Associated with the 2010 Ahmedabad Heat Wave (March 2014)

Rising Temperatures, Deadly Threat: Series of Four Issue Briefs of Recommendations for Heat Adaptation in Ahmedabad

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