EXPANDING HEAT RESILIENCE ACROSS INDIA

With temperatures breaking records around the globe, cities and regions across India are taking concrete actions to better prepare and protect communities from deadly heat. The Intergovernmental Panel on Climate Change (IPCC) 2018 report emphasizes that global warming of 1.5°C-2°C will drive local average temperatures upwards and increase the frequency, intensity, and duration of heat waves, along with poverty and health risks.[1] Drawing lessons from the ground-breaking Ahmedabad Heat Action Plan (HAP) released in 2013, action is ramping up at the city, state, and national levels to implement extreme heat warning systems and preparedness plans. In 2019, the national government is working with 23 states and over 100 cities and districts to implement and develop heat action plans in India.

At the national level, the National Disaster Management Authority (NDMA) is leading efforts by supporting state-level heat action plans and facilitating ministerial coordination at the national level through updated NDMA Heat Guidelines. The India Meteorological Department (IMD) continues to provide the vital seasonal and daily temperature forecasts to over 350 cities.[2] The IMD forecasts are a critical trigger for prompting early warning for extreme heat by city officials.

The Natural Resources Defense Council (NRDC) and Public Health Foundation of India - Indian Institute of Public Health-Gandhinagar (PHFI-IIPH-G) work with government leaders and key experts across India and internationally to develop, launch, and implement heat action plans. Heat action plans are a comprehensive early warning system and preparedness plan for extreme heat events with the objectives of broader public awareness and community outreach; early warning system and interagency coordination; capacity building among health care professionals; and reducing heat exposure and promoting adaptive measures. This issue brief highlights the progress at the city, state and national level in 2019 to improve climate resilience to extreme heat and captures key elements of heat action plans.

NATIONAL LEADERSHIP

NDMA identified 23 heat-prone states in 2019, up from 19 states in 2018 and convened annual workshops on preparedness, monitoring and management strategies with local officials and key experts. NDMA also coordinates with state disaster management departments to support local activities, including disaster management and heat reduction. To update the national Guidelines on Heat Waves, originally written in 2016, NDMA is proposing "roles and responsibilities for managing heat waves" among several ministries at the national level, including short, medium and long term mitigation efforts, including reducing carbon

1 IPCC, Special Report on 1.5°C "Summary for Policy Makers", 2018. https://www.ipcc.ch/sr15/chapter/summary-for-policy-makers/ (Accessed 28 May 2019)

2 IMD, "All India Heat Wave Information", 2019. http://www.imd.gov.in/pages/heatwave.php (Accessed 28 May 2019)

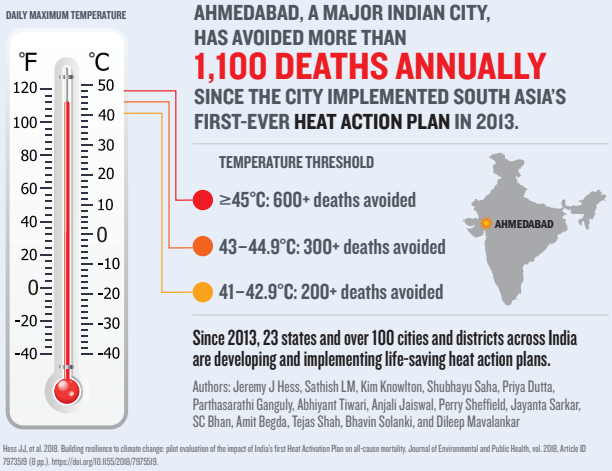
pollution emissions and reducing extreme heat.[3] NDMA also runs television and social media campaigns and dedicates a section of its website to provide resources on combating extreme heat.[4] NDMA has tracked heat-related deaths with 24,223 deaths from 1992 to 2015 across India. Intense and sustained efforts by all stakeholders have significantly reduced mortality from 2040 deaths in 2015 to 1111 deaths in 2016. Mortality due to heat wave further reduced to 384 deaths in 2017 and 25 deaths in 2018, according to NDMA.

IMD forecasts are vital since they give communities lead-time to prepare for extreme heat. IMD and the regional meteorological offices now provide 5-day forecasts of daily maximum temperatures to over 350 cities, expanded from 100 in 2016. The daily 5-day forecast is critical to interagency coordination allowing for planning and preparation to ensure water availability, stocking of ice-packs and Oral Rehydration Solutions (ORS) in clinics and more. In 2018, IMD started issuing daily heat bulletins at 7:30 am to enhance interagency coordination and alert-notifications, allowing residents to plan their days to reduce heat exposure. Continuing from 2016 and 2017, IMD issued a "Seasonal Outlook for Temperature for the Hot Weather Season (April-June)".[5] IMD's seasonal outlook aims to warn residents and key groups about extreme temperatures expected during the heat season. IMD also collaborates with Indian Meteorological

Evaluating Heat Action Plans

As recent study found that Ahmedabad, one of India's largest cities, avoided an estimated 1,190 deaths a year after implementing the country's first Heat Action Plan (or "HAP") in 2013. This plan included a heat wave early warning system, public outreach to explain heat-health risks, and trainings aimed at health professionals who diagnose and treat heat-related illnesses.

The study, "Building resilience to climate change: pilot evaluation of the impact of India's first heat action plan on all-cause mortality" jointly authored by public health and municipal authorities in India, academic environmental health researchers in the United States, and NRDC, was published in the peer-reviewed scientific Journal of Environmental and Public Health (JEPH).[7]



By comparing citywide summertime death rates before and after the HAP was launched, researchers found that:

- The HAP was associated with a reduced death rate on hot days. Ahmedabad, a major Indian city, avoided more than 1100 deaths each year after it implemented the region's first-ever Heat Action Plan in 2013.
- The biggest decrease in death rates was on the hottest days. Mortality rates on the hottest days (at or above 45°C (113°F) daily maximum temperature) dropped by 27% after the HAP was implemented, relative to pre-HAP years.
- While very hot days were still dangerous, the risks were much lower post-HAP. Before the HAP, death rates more than doubled on days when the maximum temperature reached 47°C (116°F), compared to rates at 40°C (104°F). After the HAP was implemented, death rates were only 25% higher on days when maximum temperatures reached 47°C (116°F) compared to death rates at 40°C (104°F).

Extreme heat warnings, a key part of Ahmedabad's HAP, were associated with decreased summertime all-cause mortality rates, with the largest declines at the highest temperatures.

Jeremy J Hess, Sathish LM, Kim Knowlton, Shubhayu Saha, Priya Dutta, Parthasarathi Ganguly, Abhiyant Tiwari, Anjali Jaiswal, Perry Sheffield, Jayanta Sarkar, SC Bhan, Amit Begda, Tejas Shah, Bhavin Solanki, and Dileep Mavalankar. 2018. "Building Resilience to Climate Change: Pilot Evaluation of the Impact of India's First Heat Action Plan on All-Cause Mortality." Journal of Environmental and Public Health, col. 2018, article ID 7973519 (8 pp.), https://doi.org/10.1155/2018/7973519.

3 National Disaster Management Authority (NDMA), "Guidelines for Preparation of Action Plan – Prevention and Management of Heat-Wave", 2017. https://www.ndma.gov.in/images/guidelines/heatwaveguidelines2017.pdf (Accessed on: 28 May 2019)

4 National Disaster Management Authority (NDMA), "Resources on Heat Wave", 2019. https://ndma.gov.in/en/media-public-awareness/disaster/natural-disaster/heat-wave.html) (Accessed 28 May 2019)

5 India Meteorological Department, "All India Heat Wave Information", 2019. http://www.imd.gov.in/pages/heatwave.php (Accessed 28 May 2019)

Society (IMS) to convene city leaders, health officials, civil society groups to expand HAPs.

➔ Lok Sabha – Parliamentary Question

During a parliamentary session in early 2019, the Lok Sabha posed a series of questions to the Ministry of Earth Sciences on "whether the Government has taken note of global rise in temperature especially in the Indian continent in the last five years and if so, the details thereof".[6] The Parliament also asked about the number of heat-related deaths, scientific studies, impacts of extreme heat and remedial measures to address heat waves. The Ministry of Earth Sciences and Ministry of Home Affairs responded with detailed analysis on temperatures and heat-related deaths and highlighted heat action plans as key adaptation measure.

STATE LEADERSHIP

NDMA and IMD are working with 23 states that recorded high temperatures leading to heat-wave conditions to develop heat action plans. Expanding heat resilience across India shows that extreme temperatures are becoming more frequent across the globe, including geographies with mild temperatures, such as Toronto, Canada and Himachal Pradesh, India.

- Andhra Pradesh
- Arunachal Pradesh
- Bihar
- Chhattisgarh
- Delhi
- Gujarat
- Goa
- Haryana
- Himachal Pradesh
- Jharkhand
- Jammu and Kashmir
- Karnataka
- Kerala
- Maharashtra
- Madhya Pradesh
- Odisha
- Punjab
- Rajasthan
- Tamil Nadu
- Telangana
- Uttarakhand
- Uttar Pradesh
- West Bengal

Highlighted Activities

➔ Andhra Pradesh
Public Awareness Campaigns

Hit by blistering temperatures in 2019, Andhra Pradesh stepped up efforts to combat extreme heat conditions.[7] Several of the districts distributed ORS (oral rehydration salts) to commuters and made drinking water available

Innovative mobile water station in Chandrapur. (Photo: Chandrapur Municipal Corporation).

in public places. The state also launched an awareness campaign to inform citizens to avoid peak heat times between 11 am and 5 pm and to take extra precautions for pregnant women in rural areas. Andhra Pradesh also has 1,168 automatic weather stations (AWS) – approximately one for every hundred square kilometers – to better monitor heat conditions.[8] Andhra Pradesh has also released a Heat Wave Atlas that analyses heat wave conditions across the state since 2010 and identifies local heat wave hot spots.[9]

➔ Maharashtra
Department Coordination & Water Supply

With a number of city-level HAPs and a regional approach developed in 2016, Maharashtra has put in place a state-wide strategy to combat extreme heat. Leading cities of Nagpur and Chandrapur stepped up action in 2019. In its fifth year of implementation, Nagpur is focusing on coordination among city departments, including Maha Metro, Central Railway, South Eastern Central Railway, Private Hospitals, National Highway Authority of India and others

6 Lok Sabha, Question No. 617 Heat Waves, Feb. 2019.

7 The News Minute, "Temperatures Cross Telangana 45 degrees Celsius", 21 May 2019. https://www.thenewsminute.com/article/temperatures-cross-45-degree-celsius-heat-wave-warning-andhra-and-telangana-102155 (Accessed 28 May 2019)

8 Jaiswal, A, Preparing for the heat: Indian Cities", 2018. Available online: https://www.nrdc.org/experts/anjali-jaiswal/preparing-heat-indian-cities [NDMA Workshop Presentation]. (Accessed 28 May 2019)

9 Andhra Pradesh State Disaster Management Authority (APSDMA), "Atlas on Heat wave Conditions Over Andhra Pradesh 2010-2017", http://www.apsdma.ap.gov.in/latestupdate_pdfs/heatwave/heatwave2018/Heat%20wave%20atlas%202018.pdf (Accessed 28 May 2019)

Painting cool roofs in vulnerable communities in Ahmedabad (Photo: NRDC)

to provide drinking water at railway stations, bus stops, hospitals, schools and other public places to avoid sunstroke during summer.[10] Nagpur has also formed teams for zones in the city to monitor HAP implementation. Chandrapur, also in the fifth year of its HAP implementation, amplified community outreach programs that range from awareness marches to "WhatsApp" alerts to reach people.[11] For the past three years, Chandrapur has provided drinking water to citizens, including a mobile water-kiosk, operated by volunteers.

➔ Gujarat and Telangana
Cool Roofs & Adaptive Measures

In addition to public awareness, training and early warning systems, the cities of Ahmedabad in Gujarat and Hyderabad in Telangana launched pilot cool roof programs in 2017 and 2018, painting over 3,000 roofs in slum communities. Building on the models, both cities are launching city-wide cool roofs programs in 2019. Cool roofs reflect sunlight and absorb less heat. Depending on the setting, cool roofs can help keep indoor temperatures lower by 2 to 5°C (3.6 - 9°F) as compared to traditional roofs.[12] Cool roofs can cost as little as 1.5 (~$0.02) per square foot for a simple lime-based paint, to more expensive reflective coatings or membranes.[13] The India Cooling Action Plan released in 2019 focuses on reducing the demand for air conditioning with cool roofs as a major solution. Cool roofs help keep temperatures cooler and reduce energy costs. Cool roofs are also critical in limiting air conditioner use, which limits the urban heat island effect, carbon dioxide emissions and emissions of hydrofluorocarbon (HFC) super pollutants.

Rajasthan HAP: A Climate Resilience Heat Action Plan Focused on Rural Communities

Key activities

Supported by IIPH-G and UNICEF, the State of Rajasthan developed the first rural community focused HAP, with the following activities to build resilience to climate change and extreme heat:

- Communication needs assessed to frame a comprehensive communication strategy for climate risk reduction, adaptation and mitigation
- Community vulnerability assessment to understand heat-related challenges for rural communities
- Information, Education, and Communication (IEC) materials developed in local languages for sections of the society-schools, ASHA/Auxiliary Nurse Midwife (ANM), medical officers
- More than 180 ASHA/ANM/*Anganwadi* workers and medical officers and more than 60 school teachers trained for prevention and management of climate sensitive disease including heat related illnesses
- Capacity building/sensitization workshops conducted for line department officials at the block and district level (education, public works, administration, health, disaster, and others)

10 The Hitavada, "NMC ready to handle heatwave with its Heat Action Plan" 23 April 2019. https://www.thehitavada.com/Encyc/2019/4/2/NMC-ready-to-handle-heatwave-with-its-Heat-Action-Plan.html (Accessed 28 May 2019)

11 Communication with Chandrapur Nodal Officer, 8 May 2019.

12 Vishal Garg, et al, "Assessment of the Impact of Cool Roofs in Rural Buildings in India", Energy and Buildings, 2016.

13 Telangana, "Draft Cool Roof Policy, 2019. http://tsredco.telangana.gov.in/PDFs/Telangana_Cool_Roofs_Policy_for_Public_Comments.pdf (Accessed 28 May 2019); Ahmedabad Heat Action Plan 2019.

Key Elements of Heat Action Plans

An effective heat action plan requires a combination of strong local leadership, interagency coordination, scientific expertise, broad communication strategies, and community engagement. Locally-developed plans are the most effective; one size does not fit all. Yet, the heat action plans in India have common features that are important to protecting communities from extreme heat. The five core elements are:

1. Community Outreach to Build Public Awareness

- Locally-developed and scientifically-supported IEC pamphlets, hoardings/billboards, and videos to inform people on how to protect themselves from extreme heat.
- Social media channels, bulk text messages, emails, radio and mobile applications such as WhatsApp, aiming to reach the public.
- Special efforts to reach vulnerable populations through focused sessions and direct communication by health care professionals in local clinics, ambulance service, and urban health centres.

2. Early Warning Systems and Inter-Agency Coordination

- Early warning systems (at yellow, orange, red levels corresponding to increasing heat levels) trigger joint response by relevant city and state authorities during extreme heat and alerts residents.
- Formal communication channels to alert state and city government agencies, including health officials and hospitals, emergency responders, local community groups, media outlets and other key stakeholders – with an identified "nodal" officer.

Temperature Thresholds and Heat Warning Triggers

A key component to successfully activating and implementing heat-health early warning systems are locally developed temperature thresholds. Local temperature thresholds are the triggers for cities to initiate early warning systems. Thresholds also trigger a set of coordinated actions for stakeholders based on the early warning systems. Cities and states using local thresholds have a better understanding of the temperature that corresponds to a level of heat beyond which people are likely to face adverse health effects, if they do not take adequate precautionary measures. This approach provides the authorities an opportunity to prepare and respond better to extreme heat episodes.

Thresholds are developed based on local temperatures and calculated using either a mortality and temperature-based approach or a percentile-based approach.

Mortality and Temperature Based Threshold Approach

This approach requires both heat and mortality data. It involves obtaining long term (10-15 years) daily mortality data, if possible, for the summer months from the city administration and analyzing correlation with daily maximum temperature observations. Historical temperature data is available from the IMD; the local authorities responsible for developing thresholds can request data access from IMD regional centres.

Mortality data can often be obtained from city medical department or local medical colleges. To activate early warning systems, some cities in India have developed thresholds using the mortality and temperature approach, including Ahmedabad (see figure below) and Nagpur. Mortality and temperature-based thresholds can be challenging to establish as few cities in India have publicly available long-term records of daily mortality data.

Alert Category	Alert Name	Temperature Threshold (°C)
Yellow Alert	Hot Day Advisory	41.1 °C – 43 °C
Orange Alert	Heat Alert Day	43.1 °C – 44.9 °C
Red Alert	Extreme Heat Alert Day	≥ 45 °C
White	No Alert	≤41°C

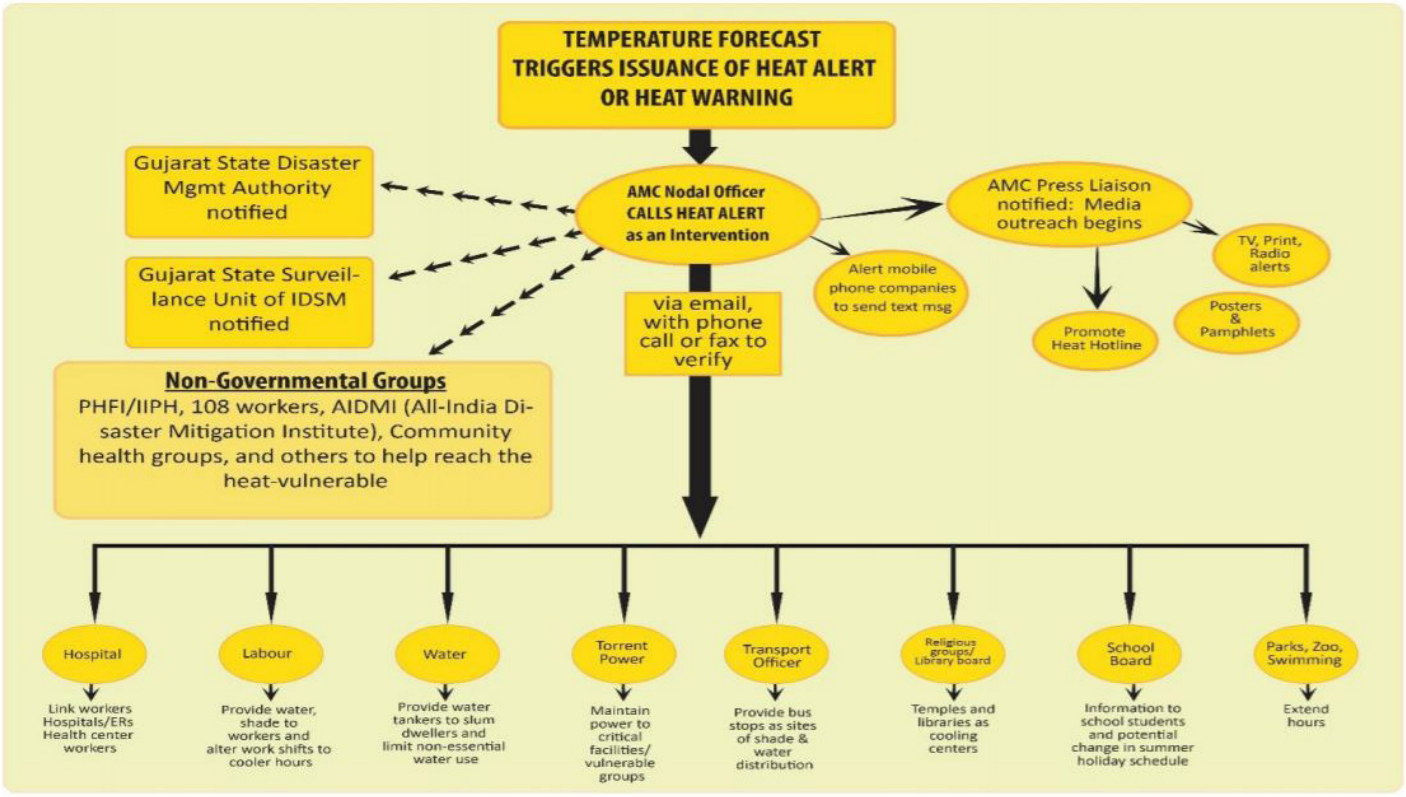
Figure 1: Temperature thresholds developed by the Ahmedabad Municipal Corporation for issuing heat alerts (Taken from Ahmedabad HAP 2016)

Percentile-Based Threshold Approach

The unavailability of daily mortality or other health outcome data can hinder the calculation of temperature-mortality based thresholds and thus impede development and implementation of early warning systems. In these situations, where meteorological information is available but sufficient health data is not, a percentile-based threshold (90th, 95th, 99th) based on local temperature data can be used as a warning trigger value that captures the relative severity of observed temperatures.

NDMA, in its 2017 Heat Action Guidelines, recommends considering a percentile-based threshold (using 90th, 95th, 99th percentile temperatures) as a warning trigger value where climate and weather data are available but not reliable daily health data. The percentile method is relevant for India and can help in a number of cities, smaller urban centres, and rural areas that lack adequate mortality data to determine local health-relevant temperature thresholds.

Sample Communication Plan for Ahmedabad Municipal Council Nodal Officer for Activation of a Heat Alert



- Standard Operating Procedures (SOPs) for activities before, during and after heat season for each department to successfully implement a HAP that identify and define responsibilities of government departments.

3. Capacity Building Among Healthcare Professionals

- Special training modules for health staff in urban health centers.
- Training programs for private general medical practitioners to equip first responders with knowledge of effective diagnosis and first-aid treatment for heat-related illnesses.
- List of "Do's and Don'ts" with help of local health professionals and disseminate to public through effective use of various media (print and social media, radio stations, TV ads).

4. Addressing Vulnerable Groups

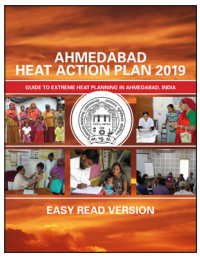
- Focused efforts, such as awareness and drinking water, for children, elderly people, people exposed to prolonged periods of extreme heat due to their profession (e.g. construction workers, farmers, traffic police), who are more vulnerable to extreme heat.
- Affordable space cooling solutions and health care for vulnerable groups.
- Adaptive measures, such as cool roofs for vulnerable communities.

5. Implementing Adaptive Measures

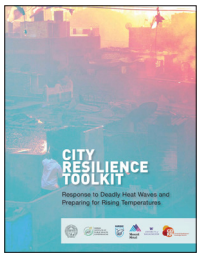
- Communication on response methods, including drinking water, cooling centers, gardens, and shade spaces during extreme heat days.
- Land use strategies to reduce the urban heat island effect, including green infrastructure, cool roofs, tree and vegetation, and increasing green spaces.
- Streamlining traffic and congestion reduction policies and strategies.

ONLINE RESOURCES

Heat Action Plan and Research Materials are available at:
https://www.nrdc.org/resources/rising-temperatures-deadly-threat-preparing-communities-india-extreme-heat-events

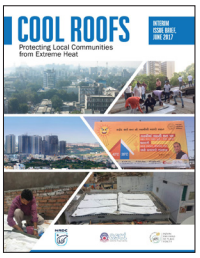


Ahmedabad's Heat Action Plan

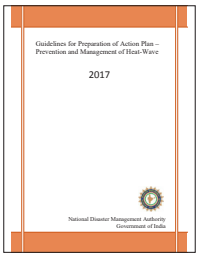


City Resilience Toolkit: Response to Deadly Heat Waves and Preparing for Rising Temperatures *(includes How-to-Manual)*

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



Cool Roofs: Preventing Local Communities from Extreme Heat



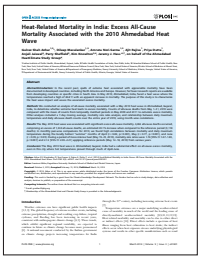
Guidelines for Preparation of Action Plan – Prevention and Management of Heat-Wave 2017

CUTTING EDGE SCIENTIFIC RESEARCH AND JOURNAL ARTICLES

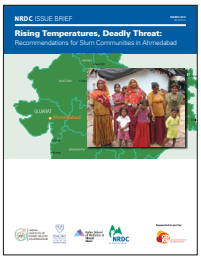
International Journal of Environmental Research and Public Health: A Cross-Sectional, Randomized Cluster Sample Survey of Household Vulnerability to Extreme Heat among Slum Dwellers in Ahmedabad, India (June 2013)

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