

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

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### Climate of Ahmedabad

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

### City Selection

After identifying extreme heat as the research focus, NRDC-PHFI team examined and developed a matrix of cities willing to engage on scientific research and take leadership on fighting climate change. The city selection process considered whether each municipality had exposure to climate change health risks and heat vulnerability; active health department with resources tracking deaths; partnerships among civil society organizations, public health groups, emergency communication agencies, media and government; interest in infrastructure improvement; appropriate size; on-the-ground PHFI presence, relation and capacity, and ability to develop a replicable program. Our city selection matrix (Table S1), developed during 2010, examined various cities across India for relevant characteristics that would enhance partnerships to develop an effective heat-health adaptation plan.

**Table S1.** City Selection Matrix Headers.

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| <b>Matrix Variability Example</b> |              |               |                 |                |                |              |            |
|-----------------------------------|--------------|---------------|-----------------|----------------|----------------|--------------|------------|
| City                              | PHFI         | Exposure to   | Health Dept.    | Existence of   | Interest in    | Appropriate  | Replicable |
|                                   | Presence or  | climate       | Resources and   | successful     | infrastructure | Scale (size) | program    |
|                                   | Relationship | change health | Administration  | partnerships   | improvements   |              |            |
|                                   | in City;     | risks;        | (track deaths); | between        |                |              |            |
|                                   | Capacity     | Heat          | High            | environmental, |                |              |            |
|                                   |              | vulnerability | environmental   | public health, |                |              |            |
|                                   |              |               | awareness       | and emergency  |                |              |            |
|                                   |              |               |                 | communication  |                |              |            |
|                                   |              |               |                 | agencies       |                |              |            |

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## Needs Assessment Activities

To provide detail on activities through which needs assessments were conducted, Table S2 provides details on activities, lead organizations and partners, methodological approaches, and project outputs.

**Table S2.** Project needs assessment activities.

| Activity  | Lead Organization | Major Partners                | Approach  | Outputs |
|---|-------------------|-------------------------------|---|---------|
| Assessment of household factors affecting vulnerability to heat                     | EUSPH/EUSM        | NRDC, IIPH-G/PHFI, MSSM       | Randomized cluster sampling of 300 slum households  | [1]     |
| Assessment of the 2010 heat wave's impact on all-cause mortality in Ahmedabad       | IIPH-G/PHFI       | EUSPH/EUSM, MSSM, NRDC        | Retrospective evaluation of all-cause mortality associated with 2010 heat wave compared with baseline                                 | [2]     |
| Assessment of the 2010 heat wave's impact on cause-specific morbidity in Ahmedabad  | IIPH-G/PHFI       | EUSPH/EUSM, MSSM, NRDC        | Retrospective evaluation of ambulance calls and selected hospital visits during 2010 heat wave  | [3]     |
| Assessment of the 2010 heat wave's impact on all-cause mortality in a neonatal ward | MSSM              | NRDC, IIPH-G/PHFI             | Retrospective analysis of an epidemic of neonatal mortality during the heat wave  | [4]     |
| Assessment of the health sector's capacity to respond to heat emergencies           | NRDC              | EUSPH/EUSM, MSSM, IIPH-G/PHFI | Focus group discussion with health care providers regarding diagnosis and management of heat illness                                  | [5]     |
| Assessment of occupational heat exposures in construction sites                     | IIPH-G/PHFI       | EUSPH/EUSM, MSSM, NRDC        | Focus groups and on-site measurements of heat exposure at outdoor construction sites  | [6,7]   |
| Assessment of thresholds for heat early warnings                                    | IIPH-G/PHFI       | EUSPH/EUSM, MSSM, NRDC        | Retrospective analysis of sensitivity and specificity of various temperature thresholds for various indicators of heat-health impacts | [8]     |

**Heat Action Plan Strategies**

The 2013 Ahmedabad Heat Action Plan is the first comprehensive early warning system and preparedness plan for extreme heat events in South Asia. The 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. The initial activities under the Heat Action Plan focus on three key strategies:

- Building Public Awareness and Community Outreach on the risks of heat waves and practices to prevent heat-related deaths and illnesses.
- Initiating a Simple Early Warning System to alert residents of predicted high temperatures, and coordinating an inter-agency response effort when extreme heat hits.
- Capacity Building among Health Care Professionals to recognize and respond to heat-related illnesses, particularly during extreme heat events.

Some of the major project milestones, key study team members, and funding organizations over the course of the project are depicted in Table S3.

**Table S3.** Major milestones, primary actors and funders in the course of the project.

| Date           | 2008  | 2010  | 2011                  | 2012         | 2012   | 2012  | 2012                             | 2013                     |
|----------------|---|---|-----------------------|--------------|--|---|----------------------------------|--------------------------|
| Milestone      | Goa Climate and Health Meeting  | Ahmedabad Heat Meeting                              | AMC Kick-off workshop | AMC Training | Heat Vulnerability Study                               | Heat Early Warning System   | AMC Heat Action Plan Development | Dry-run Heat Action Plan |
| Location       | Goa   | Gandhinagar   | Ahmedabad             | Ahmedabad    | Ahmedabad  | Atlanta   | Ahmedabad                        | Ahmedabad                |
| Primary Actors | CDC; University of Michigan; US-Indo Collaborative; IIPH-G/PHFI; NRDC | Ahmedabad Municipal Corporation (AMC); NRDC; IIPH-G |                       |              | IIPH-G; Emory; NRDC; Icahn School of Medicine/Mt.Sinai | Georgia Institute of Technology and Climate Forecast Applications Network |                                  |                          |
| Funder(s)      | CDC, US-Indo  | US-Indo, NRDC                                       | CDKN, NRDC            | CDKN, NRDC   | Emory; CDKN  | CDKN  | CDKN; NRDC                       | CDKN; NRDC               |

An alternative way to characterize implementation is by project objectives as outlined in Figure S1 below, which details the project’s objectives within its overall multi-year timeline structure.



## Extreme Heat Early Warning System

The Early Warning System consists of heat alerts that are triggered by specific temperature thresholds, correlated with four different colors applied in public messaging (see Table S4):

**Table S4.** Heat-health Early Warning system, color coding and temperature thresholds.

| Color Code   | Public Message         | Daily Maximum Temperature |
|--------------|------------------------|---------------------------|
| 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                    |

The early warning system currently involves four levels: “No Alert”; “Hot Day Advisory”; “Heat Alert Day”; and “Extreme Heat Alert Day” with color signals.

Note: More Supplementary Materials about these and other aspects of the program, including the four Policy Briefs, can be found at the Natural Resources Defense Council’s India Initiative website [9].

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