



# BUILDING CLIMATE RESILIENCE IN INDIAN CITIES WITH HEAT ACTION PLANS



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***9 June 2016 – IRI Health & Climate Colloquium 2016***

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# Why India?

A busy street scene in India, likely a market or a crowded urban area. The street is filled with people, many of whom are riding motorcycles or rickshaws. There are several rickshaws, some of which are green and some are blue. A white car is visible on the left side of the frame. The street is lined with buildings, and there are many overhead power lines. The overall atmosphere is one of a bustling, active environment. The text "Why India?" is overlaid in the center of the image.

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# Why Now?



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# NRDC India Initiative on Climate Change and Energy

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## India: Areas NRDC works in

- Clean Energy (efficiency & renewables)
- Climate Resilience
- Climate Policy



# Ahmedabad's Historic 2010 Heat Wave



## Heat wave in city: Over 50 people dead already

TNN | May 28, 2010, 04:56AM IST

AHMEDABAD: Four more people died of heat stroke in the city on Thursday. All of them were elderly people. With this the total death toll has risen to 51 in the city. At least three patients were brought to VS hospital while one death was recorded in LG hospital.

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# May 2010 Heat Wave Media Coverage

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*Courtesy of TV9 in Ahmedabad, May 2010.*

# First scientific workshop in March 2011 followed by MOU signed with IIPHG, AMC, NRDC USA



- PHFI-IIPH and NRDC entered into MOUs with the state of Gujarat and the city of Ahmedabad (AMC) for joint work on heat.
- PHFI-IIPH and NRDC hosted *Scientific Workshop on Climate Change and Heat-Health* in Ahmedabad to convene and mobilize 40+ relevant scientists, stakeholders, and partners around heat-health adaptation (March 2011)
- Preliminary studies commissioned to assess the situation on the ground in Ahmedabad

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# Ahmedabad Heat and Climate Study Group



*Project Team at Ahmedabad Met Centre, March 2012*

- Natural Resources Defense Council (NRDC)
- Public Health Foundation of India
- Indian Institute of Public Health
- Ahmedabad Municipal Corporation
- Emory University
- Icahn School of Medicine at Mount Sinai
- Georgia Tech



# Slum Community

## Heat Vulnerability Survey

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300 slum households in cross-sectional survey using randomized multistage cluster sampling.

Associations between heat-related morbidity and vulnerability factors were identified using multivariate logistic regression (info on 1,650 individuals)

Key Findings – Slum communities, especially age 65+, are vulnerable to effects of heat and unaware of temperature-related health risks.



*Int. J. Environ. Res. Public Health* **2013**, *10*, 2515–2543; doi:10.3390/ijerph10062515

**OPEN ACCESS**

International Journal of  
**Environmental Research and  
Public Health**  
ISSN 1660-4601  
[www.mdpi.com/journal/ijerph](http://www.mdpi.com/journal/ijerph)

*Article*

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

**Kathy V. Tran**<sup>1</sup>, **Gulrez S. Azhar**<sup>2,3</sup>, **Rajesh Nair**<sup>2,3</sup>, **Kim Knowlton**<sup>3,4</sup>, **Anjali Jaiswal**<sup>3,4</sup>,  
**Perry Sheffield**<sup>3,5</sup>, **Dileep Mavalankar**<sup>2,3</sup> and **Jeremy Hess**<sup>1,3,6,\*</sup>

# Heat related admissions and mortality among newborns in Ahmedabad hospitals in 2010

During April - June 2010, 24 NICU admissions with high temperature without infection; versus 8 and 4 in 2009 and 2011, respectively

High neonatal mortality in NICU; maternity ward was on top floor and under black tar roof

As a response, maternity ward was moved to the ground floor in 2012

At 42°C, 64% [95% CI 3%, 89%] reduction in heat-related admissions after moving to lower floor



# Additional Climate Adaptations

Shardaben General Hospital replaced black tar roof to cooler, white reflective, china mosaic.



*Shardaben Hospital (Government )*



*Roof replacement with china mosaic*

*Research Article*

**Neonates in Ahmedabad, India, during the 2010 Heat Wave: A  
Climate Change Adaptation Study**

**Khyati Kakkad,<sup>1</sup> Michelle L. Barzaga,<sup>2</sup> Sylvan Wallenstein,<sup>2</sup> Gulrez Shah Azhar,<sup>3,4</sup> and  
Perry E. Sheffield<sup>2,4</sup>**

*Creating strong partnerships*



*Building capacity for health professionals;  
highlighting public outreach*



*Focus group discussing heat action plan strategies*



# Policy Papers: 4 NRDC Issue Briefs

## NRDC ISSUE BRIEF

### Preventing Harmful Effects of Extreme Heat: Recommendations for Slum Communities in Ahmedabad

PREPARED BY  
Indian Institute of Public Health, Gandhinagar  
Natural Resources Defense Council



## NRDC ISSUE BRIEF

### Preventing Harmful Effects of Extreme Heat: Recommendations for Outdoor Workers in Ahmedabad

PREPARED BY  
Indian Institute of Public Health, Gandhinagar  
Natural Resources Defense Council

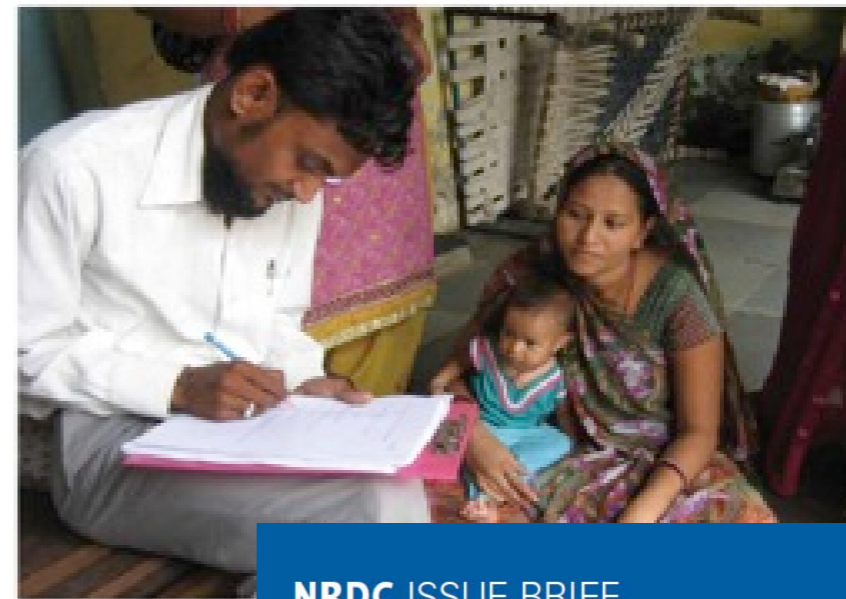


## NRDC ISSUE BRIEF

JANUARY 2013  
IB:13-01-D

### Preventing Harmful Effects of Extreme Heat: Recommendations for Ahmedabad's Government Officials

PREPARED BY  
Indian Institute of Public Health, Gandhinagar  
Natural Resources Defense Council



## NRDC ISSUE BRIEF

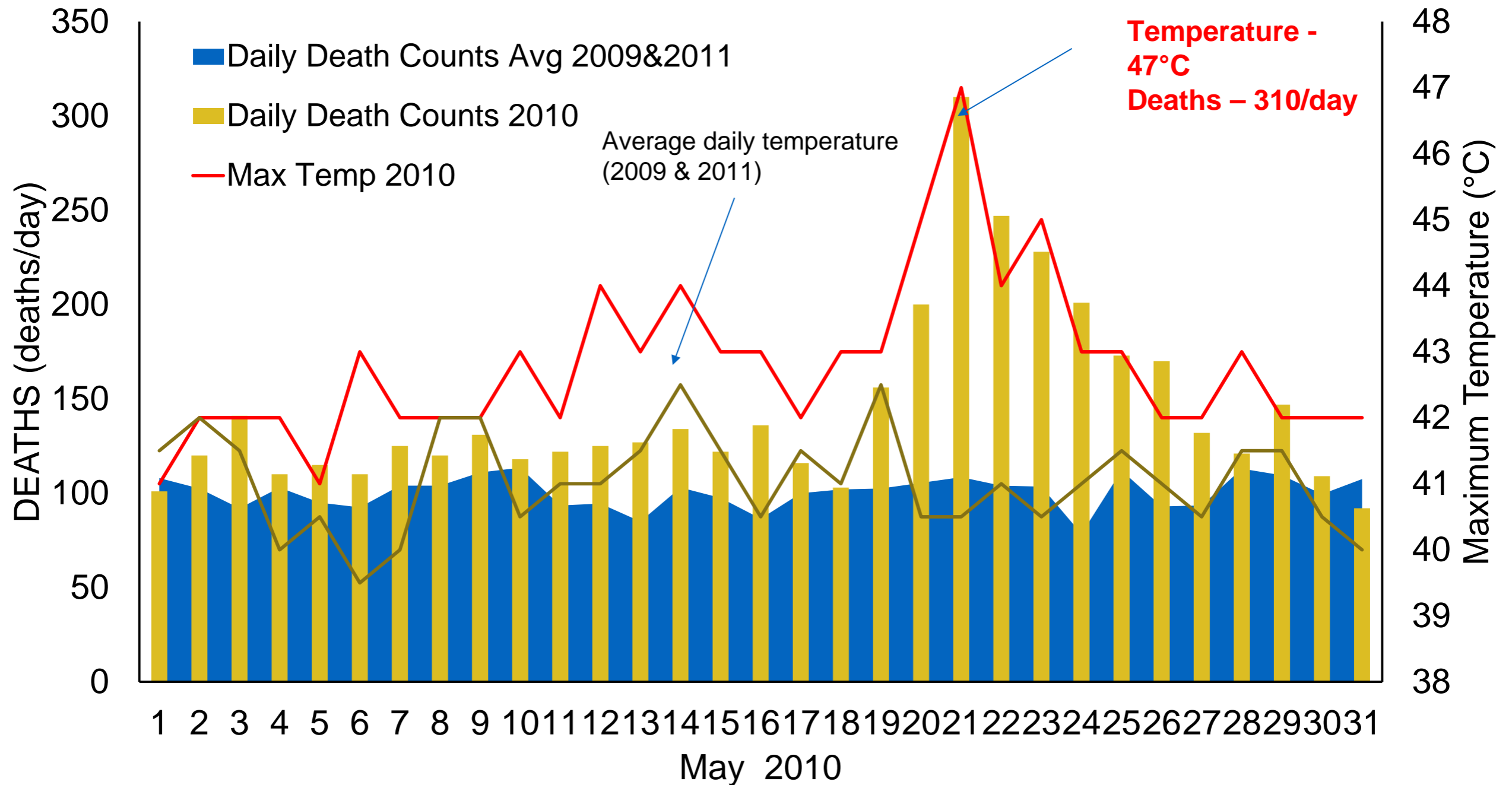
MARCH 2013  
IB:13-01-E

### Rising Temperatures, Deadly Threat: Recommendations for Health Professionals in Ahmedabad



2010 Ahmedabad heat wave : May 20-27<sup>th</sup> – excess deaths 800  
in one week and 1344 excess deaths in May 2010.

Azhar Shah et al., PlosONE 2014



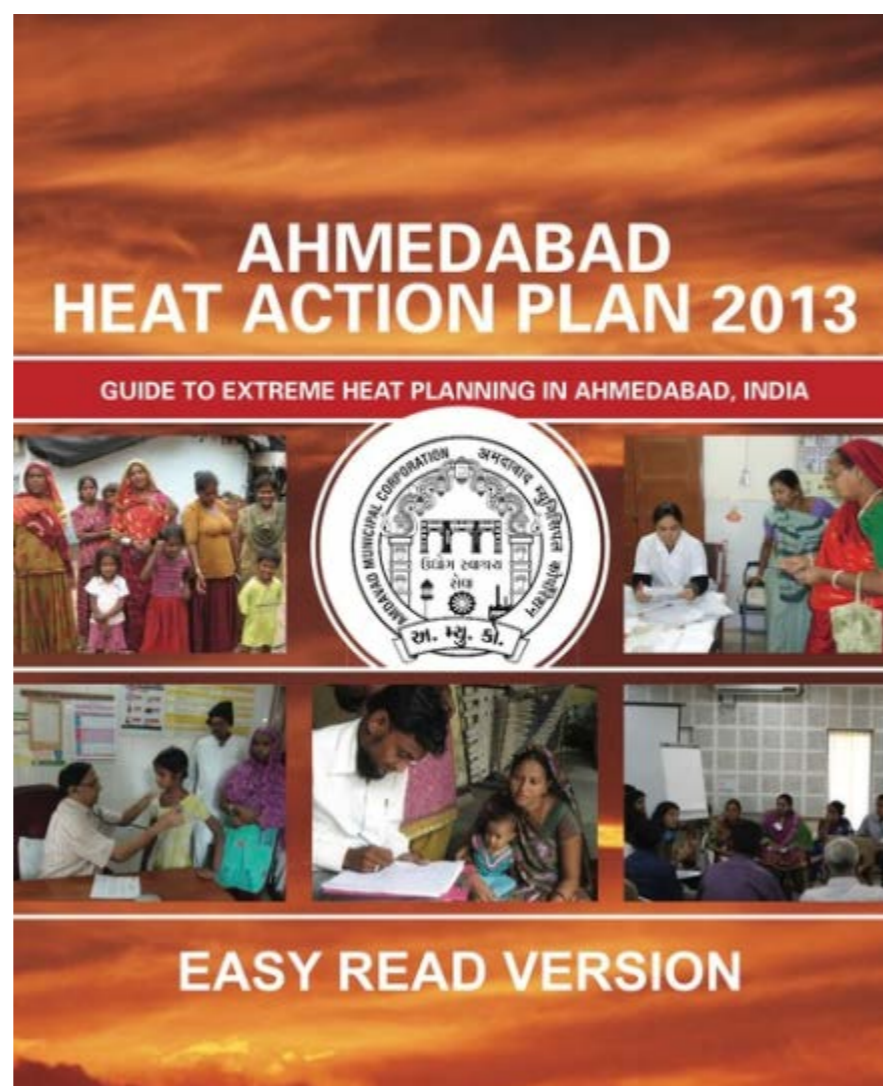


# Heat-Related Mortality in India: Excess All-Cause Mortality Associated with the 2010 Ahmedabad Heat Wave

**Gulrez Shah Azhar<sup>1,2\*</sup>, Dileep Mavalankar<sup>1,2</sup>, Amruta Nori-Sarma<sup>1,3</sup>, Ajit Rajiva<sup>1</sup>, Priya Dutta<sup>1</sup>, Anjali Jaiswal<sup>4</sup>, Perry Sheffield<sup>5</sup>, Kim Knowlton<sup>3,4</sup>, Jeremy J. Hess<sup>6,7</sup>, on behalf of the Ahmedabad HeatClimate Study Group<sup>¶</sup>**

**1** Indian Institute of Public Health, Ahmedabad, Gujarat, India, **2** Public Health Foundation of India, New Delhi, India, **3** Columbia Mailman School of Public Health, New York, New York, United States of America, **4** Natural Resources Defense Council, New York, New York, United States of America, **5** Icahn School of Medicine at Mount Sinai, New York, New York, United States of America, **6** Department of Emergency Medicine, Emory University School of Medicine, Atlanta, Georgia, United States of America, **7** Department of Environmental Health, Emory University School of Public Health, Atlanta, Georgia, United States of America

# Ahmedabad Heat Action Plan



Available online from:

[www.egovamc.com/downloads/HealthCare/healthpdf/heat\\_action\\_plan.pdf](http://www.egovamc.com/downloads/HealthCare/healthpdf/heat_action_plan.pdf)

# Heat Action Plan's Key Strategies

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

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



# Heat Action Plan Interventions – 1

## Public Awareness & Community Outreach



18 04 2014

### HEAT ALERT

**Dos & DON'TS DURING HEAT WAVES**

- Drink water, chaas, and other liquids (no soft drinks)
- Stay out of the sun
- Find a place to cool down
- Wear light clothing
- Check in with friends & family

**Symptoms to watch for:**

- Heat rash or cramps
- Heavy sweating and weakness
- Headache and nausea
- Lack of sweating despite the heat
- Red, hot, and dry skin
- Muscle weakness or cramps
- Nausea and vomiting

**DRINK MORE WATER**

People at high risk: children, elders, and pregnant women

In case of an emergency, CALL 108



18 04 2014



17 05 2014





March 2013: *HAP* posters on the streets of Ahmedabad.

Dec 2013: *Community sensitization workshop in action.*



## • *Coordination and Communications*

- AMC created *formal communication channels* to more efficiently communicate and respond during extreme heat events
- AMC appointed a *nodal officer* who issues advance warnings and coordinates the Plan's activities to improve communication within government and with the public ahead of extreme heat events
- Capacity building and trainings for *health care professionals* to improve medical officers' overall ability to recognize and respond to heat-related illnesses
- Awareness-raising trainings and activities to improve *worker safety protocols* during heat waves
- Community outreach and education through trainings and communication materials developed for health centers and schools to *increase resilience among vulnerable populations*

**SAVE YOURSELF FROM HEAT**

SPRING AND SUMMER IN AHMEDABAD CAN GET VERY HOT! CLIMATE CHANGE WILL CAUSE HEAT WAVES TO BE MORE FREQUENT. THE ELDERLY, INFANTS AND CHILDREN, OUTDOOR WORKERS AND SLUM COMMUNITIES ARE AT HIGH-RISK OF SERIOUS HEALTH EFFECTS FROM HEAT. HEAT ILLNESSES ARE PREVENTABLE! ALL SHOULD BE CAUTIOUS. DIAL 108 FOR MEDICAL EMERGENCIES! HERE IS HOW YOU CAN PROTECT FROM THE HEAT:

PREPARATION	DURING HEAT WAVES	COOLING CENTERS
<ul style="list-style-type: none"> <li>Be aware of heat illnesses</li> <li>Ensure you have a functioning fan or access to shade</li> <li>Locate parks, pools or other areas with shade or air conditioning access</li> </ul>	<ul style="list-style-type: none"> <li>Create a plan of action with neighbors</li> <li>Subscribe to the emergency SMS system</li> <li>Drink water, lemonade or chhaas</li> <li>Use air-conditioning, fans or shade to stay cool</li> </ul>	<ul style="list-style-type: none"> <li>Stay out of the sun</li> <li>Avoid physical activity during peak hours</li> <li>Wear loose-fitting, light-colored clothing</li> <li>Use the Bus Rapid Transit System to travel to public pools, shelters, and shaded parks.</li> <li>Consult <a href="http://www.ahmccm.com">www.ahmccm.com</a> for maps of locations and operating hours</li> </ul>

**NOT FEELING WELL?**  
Heat illnesses occur when your body cannot cool off. These illnesses are treatable, but require IMMEDIATE attention.

Stress	Symptoms	Actions
Heat cramps	Muscle cramps in abdominal area or extremities. Can be accompanied by heavy sweating and mild nausea.	Move to a cool or shaded place. Apply firm pressure to muscle. Gently stretch the muscle, follow with gentle massage. Drink water or chhaas.
Heat exhaustion	Heavy sweating, lightheadedness, dizziness, nausea, weakness.	Move to cool or shaded place. Loosen clothes, and apply cold cloths. Sip water slowly. Heat exhaustion can lead to heat stroke. If symptoms worsen, dial 108.
Heat stroke (This is an emergency)	Hot, red, dry skin, rapid pulse, high fever, loss of alertness and confusion, unconsciousness, rapid breathing.	Dial 108. Wrap victim in cool sheets. Bring to cooled or shaded space.



Adapted from New York State Department of Health documents. For more information visit [www.ny.gov](http://www.ny.gov) or [www.ahmccm.org](http://www.ahmccm.org)



# Heat Action Plan Interventions – 2

## Heat Early Warning System:

### Daily 7-day probabilistic forecasts by email from Georgia Tech

 <span style="background-color: orange; padding: 5px; font-weight: bold;">Monday 02 June 2014 - ORANGE ALERT LEVEL</span> 							
Current Forecast (Created 01-Jun )	02-Jun	03-Jun	04-Jun	05-Jun	06-Jun	07-Jun	08-Jun
<b>Alert Level</b>	Orange	Red	Red	Red	Orange	Orange	Orange
<b>Likelihood of Crossing Threshold</b>	High	High	High	High	High	High	Med
<b>Maximum Temp (+/- 1 SD)</b>	44.3°C (42.9-45.5)	46.1°C (44.7-47.5)	46.4°C (45.1-47.6)	45.8°C (44.0-47.4)	44.3°C (42.7-45.9)	43.8°C (42.6-45.2)	43.5°C (42.1-45.0)
<b>Probability of "Safe Day"</b>	0%	0%	0%	0%	0%	0%	0%
<b>Probability of "Hot Day"</b>	5%	0%	0%	2%	6%	18%	33%
<b>Probability of "Very Hot Day"</b>	75%	16%	2%	16%	67%	71%	59%
<b>Probability of "Extreme Heat Day"</b>	20%	84%	98%	82%	27%	12%	8%

<b>Alert Levels:</b>	Safe <41°C	Hot 41°C - 42.9°C	Very Hot 43°C - 44.9°C	Extreme Heat ≥45°C	<b>Likelihood of Crossing Threshold</b> High>75% Med 50-75% Low<50%
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**TEMPERATURE FORECAST TRIGGERS  
ISSUANCE OF HEAT ALERT  
OR HEAT WARNING**

**AMC Nodal Officer  
CALLS HEAT  
ALERT  
as an Intervention**

**AMC Press  
Liaison notified:  
Media outreach  
begins**

**Gujarat State  
Disaster Mgmt  
Authority notified**

**Gujarat State  
Surveillance Unit of  
IDSM notified**

**Non-Governmental Groups  
PHFI/IIPH, 108 workers, AIDMI (All-India  
Disaster Mitigation Institute),  
Community health groups, and others to  
help reach the heat-vulnerable**

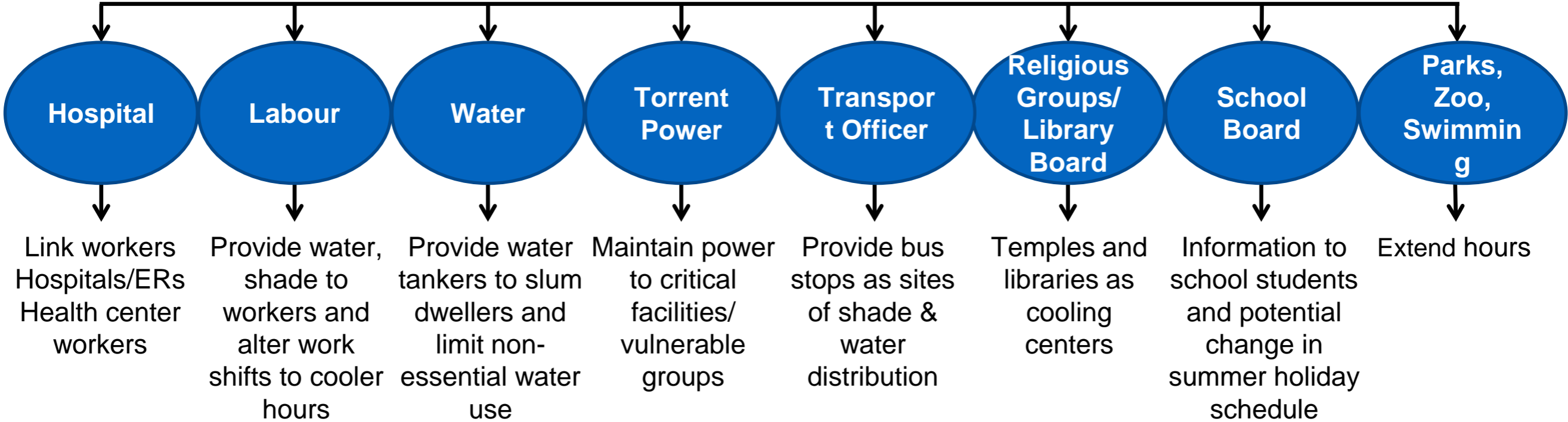
**via email,  
with phone  
call or fax to  
verify**

**Alert mobile  
phone  
companies  
to send text  
msg**

**Promote  
Heat  
Hotline**

**Posters &  
Pamphlets**

**TV, Print,  
Radio  
alerts**





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# Tabletop Exercises

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Opportunity for Steering Committee practice and discussion on what works well vs. what needs work

Committee members were each given a description of their roles and responsibilities

Talked through different Heat Alert scenarios re: *'What would you would be doing in response?'*

Committee played roles as if the scenario were happening in real life

Followed by discussion in small breakout groups & exit survey on experiences and suggestions

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# Expanding outreach – social media

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# Heat Action Plan Intervention – 3

## Building Capacity in Health Sector



## Case Definitions

### Heat Illness - Typical Presentations

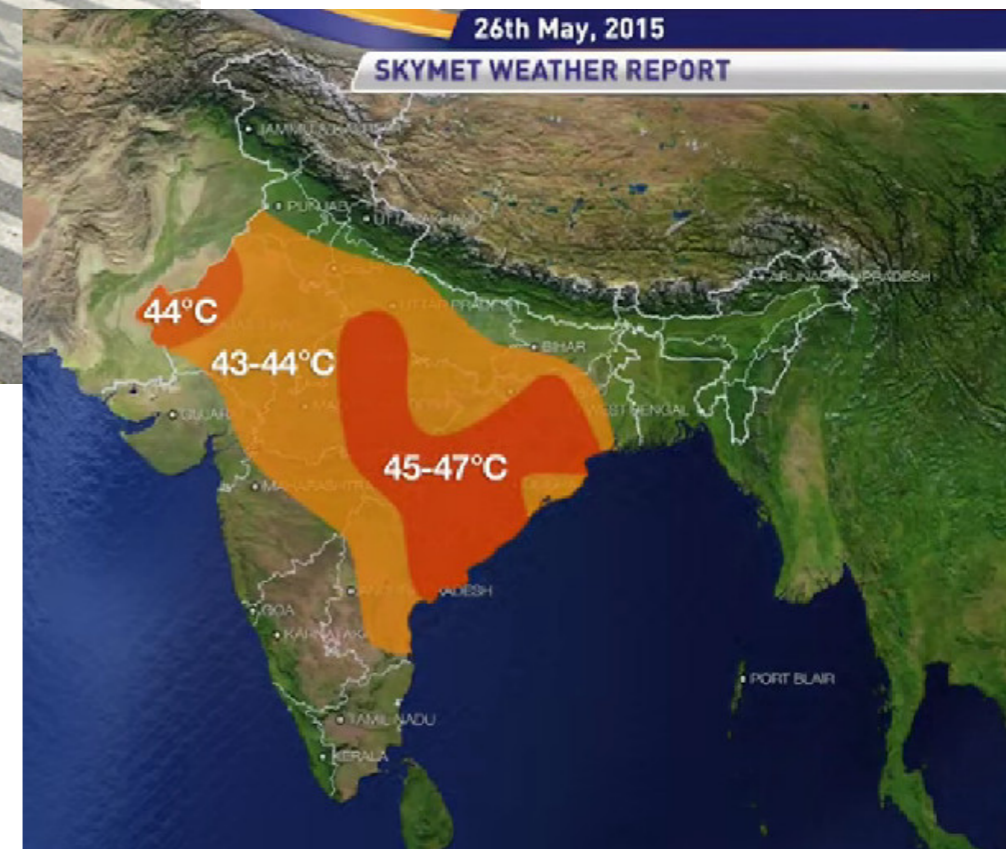
Clinical Entity	Age Range	Setting	Cardinal Symptoms	Cardinal Signs	Pertinent Negatives	Prognosis
Heat rash	All, but frequently children	Hot environment; +/- insulating clothing or swaddling	Itchy rash with small red bumps at pores in setting of heat exposure; bumps can sometimes be filled with clear or white fluid	Diffuse maculopapular rash, occasionally pustular, at hair follicles; pruritic	Not focally distributed like a contact dermatitis; not confluent patchy; not petechial	Full recovery with elimination of exposure and supportive care
Heat cramps	All	Hot environment, typically with exertion, +/- insulating clothing	Painful spasms of large and frequently used muscle groups	Uncomfortable appearance, may have difficulty fully extending affected limbs/joints	No contaminated wounds/tetanus exposure; no seizure activity	Full recovery with elimination of exposure and supportive care
Heat exhaustion	All	Hot environment; +/- exertion; +/- insulating clothing or swaddling	Feeling overheated, lightheaded, exhausted and weak, unsteady, nauseated, sweaty and thirsty, inability to continue activities	Sweaty/diaphoretic; flushed skin; hot skin; normal core temperature; +/- dazed, +/- generalized weakness, slight disorientation	No coincidental signs and symptoms of infection; no focal weakness; no aphasia/dysarthria; no overdose history	Full recovery with elimination of exposure and supportive care; progression if continued exposure
Heat syncope	Typically adults	Hot environment; +/- exertion; +/- insulating clothing or swaddling	Feeling hot and weak; lightheadedness followed by brief loss of consciousness	Brief, generalized loss of consciousness in hot setting, short period of disorientation if any	No seizure activity, no loss of bowel or bladder continence, no focal weakness, no aphasia/dysarthria	Full recovery with elimination of exposure and supportive care; progression if continued exposure
Heat stroke	All	Hot environment; +/- exertion; +/- insulating clothing or swaddling	Severe overheating; profound weakness; disorientation, obtundation, seizures, or other altered mental status	Flushed, dry skin (not always), core temp $\geq 40^{\circ}\text{C}$ ; altered mental status with disorientation, possibly delirium, coma, seizures; tachycardia; +/- hypotension	No coincidental signs and symptoms of infection; no focal weakness; no aphasia/dysarthria; no overdose history	25-50% mortality even with aggressive care; significant morbidity if survive

*Article*

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

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

# Historic May 2015 Heat Wave Across India




$43-44^{\circ}\text{C} = 109.4-111^{\circ}\text{F}$







$45-47^{\circ}\text{C} = 113-116.6^{\circ}\text{F}$

# IMD now issues forecasts for ~300 large cities

## Local Weather Report and Forecast For: Ahmedabad Dated :Jul 09, 2015

	<b>Past 24 Hours Weather Data</b>	
	Maximum Temp( <sup>o</sup> C)	33.5
Departure from Normal( <sup>o</sup> C)	-2	
Minimum Temp ( <sup>o</sup> C)	27.7	
Departure from Normal( <sup>o</sup> C)	2	
24 Hours Rainfall (mm)	2	
Today's Sunset (IST)	19:29	
Tomorrows Sunrise (IST)	06:01	
Moonset (IST)	13:11	
Moonrise (IST)	00:24	

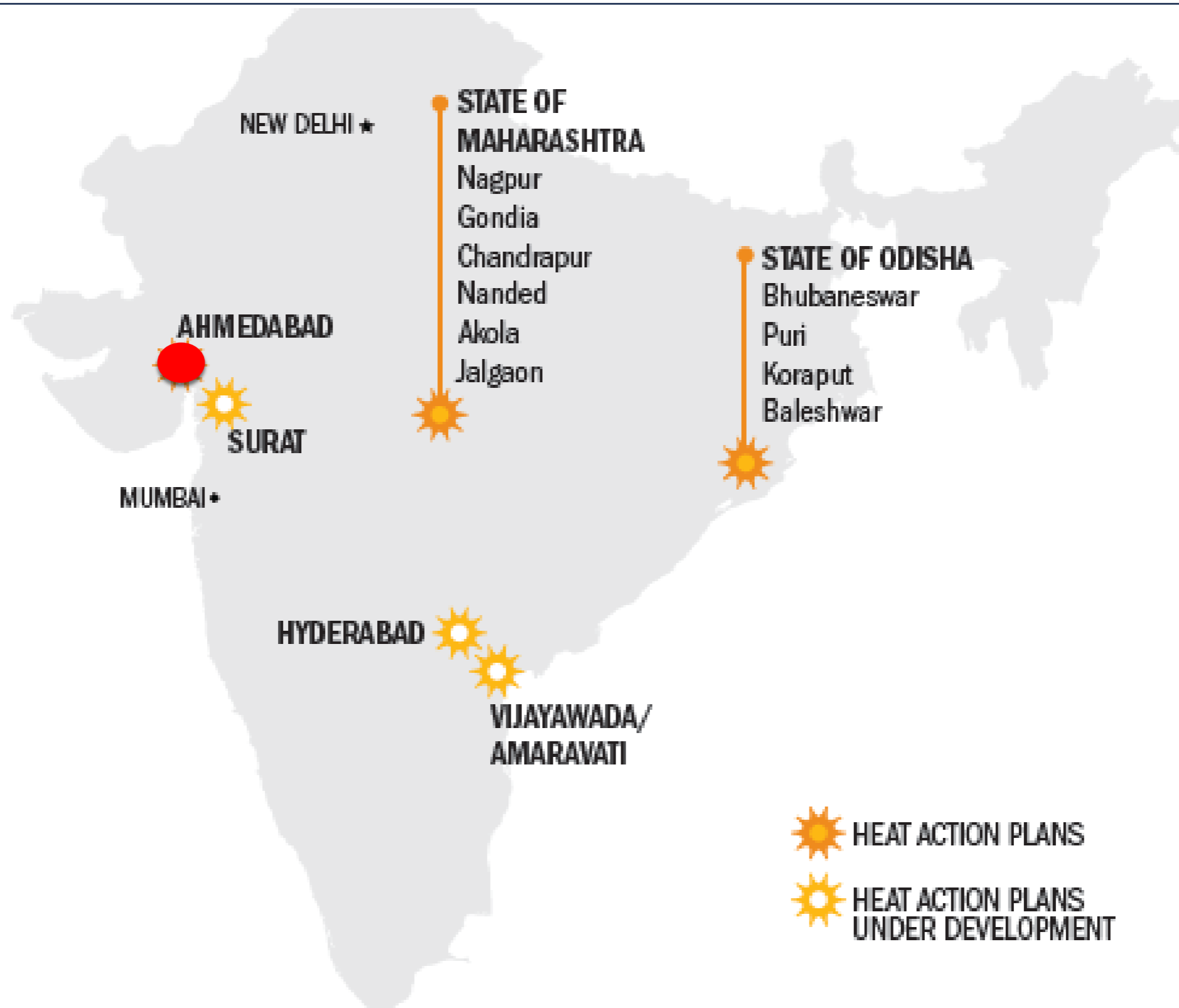
Today's Forecast: RAIN OR THUNDER SHOWER WOULD OCCUR.

Date	Temperature ( ° C )		Weather Forecast	
	Minimum	Maximum		
10-Jul	28.0	34.0		Mainly or Generally cloudy sky with possibility of rain or Thunderstorm
11-Jul	28.0	34.0		Mainly or Generally cloudy sky with possibility of rain or Thunderstorm
12-Jul	27.0	35.0		Partly cloudy sky
13-Jul	28.0	34.0		Partly cloudy sky
14-Jul	28.0	36.0		Partly cloudy sky
15-Jul	27.0	34.0		Partly cloudy sky

# April 2015 Workshop for new cities developing HAPs

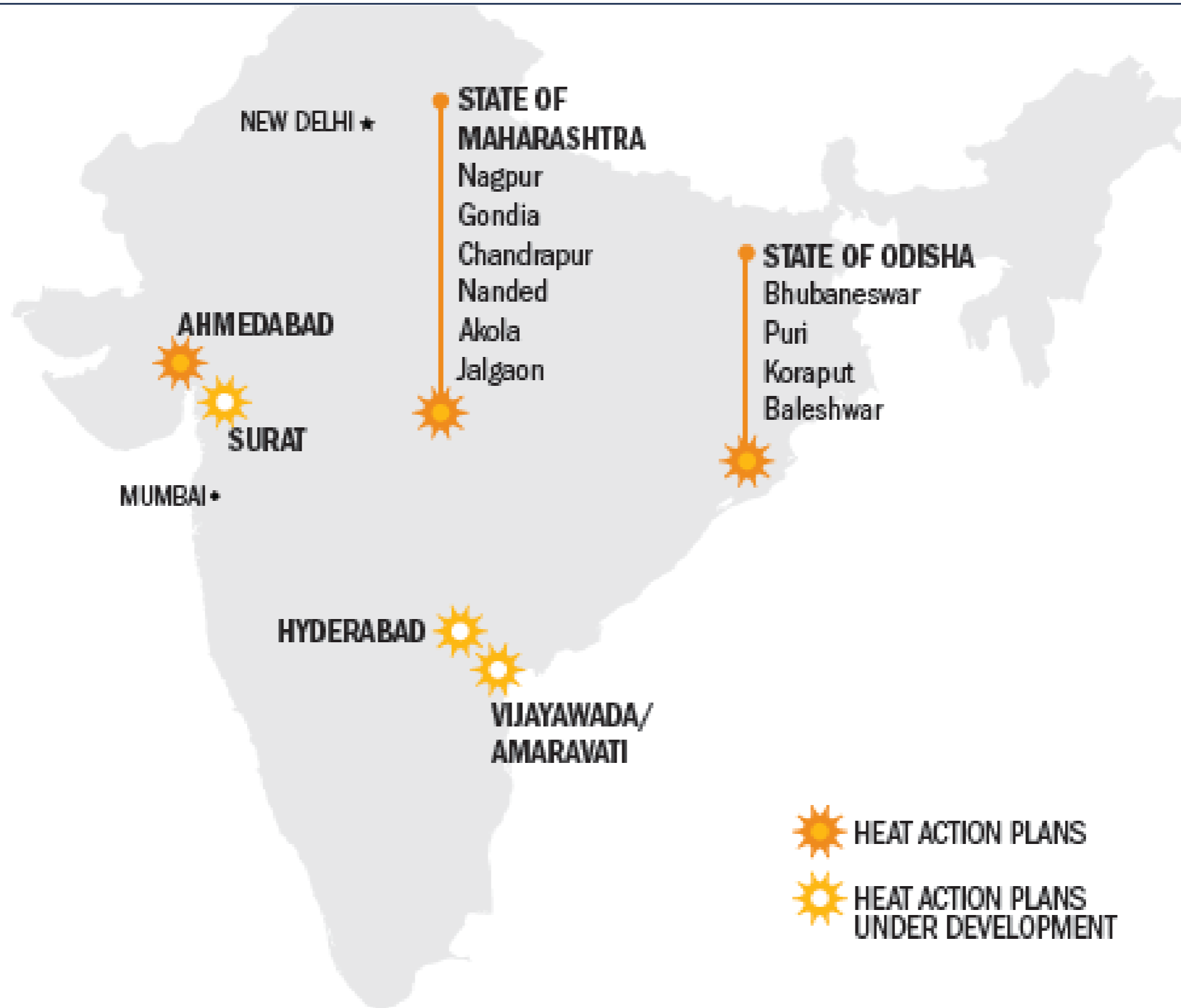


# Where We Are Working





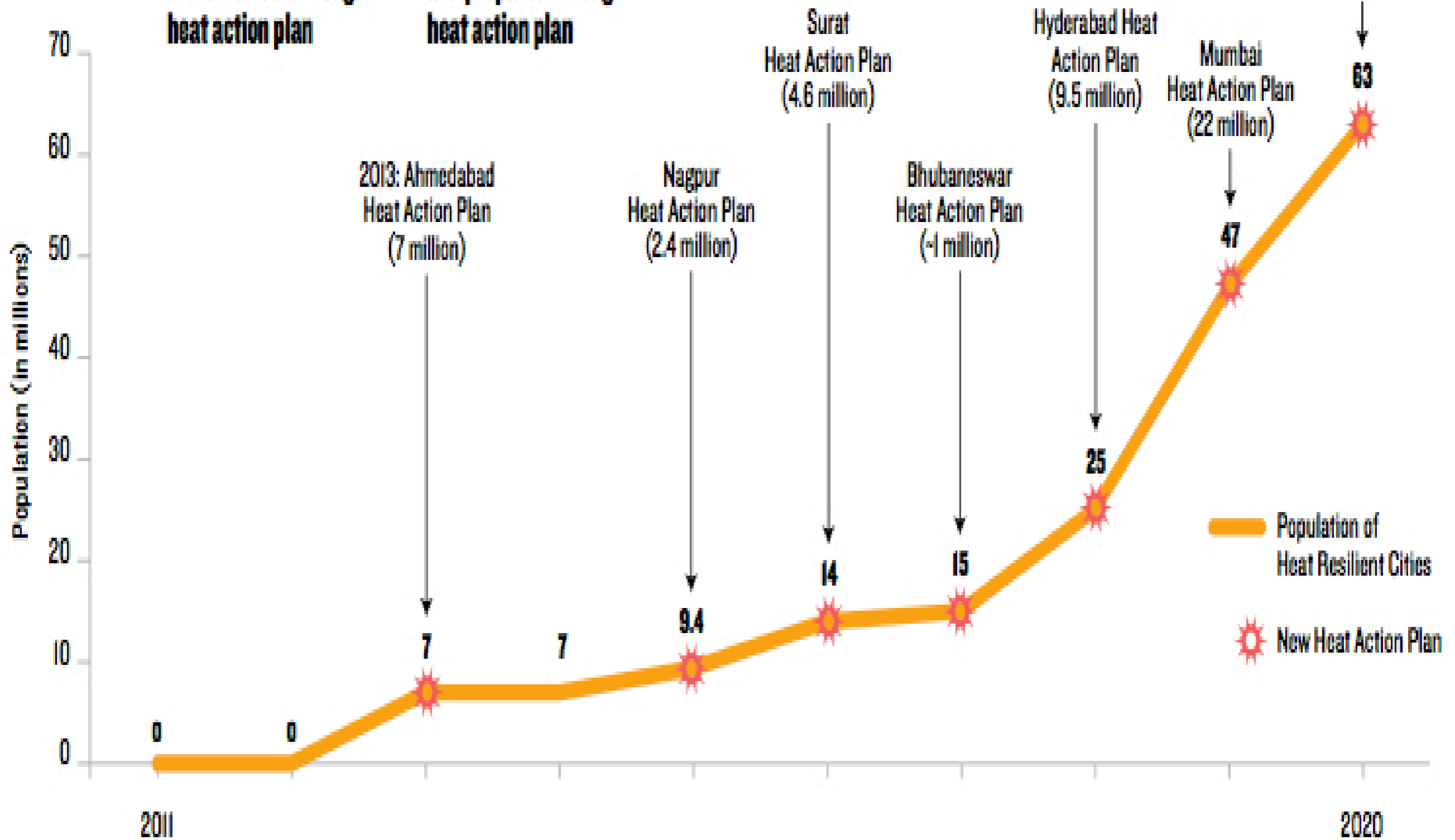
# Where We Are Working



# IMPACT OF HEAT RESILIENCE WORK

**2015: 7 million**  
residents prepared for  
extreme heat through  
heat action plan

**2020: 63+ million**  
residents protected  
and prepared through  
heat action plan



# Summer 2015 & 2016 Pilot – Occupational Heat & Air Pollution Exposures Among Traffic Police in Ahmedabad

Among a cohort of 16 police, interviewer-administered survey on heat exposures, self-report symptoms, coping strategies, pre-existing vulnerabilities

Baseline survey & 3 follow-ups (every 2 weeks)

Temperature loggers worn around neck

Initial pilot findings: 50% of the participant reported that heat leads to:

- Absenteeism
- Irritation
- Diminished social life

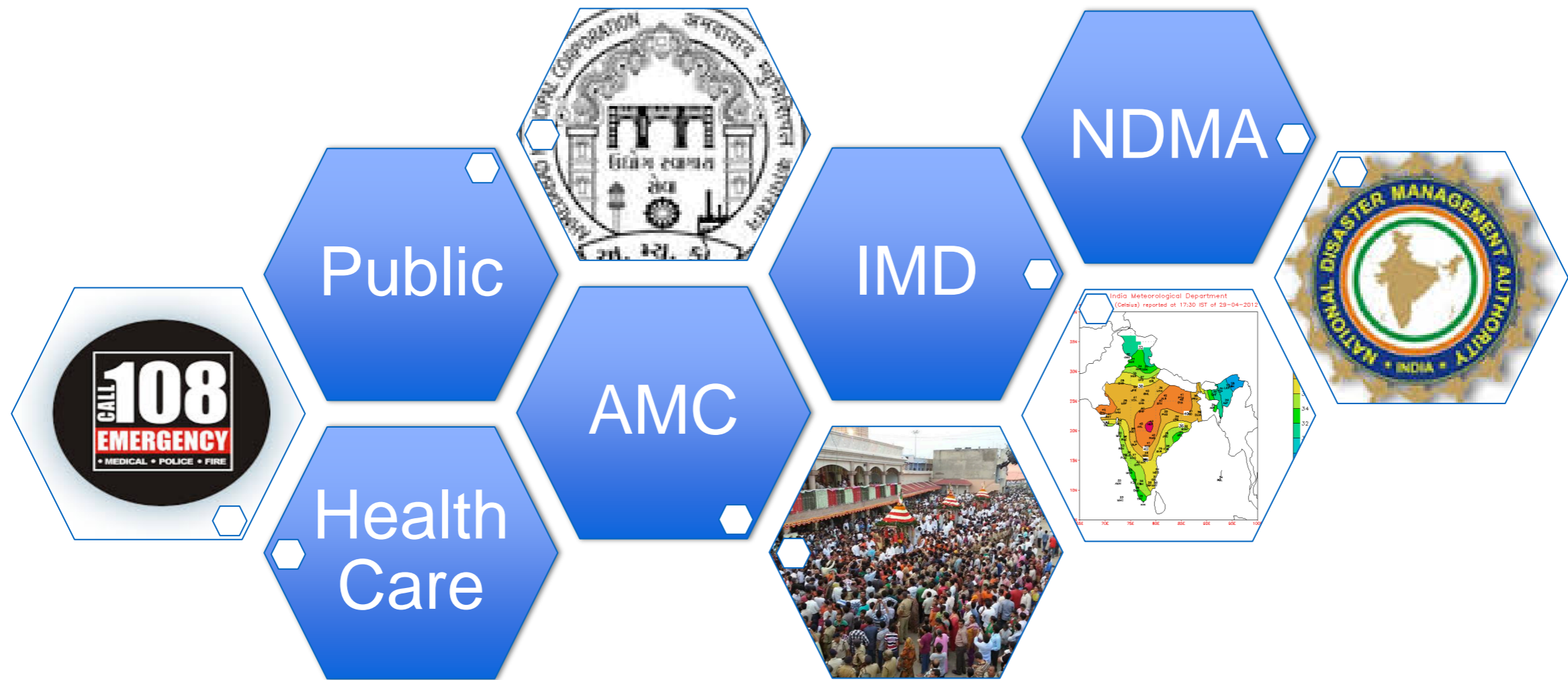
More than 50% of the participants complained about insufficient water availability in the work place.

Apart from extreme temperature, other reported workplace stresses were **Air Pollution, Noise** and Standing position


Summer 2016: expanded Heat Survey among 40-45 Traffic Police Officers + adding an Air Pollution exposure assessment



# Heat Action Plan – Communication and Engagement



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A group of people, including a woman in a yellow sari and a man in a blue shirt, are gathered around a small, green and blue water pump in a dry, cracked field. The ground is parched and cracked, with a small pool of water visible in the background. The scene is set in a vast, open landscape under a clear sky.

India Initiative has accomplished a lot with very few people: Ahmedabad's Heat Action Plan has become a model for other cities thanks to Partnerships, Coordination & Successful International Working Relationships. But there are still enormous opportunities and needs in India.

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*Thank you to Ahmedabad Heat & Climate Study Group,  
Climate Development Knowledge Network, Indo-US Science & Technology  
Forum, National Institutes of Health, and*

*to the people of Ahmedabad, 10 other cities and 2 regions in India*

[kknowlton@nrdc.org](mailto:kknowlton@nrdc.org); [kmk47@columbia.edu](mailto:kmk47@columbia.edu)

<http://www.nrdc.org/international/india/extreme-heat-preparedness/>





THANK YOU

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