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**Georgia  
Tech**



# Ahmedabad Heat Action Plan case study: India

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# India is hot – but heat waves are not seriously taken

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Climate change will bring in higher average temperature and more heat waves.

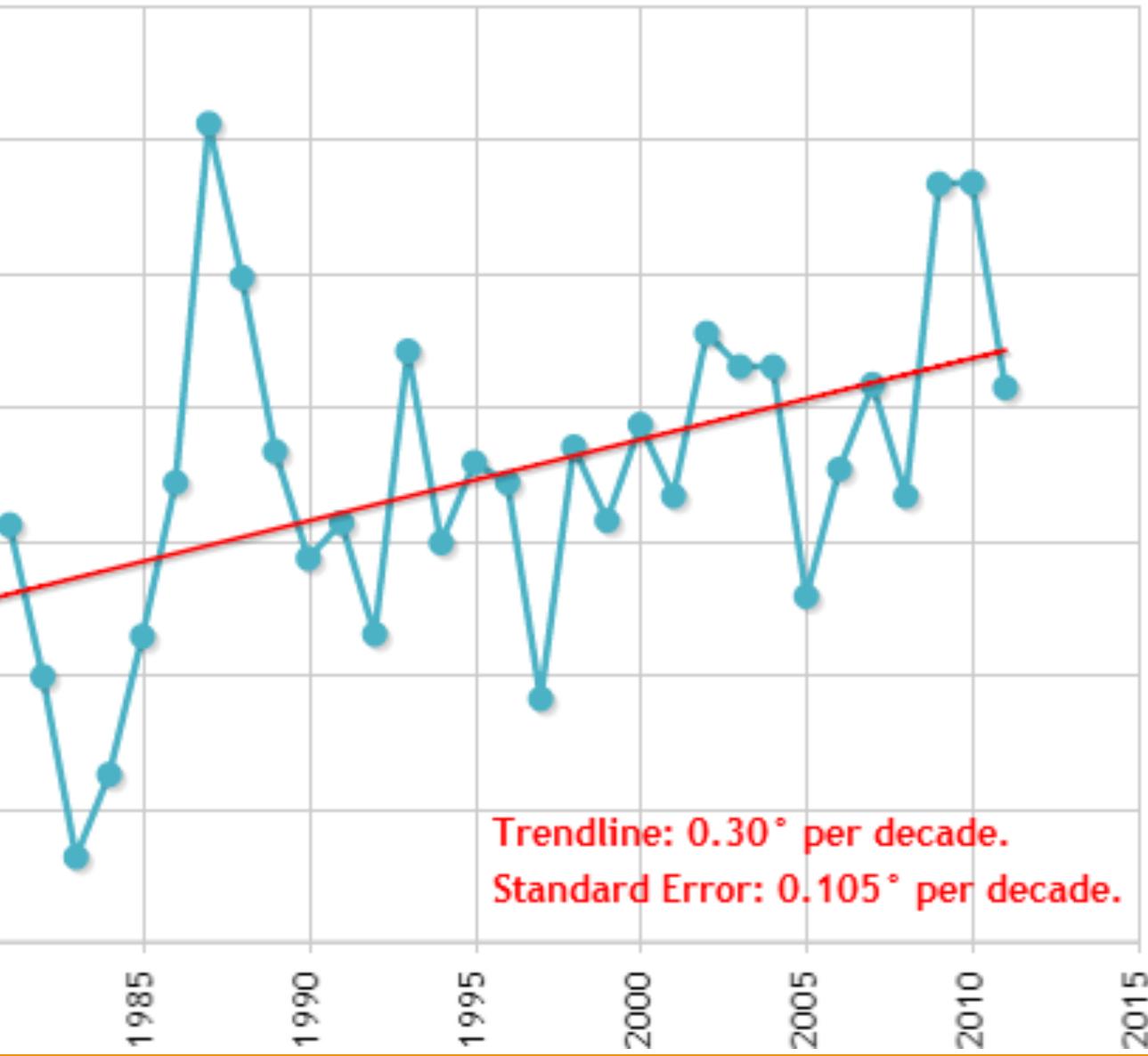
**Yet heat stress is an understudied area of climate change**

India has projected increases in air temperature of about **2-4 degrees by 2030**

**Until 2013, the Indian government and National Disaster Management Agency (NDMA) did not recognise that heat waves are a natural disaster**

**2015 heat waves – 2000+ deaths and lot of media coverage**

Maximum Temperature(Annual Average).  
Latitude: 23.25 & Longitude: 72.75



In Ahmedabad ( pop 6 m) Annual average of Maximum Temperatures have been increasing steadily over the past 30 years

Graph data: HOTHAPS

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



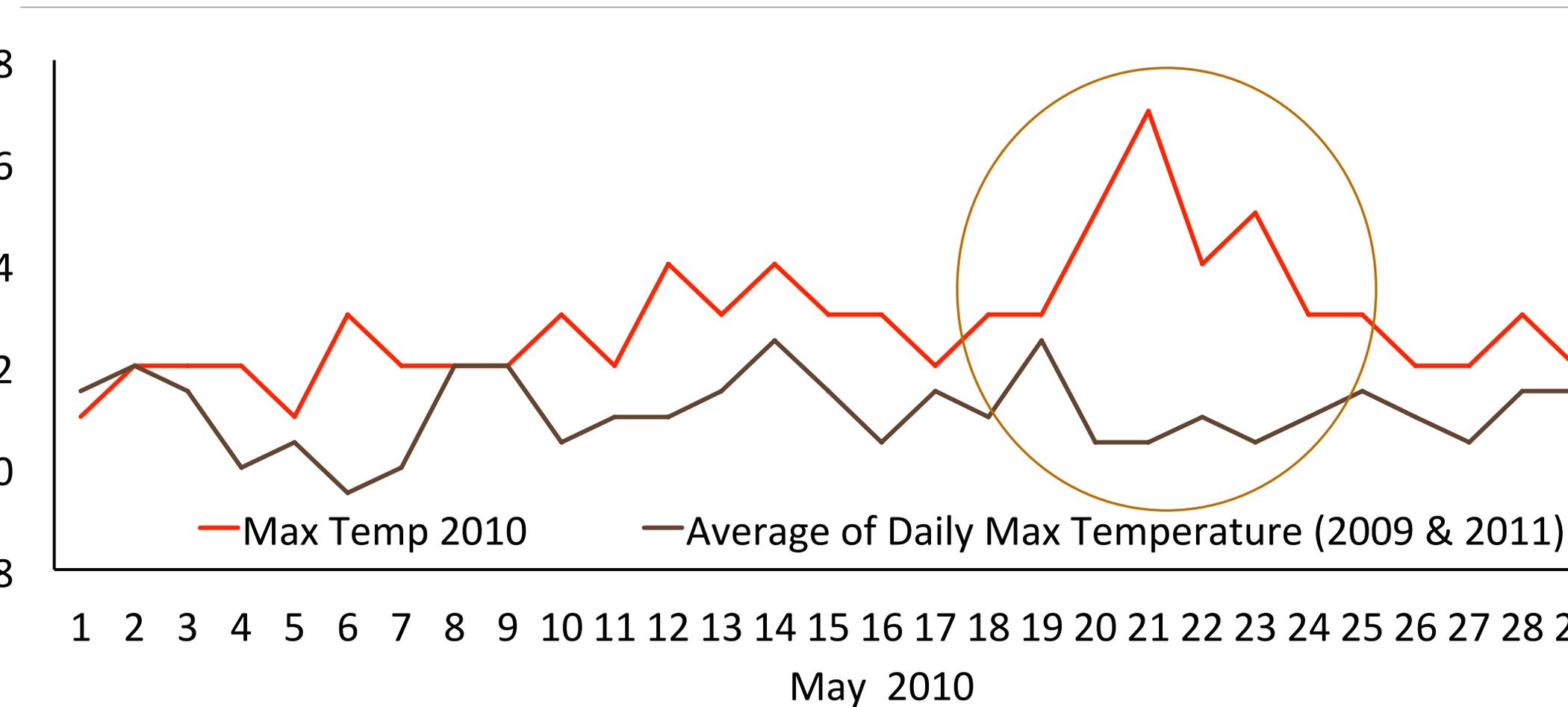
PHFI-IIPH and NRDC entered into Memorandums of Understanding (MOUs) with the state of Gujarat and the city of Ahmedabad (AMC) to formalize collaboration for joint research on heat.

PHFI-IIPH and NRDC hosted a **first scientific Workshop on climate change and Heat-health** in Ahmedabad to convene and mobilize relevant scientists, stakeholders, and partners in March 2011

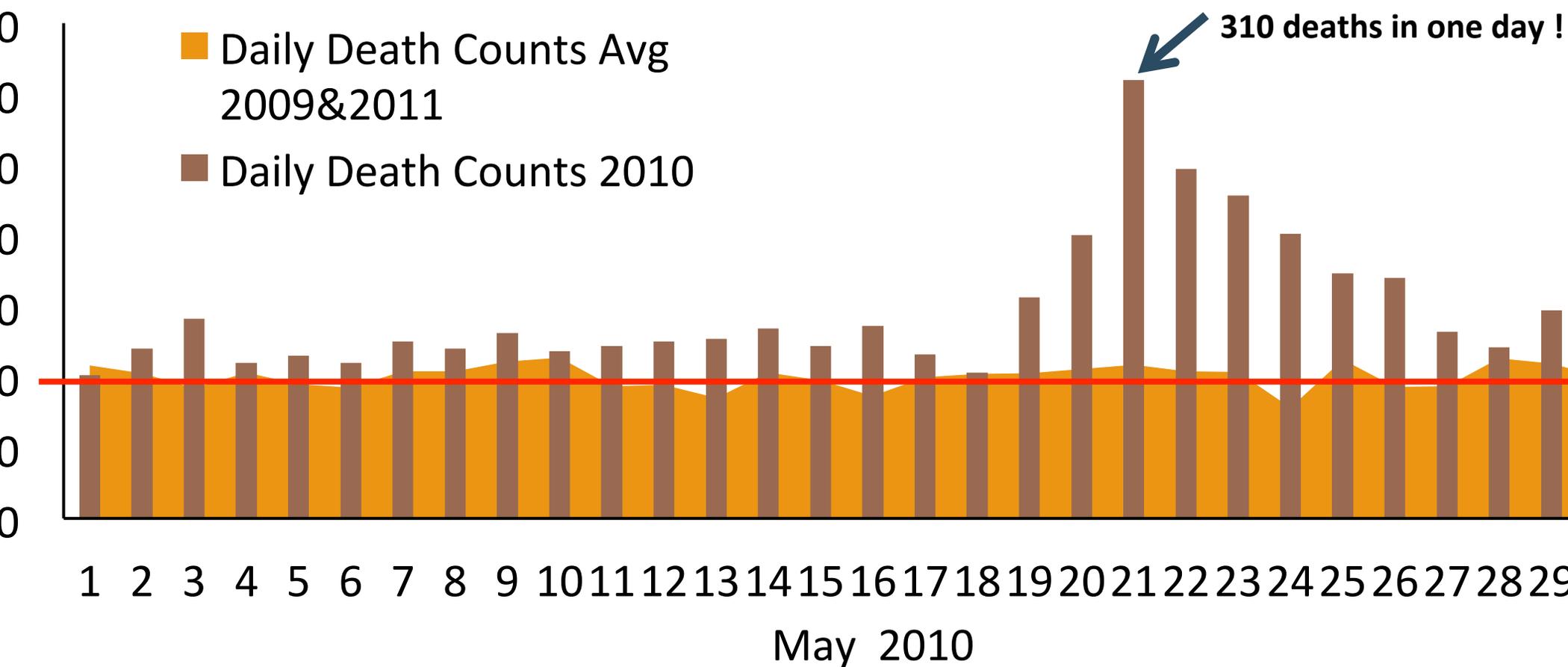
A number of **preliminary studies** were commissioned to assess the situation on the ground in Ahmedabad

# Analysis of temperature and mortality data of Ahmedabad.

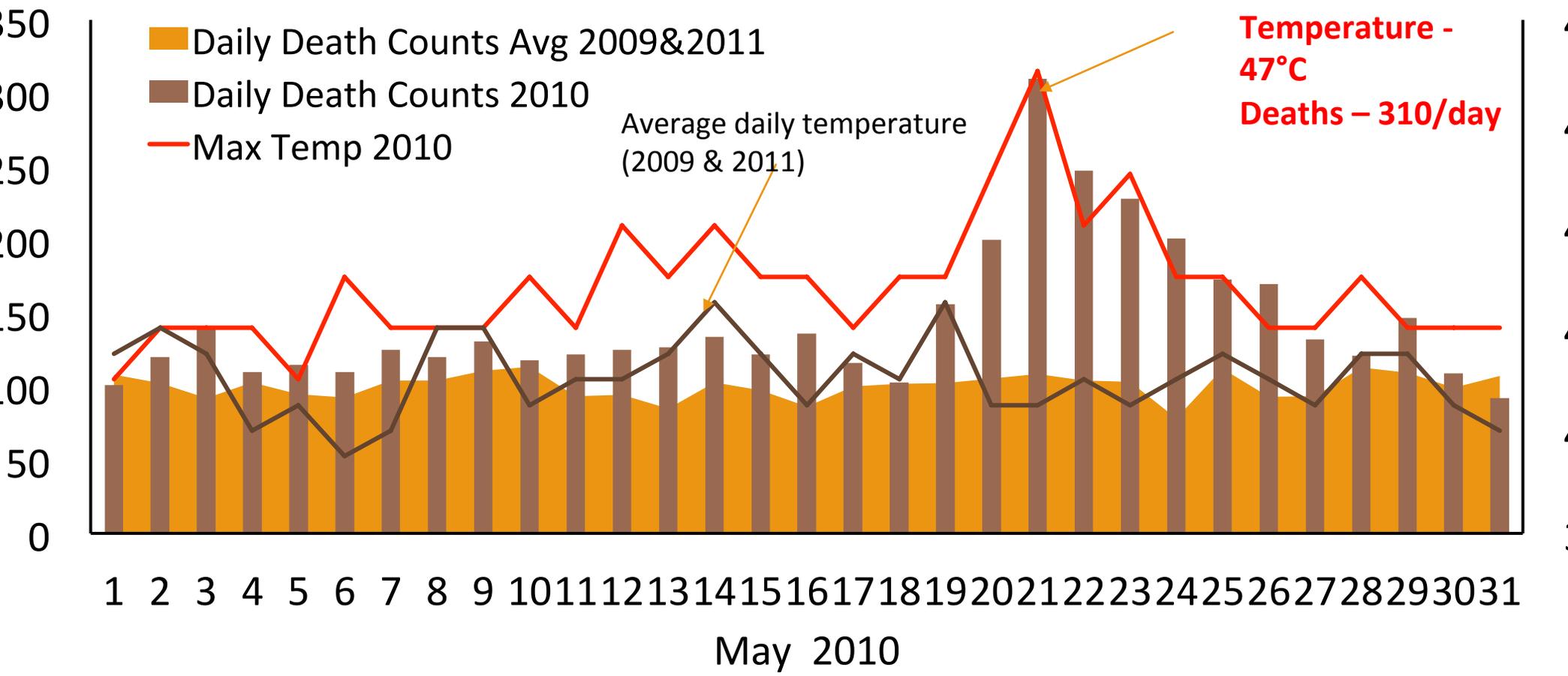
2010 Heat wave in Ahmedabad – Temp. reached 47deg C on 21<sup>st</sup> May



# 2010 Heat wave – daily mortality compared to 2009 and 2011



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



# Heat related admissions and mortality among new-borns in Ahmedabad hospitals in 2010 – Dr Kakkad and Dr Sheffield work

During April, May, and June 2010,

24 NICU admissions with high temp. without infection in newborns: versus 8 and 4 in 2009 and 2011, respectively

Increased NN mortality in hospital ward:

Possible cause - NICU because very hot as it was on top floor and under black tar covered roof.

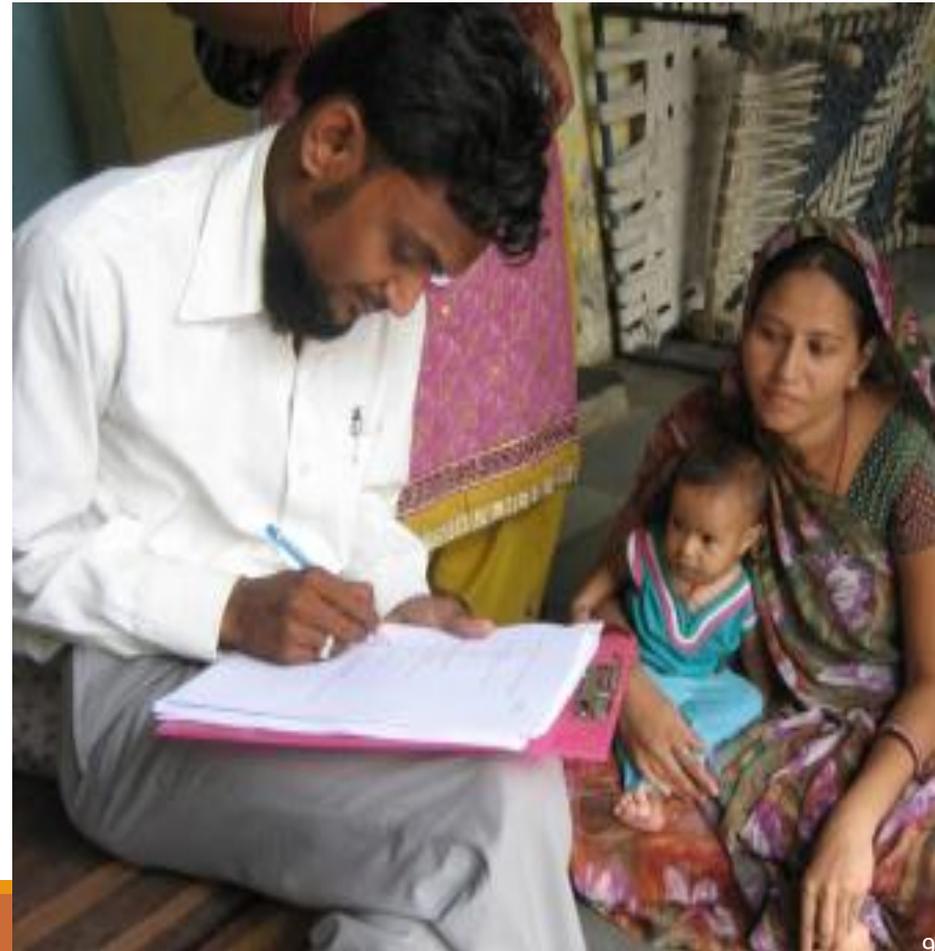
As a solution, NICU was moved to the ground floor and the roof was replaced with a cool roof (china mosaic).



# Slum Community Heat Vulnerability Survey

*Method* - 300 slum households surveyed –  
got info on total of 1,650 individuals

***Key Findings* – Slum communities are  
vulnerable to effects of heat and  
unaware of temperature and extreme  
heat dangerous.**



# Construction Worker Vulnerability Survey (HOTHAPS) – 319 workers from 5 sites around Ahmedabad

## *Key Findings –*

- All construction workers work in extreme heat conditions (above ACGIH\* standards)
- **10% hospitalized at least once during summer**
- **Awareness of heat health impact is low.**

\*American Conference of Governmental Industrial Hygienists



# Vulnerability Survey of Various Occupational Groups -

*Occupational Groups – Construction workers, Kite Makers, Aggarbatti rollers, Pickers and Street Vendors (368 people)*

## *Findings*

***High prevalence of heat related illnesses (dehydration, exhaustion, headache, heavy thirst, body cramp)***

***Increased core body temperature during hot days***

*WBGT greater than ACGIH standards*

***Awareness of heat stress and illnesses is minimal***



# Urban Heat Island Effect and impact of vegetation on local temperatures

Comparison of areas with vegetation and no vegetation

	Dry (°C)	Globe (°C)
Vegetation	43.8	57.7
No Vegetation	45.6	60.4

Our research shows the presence of a large urban heat island over Ahmedabad

Differences between temperatures in hotspots and “official” IMD temperatures range from 1-3°C air temperature and up to 10°C globe temperature.

**Areas with vegetation (esp. grass) are cooler by 2°C than those without**

More work is needed in this area. We aim to build a heat contour map to identify areas of particular vulnerability

# Development of Ahmedabad Heat Action Plan 2013 - an collaborative effort –

Plan was developed collaboratively by IIPHG, NRDC and AMC and other partners

Review of heat action plans of cities in the west

Review of data and evidence from Ahmedabad.

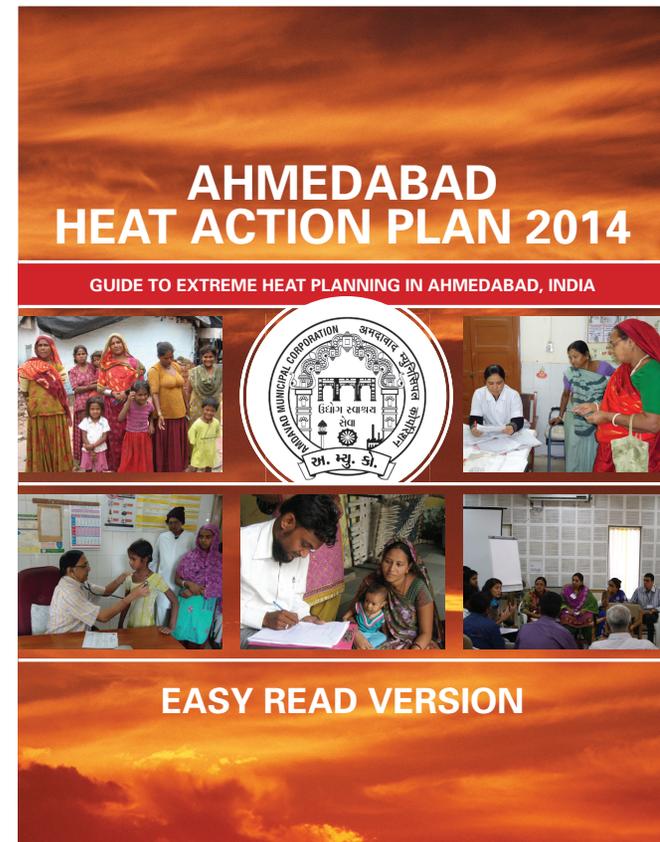
Series of meetings and workshops with key stakeholders,

Deciding temperature cut off levels

Identification of locally possible key actions

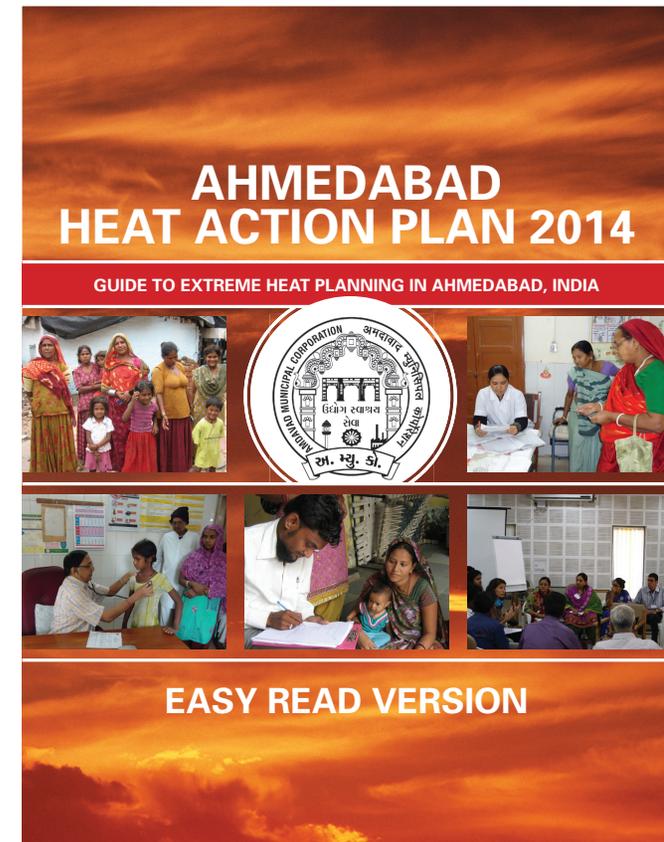
Writing of draft plan and dissemination

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



# Ahmedabad Heat Action Plan 2013- refined in 2014 – Key activities

- Analysis of local data -2010 and setting cut-offs
- Appointment of Nodal officers at AMC and steering committee.
- public awareness of the risks of extreme heat and actions to be taken – posters, hand bills, hoardings and field workers
- Training of medical officers and hospital staff for better management of heat illness - supplies to hospitals
- Information network to inform various departments.
- Learning from international experiences and best practices
- Media engagement for public awareness
- **Created advance 7-day forecast for heat early warning system with help of CFAN center at Georgia tech. USA**



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

# Temperature Thresholds decided based on mortality rise

Condition	Temperature Thresholds	Alert Level
No Alert (Cool Day)	<41.0	White
Hot Day	41.0 – 42.9	Yellow
Heat Alert Day	43.0 – 44.9	Orange
Extreme Heat Alert Day	$\geq$ 45.0	Red

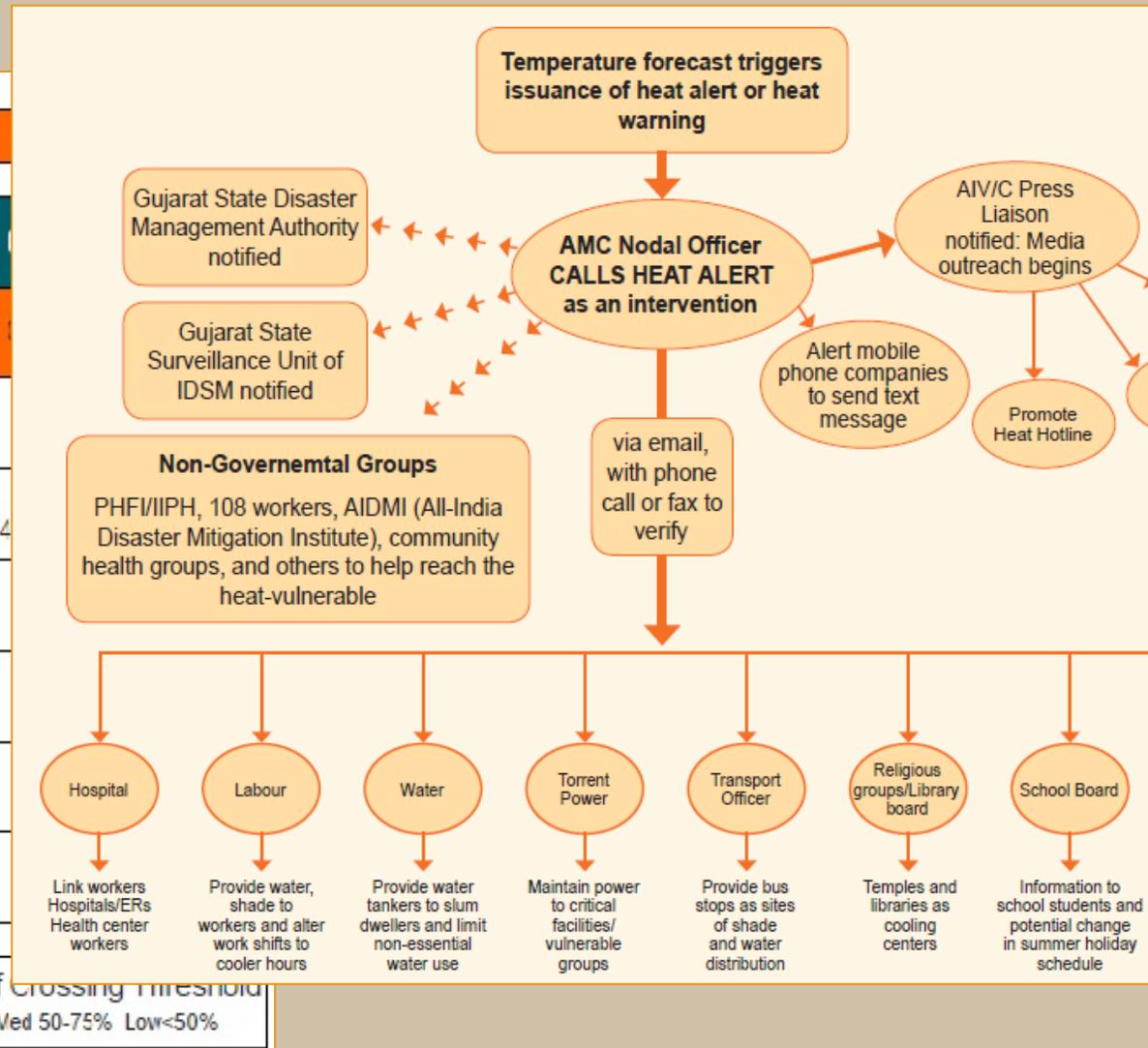
# 7 day Early warning system & Inter-agency emergency response plan

Monday 02 June 2014 - ORANGE ALERT LEVEL

Forecast (01-Jun )	02-Jun	03-Jun	04-Jun	05-Jun	06-Jun
Alert level	Orange	Red	Red	Red	Orange
Food of Threshold	High	High	High	High	High
Min Temp (SD)	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)
Probability of "Hot Day"	0%	0%	0%	0%	0%
Probability of "Very Hot Day"	5%	0%	0%	2%	6%
Probability of "Extreme Heat Day"	75%	16%	2%	16%	67%
Probability of "Heat Day"	20%	84%	98%	82%	27%

Safe <41°C	Hot 41°C - 42.9°C	Very Hot 43°C - 44.9°C	Extreme Heat ≥45°C
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Likelihood of Crossing threshold  
High>75% Med 50-75% Low<50%



# Public Awareness , Community Outreach & training



# Planning cycle for the Heat action in summer of 2014

## Before Extreme Heat Season (Jan-Feb)

- Biweekly preparation & information sharing meetings with stakeholders.
- Public media events to raise awareness about heat-health vulnerability

## During Extreme Heat Season (Mar-Jun)

- More frequent meetings & preparation
- Weekly meeting of Steering Committee members
- Community, NGO groups meet weekly & contact Steering Committee Liaison

## During Heat Wave

- Steering Committee members meet daily
- Media outreach & communications to the public
- Municipal Departments heat-reduction interventions

## After Extreme Heat Season (Jul-Sep)

- Collection and analysis of data on heat-related illness and mortality
- Evaluations of HAP - what worked well, what didn't
- Discuss climate change scenarios, multiple emergencies, resources needed

# Health outcomes of the Heat Action Plan

## – Did HAP help reduce mortality?

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Measuring the impact of the heat action plan is primarily dependent on the mortality reduction achieved as a result of the plan

Difficult – as data for mortality comes from very few heat wave events in the past decade.

Our current knowledge of mortality temperature relationships comes from the 2010 heat wave from one city - Ahmedabad

**2010 summer used as a base for calculating the impact of the HAP**

# Method for calculating mortality decline

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Temperature-mortality relationship calculated using data from 2010.

This temp-mortality relation of 2010 applied to 2014 heat wave temperatures to predict mortalities in 2014.

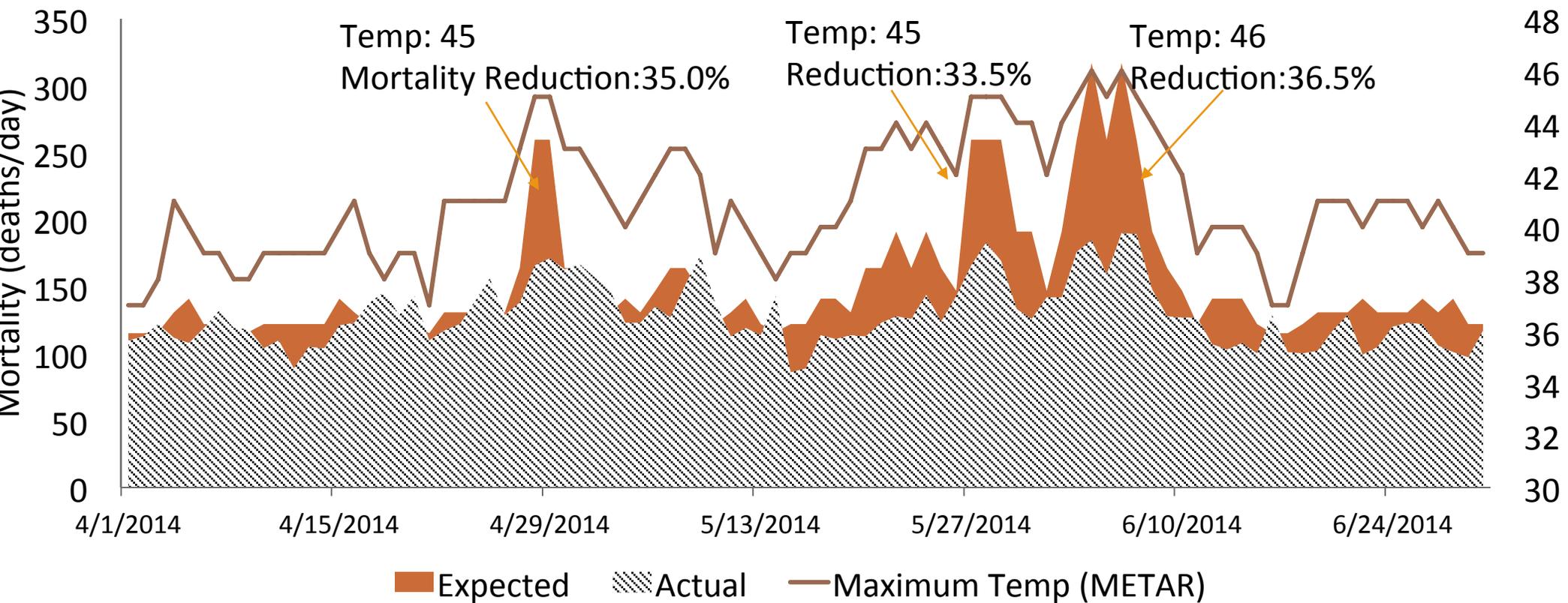
Compared against actual mortality data from the same source ( death registration for AMC) for 2014

**For heat stroke and deaths** – data was collected by the AMC from 5 of Ahmedabad's municipal/government hospitals – VS Hospital, LG Hospital, Sola, Sardar Patel Hospital and Civil Hospital.

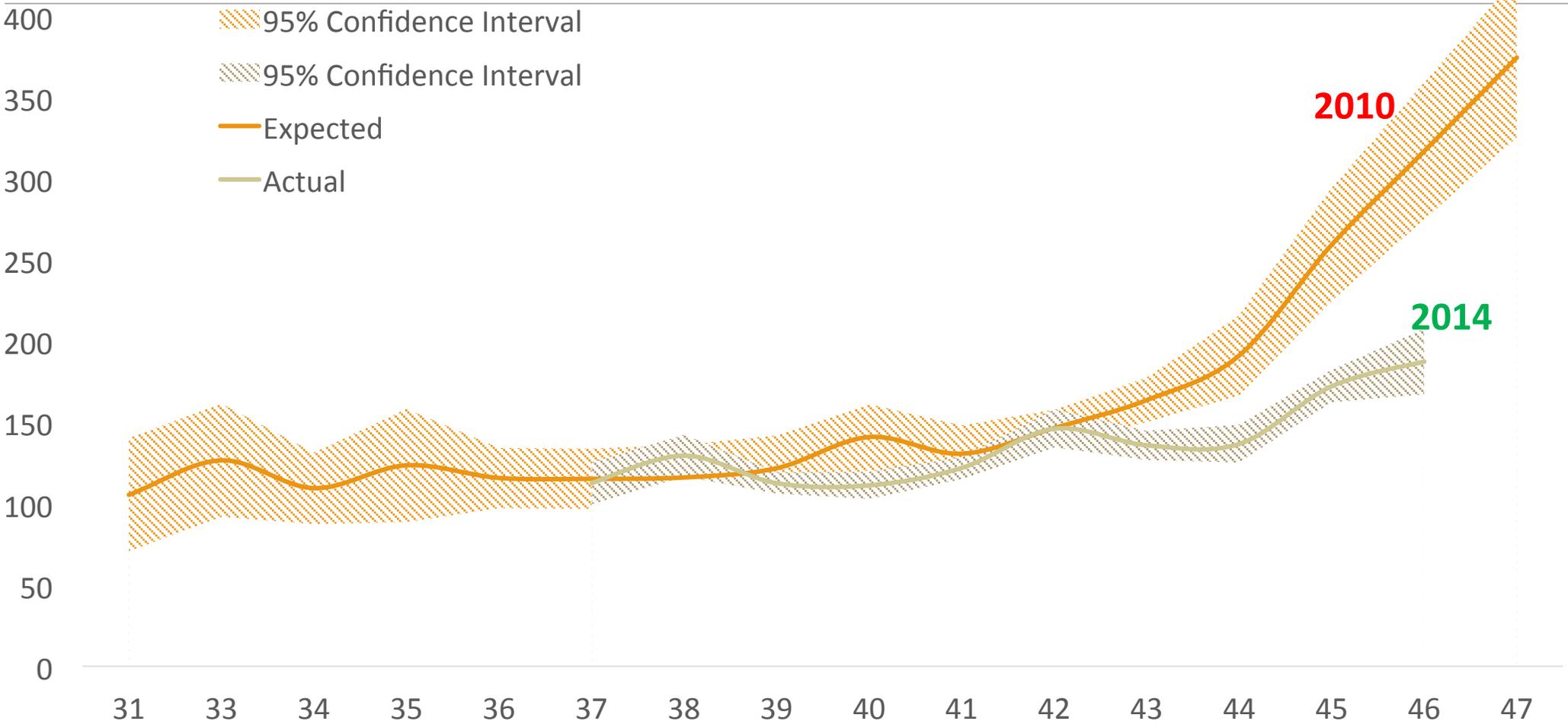
# Summer of 2014 (April-June) – temperature & mortality

## Expected deaths (13,896) Vs. Actual deaths (11,697)

**Lives saved = 2,199 [351-4,048] ( 95% CI)**



# Mortality Temperature Relationship: Actual of 2014 (Post HAP) as compared to pre-HAP years ( 2010)

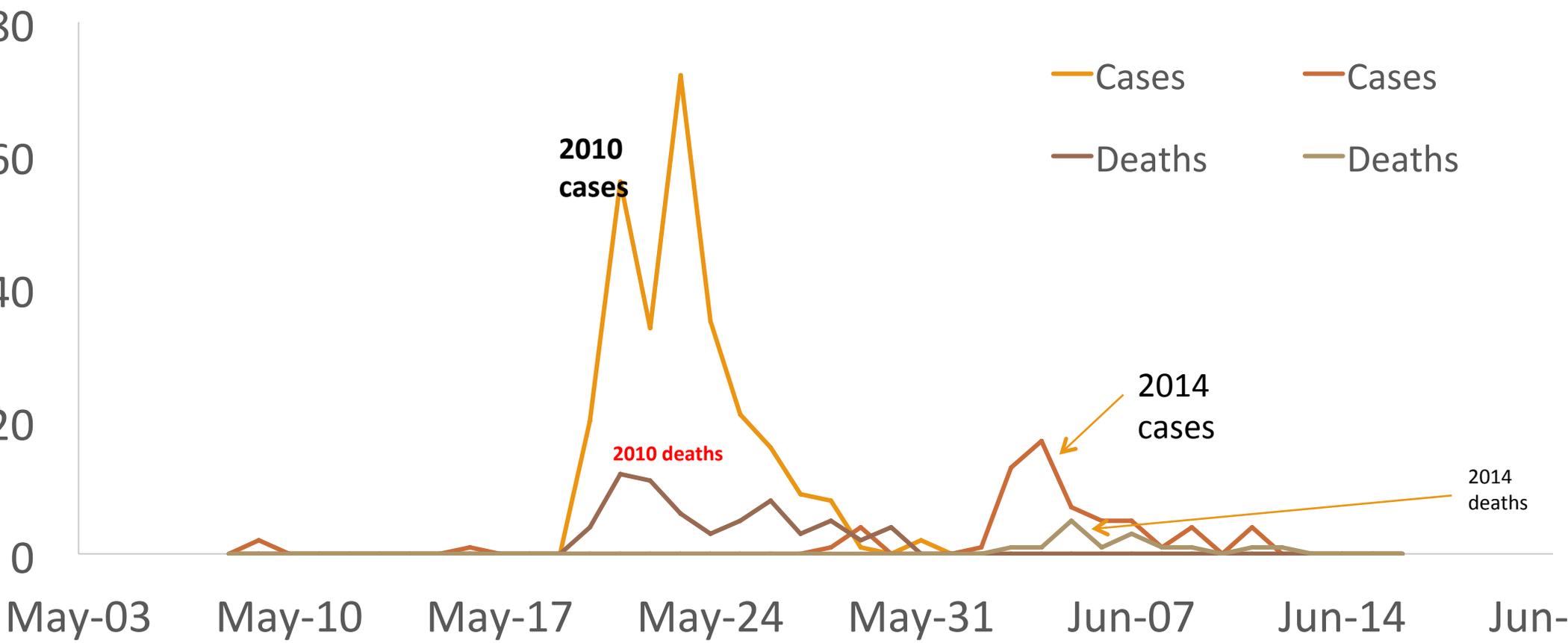


# Heat Wave 2014: Hospital Case reports

	2010 (temp 47)	2014 (temp 46)	Crude reduction (%)
Total heat stroke mortality *	65	15	76.19%
Total heat stroke cases*	274	63	76.28%

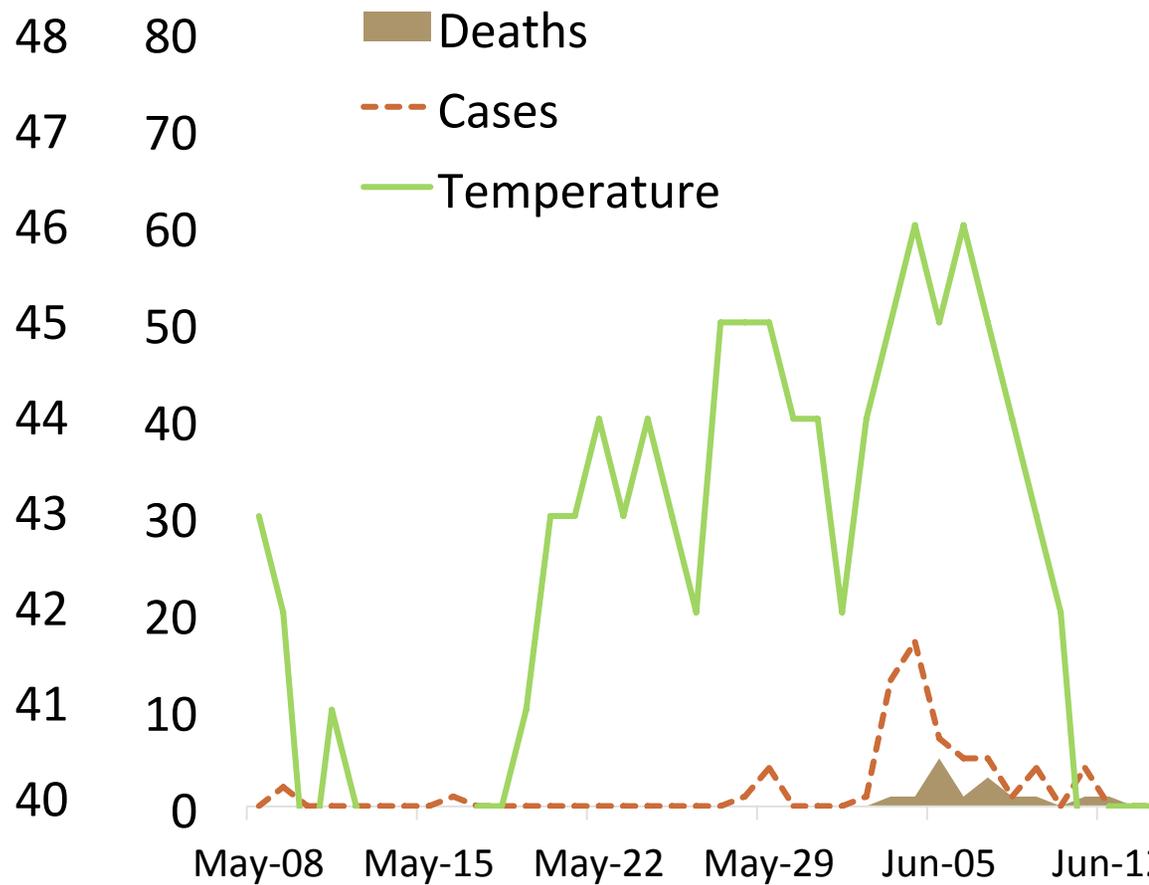
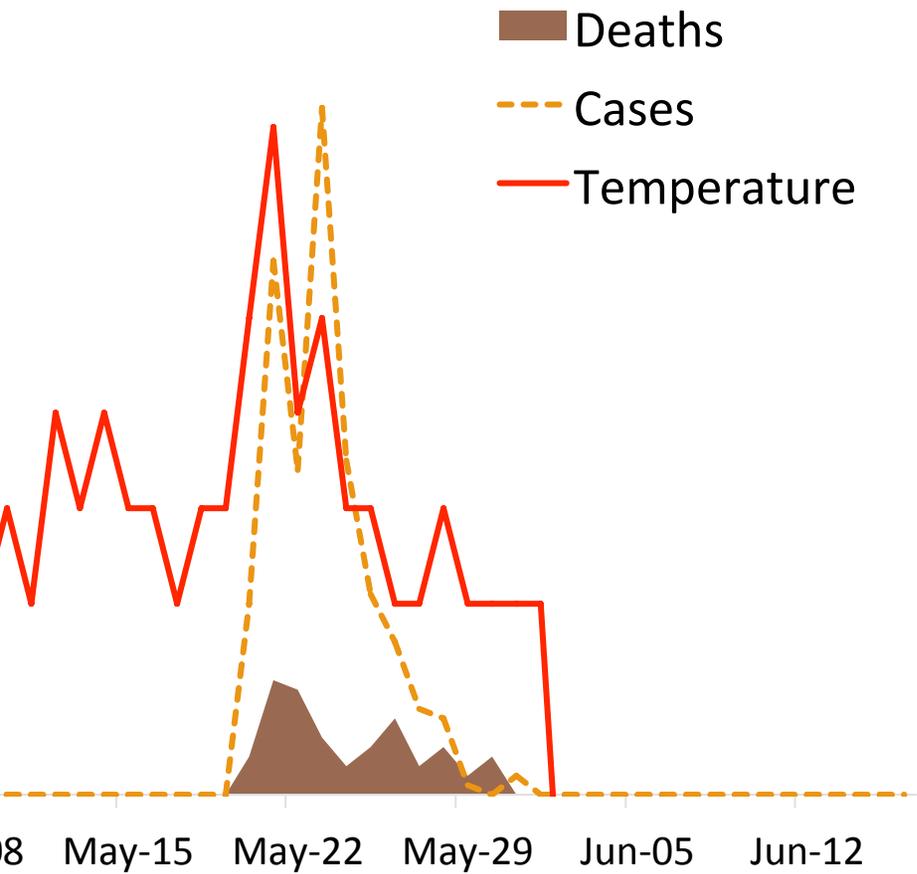
Reported from 5 of Ahmedabad's municipal hospitals – VS Hospital, LG Hospital, Sola civil hospital, Sardar Patel and Civil Hospital Asarwa.

# Reported number of heat stroke Case and deaths: 2010 and 2014



# Comparing temperature, heat stroke cases and death

## 2010 2014



# Ahmedabad Traffic Police Study by IIPHG



Lal-Darwaja # Ahmedabad  
18<sup>th</sup> June 2015 09:30 am

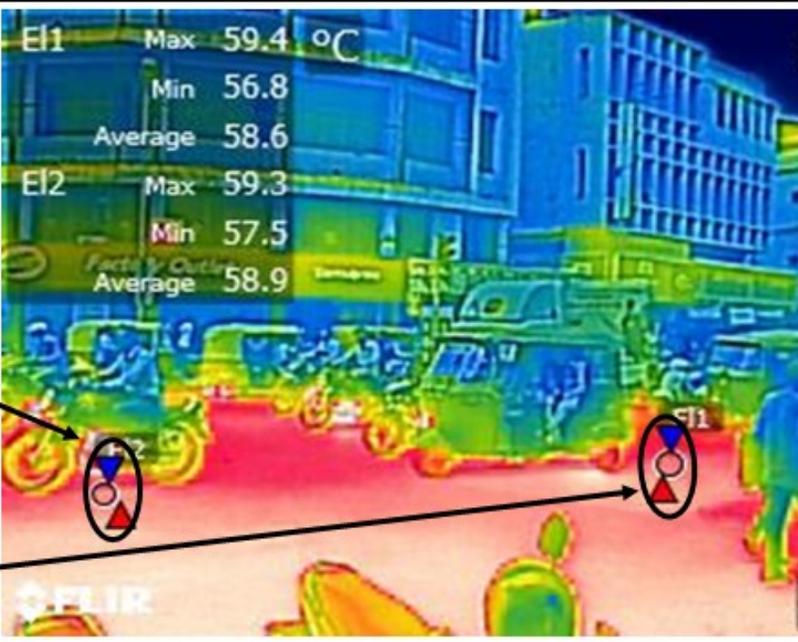


Temp.- 42.5°C

Temp.- 42.8°C



Lal-Darwaja # Ahmedabad  
18<sup>th</sup> June 2015 02:30 pm



Temp.- 59.3°C

Temp.- 59.8°C

# Lessons and future Plans:

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The success of this plan can be attributed to the strong partnership and communication between the various institutions and the leadership and commitment of Local government - AMC

Good prediction system for weather for 7 days in advance

Focus on doable action at local city level

Involve all stakeholders

Write a plan and disseminate – use media widely.

Monitor progress and evaluate using morbidity and mortality data

Use rigorous scientific methods and publish the results

**We plan to help other cities and states make HAPs. And make adaptation to heat waves part of the national dialogue on climate change.**

# Helping develop HAPs in other cities

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**Nagpur and other 7 cities in central India.**

**Orissa state in east**

**Hydrabad and Telangana state in south**

**Discussions with Health dept, NDMA and IMD for national replication**

# Journal Publications

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Kim Knowlton, Anjali Jaiswal, Gulrez Shah Azhar, Dileep Mavalankar, Amruta Nori-Sarma, Ajit Rajiva, Priya Dutta et al. (2014) **Ahmedabad, Gujarat: Development and Implementation of South Asia's First Heat-Health Action Plan**. *Int. J. Environ. Res. Public Health*, 11: 3473-3492. (IF: 2.197) [http://www.mdpi.com/journal/ijerph/special\\_issues/weather-risks](http://www.mdpi.com/journal/ijerph/special_issues/weather-risks)

Gulrez Shah Azhar, Dileep Mavalankar, Amruta Nori-Sarma, Ajit Rajiva, Priya Dutta et al. (2014) **Heat-related mortality in India: Excess all-cause mortality associated with the 2010 Ahmedabad heat wave**. *PLOS ONE* 9(3): 1-8. (IF: 3.73) <http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0091831>

Khyati Kakkad, Michelle L. Barzaga, Sylvan Wallenstein, Gulrez Shah Azhar, and Perry E. Sheffield (2014) **Neonates in Ahmedabad, India, during the 2010 Heat Wave: A Climate Change Adaptation Study**. *Journal of Environmental and Public Health*, Article ID 946875, 1:8. <http://www.hindawi.com/journals/jeph/2014/946875/>

Tran, Kathy V., Gulrez S. Azhar, Rajesh Nair, Kim Knowlton, Anjali Jaiswal, Perry Sheffield, Dileep Mavalankar, and Jeremy Hess (2013). **A cross-sectional, randomized cluster sample survey of household vulnerability to extreme heat among slum dwellers in Ahmedabad, India.** *International journal of environmental research and public health* 10, no. 6: 2515-2543. <http://www.mdpi.com/1660-4601/10/6/2515>

# City leadership releasing the 2015 HAP

