Health-Based Thresholds for Early Warning Systems

Venue: Vigyan Bhavan

Date: 13th February 2024

Thresholds for Heat Health Warning Systems
Challenges and Opportunities

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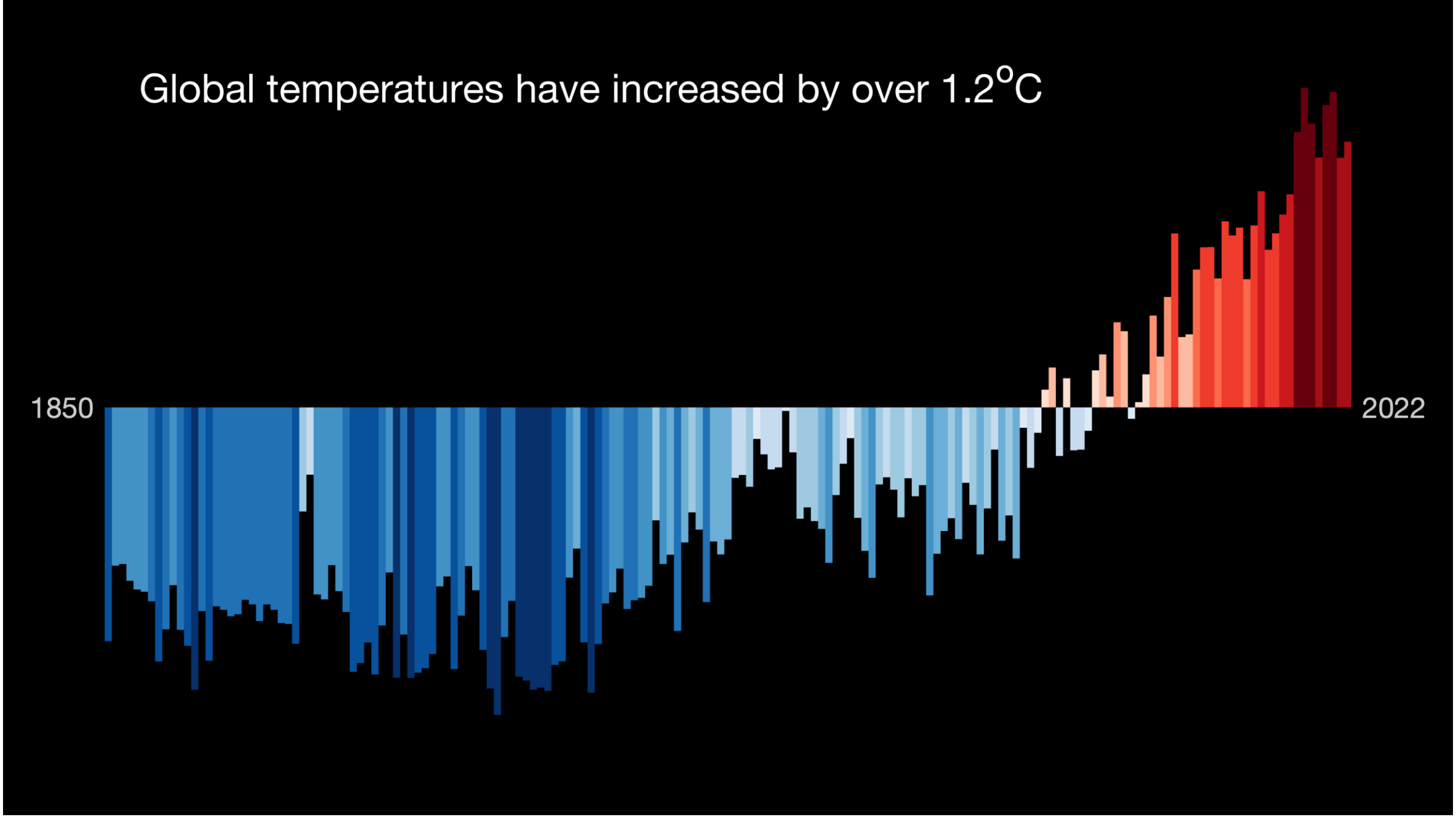
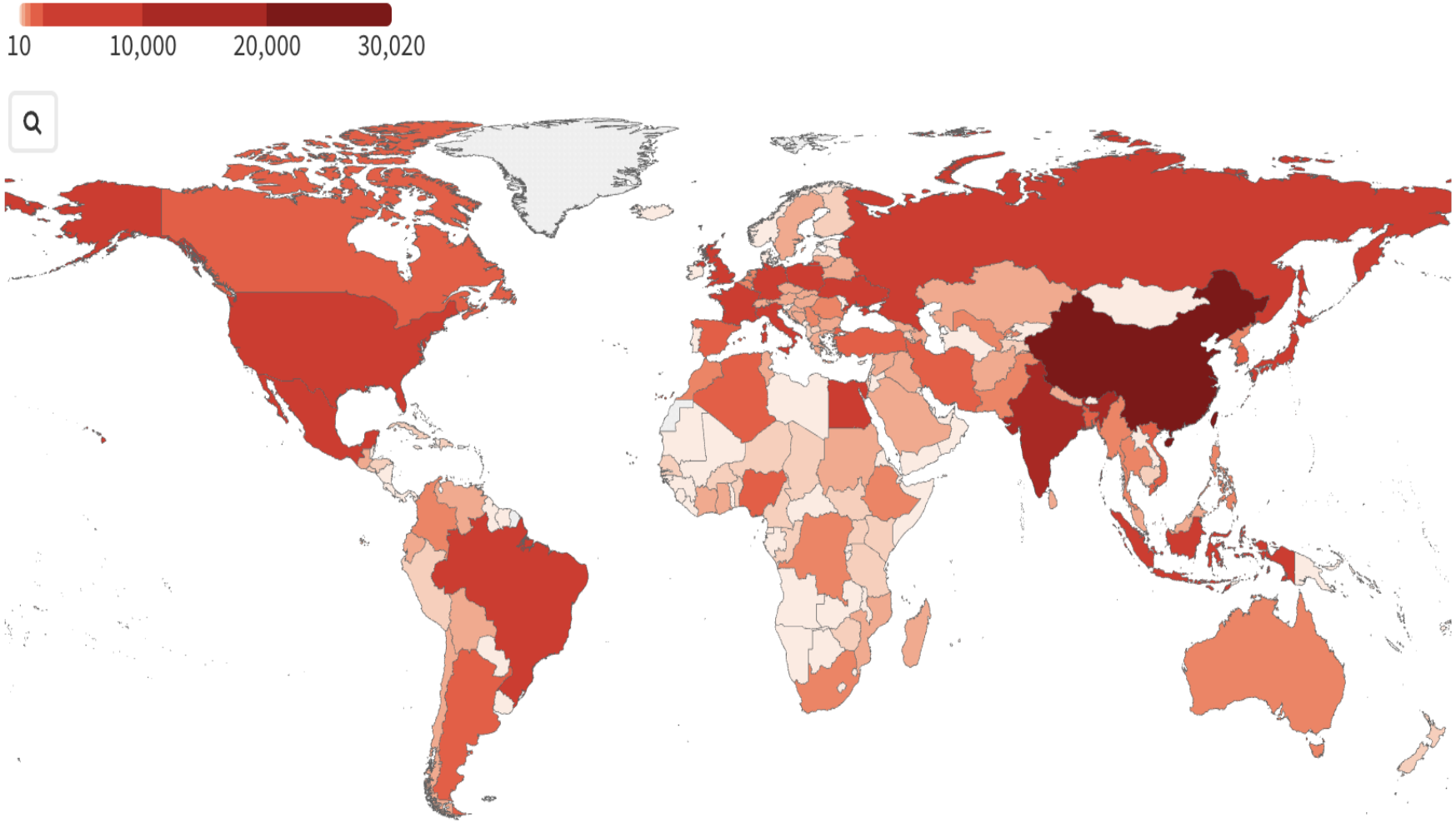


Source: https://showyourstripes.info/



Heat-related mortality for vulnerable people (adults over 65 years age) **increased by approximately 68% between 2000-2004 and 2017-2021.**

Image Source: Lancet

Projection: Heat-related mortality at Mid-Century

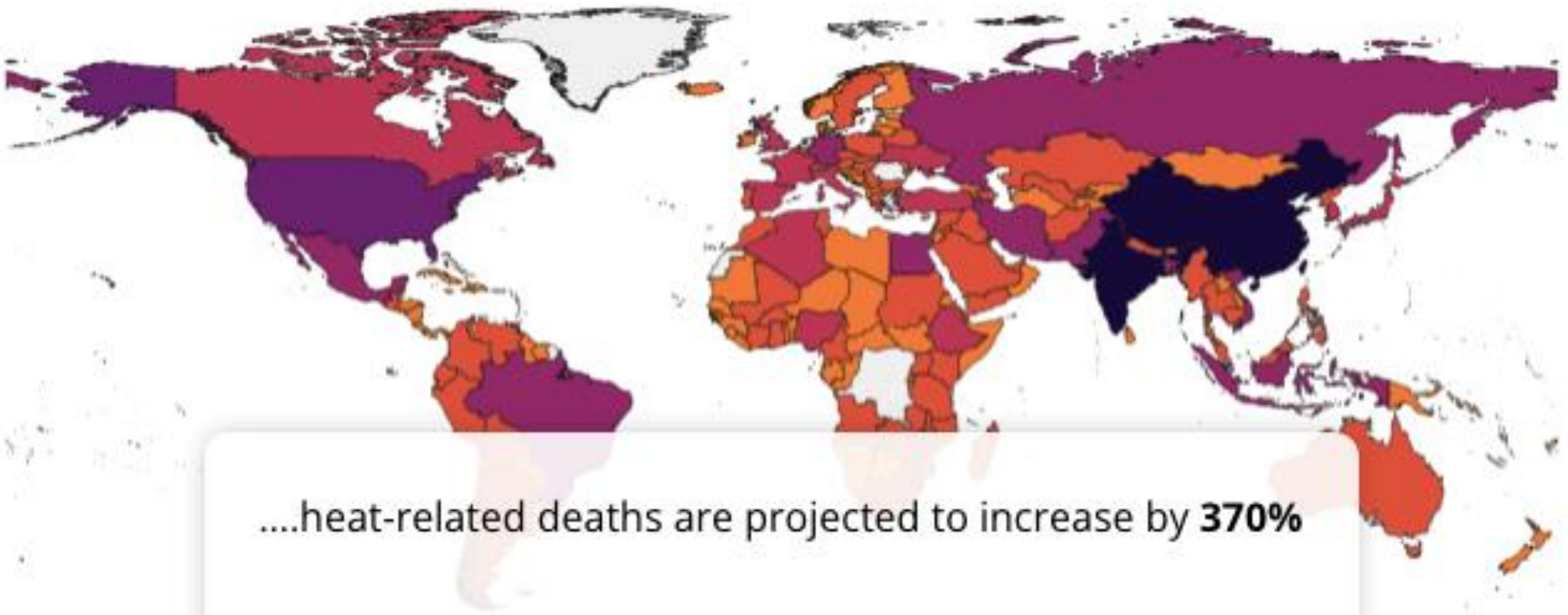
Estimated absolute change in health-related deaths in adults over age 65 at mid-century (2041 - 2060), with 1995-2004 baseline. Results are shown for two emissions scenarios.

Emissions scenarios are denoted by estimated increase in average global temperature by 2100

Emissions Scenarios: **Under 2° Scenario** | **3.7° Scenario**

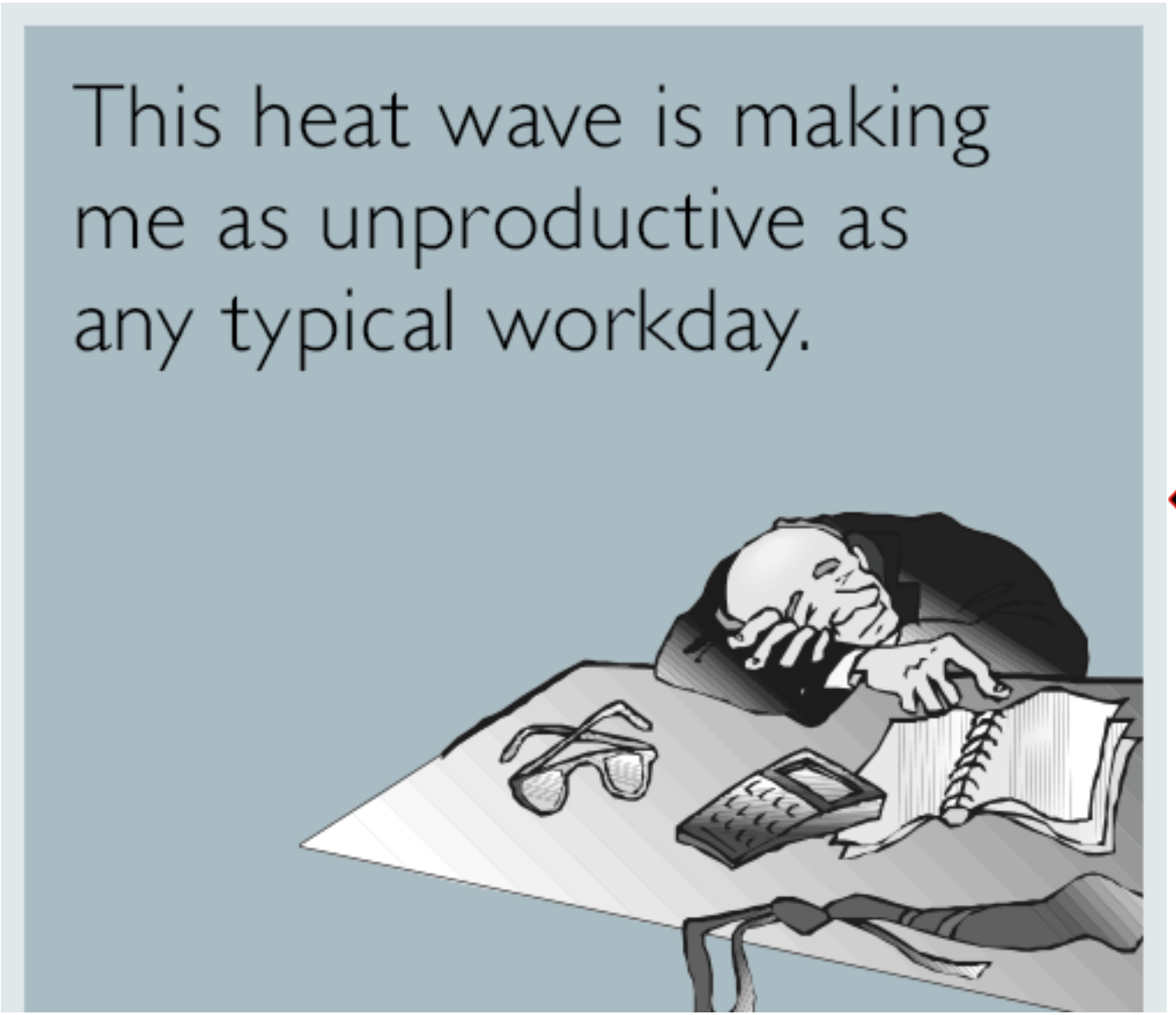
Heat-related Mortality:

-3800 50,000 100,000 200,000



....heat-related deaths are projected to increase by **370%**

Source: Lancet



False Positive Forecast...!?!

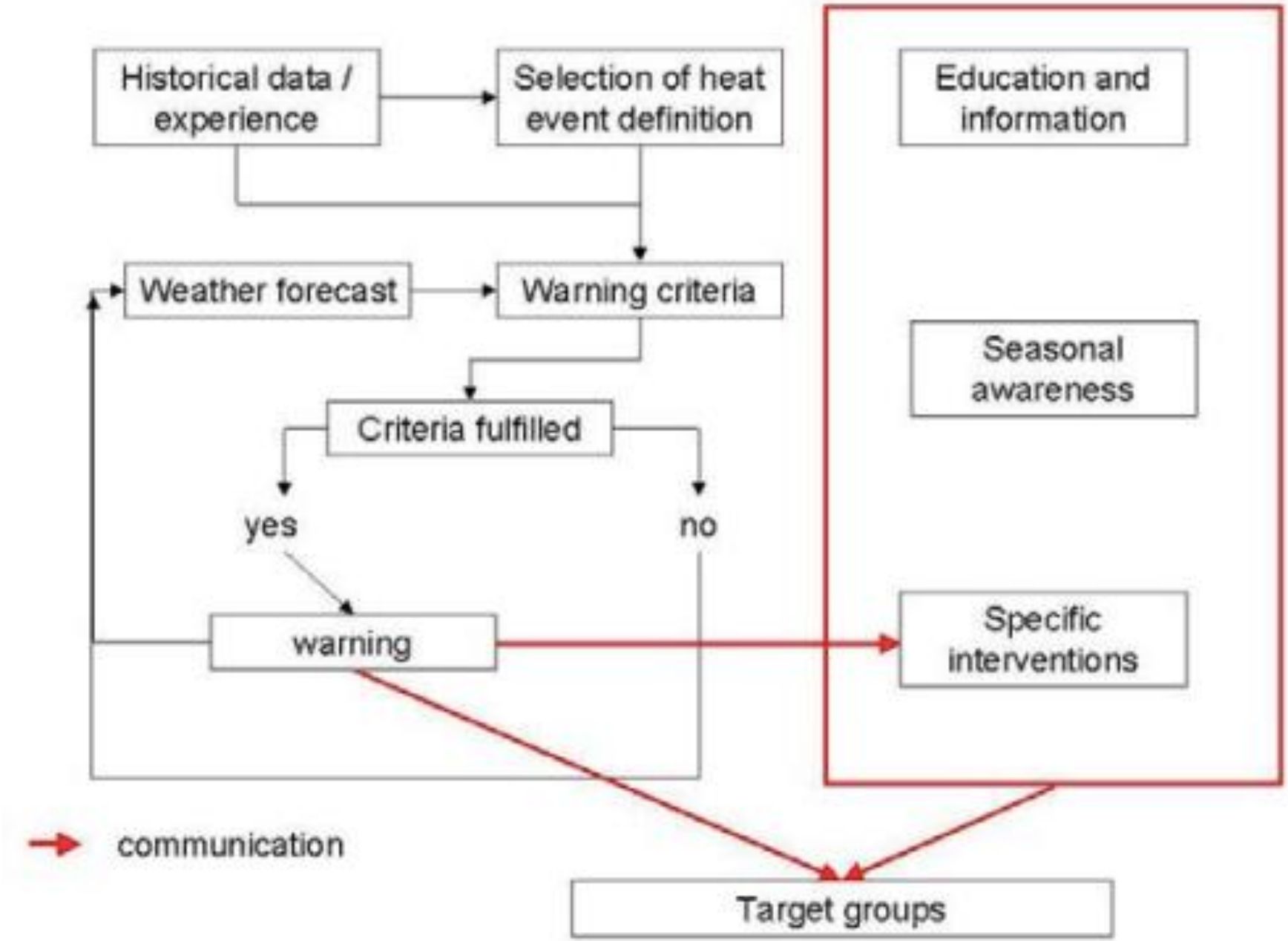
In this session:

- **Importance of temperature thresholds in Heat Health Warning System (HHWS)**
- **Available options & best in use methods of estimating threshold**
- **Constraints in policy decision making – “decision-maker’s dilemma”**

Heat Health Warning System (HHWS)

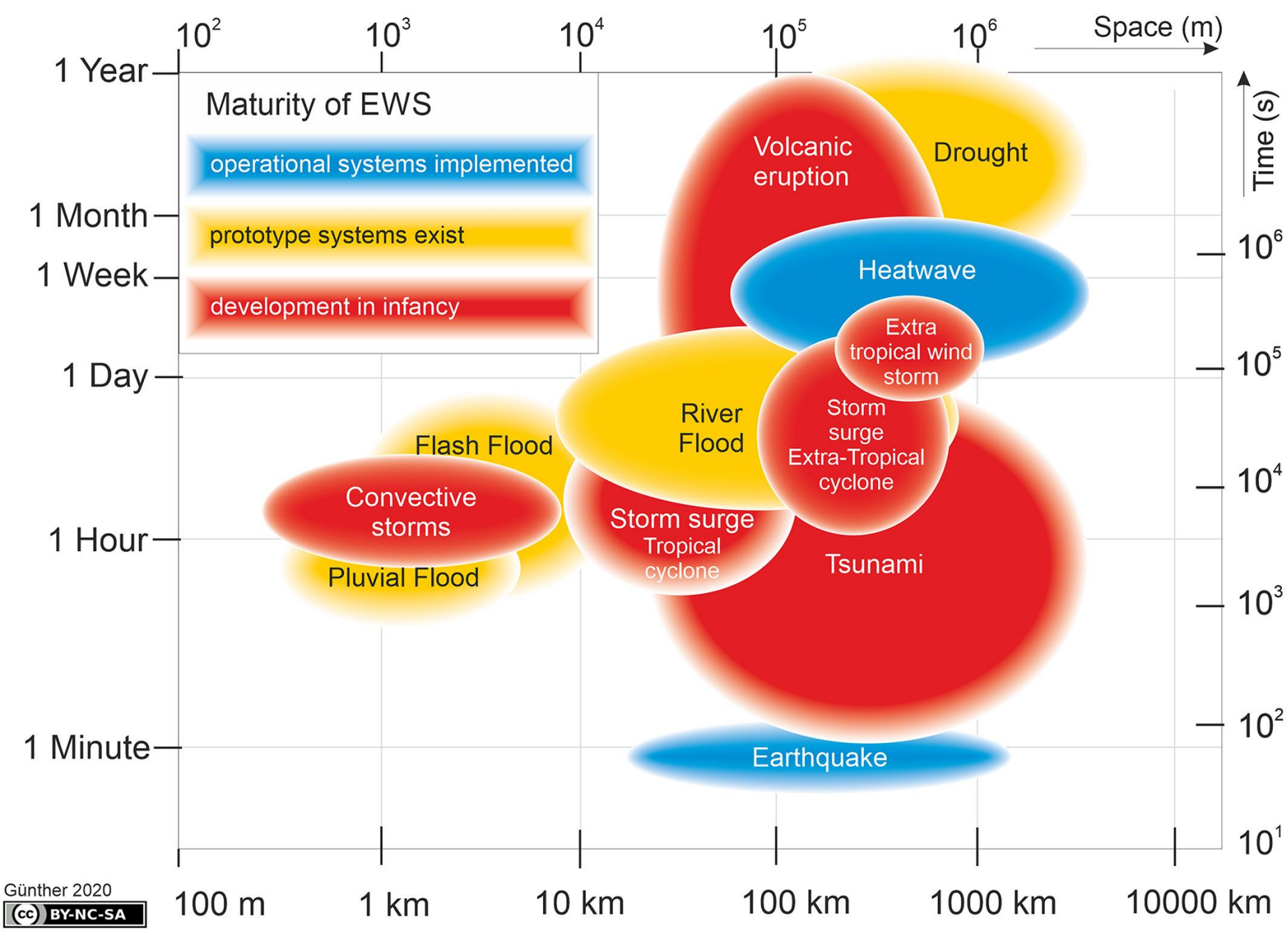
"The broad purpose of an HHWS, which is an integral part of a wider Heat-Health Action Plan (HHAP), is to provide ***meteorological and/or climate-prediction-based information (forecast)*** *on the likelihood of forthcoming hot weather that* ***may have an effect (impact)*** *on health. This information is used to alert decision-makers and the general public to impending dangerous hot weather and for the implementation of a range of actions, as encapsulated in an HHAP, designed to reduce the effects of hot-weather extremes on health."*

Source: McGregor, Glenn R., et al. *Heatwaves and health: guidance on warning-system development*. WMOP, 2015.



Flow diagram demonstrating the operation of a typical Heat–Health Warning System within a wider Heat–Health Action Plan

Source: McGregor, Glenn R., et al. *Heatwaves and health: guidance on warning-system development*. WMOP, 2015.



Günther 2020

Maturity of impact forecasting systems

Source: https://doi.org/10.1029/2020RG000704

Available options & best in use methods of estimating threshold for HHWS

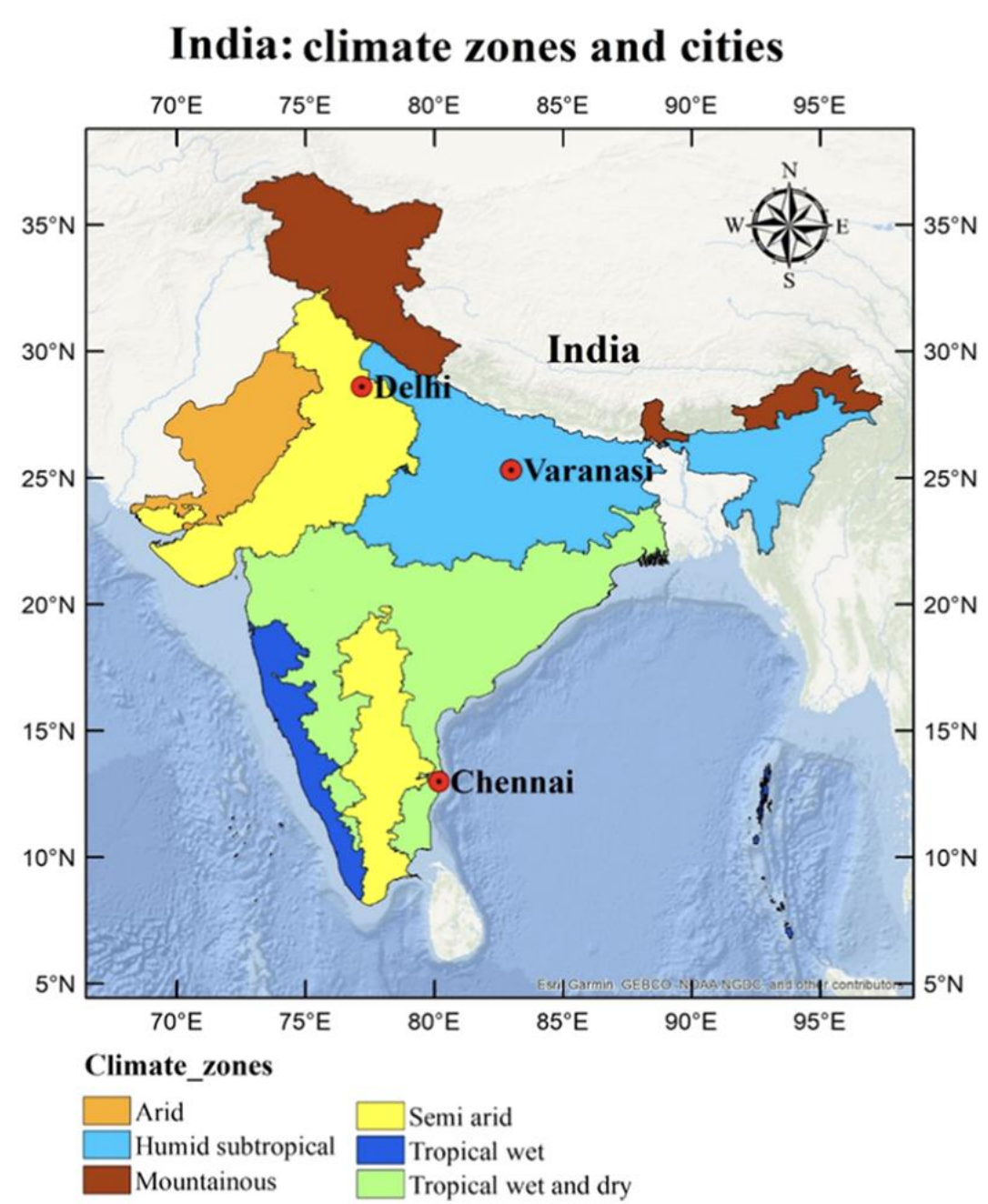
What is Heat Stress?

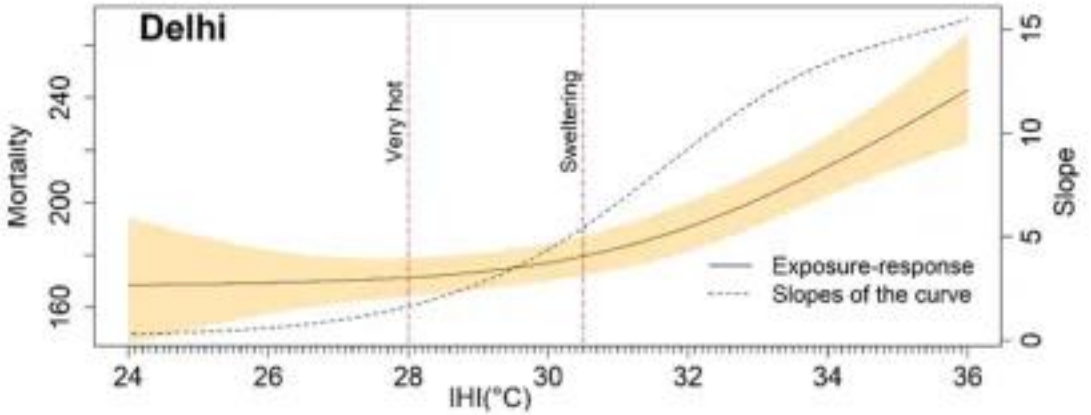
"A situation where **too much heat** is absorbed by a person..."

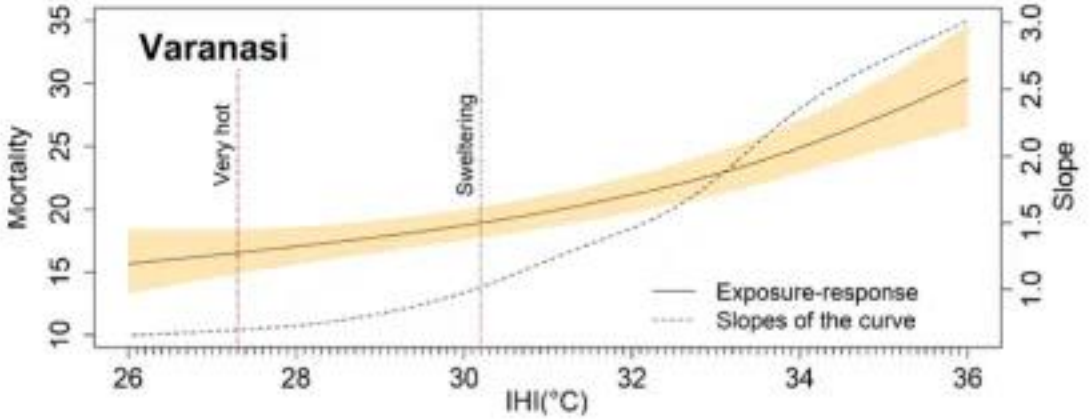
How much heat is too much heat? Is that what we call heat wave?

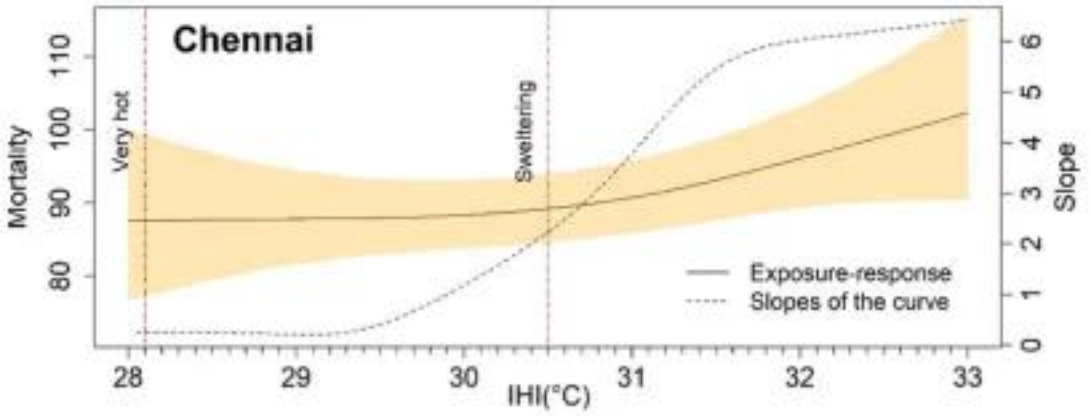
What is Heat Wave?

- "A prolonged period of abnormally hot weather…"
- No universal definition/threshold
- Local phenomenon









Source:
https://doi.org/10.1021/acs.est.3c05218

Europe Heat wave

Around 18000 people di

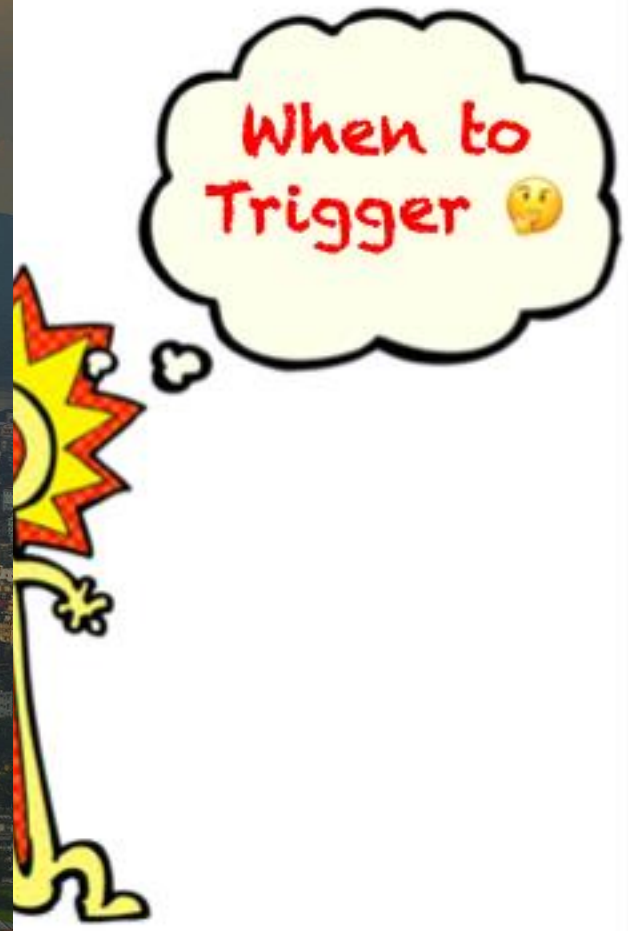
IMD Heat Wave

Definition starts at 40°C

Why is threshold

- No universal definition of h
- Spatial phenomenon – Reg
- Temporal phenomenon – C
- No one size fit for all – effe
- Threshold is a practical dec
- Many methods - simple an
  - **Statistical Simple and Biom**

Local thresholds are **arly warning system**



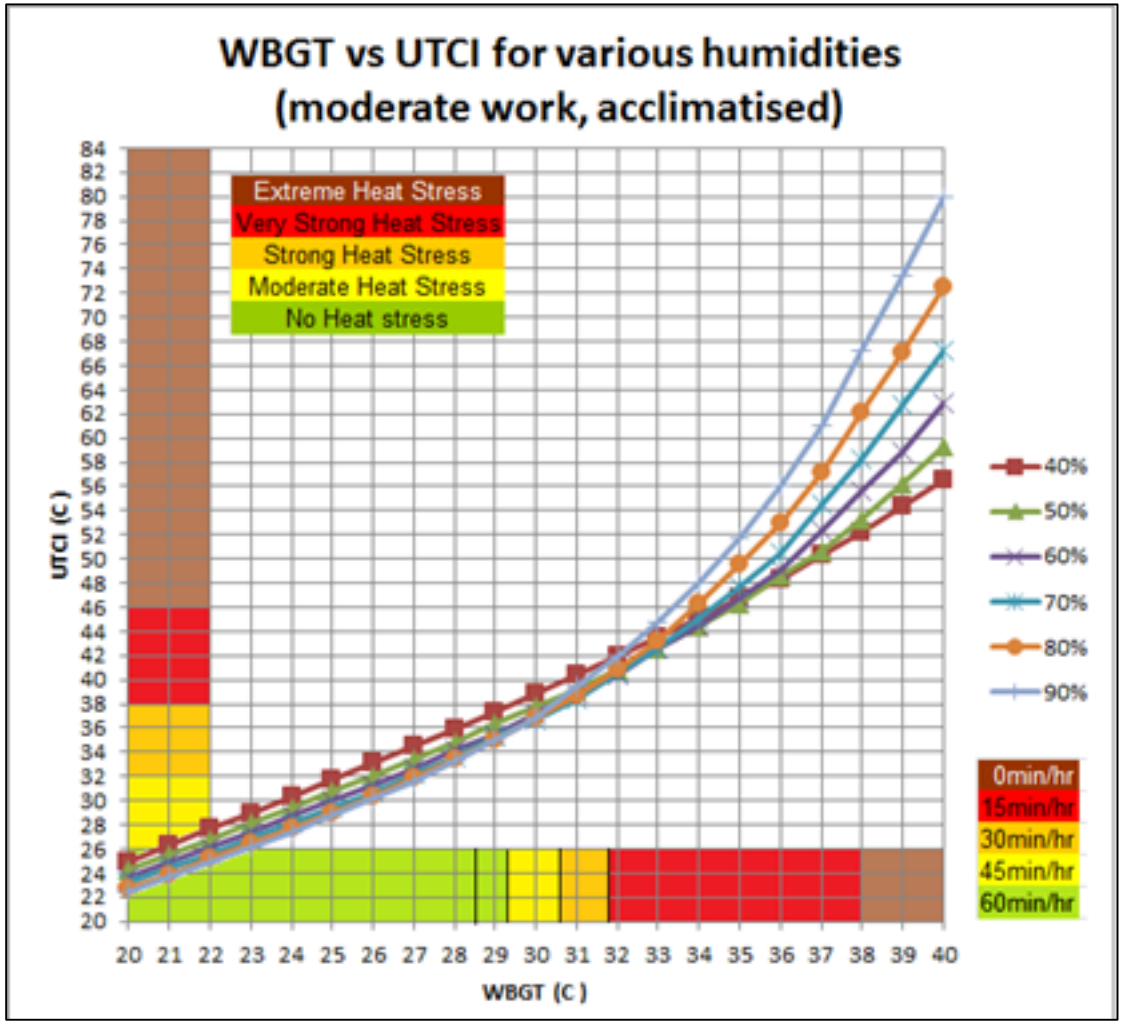
What is threshold for heat?

A Thermal variable at which the risk of adverse health outcome increases substantially.

What are thermal variables?

- Tmax
- Tmin
- Tmean
- HI
- PT/AT
- Humidex
- WBGT
- UTCI

Tmax – most widely used variable



Country	Threshold	Thresholds based on historical mortality	Excess mortality forecast	Duration of heat event included	Seasonality or adaptation included	Regionally variable thresholds	Human expertise
Australia (Queensland)	*AT*			2 days		✓	✓
Belarus	*T*						
Belgium	*Tmax/Tmin*/Ozone			3 days			
Canada (Toronto region)	Airmass	✓	✓	✓	✓	✓	✓
Canada (Montreal)	*Tmax/Tmin*			✓			
Canada (all others)	*Humidex*			✓			
China (Hong Kong)	*NET*						
China (Shanghai)	Airmass	✓	✓	✓	✓		✓
France	*Tmax/Tmin*	✓		3 days		✓	✓
Germany	*PT*			2 days	✓	✓	✓
Greece	*Tmax*			✓			
Hungary (Budapest only)	*Tmean*	✓					
Italy	Airmass/*Tapp*	✓	✓	✓	✓	✓	
Republic of Korea	Airmass	✓	✓	✓	✓	✓	✓
Republic of Korea (Seoul*)	Airmass	✓	✓	✓	✓	✓	✓
Latvia	*Tmax*			✓			
Netherlands	*Tmax*			✓			
Poland	*Tmax/Tmin*						
Portugal	*Tmax*	✓	✓	✓		✓	✓
Romania	*ITU*						
Slovenia	Forecaster						✓
Spain	*Tmax/Tmin*	✓				✓	✓
Switzerland	*HI*						
United Kingdom (England and Wales)	*Tmax/Tmin*			✓		✓	
USA (synoptic**)	Airmass	✓	✓	✓	✓	✓	✓
USA (all others)	*HI*			2 days		✓	✓

where:

T	temperature	*HI*	Heat Index
AT or Tapp	apparent temperature	*PT*	perceived temperature
Tmax	maximum temperature	*ET*	equivalent temperature
Tmin	minimum temperature	*ITU*	Temperature Humidity Index
Tmean	mean temperature		

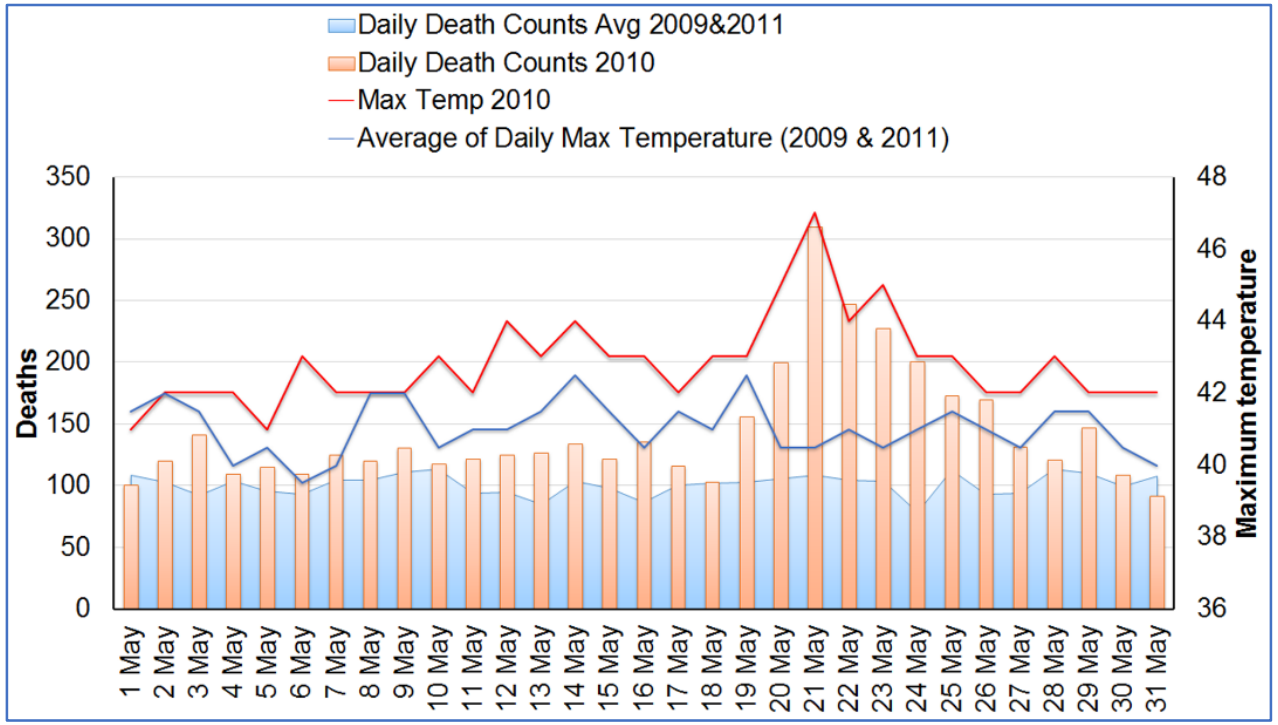
* *Seoul has been subdivided into five regions based upon unique climatology and health response. This represents the only subdivided urban HHWS currently in operation.*

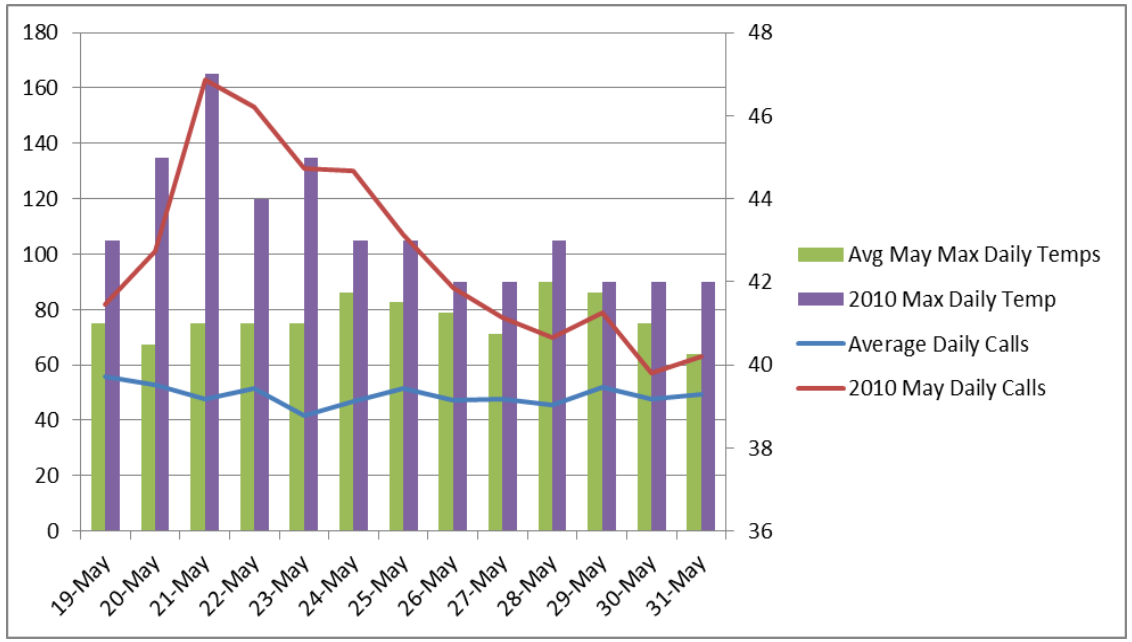
** *Seattle (Washington), Portland (Oregon), San Francisco and San Jose (California), Phoenix and Yuma (Arizona), Dallas and Houston (Texas), Minneapolis (Minnesota), Chicago (Illinois), St. Louis (Missouri), Dayton, Columbus and Cincinnati (Ohio), Philadelphia (Pennsylvania), Washington (DC), Baltimore (Maryland), New Orleans, Monroe, Shreveport, and Lake Charles (Louisiana), Little Rock and Fort Smith (Arkansas), Memphis (Tennessee), Jackson and Meridian (Mississippi)*

Source: McGregor, Glenn R., et al. *Heatwaves and health: guidance on warning-system development*. WMOP, 2015.

Which health impact (outcome) variable can be used?

- All cause daily mortality count data
- Cause specific daily mortality count data
- Hospital daily admissions count data
- Emergency ambulance (108) services daily call count data





All cause daily mortality – most widely used variable

Epidemiological Study Method

✓Time series analysis

Things to consider:

- Confounders like Air Pollution, Outbreaks
- Acute or Average Effect (Prolong Duration)
- Lag Effect

Who can do it?

Epidemiologist / Biostatistician in

- State or District Medical Colleges
- Public health institutions
- Any other domain expert or institute with interest

Percentile Based

✓90^{th}, 95^{th}, 99^{th} (Seasonal / Monthly)

Who can do it?

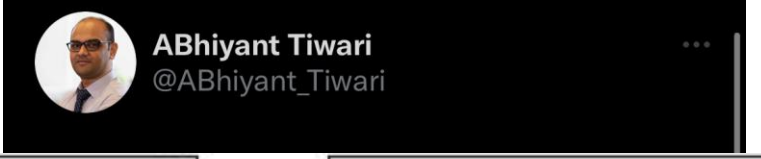
- IMD has already done for several cities/districts

"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."

– *2015 WMO WHO Heatwaves and Health: Guidance on Warning-System Development.*

Epidemiological Study Method

✓Time series analysis



Contents lists available at ScienceDirect

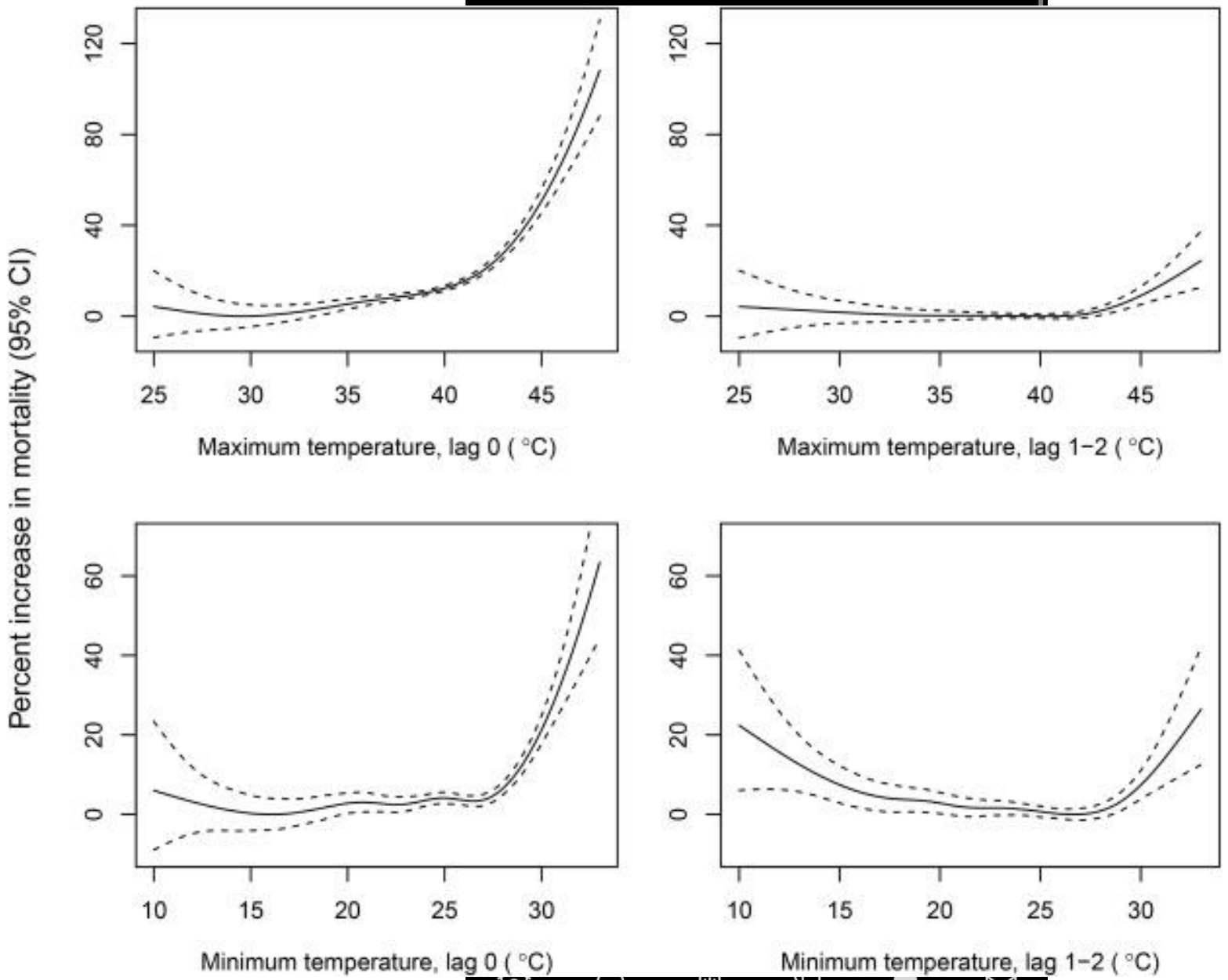
Environmental Research

journal homepage: www.elsevier.com/locate/envres

Assessing mortality risk attributable to high ambient temperatures in Ahmedabad, 1987 to 2017

Yaguang Wei [a,*], Abhiyant Suresh Tiwari [a], Longxiang Li [a], Bhavin Solanki [b], Jayanta Sarkar [c], Dileep Mavalankar [d], Joel Schwartz [a]

[a] Department of Environmental Health, Harvard T.H. Chan School of Public Health, Boston, MA, USA
[b] Health Department, Ahmedabad Municipal Corporation, Ahmedabad, Gujarat, India
[c] India Meteorological Department, Ahmedabad, Gujarat, India
[d] Indian Institute of Public Health, Gandhinagar, Gandhinagar, Gujarat, India

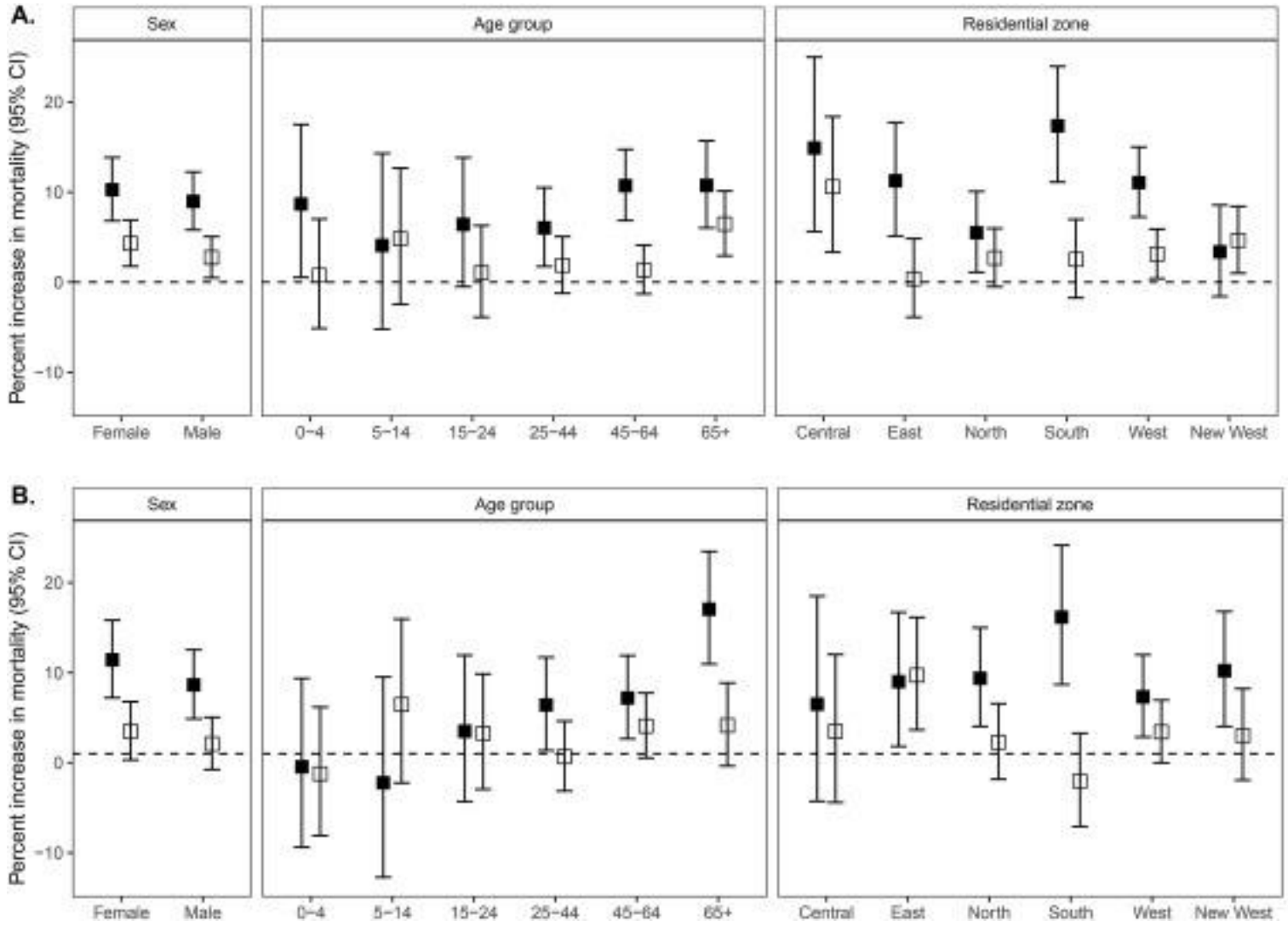


Source:
https://doi.org/10.1016/j.envres.2021.111232

Epidemiological Study Method

✓Time series analysis

Vulnerabilities

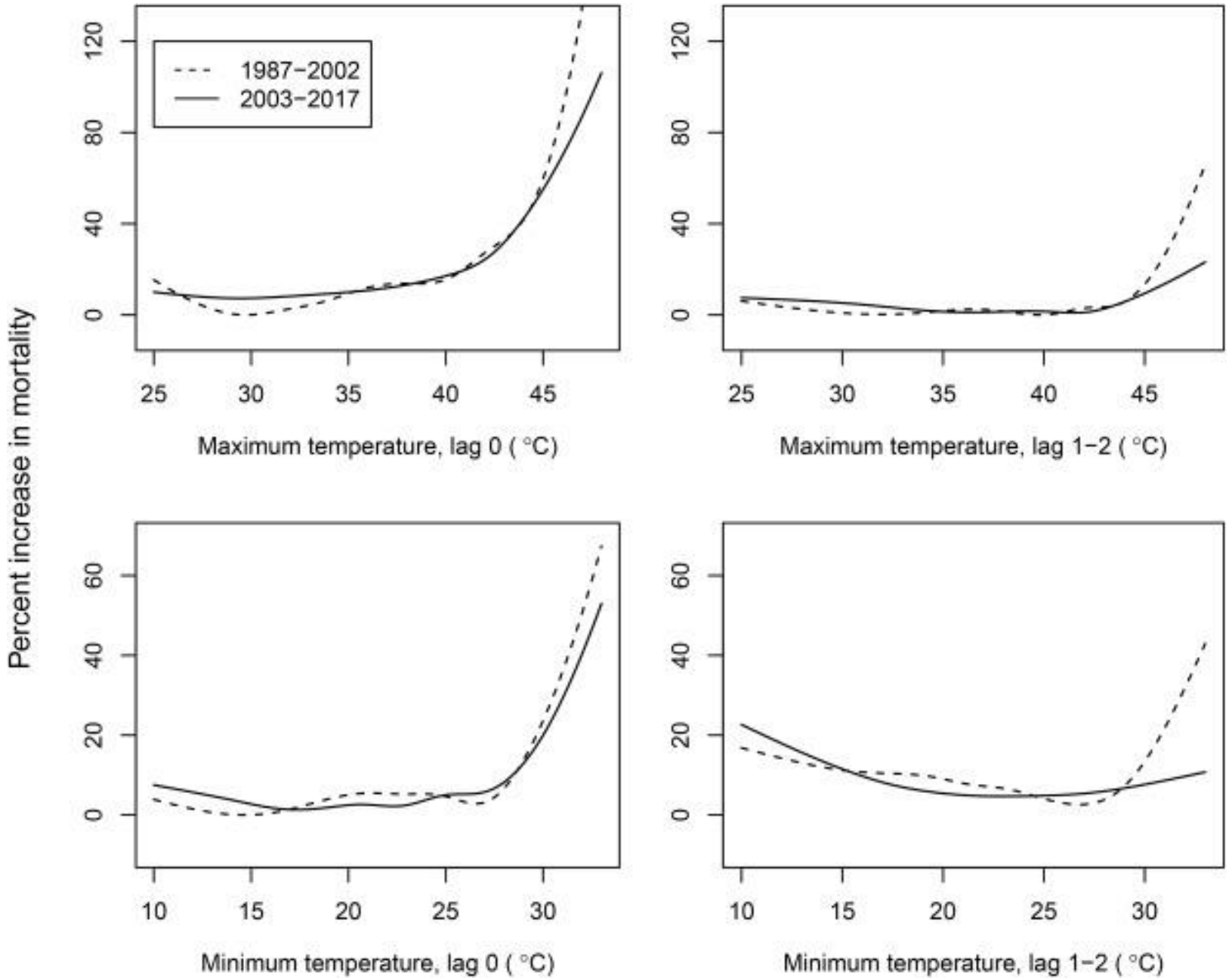


Source:
https://doi.org/10.1016/j.envres.2021.111232

Epidemiological Study Method

✓Time series analysis

Adaptation..!!



Source:
https://doi.org/10.1016/j.envres.2021.111232

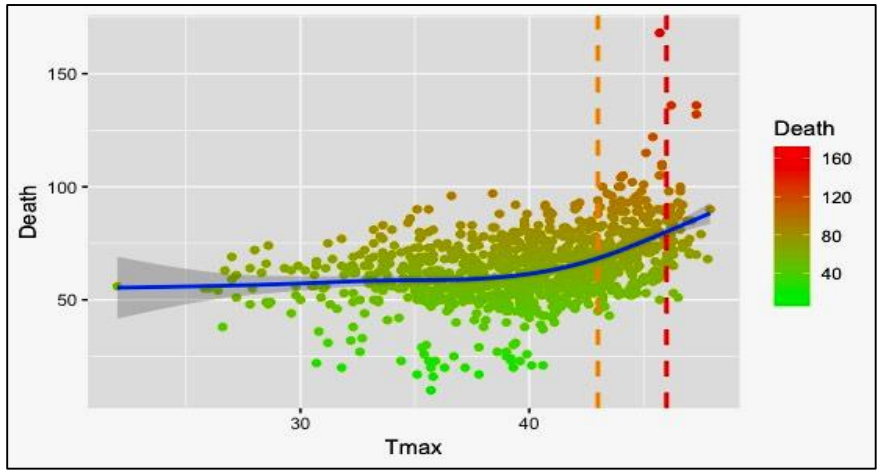
What should be the statutory unit for threshold estimation ?

Megacity / City / UA / District / Village?

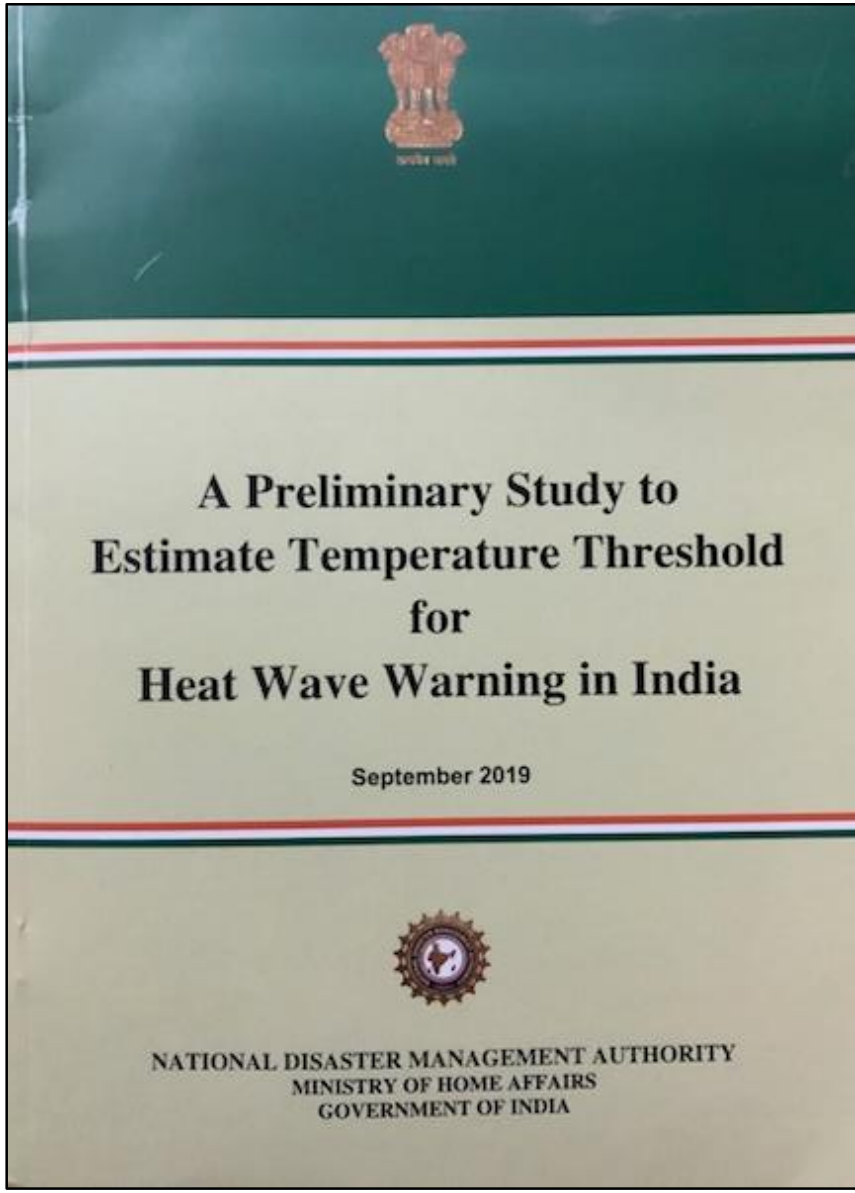
- Ambient temperature doesn’t vary much geographically within district unless major differences in contour/weather system
- Threshold estimation should be done at Megacity (**Population > 1 Million**) and District levels.
- They should be the operational units for HAP development and implementation.
- States should develop state specific guidelines using national guidelines issued by NDMA and cities/districts should prepare and implement their local heat action plans with locally determined thresholds for early warning.

Thresholds Determination for Heat Early Warning

Preliminary study to estimate temperature threshold for heat wave warning in India done for 103 cities across 19 States and UTs done by NDMA, IMD & IIPHG in September 2019.



S.N.	City	Month	Yellow	Orange alert (Heat alert day)	Red alert (Extreme heat alert day)
1	AKOLA CITY	April	43.0	43.8	44.7
		May	44.3	45.0	46.3
		June	43.1	44.1	45.0
2	CHIKALTHANA (AURANGABAD)	April	41.2	41.4	41.7
		May	41.7	42.2	42.8
		June	41.4	41.6	41.9
3	NADED	April	42.2	43.0	43.6
		May	43.2	43.7	44.5
		June	42.6	43.0	44.0
4	NASHIK	April	38.9	39.5	40.4
		May	38.7	39.3	40.1
		June	34.3	35.3	37.1
5	PARBHANI	April	43.0	43.5	44.0
		May	43.9	44.5	45.5
		June	43.4	43.8	44.1
6	PUNE	April	39.4	40.0	40.8
		May	39.0	39.7	40.4
		June	34.2	35.8	37.3
7	SOLAPUR	April	42.3	42.6	43.2
		May	42.6	43.1	43.7
		June	40.7	41.3	41.8
8	YEOTMAL	April	42.0	42.5	43.6
		May	43.5	44.0	45.0
		June	39.0	40.1	42.8



PS: Can be further strengthened and extended to more cities / districts if data is made available

Constraints in policy decision making – "decision-maker's dilemma"

Which methodology to use??

Biostatistical Simple
OR
Biometeorological Complexed

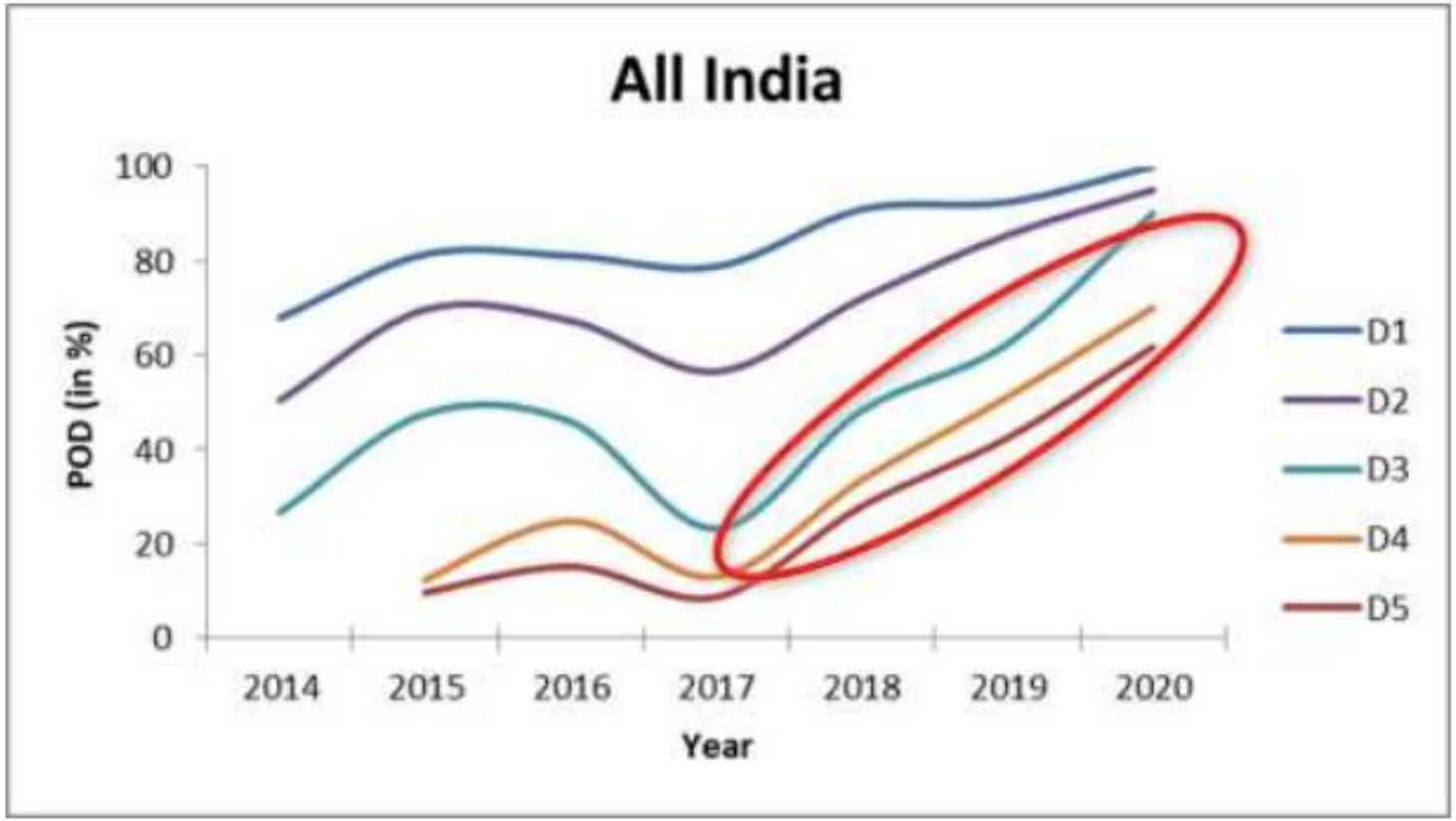
Which thermal variables to use??

- Tmax
- Tmin
- Tmean
- HI
- PT
- Humidex
- WBGT
- UTCI

Constraints in policy decision making – "decision-maker's dilemma"

Reliability of forecast?

Heat wave skill (Probability of Detection (PoD) during 2014 to 2020 is as follow:



There is significant improvement in Day 1 (D1) to Day 5 (D5) forecast warning in the recent years specifically for Day 3 (D3) to Day 5 (D5) warning. The accuracy of warning in term of PoD is more than 80% for D1 & D2.

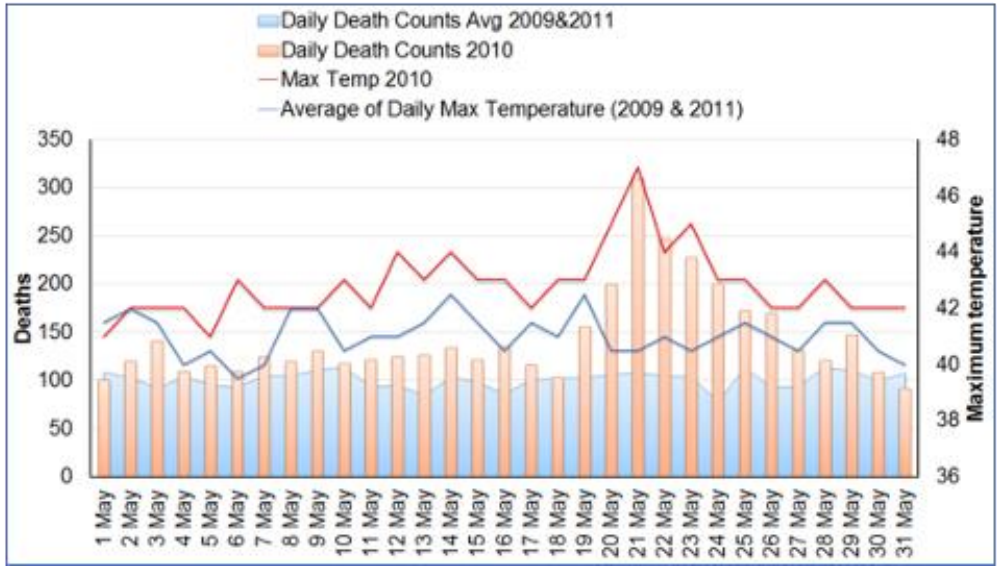
Source: IMD

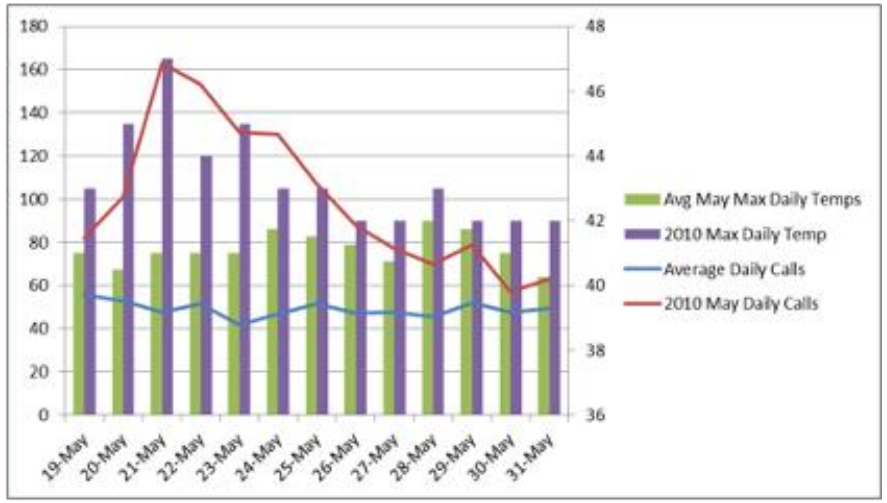
Constraints in policy decision making – "decision-maker's dilemma"

Which impact data to use??

Availability..!!!!

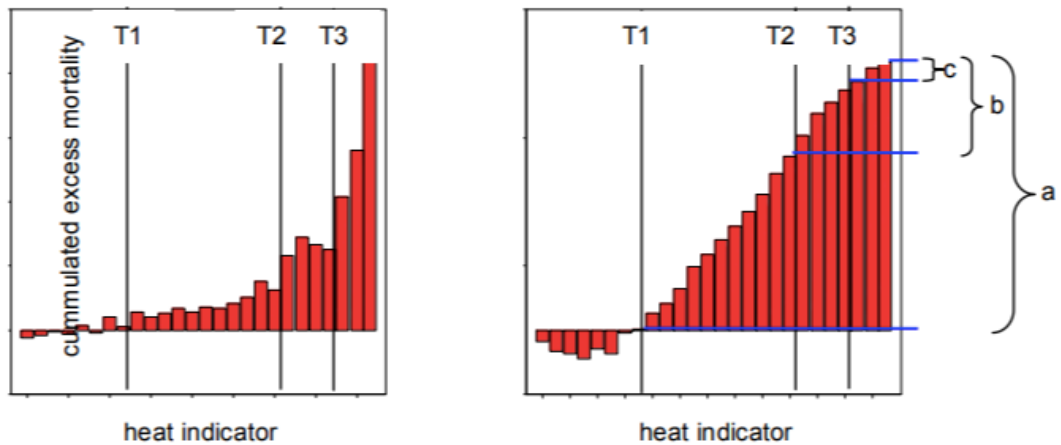
- All cause daily mortality count data
- Cause specific daily mortality count data
- Hospital daily admissions count data
- Emergency ambulance (108) services daily call count data





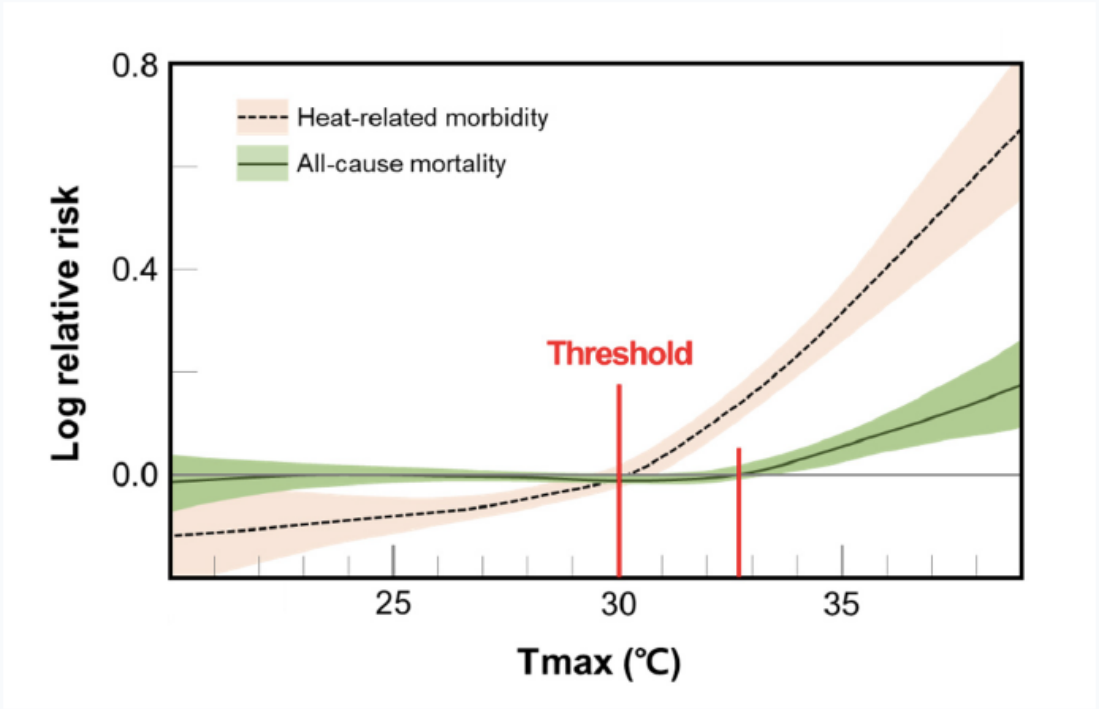
All cause daily mortality – most widely used variable

Where would you as a decision maker set threshold??



T 1 T 2 T 3

Where would you as a decision maker set the threshold??



30°C

33°C

Source: https://doi.org/10.3390/ijerph18052380

Countries with effective Early Warning Systems have

8 TIMES LOWER

mortality rates from disasters

Source: https://practicalaction.org/news-media/2023/02/07/at-cop27-the-climate-movement-finally-promotes-early-warning-systems/

And,

We all together must act now

to

Manage the Unavoidable (Adaptation)

And

Avoid the Unmanageable (Mitigation)

Before its too late…

We Need Better Communication for Better Change

Thanks

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