Global Best Practices for Management of Heat Waves and Lessons Learned

Paul B. English, PhD, MPH

Public Health Institute
CA Dept of Public Health
Paul.english@cdph.ca.gov

Training Workshop on Heat Wave Preparedness and Response

8-10 March, 2018

SAARC Disaster Management Centre

Gandhinagar, Gujarat

Outline

- Climate change and heat
- Heat wave impacts and response
- Severity of heat illness
- Measuring extreme heat
- Measuring heat morbidity and mortality
- Heat vulnerability assessments
- Heat/health warning systems, and other policy solutions
- Interaction of heat and air pollution on health
- Low cost sensors and new technologies to address air quality issues

Climate Change and Heat

- Heat Waves expected to increase in severity and frequency, last longer and occur earlier (IPCC)
- 2016 hottest year on record
- Nights warming

faster than days

- Effects on/of

Air pollution and

Wildfires

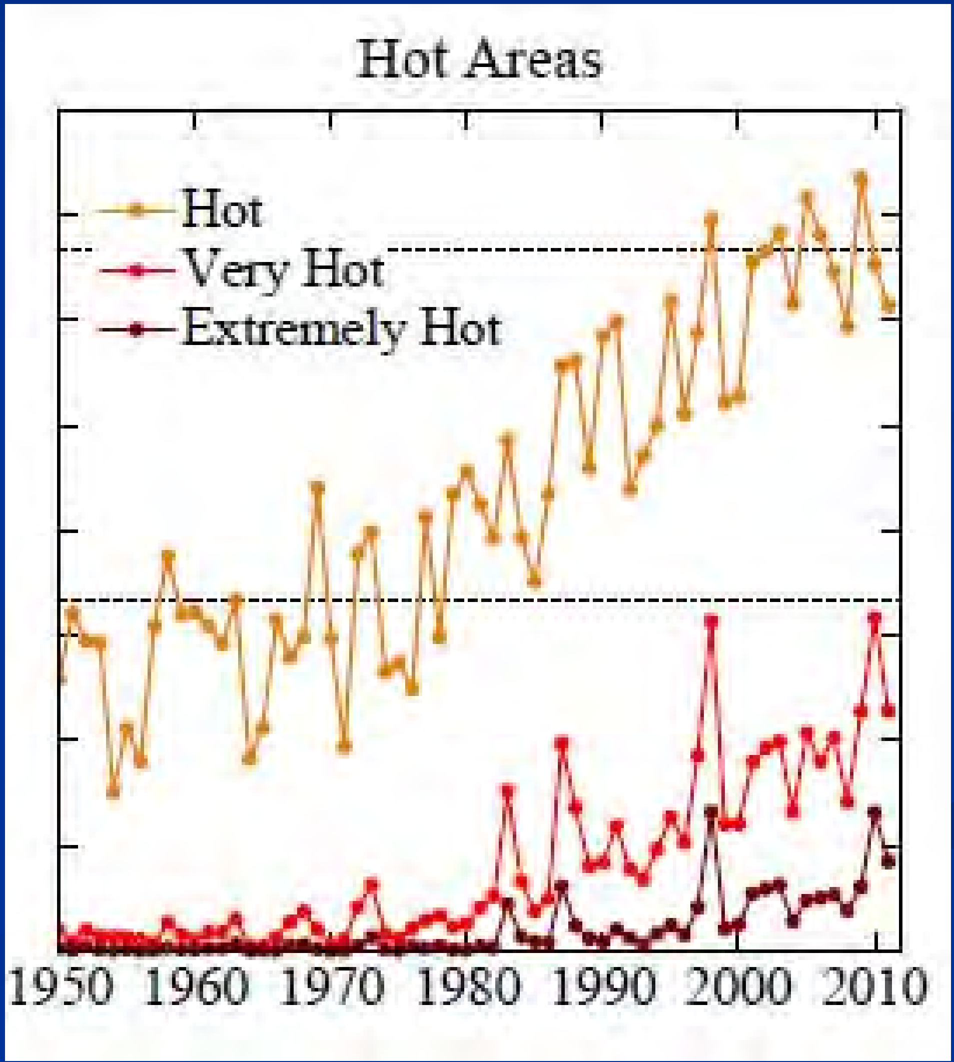
Extremely hot areas now cover 10% of earth's surface

July-Aug Temp Anomalies (summertime hot outliers)

% Area Of World surface

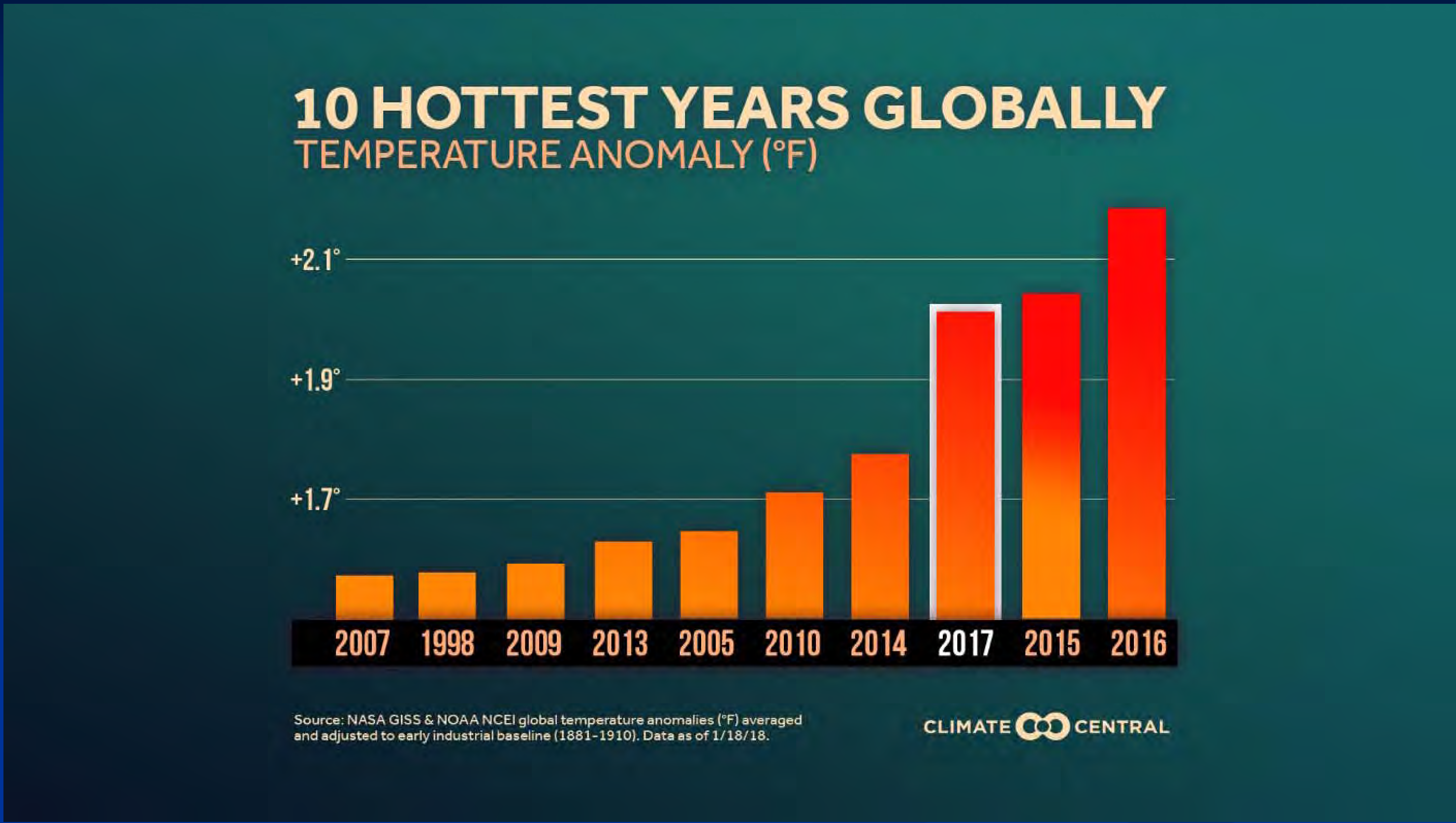
80

10



hot (σ > 0.43 from average), very hot (σ > 2), and extremely hot (σ > 3)

(Hansen, et al 2011)

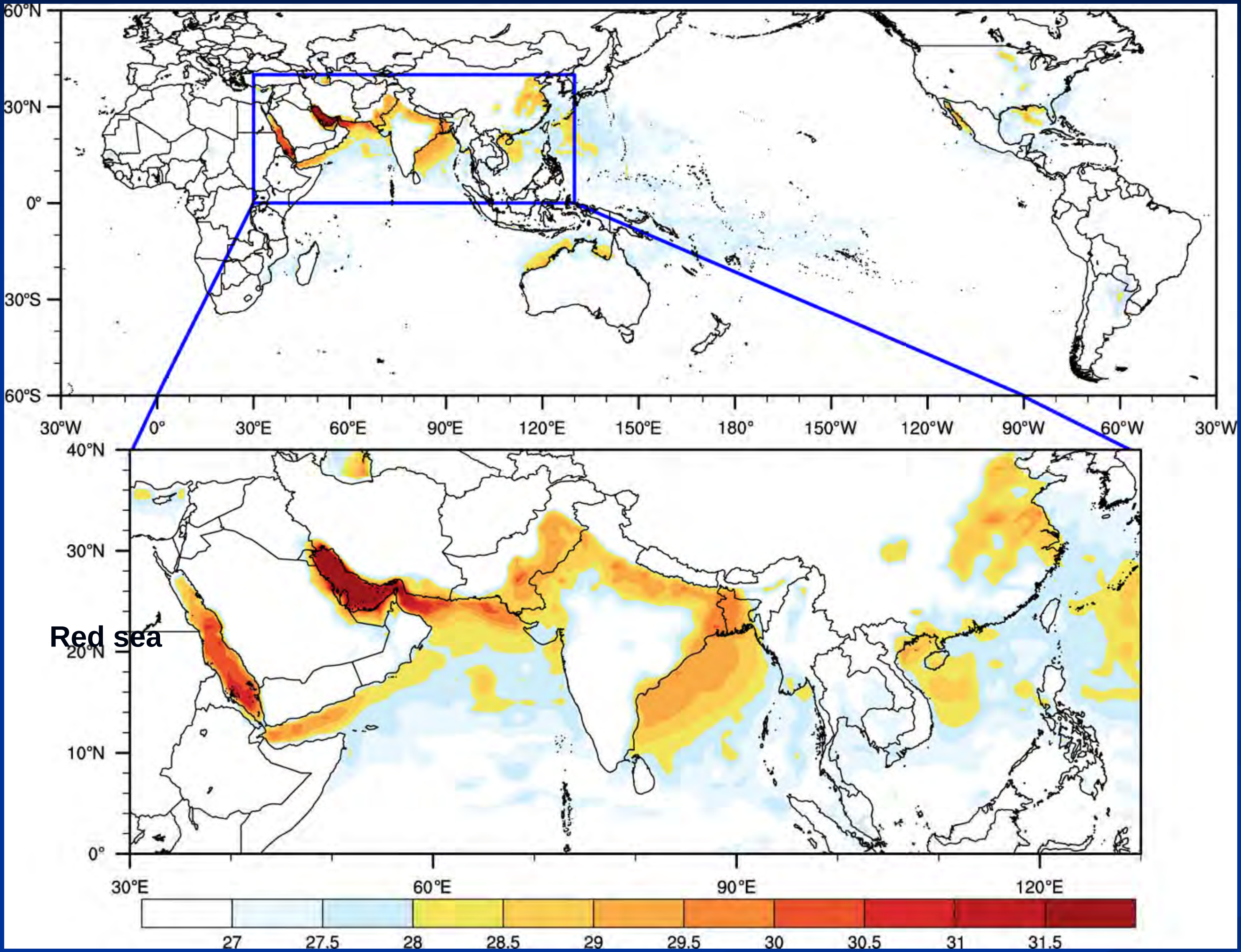


10 HOTTEST YEARS GLOBALLY
TEMPERATURE ANOMALY (°F)
+2.1°
+1.9°
+1.7°
2007
1998
2009
2013
2005
2010
2014
2017
2015
2016
Source: NASA GISS & NOAA NCEI global temperature anomalies (°F) averaged and adjusted to early industrial baseline (1881-1910). Data as of 1/18/18.
CLIMATE CENTRAL

“Extremes of wet bulb temperature of 35C (upper limit of human survivability) expected by the late 21st century

Wet bulb temp = air temp + humidity + radiation

Fig. 1 Spatial distribution of highest daily maximum wet-bulb temperature, TWmax (°C), in modern record (1979–2015).

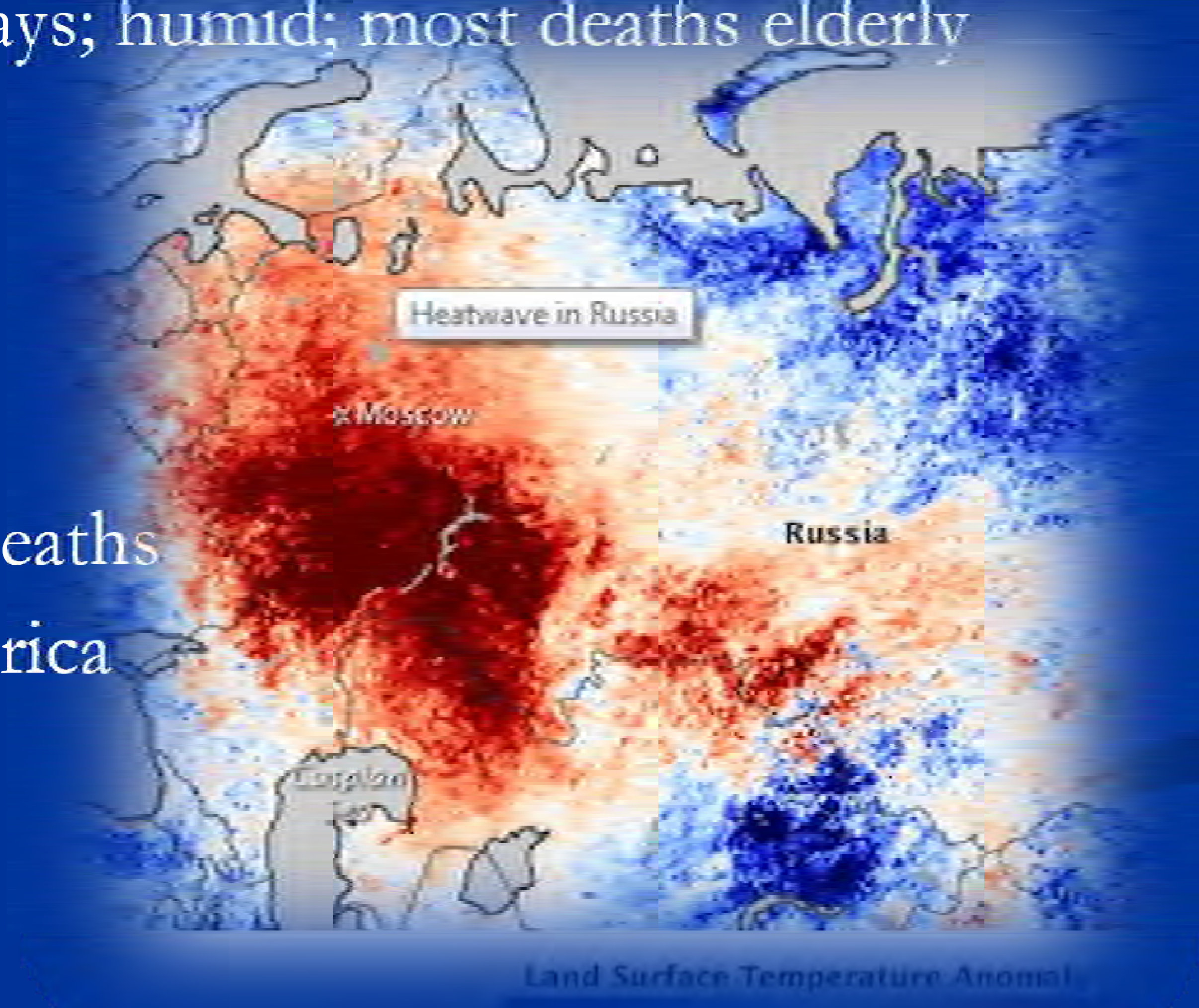


Eun-Soon Im et al. Sci Adv 2017;3:e1603322

Science Advances
Published by AAAS

Great Recent Heat Waves

- Chicago Heat Wave of 1995
  - 700 deaths in 5 days; humid; most deaths elderly men (poor black community hit)
- European Heat Wave 2003
  - At least 40,000 deaths
- Europe/North America Heat Wave 2006
- Moscow Heat Wave 2010 (killed 55,000)



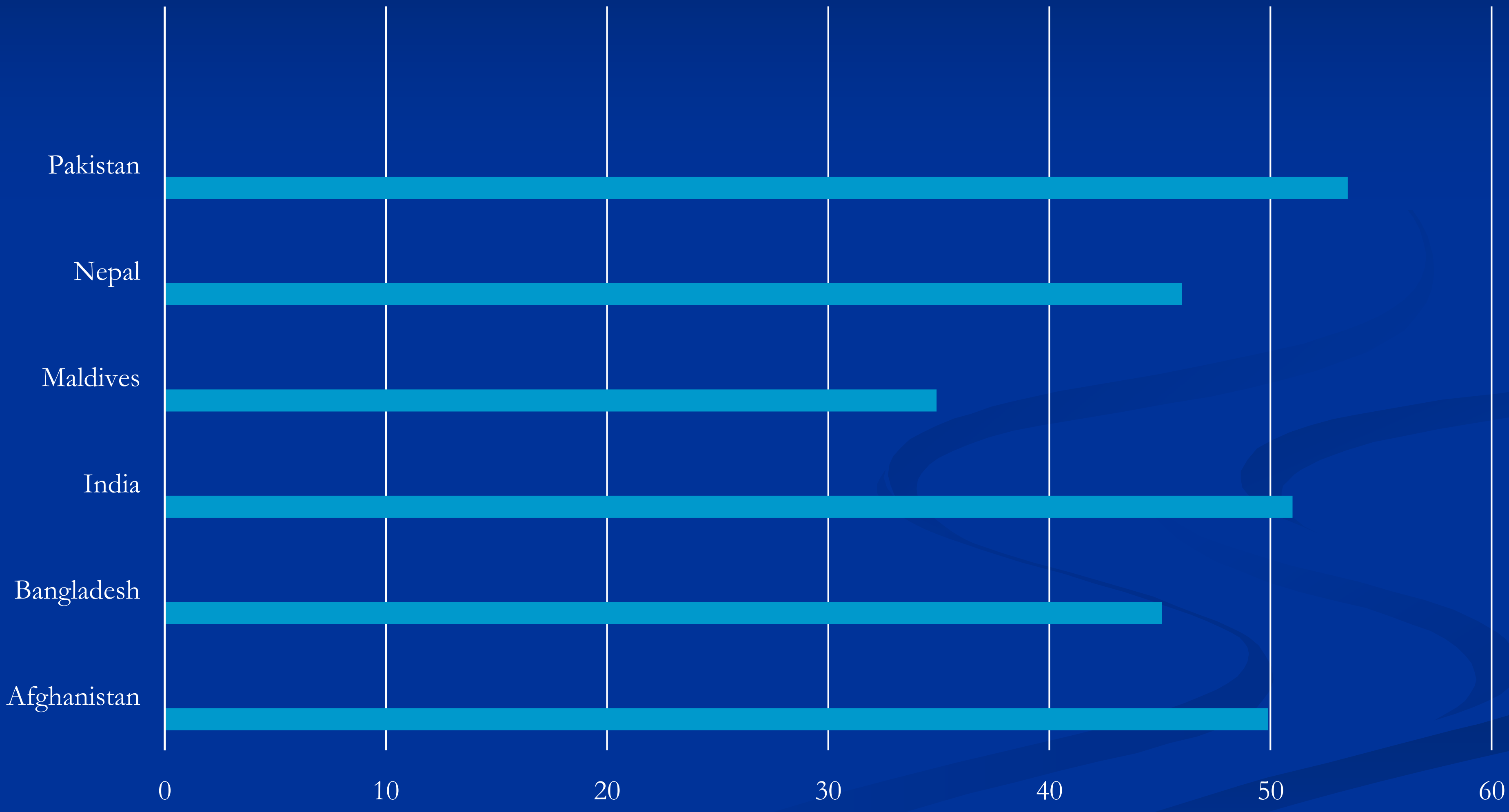
Some Lessons Learned

Chicago: Poor Preparedness: City response system that calls on vulnerable and elderly; fear of crime and closed windows

France: Vast majority elderly; during summer vacation; not enough staff to cool residents; poor living conditions; isolated populations; poor public communication

Russia: Lack of Preparedness, lack of cooling centers, firefighters

Hottest Temps (C) ever recorded, South Asia



Source: Wiki

Economic Effects

- Each 1 deg C rise in average temp of a country, national income is 8.5% lower.
- Being 1 deg C warmer in a given year, reduces income per head by 1.4%

- U.S.: when temps reach 100 deg F labor supply falls by hr/day compared to 76-80 deg.
- Each additional day above 32 deg C (89.6 F) annual age adjusted mortality rate increases by 0.1% to 0.8%

Source: Kousky, Energy Economics 2013; Dell, et al..
"Temperature Shocks and Economic Growth:
Evidence from the Last Half Century." American Economic Journal:
Macroeconomics 4.3 (2012): 66–95.

Hyperthermia

- Sweating is primary means of thermoregulation. Evaporation has cooling effect, decreases core temp. Heat exposure exceeds physiological capacity to cool, core body temperature increases.

Severity of heat-related illness

Heat cramps. Mild and easy to treat, this level involves fevers generally under 102 degrees Fahrenheit.

Heat exhaustion: Involves fevers over 102 degrees Fahrenheit, often with vomiting, diarrhea, and fatigue.

Heat stroke: A severe and life-threatening failure of body’s ability to cool (e.g., sweating ceases), with fevers over 104 degrees Fahrenheit. Heat stroke can result in organ and neurologic damage and lead quickly to death.

Classic and Exertional Heat Stroke

Maria Isabel Jimenez
May 14, 2008
17 y.o. picking grapes

Ramiro Rodriguez
July 9, 2008
48 y.o. picking nectarines

Jose Hernandez
June 20, 2008
64 y.o. picking squash

Jorge Herrera
July 31, 2008
37 y.o. loading grapes

Abdon Garcia
July 9, 2008
46 y.o. loading grapes

Maria Alvarez
August 2, 2008
63 y.o. picking grapes

Measuring "Extreme Heat"

- No universal definition of extreme heat or heat waves
- Consensus revolving around using a percentile cutpoint (say 95%) of max temp or heat index compared to historic (30 yr) baseline record for that day
- Heat waves: 2 or more days of extreme heat?

Measuring "Extreme Heat"

- Apparent temperature: what humans feel (air temp, wind speed, humidity)
- Heat index: air temp plus humidity
- Dry bulb temp: air temperature
- Wet bulb temp: air temperature plus humidity

Measuring "Extreme Heat"

- Max, min, range
- Day above a certain threshold temp

Measuring heat deaths

- Coroners' reports
- Death Certificates
- Case definition:
  - Primary and underlying cause of death
- Using ICD codes for heat as cause of death underestimates the true number of deaths

Measuring "excess mortality"

- Excess mortality = total all-cause mortality during a heat wave – total all-cause mortality during a reference period
- Provides a better estimate of the true burden of death during a heat wave
- Gold standard method uses regression modeling

Measuring heat illness

- Hospitalization and emergency room records
  - Again underestimating true burden of illness
- Excess morbidity
- Syndromic Surveillance

Syndromic Surveillance

- "Syndromic surveillance systems use (near) real-time health-related data for the early identification of disease outbreaks, disease trend monitoring and the tracking of adverse health outcomes related to an event "
- used as an indicator of HRI incidence

Council of State and Territorial Epidemiologists

http://c.ymcdn.com/sites/www.cste.org/resource/resmgr/pdfs/pdfs2/Syndromic_surveillance_clima.pdf

Steps in Syndromic Surveillance

- (1) identifying a weather- or climate-related surveillance outcome
- (2) developing a syndrome case definition, (search

terms of chief complaint)

- (3) combining, externally and internally, syndromic surveillance data with environmental data,
- (4) interpretation and display of data
- (5) Validation of data; and
- (6) engaging with partners.

Uses of Syndromic Surveillance

- Assessing the severity of an ongoing heat event with statistical models or aberration detection
- Augmenting public health messages during an ongoing heat wave or targeting messaging to specific sub-populations or areas
- Providing evidence for needing additional response resources in a jurisdiction (e.g., requesting additional cooling center hours or water distribution sites)
- Preparing emergency department staff for visit surges during severe, prolonged heat waves

Best practices in implementing syndromic surveillance of illness associated with exposure to heat

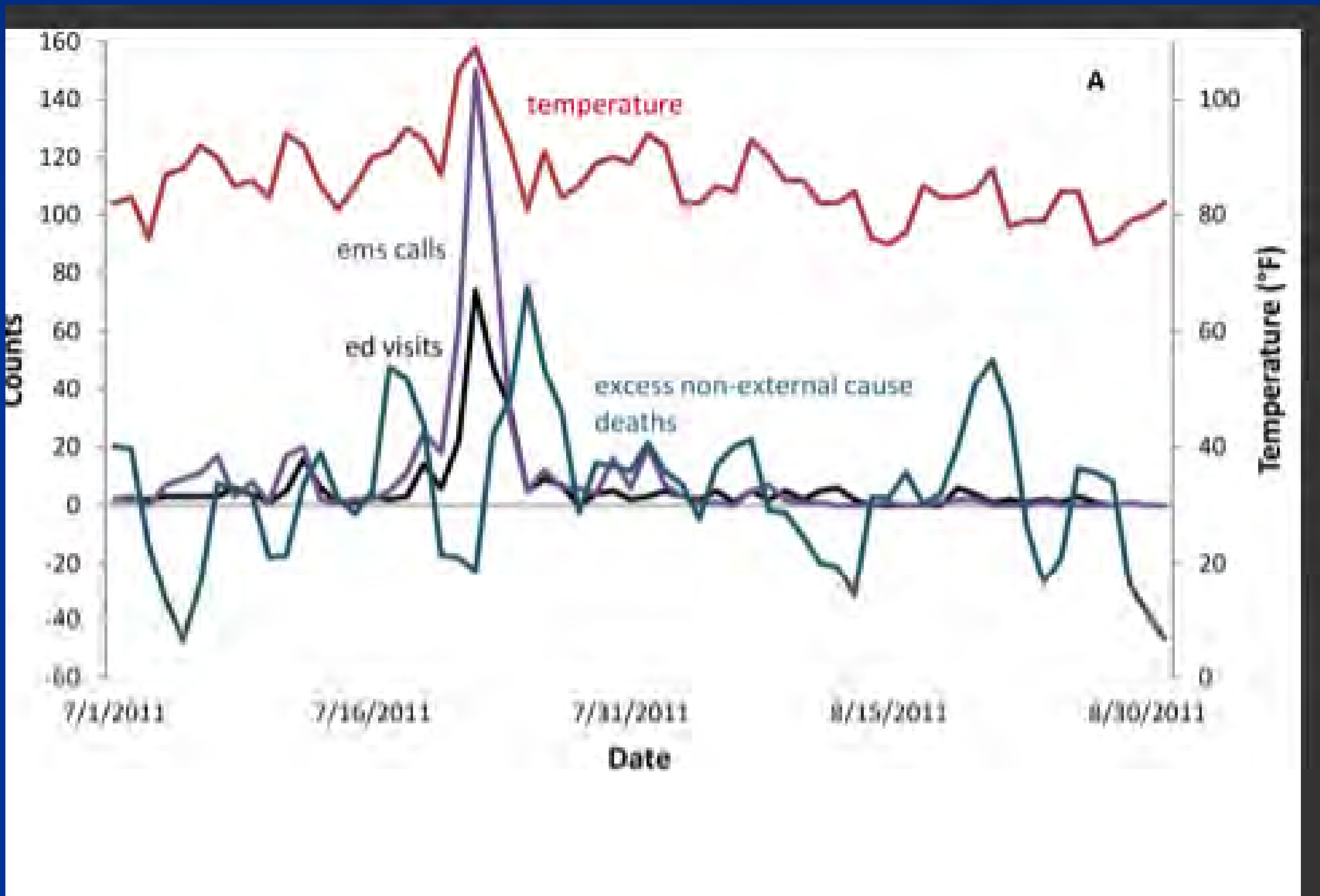

HEAT-RELATED ILLNESS SYNDROME QUERY: A GUIDANCE DOCUMENT FOR IMPLEMENTING HEAT-RELATED ILLNESS SYNDROMIC SURVEILLANCE IN PUBLIC HEALTH PRACTICE

Provides a novel syndromic surveillance query for heat related illness (HRI) and (2) provide guidance to public health professionals as they adapt the query and implement a HRI syndromic surveillance program in their own jurisdictions.

Council of State and Territorial Epidemiologists

http://c.ymcdn.com/sites/www.cste.org/resource/resmgr/pdfs/pdfs2/CSTE_Heat_Syndrome_Case_Defi.pdf

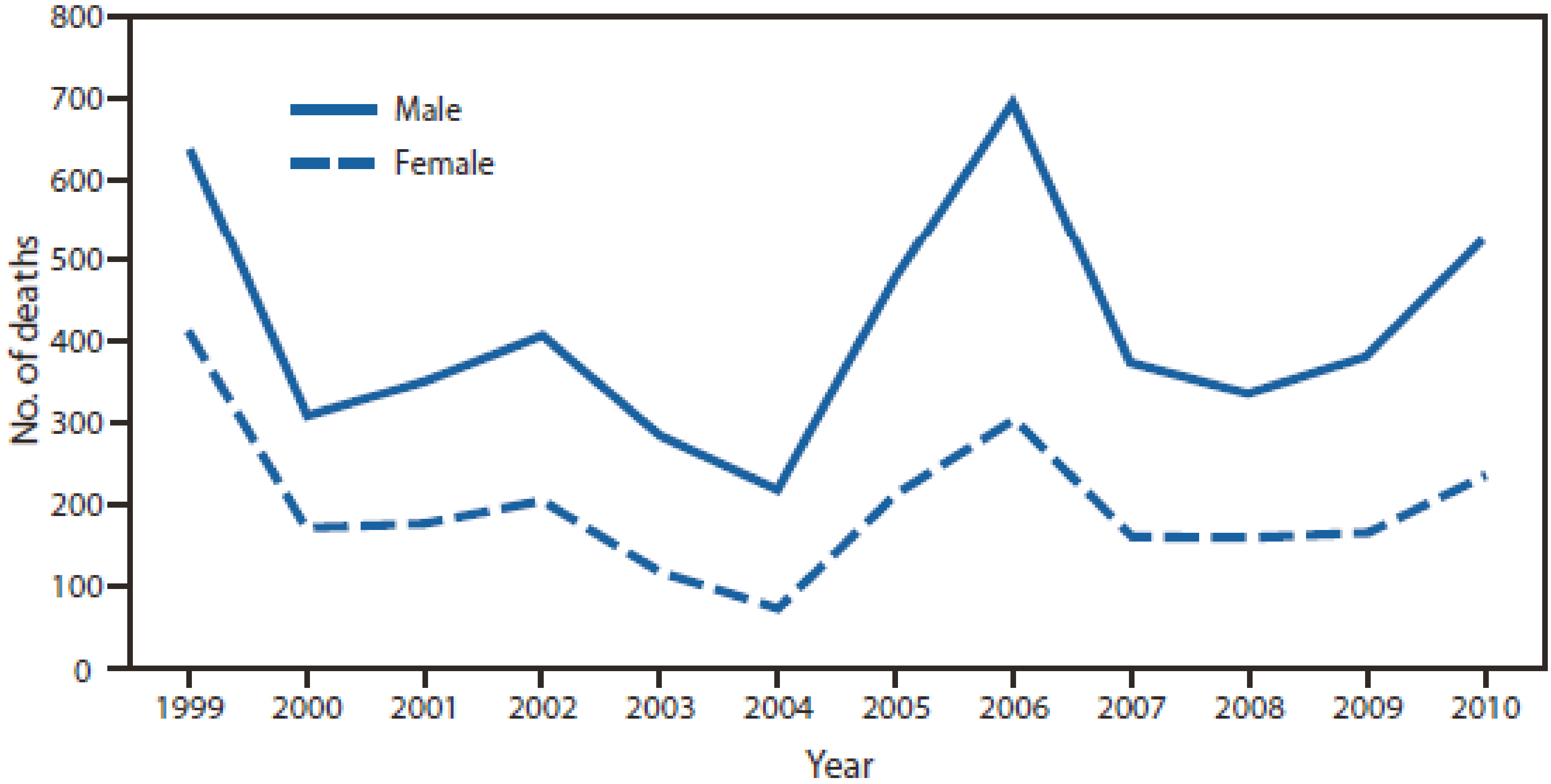
Time-series of daily heat-related EMS calls, ED visits, excess non-external cause deaths, and maximum temperature or heat index.



Mathes et al Real-time surveillance of heat-related morbidity: Relation to excess mortality associated with extreme heat.

PLoS one. 2017 Sep 6;12(9):e0184364.

Number of Heat-Related Deaths by Sex in the U.S. 1999-2010



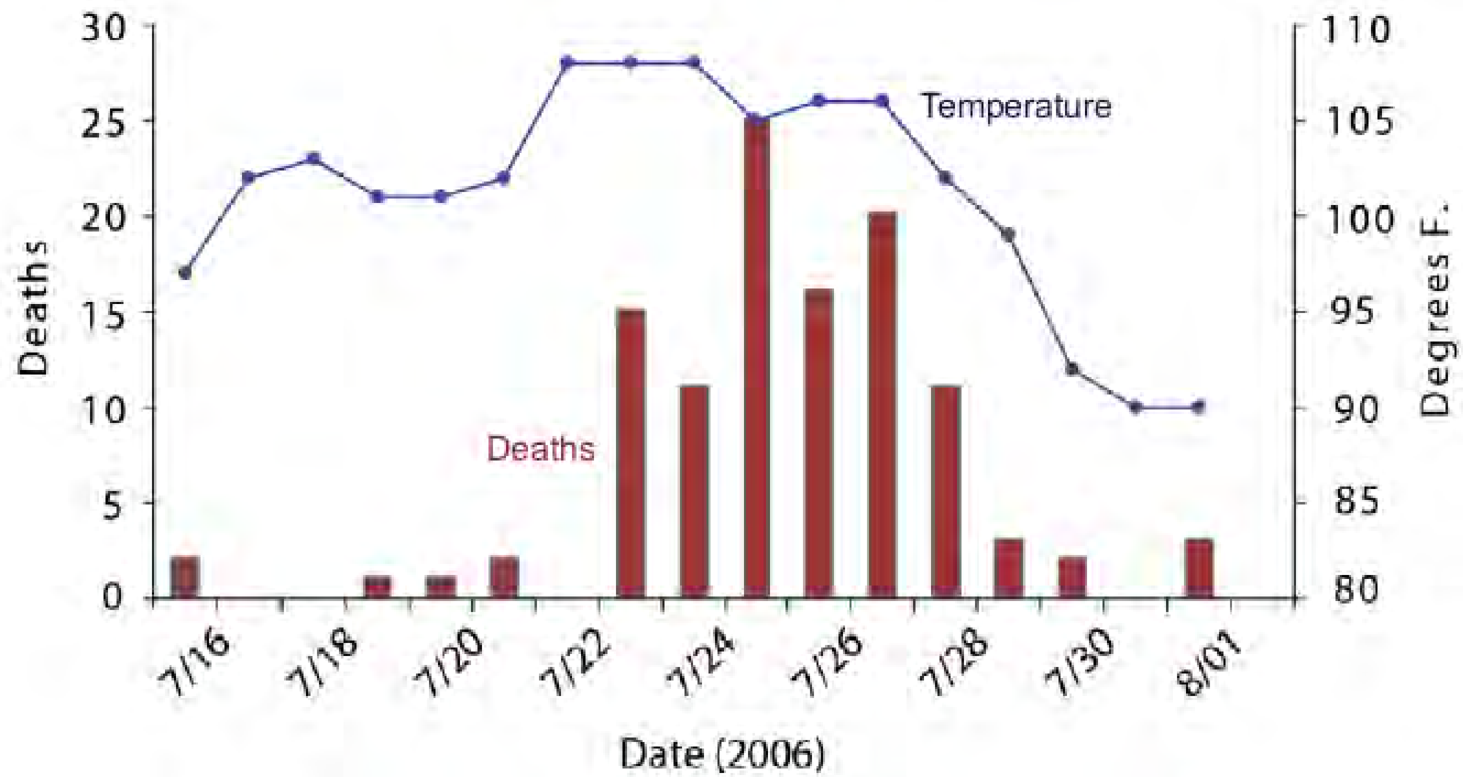
Deaths attributed to exposure to natural heat, as the underlying and contributing causes of death, are coded as X30 and T67, according to the *International Classification of Diseases, 10th Revision*.

Source: National Vital Statistics System, United States,1999–2010, *Weekly,* September 14, 2012 / 61(36);729

2006 CA heat wave

- 655 excess deaths, 16,166 excess ED visits and 1,182 excess hospitalizations
- Children, the elderly, and the poor were at greatest risk.
- Cost CA $133 million in health-related costs
- Agricultural losses exceed $1 billion

Figure 7: Deaths due to Extreme Heat in California and Typical Central Valley Temperature*, July 15- August 1, 2006



Source: California Department of Public Health

***Maximum temperature from a weather station in the northern Central Valley region (Willows, CA) that was a typical pattern for most counties which experienced heat-related deaths.**

Notes on 140 coroner cases California 2006

- Inside temperatures (noted in 36 of 140 cases) averaged 103.5 degrees Fahrenheit with a range of 85 to 140 degrees Fahrenheit
- 46% of decedents lived alone, 55% of these had a social contact who routinely checked on them, and 19% seen by social contacts within 24 hours prior to death.
- Isolation, residence in a poor area, age, and chronic disease are common risk factors. Risk rises rapidly with age, after about age 50 years old. Only one child death.
- Only one decedent had AC on.
- Some classic heat stroke victims were reported to have had a fan trained on them.

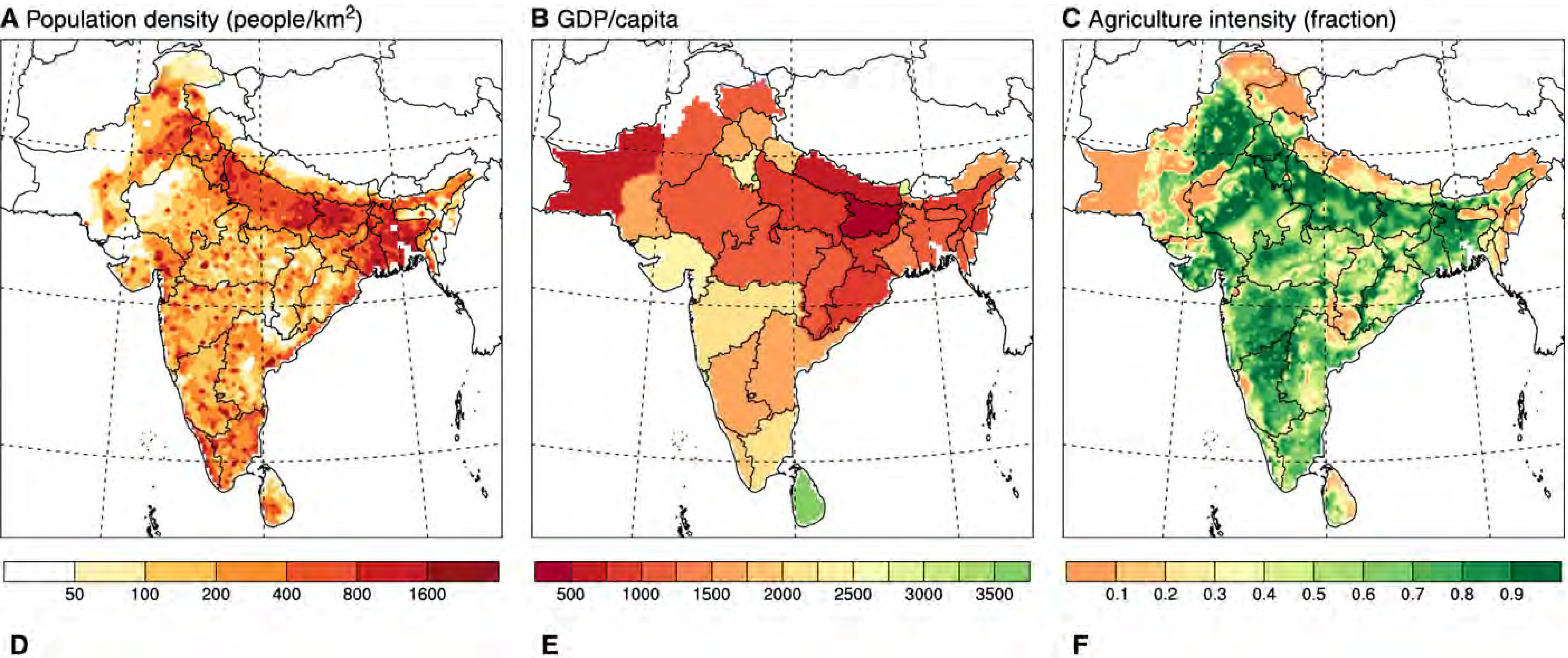
Morbidity from CA heat wave

- 16,166 excess ED visits and 1,182 excess hospitalizations
- Children and the elderly were at greatest risk.
- ED visits showed significant increases for HRI, acute renal failure, cardiovascular diseases, diabetes, electrolyte imbalance and nephritis.
- Significantly elevated RRs for hospitalizations for HRI (RR 10.15; 95% CL 7.79, 13.43), acute renal failure, electrolyte imbalance and nephritis.

Community's overall vulnerability

- Exposure: Changing environment due to global warming
- Population characteristics/Sensitivity (e.g. age, pre-existing disease)
- Adaptive capacity :
  - Community Resilience (Resources)
  - Response Capacity: Capacity of public health and emergency response infrastructure

Fig. 3 Vulnerability due to population density, poverty, and outdoor working conditions.



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How can individuals, communities, govt, prepare?

- Personal (including clinicians): Behaviour change, knowing signs and symptoms of health illness
- Communities: Increased Resilience
- Govt: Increased health surveillance, outreach/education, policy changes

Early Heat Warning Systems

- Forecasting the heatwave event,
- Predicting possible health outcomes,
- Triggering effective and timely response plans
- Targeting vulnerable populations,
- Notification of heatwave events,
- Communication of prevention responses and evaluation and revision of systems

(Lowe et al, 2011)

Personal Adaptation

How much will it blunt health effects of future heat?

- Changes in behaviors (e.g. hydration, avoiding exposure, cooling centers, restrict exercise)

- Awareness of signs and symptoms of heat illness by social contacts

- Acclimatization (why earlier heat waves are more deadly that later heat waves)

Community Resilience (Resources) factors

- Availability of parks, open space
- Medical and Public Health Infrastructure
- Unemployment
- Violence/crime rates
- Food security
- Environmental quality
- Availability of cooling centers
- Heat wave warning/heat island mitigation

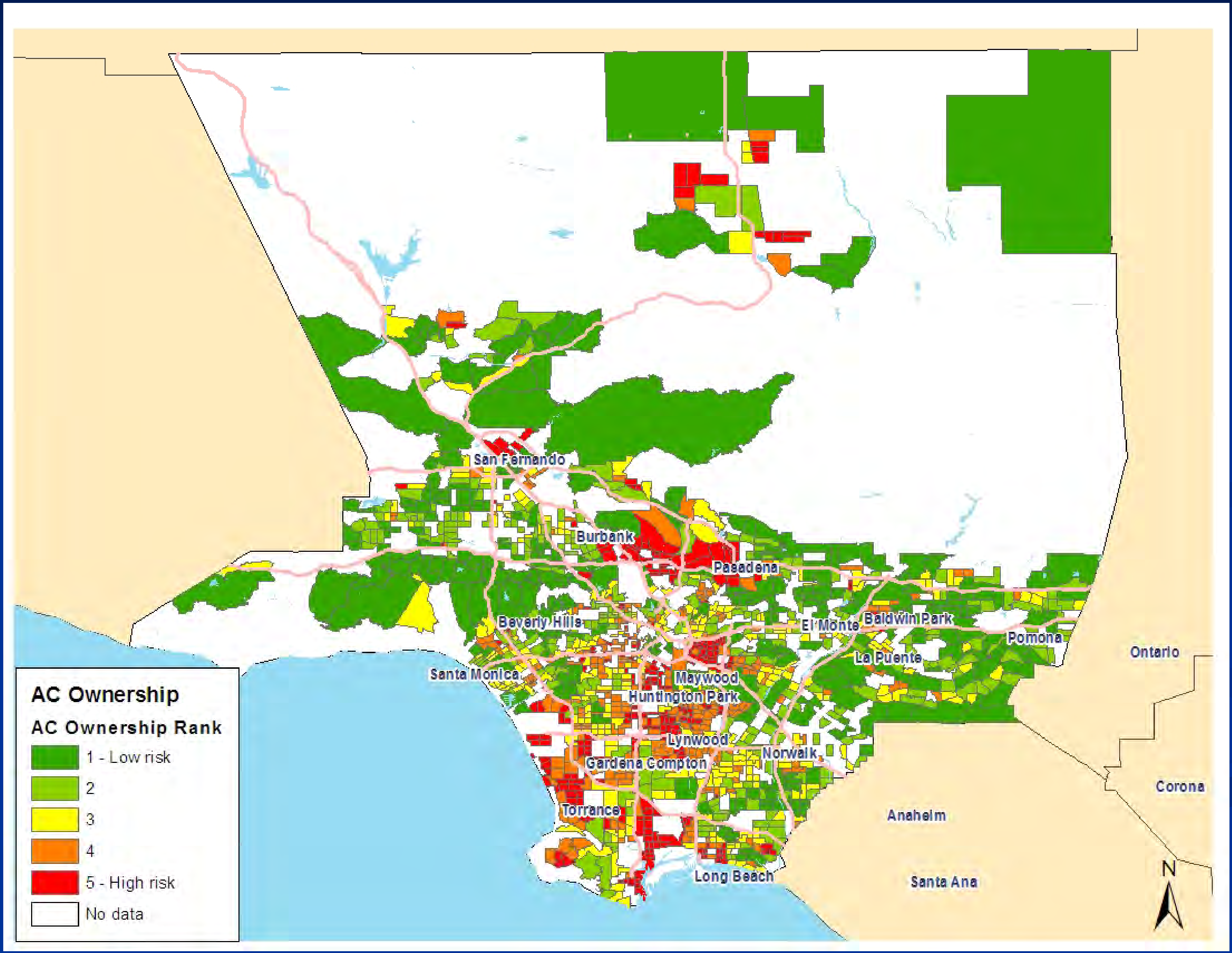
Climate Change Vulnerability Data

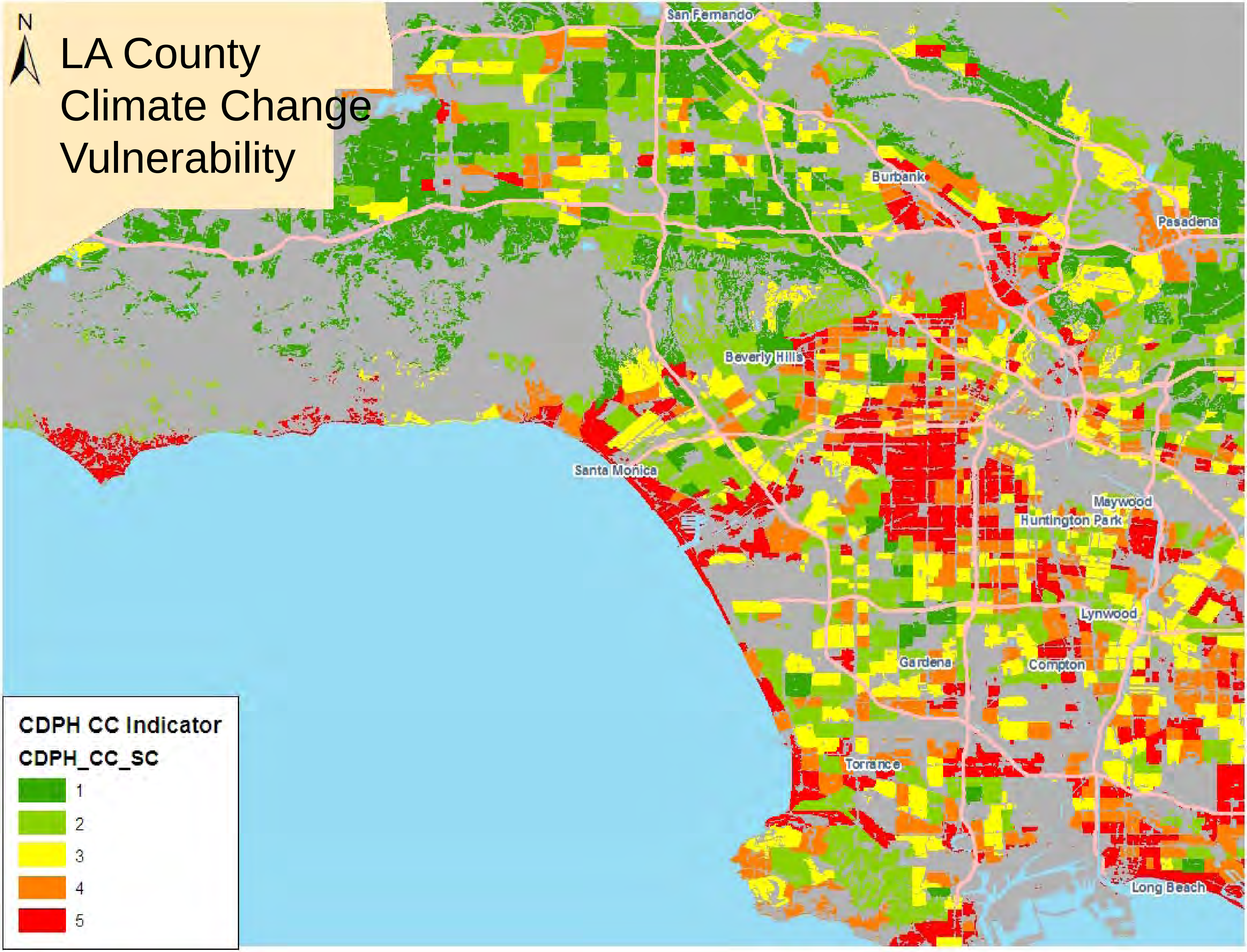
Metric	Source
Central air conditioning	CA Energy Commission (2009)
Tree canopy	National Land Cover Database (2001)
Impervious surface	National Land Cover Database (2001)
Public transit routes	SCAG 2011; Fresno COG 2011
Elderly living alone	Census 2000
Household car access	Census 2000
Wildfire risk	CAL FIRE 2003
Flood risk	FEMA (Fresno 2009; LA 2008)
Sea rise inundation	Pacific Institute 2009 (LA only)

- Data were ranked by quintiles and mapped for census tracts
- Final vulnerability score a sum & re-ranking across all metric ranks

LA County Climate Change Vulnerability

RANK: Proportion of households with central AC




N
LA County
Climate Change
Vulnerability
San Fernando
Burbank
Pasadena
Beverly Hills
Santa Monica
Maywood
Huntington Park
Lynwood
Gardena
Compton
Torrance
Long Beach
CDPH CC Indicator
CDPH_CC_SC
1
2
3
4
5

Policy Responses: Community

- Urban Heat Island Mitigation
  - Cool roofs
  - Urban forestry
  - Urban design elements and land use

- Energy Conservation
- Reduction of cumulative stressors (crime, env. degradation, food insecurity)

Policy Responses: Gov't

- Improve Capacity of Public Health (response capacity/surveillance/public messaging/cooling centers)
- Develop Heat-Health Alert Warning Systems
- Utility shut off protection for low-income groups
- Improved regulations for outdoor workers

State Contingency Plan for Excessive Heat Emergencies (Cal EMA)

- CA state Warning Center issues emergency notification based on NWS heat alerts
  - Coordination Calls among State Agencies
  - Public Information/Local Public Health
  - Cooling Centers
- Heat Emergency:
  - Activation of State Operations Center (SOC) (Coordination with local emergency management)
  - Cooling Centers
  - State of Emergency

Policy Responses: STATE OF CALIFORNIA EXTREME HEAT ADAPTATION GUIDANCE (to be released soon)

- Examine and expand the use of porous pavements where possible.
- Promote and expand urban greening and the use of green infrastructure as part of cooling strategies in public and private spaces.
- Improve Heat-Health Alert Warnings.
- Improve community resilience for increasing heat, especially for vulnerable populations

Extreme Heat Recommendations (cont)

- Protect the energy grid.
- **Increase the health care system's extreme heat preparedness and resiliency.**
- **Improve the timeliness and completeness of heat illness and death surveillance activities**
- **Augment training of employers and workers in industries with outdoor work, including assurance of adequate water, shade, rest breaks and training on heat risks.**
-

Interactions between heat and air pollution

Europe: The heat wave effect on mortality was larger during high ozone or high PM10 days (Epidemiology. 2014 Jan;25(1):15-22)

Moscow heat wave: "Interactions between high temperatures and air pollution from wildfires…. contributed to more than 2000 deaths." Epidemiology. 2014 May;25(3):359-64.

China: Interactions between PM10 and temperature were statistically significant on respiratory mortality. Asia Pac J Public Health. 2014 Nov;26(6):614-2

Sensors for ***non-regulatory*** monitoring

"Community Air Monitors"

Customized low-cost optical particle counter

\+

Small computer & other env sensors (e.g., temp and RH)

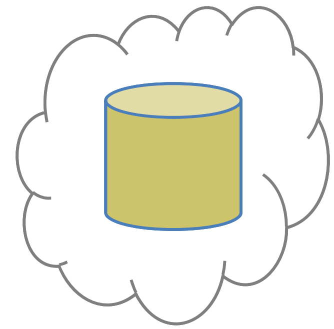
\+

Wireless Networking

\+

Robust Enclosure

\+



Internet Database on the Cloud with data available on the web

System designed by Graeme Carvlin, PhD student UW
Deployed and maintained by Comite Civico del Valle

Using and building community capacity to install and maintain monitors




Community capacity and resources support installation of monitors

-

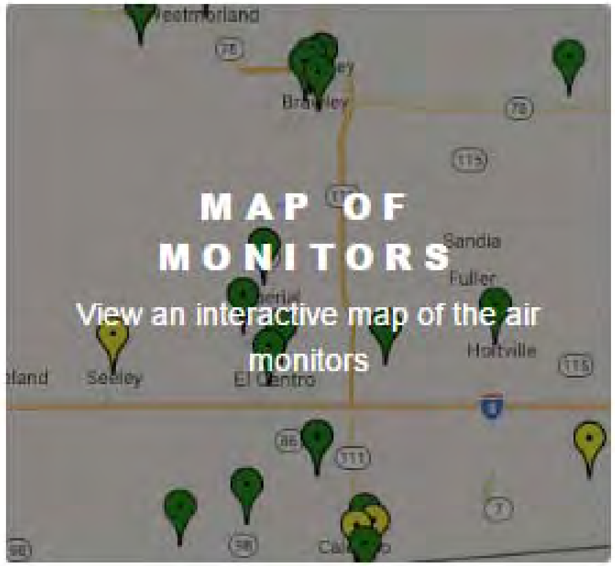
Increasing community capacity promotes sustainability

- Training for monitor installation and maintenance
- Increased awareness leads to support and potential growth

IMPERIAL

IVAN Air Monitoring

Poor air quality can harm your health. Take action to reduce your exposure to air pollutants. Use the list or map to view current air quality levels at your nearest air monitor. Sign up to receive alerts when the air quality near you is unhealthy. Scroll down to learn more.



ABOUT THE NETWORK

IVAN Air Monitoring is a network of 40 air monitors located throughout Imperial County. These monitors measure current levels of particulate matter air pollution (PM2.5 and PM10). The air quality measurements are displayed on this website.

Community Air-Quality Levels (CALs)

Number range	Category	Color	Health Recommendation
0-50	Low Risk	Green	It's a good time to be active outside
51-100	Moderate	Yellow	**If you are unusually sensitive to particle pollution,** reduce physical activity outdoors. Watch for symptoms like coughing or breathing problems.
101-150	Unhealthy for Sensitive Groups	Orange	**Sensitive groups*** should reduce physical activity outdoors. Watch out for symptoms like coughing, breathing problems, unusual heartbeat, or unusual fatigue.
Above 150	Unhealthy	Red	Avoid physical activity outdoors.

***Sensitive groups** include children, teens, older adults, pregnant women, and people with heart, lung, or other chronic diseases

IVAN **IMPERIAL**

MENU

TL WAGGONER ELEMENTARY SCHOOL

Imperial

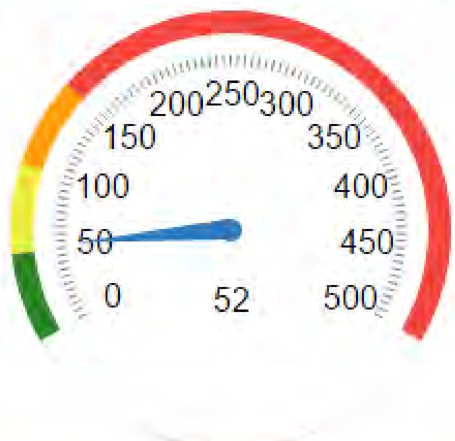
Tuesday, October 18, 2016 at 08:22 PM

The current air quality at this monitor is

52

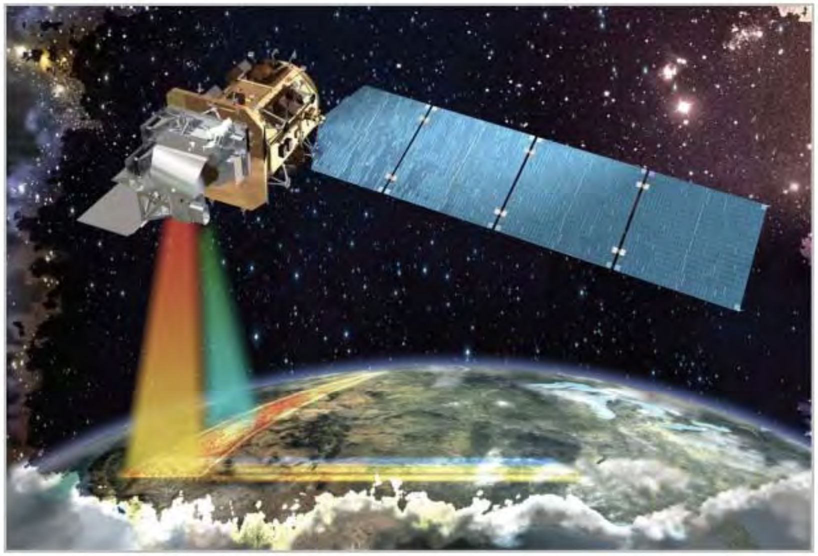
Moderate

Health recommendations: If you are unusually sensitive to particle pollution, reduce physical activity outdoors. Watch for symptoms like coughing or breathing problems.



Current Past 24 hrs Past 30 days Past 90 days About CALs Disclaimer More info Government air data Report an air problem

Satellite Remote Sensing for Surface Air Quality



dat… …ity research. Our study clearly demonstrates that satellite-derived AOT is a good surrogate for monitoring PM air quality over the earth. However, our analysis shows that the $PM_{2.5}$–AOT relationship strongly depends on aerosol concentrations, ambient relative humidity (RH), fractional cloud cover and height of the mixing layer. Highest correlation between MODIS AOT and $PM_{2.5}$ mass is found under clear sky

Gupta, P., Christopher, S.A., Wang, J., Gehrig, R., Lee, Y.C. and Kumar, N., 2006. Satellite remote sensing of particulate matter and air quality assessment over global cities. *Atmospheric Environment*, *40*(30), pp.5880-5892.

For more info

California Heat Illness Surveillance Information:
www.cehtp.org under climate change

Extreme Heat Adaptation Guidance:
www.climatechange.ca.gov

Thank You!