Mapping Heat and Vulnerability to Inform Decision-Making

Yoon Kim, Director of Advisory Services, Four Twenty Seven, Inc.

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Outline

- Key concepts
- Assessing vulnerability to extreme heat

Key Concepts

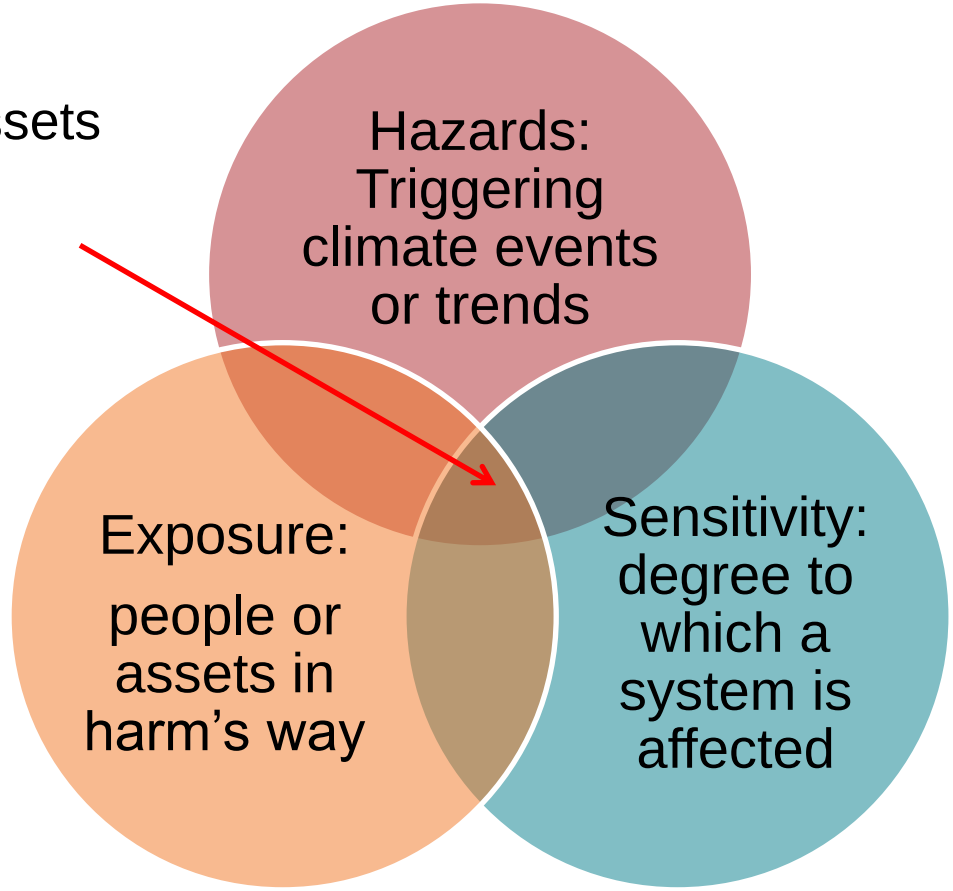
Definitions

- Vulnerability is a function of:
  - Exposure: Presence of people, livelihoods, in places and settings that could be adversely affected.
  - Sensitivity: Degree to which a system or species is directly or indirectly affected by climate variability or change.
  - Adaptive capacity: Ability of systems, institutions, humans, and other organisms to adjust to potential damage, take advantage of opportunities, or respond to consequences
- Risk is defined as:
  - A probability or threat of damage, injury, liability, loss, or any other negative occurrence that is caused by external or internal vulnerabilities, and that may be avoided through preemptive action.
  - Risk = Probability x Outcome

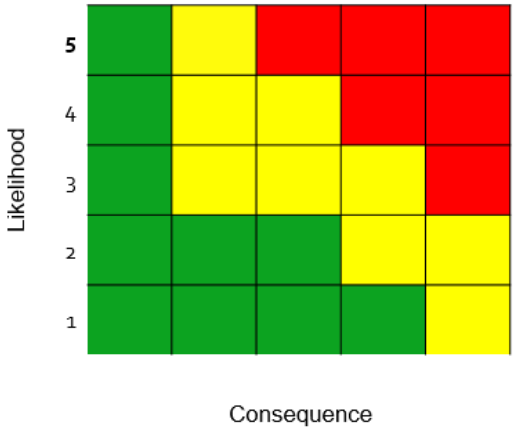
Source for vulnerability definitions: IPCC, 2014: *Climate Change 2014: Impacts, Adaptation, and Vulnerability*. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Barros, V.R. et al. (eds.)].

Understanding Climate Vulnerability

Most vulnerable assets
= hotspots

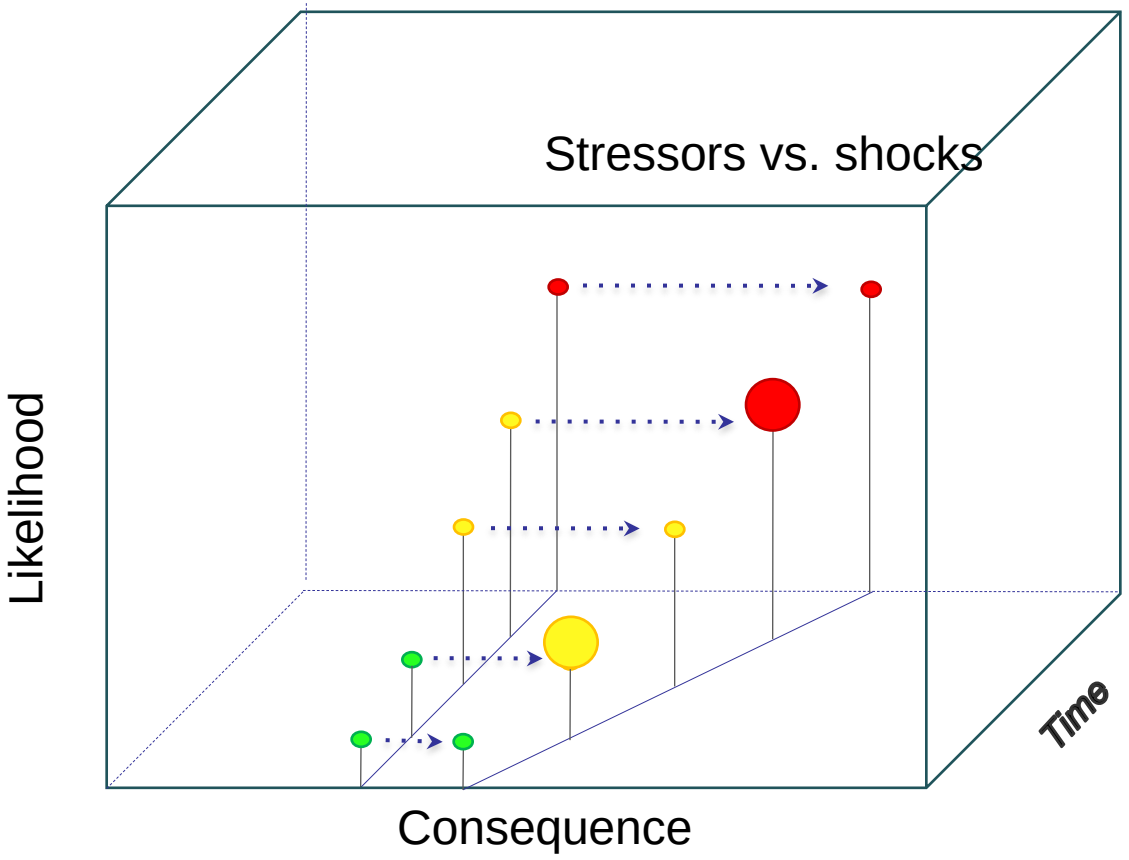


Hazards: Climate risk shifts over time



Standard depiction of risk

Risk in the context of climate change



Source: Kevin Watson, NASA, November 2013

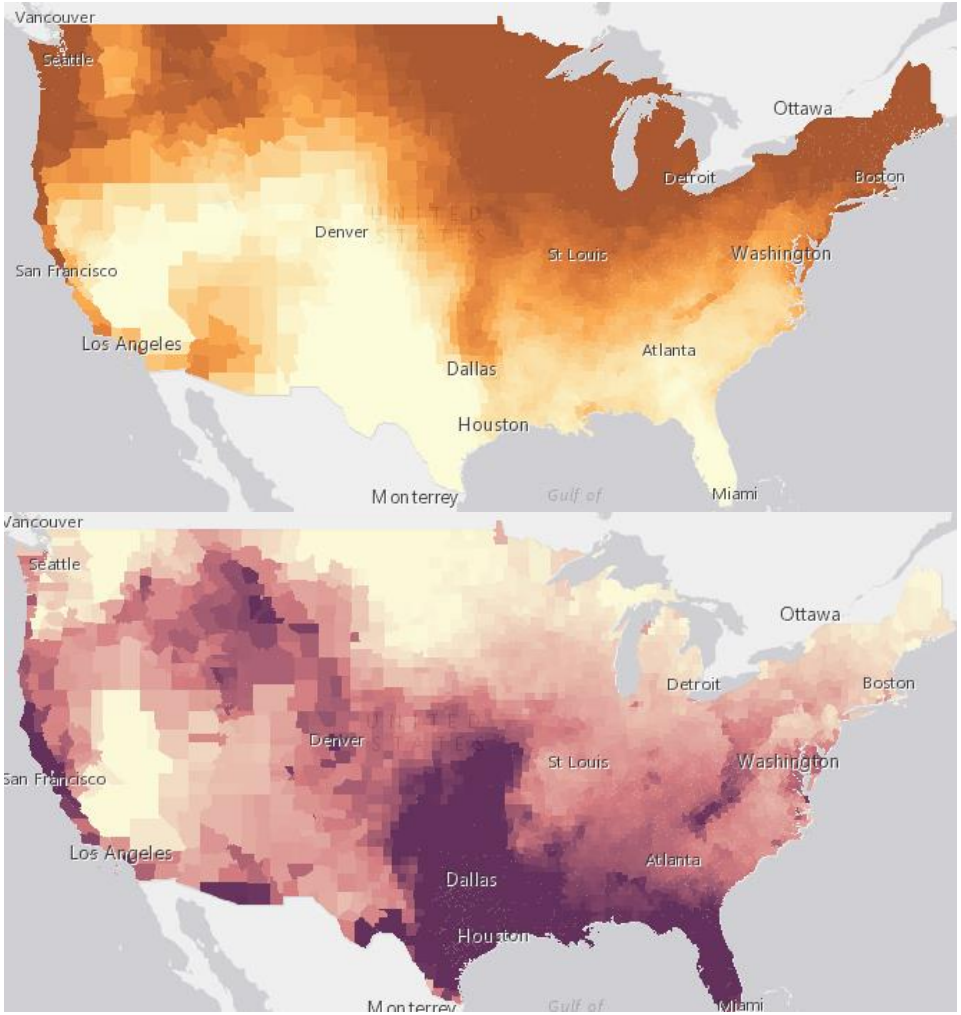
Assessing Vulnerability to Extreme Heat

White House Climate Data Initiative

- Heat and Social Inequity mapped at the county level for the entirety of the US
- Five interactive maps – changes in heat severity, frequency of heat, exposure to extremes, social vulnerability score, heat vulnerability score
- Use
  - To discuss climate change impacts on public health with doctors, nurses and other healthcare professionals
  - Identify key drivers of vulnerability as a starting point for planning and evaluation
  - Engage the community and help improve preparedness ahead of heat events in the short- and long-term.

Exposure

- Relative changes in heat and humidity in the US by 2050:
  - Severity of (Wet bulb) temperature (WBT 95th percentile)
  - Frequency of very hot days (days over historical 95th percentile)

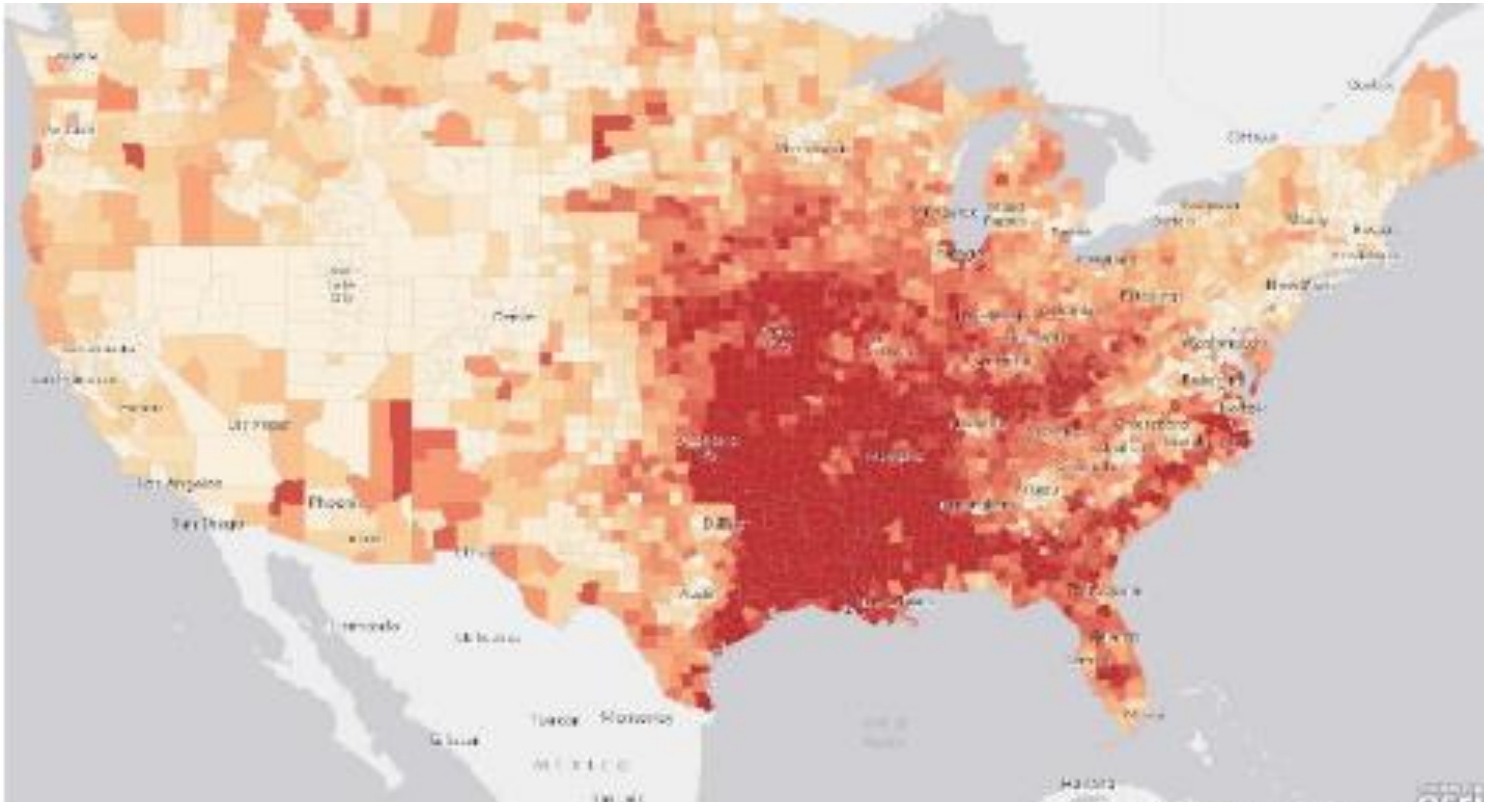


Sensitivity:

Factor		Indicators[3]
1	Social Isolation	Age 65+
		Age 65+living alone
		Living alone
		Housing stress
2	Economic Opportunity	No high school diploma
		Diabetes
		Race
		Poverty
3	Living Conditions	Race
		Poverty
		Housing Stress

Vulnerability

- Cumulative Heat Vulnerability Score



Data Sources

- Heat and humidity – inhouse modeling
- Social isolation, economic opportunity, living conditions

Housing stress: Percentage of households with at least 1 of 4 housing problems: overcrowding, high housing costs, or lack of kitchen or plumbing facilities (County Health Rankings & Roadmaps (CHR), averaged across 2014-2016

65+: Percent of residents 65 years and over (US Census, averaged across 2005-2014)

65+ living alone: Percent of households - one-person, 65 years and over (US Census, (averaged across 2005-2014)

Race: Percent of non-white residents (US Census, averaged across 2005-2014)

Living alone: Percent of households with only one-person (US Census, averaged across 2005-2014)

Below Poverty Line: Percent of people of all ages in poverty (US Census, averaged across 2005-2014)

No High School Diploma: Percent 25 years and over without finishing high school (US Census, 2006-2014)

Diabetes: Diagnosed diabetes prevalence (Centers for Disease Control, averaged across 2005-2013)

California Heat and Health Tool

- Four Twenty Seven is developing a decision-support tool for public health and emergency management professionals to better plan for future extreme heat
  - Project funded under the CA 4th Climate Change Assessment
- We performed an extensive lit review and user need assessment across California:
  - Identify health and emergency response practitioners greatest needs
  - Understand short- and long-term interventions to prevent heat-related health impacts
  - Conclusion - develop a tool to support the inclusion of climate change (heat) considerations into long-term policy and planning decisions

Historical Barriers to Adaptation

Heat impacts are avoidable yet public health impacts continue to occur

Thresholds for alerts

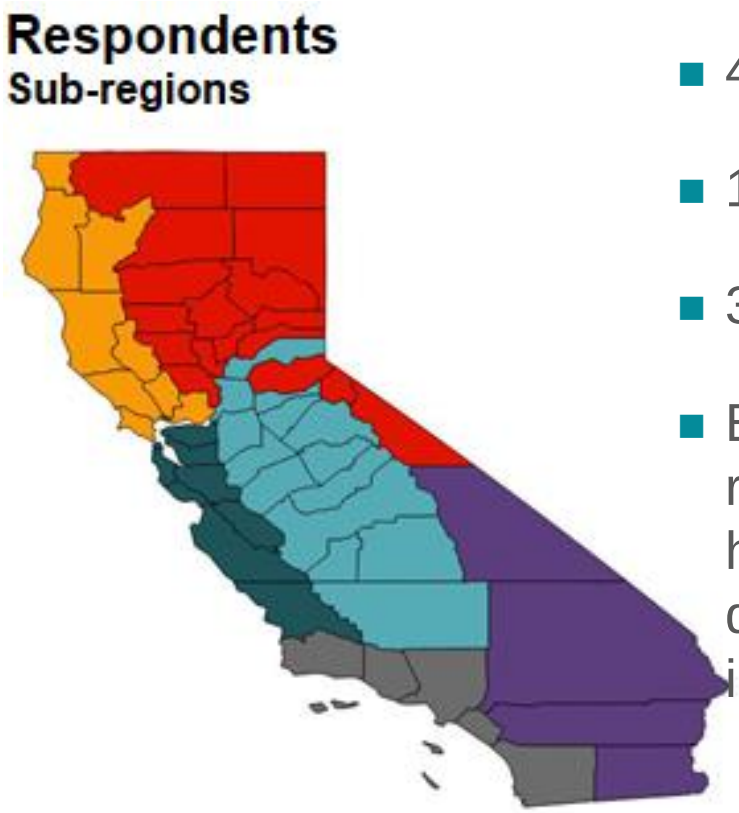
Interventions

- Historically inadequate:
  - NWS issued only six heat alerts from 2000 to 2009 in California, despite evidence showing heat events resulting in negative health outcomes occurred 19 times during this period[1]
- Effectiveness varies by
  - Rural vs. urban
  - Race and age of target population
  - Government resources

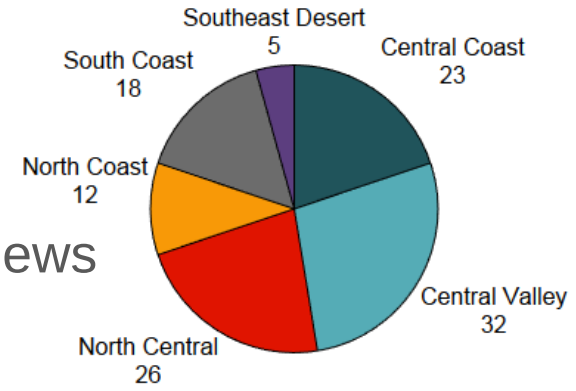
1. Guirguis *et al.*, (2014)

Ask the Decision Makers

Explore if improved weather/climate forecasts would actually help public health officials adapt to current levels of climate variability



- 43 counties
- 116 surveys
- 30+ phone interviews
- Emergency responders, planners, health officers, directors, nurses, information officers



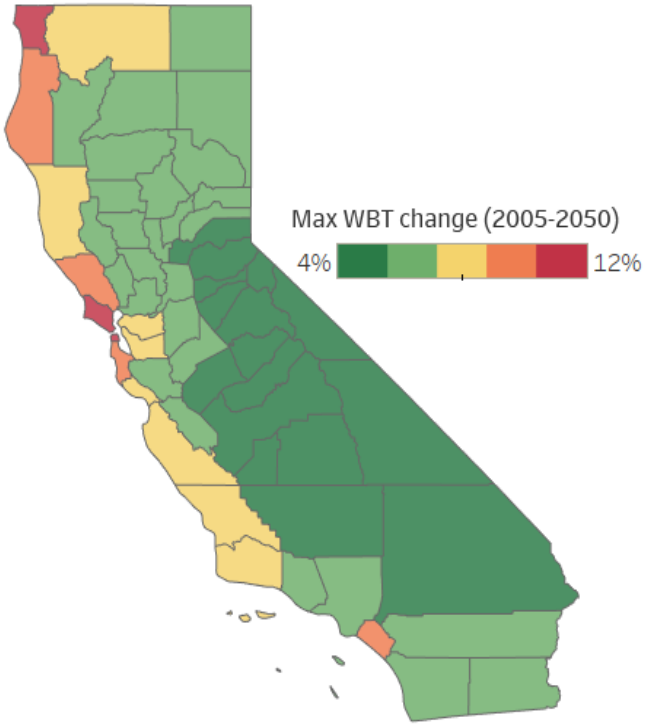
Target Users

- **ADVOCACY -- Liaison, Local Elected**
  - Goal for the Tool: Support advocacy and communication
  - User needs to better understand and communicate how heat-health related conditions are going to shift in the future so that s/he can make the case to prioritize relevant interventions
  - Specific challenge – communicating the health impacts of extreme heat to multiple agencies/practitioners/elected officials with varying level of understanding and interest in climate change and heat-health impacts.
- **PLANNING – Planner, Policy Analyst**
  - Goal for the Tool: Inform policy and planning priorities
  - User needs to know the community-specific factors in heat emergencies to inform multiple planning processes and prioritize interventions and response for vulnerable populations/locations in the future
  - Specific challenge – understanding how current and future heat health impacts will affect local vulnerable populations and individuals at a very granular level

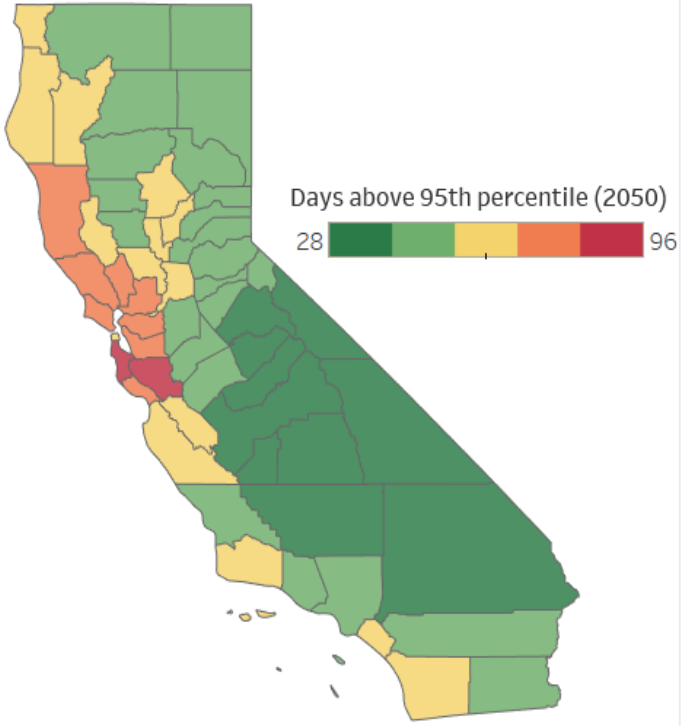
Exposure

California heat waves are changing, becoming more humid, and occurring in places not accustomed to extreme heat

Relative change in severity of very hot days



Relative change in frequency of very hot days



Exposure, Sensitivity, Adaptive Capacity

Current (recent average)

Inputs	Outputs
Heat : Frequency of days over local threshold	Heat Wave Danger
RR heat-related ER visits*	
Elderly, Children, Poverty, Education, Race and Ethnicity, Outdoor workers, Vehicle Ownership, Linguistic Isolation, Physical Disability, Mental Disability, Mental Disability, Violence	Social Vulnerability Population
Access to Parks*	Social Vulnerability Adaptive Capacity
Air conditioning ownership*	
Public Transit/ Vehicle Access*	
Impervious Surfaces	Vulnerability Built Environment
Tree Canopy	
Degree Day Hours / urban heat island*	
Cooling spaces and areas	Other
Areas of exposure (agr, sports, etc)	
Ares of treatment (clinics, hospitals, urgent care)	

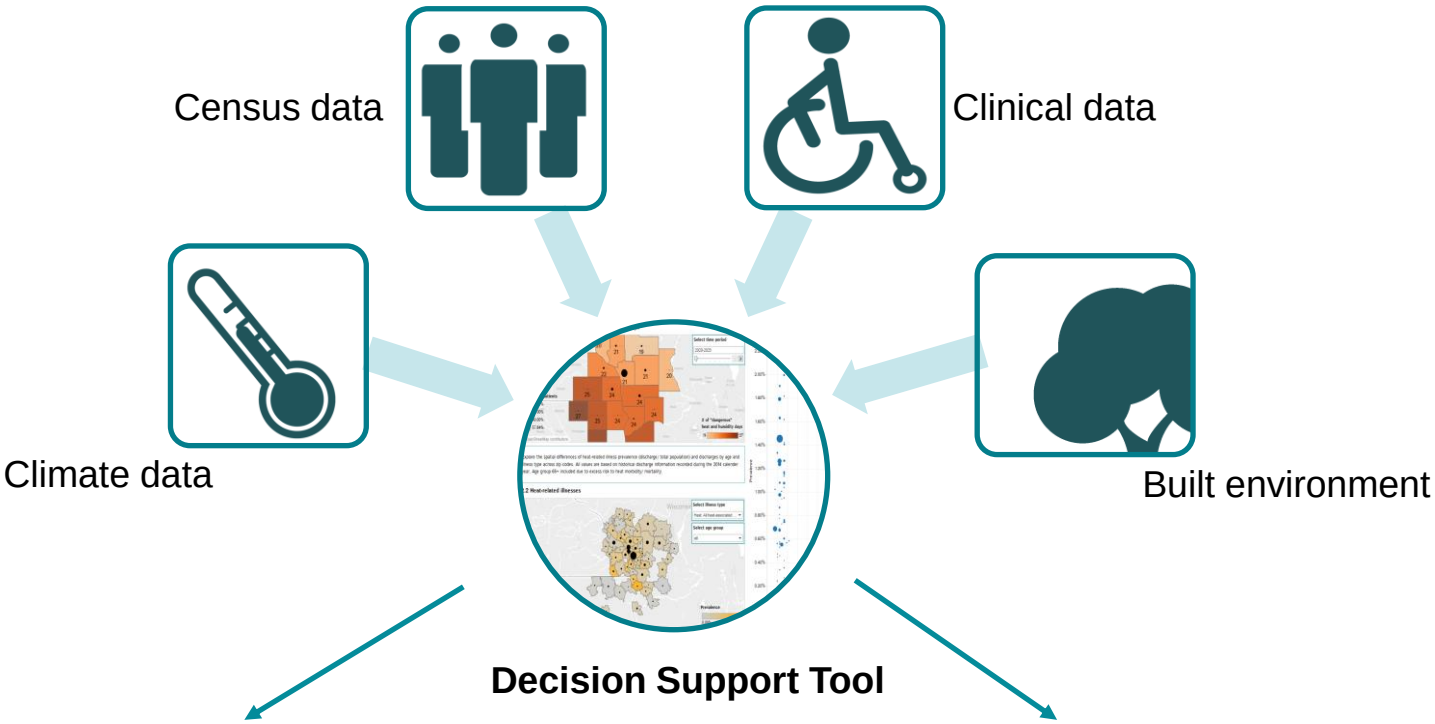
Projected

(2020-2100, at 5 or 10-yr intervals and compare climate metrics to monthly normal)

Inputs	Outputs
Min and max temp	Relative change: frequency (days over local threshold) severity (change in Tmax, Tmin, diurnal, heat index, seasonality, and length of consecutive days when threshold is met)
Diurnal temp	
Seasonality	
Humidity (relative)	
Impervious surfaces growth	Relative change: Hazard intensification due to change in UHI exposure
Housing density growth	
Population growth	Relative change: Number of exposed and new areas of exposure (metric is delta)
Projected RR heat-related ER visits*	*TBD*

*included in determination of vulnerability

Vulnerability



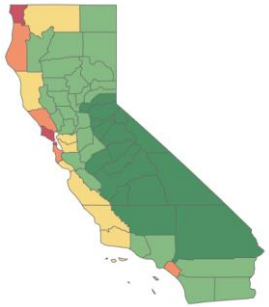
- Climate & built environment
  - Urban heat island
  - Housing density
  - Changing heat waves

- Population
  - Medically vulnerable
  - Outdoor workers
  - Low acclimation

Five Levels of Data

Resolution

1. Counties and climate zones
   - Indicators: ALL(Heat wave danger, medical vulnerability, social vulnerability, future housing density, population growth, future built environment)

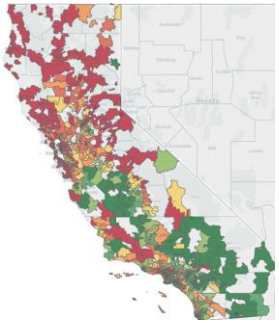


2. “Heat Wave Zones”
   - Indicators: Heat wave danger, medical vulnerability, social vulnerability

in progress

3. Cities
   - Indicators: Heat wave danger, medical vulnerability (some), social vulnerability

4. Census tracts
   - Social vulnerability, heat wave danger



5. Grid cells (~6km)
   - Heat wave danger

A heat wave zone is an area, made up of zip codes with similar extreme temperature characteristics (Tmax, Tmin, diurnal, relative humidity)

What are the limitations of and considerations for a vulnerability assessment?

- Climate data may be difficult to access, retrieve and reconcile at useful geographical and temporal scales
- Determine objective up front – e.g., understand climate trends and projections, screen for climate risks, inform planning
- To inform decision-making, helpful to start with a specific entry point
- Stakeholder engagement is critical for obtaining buy-in and support for the results – the process is equally, if not more, important than the outputs

What can a vulnerability assessment provide?

- Identification of vulnerable areas, populations, assets
- Understanding of the factors that contribute to vulnerability
- Inform prioritization of most pressing vulnerabilities to address
- Determination of potential entry points for adaptation
- Awareness raising
- Ensuring stakeholders have a shared understanding of vulnerabilities

427mt.com

Yoon Kim
Director of Advisory Services
ykim@427mt.com
Tel: 415.930.9797
www.427mt.com