Heat in Cities:
What It Means for Human Health

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Heat

= Extreme Weather?
Heat-health impacts in Maricopa County

Heat-Associated Deaths

- 2006: 80
- 2007: 50
- 2008: 50
- 2009: 70
- 2010: 80
- 2011: 100
- 2012: 120
- 2013: 70

Extreme heat events cause health problems and can make other health problems worse. Mild effects are more common, but in extreme cases, people can die.⁷

Maricopa County 2008–2011

153 deaths
1,336 hospitalizations
5,247 ED visits

Deaths
Require medical attention: emergency room/emergency medical services, physician office, clinic visit

Heat cramps, heat exhaustion, heat stroke

Mild symptoms, discomfort, subtle effects (e.g., skin eruptions, heat fatigue)
Heat & Water?
Phoenix Mayor Greg Stanton is calling on employers and individuals to donate bottled water to be given away to the homeless and others in need during the hot summer. Stanton is renewing a so-called “call for water” that resulted in the city collecting and distributing more than 210,000 bottles of water last year. According to Stanton’s office, the donated water goes to the homeless, individuals with disabilities, homebound seniors and young people and families.
Heat in cities
Heat in cities

[Diagram showing temperature differences between rural, suburban, and urban areas with labels for rural, suburban, and urban regions.]
Phoenix’s UHI
Research Areas

- Spatial Analysis of Heat Impacts
- Individual Heat Exposure
- Urban Climate Modeling
Average summer max. temp: 39.9°C
Threshold temperature (T*): 42.5°C
Average RR when T* exceeded: +3.7%
(+): Medium-intensity development
$p<0.01$, Adj. $R^2 = 0.167$

(+): PC1: Low education, high poverty, high public assistance, high nonwhite

(+): PC2: High living alone, medium-intensity development

(-): PC4: High home values, high income, forest land cover

$p<0.01$, Adj. $R^2 = 0.219$
Research Areas

• Spatial Analysis of Heat Impacts
• Individual Heat Exposure
• Urban Climate Modeling
(Re)Defining Heat Exposure

Activities
Behavior
Access to Resources
Outdoor Environment

Individually Experienced Temperatures
Health Outcomes
What are your IETs today?
Individually Experienced Temperatures (IETs)
Measuring IETs in Phoenix

5 neighborhoods
8 undergrad researchers
100+ iButtons
80 participants
~20 iButtons in homes
~15 iButtons in trees
September 13-20, 2014
daily surveys
exit interviews
temperature sketch maps
demographic surveys
ethnographic field observations
activity logs
## The Phoenix Neighborhoods

<table>
<thead>
<tr>
<th>Neighborhood</th>
<th>%White</th>
<th>Med HH Income</th>
<th>Important Trait</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coffelt (CO)</td>
<td>48.0%</td>
<td>13.3K</td>
<td>Public Housing</td>
</tr>
<tr>
<td>Encanto-Palmcroft (EP)</td>
<td>92.1%</td>
<td>121.4K</td>
<td>Historic Anglo Phoenix</td>
</tr>
<tr>
<td>Garfield (GF)</td>
<td>47.2%</td>
<td>27.6K</td>
<td>Gentrifying</td>
</tr>
<tr>
<td>Power Ranch (PR)</td>
<td>81.1%</td>
<td>87.2K</td>
<td>Master-planned</td>
</tr>
<tr>
<td>Thunderhill (TH)</td>
<td>84.8%</td>
<td>141.3K</td>
<td>World’s Largest Cul-de-sac</td>
</tr>
</tbody>
</table>
Sample of IET data (Boston)

No AC, most of day inside

OAT = Outdoor Ambient Temperature

Works in a cold office

 Mostly stayed in AC places, like the gym

Kuras, Hondula, and Brown-Saracino 2015
Int. J. Biometeorol
Neighborhood IETs vs. PHX outdoor temperature

Temperature (˚C) vs. hour

Legend:
- CO: Public Housing
- EP: Historic Anglo
- GF: Gentrifying
- PR: Master-planned
- TH: Cul-de-sac
Comparing neighborhood IETs

![Temperature chart showing hourly temperature variations for different neighborhoods. Each neighborhood is represented by a different colored line. The X-axis represents the hour of the day, and the Y-axis represents temperature in °C. The chart includes labels for different types of neighborhoods such as Public Housing, Historic Anglo, Gentrifying, Master-planned, and Cul-de-sac.]
Comparing neighborhood IETs

![Graph showing temperature and p-value over hours with different neighborhoods represented by different colors and markers.](image-url)
Neighborhood Heat Sensitivity

Heat sensitive neighborhood

Heat insensitive neighborhood
Neighborhood Heat Sensitivity

CO slope: 0.19 °C/°C
TH slope: 0.08 °C/°C
Research Areas

• Spatial Analysis of Heat Impacts
• Individual Heat Exposure
• Urban Climate Modeling
Urbanization: A key climate forcing

SunCorrHi Scenario

Georgescu et al. 2013, Nature Climate Change
Urbanization: A key climate forcing

SunCorrHi vs. B1 2040-2060

SunCorrLow vs. A2 2040-2060

Georgescu et al. 2013, Nature Climate Change
Urbanization Effects on Temperature

Hondula et al. 2014
Temperature-Mortality Model

\[ E(M) = s(\text{trend}, k = n \times y) + s(\text{temperature}, k = m) \]
Temperature-Mortality Model

Hondula et al. 2014
Projections of urbanization-induced heat-related mortality for greater Phoenix

Hondula et al. 2014
Research Areas

• Spatial Analysis of Heat Impacts
• Individual Heat Exposure
• Urban Climate Modeling
What are the solutions?
Urban Greening

City of Phoenix
Tree and Shade
Master Plan

*An investment strategy for creating a healthier, more livable and prosperous Phoenix*
Phoenix Heat Relief Network

Water Hydration Stations and Refuge Locations, Summer 2014

[Map showing hydration stations and refuge locations in Phoenix]
Heat Warnings

Excessive Heat Watch in effect from July 23, 10:00 AM MST until July 24, 08:00 PM MST

Current Conditions
Mostly Cloudy

Humidity: 17%
Wind Speed: VRBL 3 MPH
Barometer: 29.94 in (1011.6 mb)
Dewpoint: 47°F (8°C)
Visibility: 10.00 mi
Heat Index: 96°F (36°C)

Current conditions at Phoenix, Phoenix Sky Harbor International Airport (KPHX)

Phoenix AZ
7 Day Forecast

For More Weather Information:
Phoenix, AZ Local Forecast Office
Wireless Emergency Alerts

FEMA

National Weather Service

Wireless Carriers

Emergency Alert
Flash Flood Warning this area till 6:00 PM EDT. Avoid flood areas. Check local media. -NWS
Emergency Alert

Heat Warning: Avoid this area until 6:00 PM EDT. Avoid flood areas. Check local media. -NWS
Heat Warning
Maricopa County 2008–2011

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