Assessing Exposure and Experience with Extreme Heat in Phoenix, AZ

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Extreme Heat Threatens Human Health and Well-being

More people die from extreme heat than all other weather-related phenomena combined [1].

- Extreme heat events, defined as sustained high temperatures exceeding the normal range of temperature variability, occur throughout the world and are projected to become more intense, more frequent, and longer lasting over the next century [2].
- Public perceptions of risk to climate is relatively under-researched yet critical for developing strategies to effectively adapt to or mitigate the impacts of climate change, locally or globally.

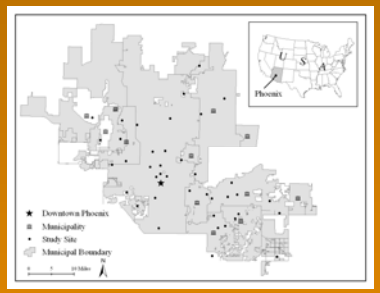
Analyses examine the distribution of extreme heat throughout the Phoenix metropolitan area while incorporating residents perceptions of and experiences with threshold temperatures.

Research Question:
How is exposure to extreme heat distributed among places and people in the Phoenix metropolitan area?

Calculating Exposure to Threshold Temperatures

Study Area

Located in the Sonoran Desert, the Phoenix metropolitan area is ideal for studying human vulnerability to high temperatures. It has a naturally warm climate and over the past 50 years of population growth, the average temperature has increased by more than 3°C.

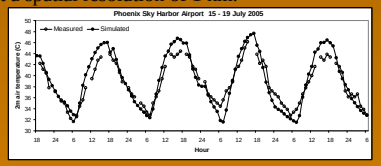


Metropolitan Phoenix, Arizona

Methods

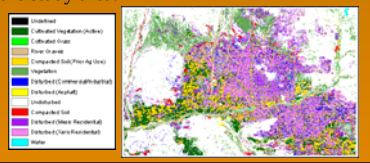
Weather Research and Forecast (WRF)

This study utilized the WRF mesoscale climate model to simulate local environmental conditions at a spatial resolution of 1 km.



Remote Sensing

Landsat 2005 imagery was used to classify LULC of the study area.



Data

NOAA Temperature Readings

Historical temperature readings were used to create Heat Intensity Classes.

- 97.5th Percentile: Threshold Temp = 45°C

Hours of Exposure to Extreme Heat

Temp	Range	Mean	Heat Intensity Class		
			Low	Med	High
N Neighborhoods			15	10	15
97.5th Percentile	24	12.65	<9	9-17	>17

PASS 2006

808 Phoenix area residents surveyed across 40 diverse neighborhoods.

- Perceived Temperature: How does temperature in your neighborhood compare to other Valley neighborhoods?
- Illness: Reported illness in household related to extreme heat in summer of 2005

Census Neighborhood Demographics

Block Group 2000.

The Spatial Distribution of Extreme Heat Correlates with Social Perceptions and Experiences

Variable Levels of Exposure to Extreme Heat

- Exposure to mean and threshold temperatures is significantly correlated with Heat Intensity Class;
- On average, mean average temperature is 2°C hotter in neighborhoods classified as High intensity when compared to Low intensity neighborhoods;
- Neighborhoods in the High intensity class were exposed to an average of over 6 times the hours that Low intensity neighborhoods experienced threshold temperatures.

Variable Levels of Exposure

Temperature	Heat Intensity Class		
	Low	Medium	High
N Neighborhoods	15	10	15
4-Day Heat Event C			
Mean Average	37.2	38.5	39.2
Mean High	44.7	45.9	46.5
Mean Low	29.8	30.9	31.8
Hours Exposure			
97.5th Percentile	3.3	14.5	20.7

Perceptions Parallel Environmental Conditions

- Residents' perceptions of and experiences with threshold temperatures align with the distribution of environmental conditions;
- Perception of risk is correlated with exposure to environmental conditions – perceptions that a respondent's neighborhood was "hotter" relative to others for summer 2005 are lowest in the Low heat intensity class;
- Residents in High intensity neighborhoods had more experiences with heat-related illness when compared to Low and Medium classes.

Experience with Threshold Temperatures

Measure	Heat Intensity Class		
	Low	Med	High
N Neighborhoods	15	10	15
Perception of Risk			
Temp of neighborhood*	19%	22%	31%
Illness			
Heat-related illness	24%	24%	31%

Chi-Square: *p<.01

Socio Factors Correlate with Exposure

- Social demographics are highly correlated with the distribution of extreme heat;
- Interestingly, neighborhoods in the High and Medium classes have larger percentages of elderly residents, which is cause for concern because the elderly are one of the most vulnerable groups to threshold temperatures;
- Low intensity neighborhoods are characterized as low population density, higher income areas with a relatively low presence of minorities or elderly.

Neighborhood Demographics

Variable	Heat Intensity Class		
	Low	Med	High
N Neighborhoods	15	10	15
Pop per sq mi	3,569	3,757	7,550
HH Income	$71,903	$62,669	$38,621
Minority	21%	26%	45%
Elderly (65+)	10%	20%	18%

Conclusion

Research Observations

- There is significant intra-urban temperature variation of exposure to threshold temperatures;
- Socio and ecological factors are highly correlated with risk to threshold temperatures;
- The identification of areas vulnerable to extreme heat, which may inform policy to reduce factors contributing to extreme heat in selected areas.

Implications on the Literature

- GIS provides a unique platform to synthesize physical and social data at spatially discrete locations to investigate exposure to and perceptions of extreme heat;
- Mixed method analyses report consistent findings regarding exposure to and self-reported illness with extreme heat among forty Phoenix neighborhoods.

Future Research

- Examine physical and social data at multiple spatial scales;
- Investigate LULC as a driver of exposure to threshold temperatures.

Acknowledgement

This material is based upon work supported by the National Science Foundation under Grant No. DEB-0423704, Central Arizona-Phoenix Long-Term Ecological Research (CAP LTER). Any opinions, findings and conclusions or recommendation expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation (NSF).

References

[1] (CDC) Centers for Disease Control and Prevention (2005) Heat-Related Mortality – Arizona, 1993-2002 and United States, 1979-2002. *Morbidity & Mortality Weekly Report* 54(25):628-630.

[2] Meehl GA & Tebaldi C (2005) More Intense, More Frequent, and Longer Lasting Heat Waves in the 21st Century. *Science* 305:994-997.