Measuring Individually Experienced Temperatures in Phoenix, AZ:

A New Method for Research and Education in Urban Environmental Science

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Research Context

•Urban environmental health hazards, including exposure to extreme heat, have become increasingly important to understand in light of ongoing climate change and urbanization.[1]

•Most current knowledge about heat-health risks is based on measurements of outdoor air (or land surface) temperatures.

•Neighborhoods (or other subdivisions such as census tracts) are often considered homogenous and appropriate units with which to assess risk and implement intervention strategies.[2]

•Previous work by authors has demonstrated that heterogeneity in heat exposure can exist within an urban neighborhood,[3] but the scale of differences within and between neighborhoods remains unknown.

Problem Statement

•Little is known about temperatures individuals actually experience within neighborhoods and cities, given differential access to cooling resources, complex activity patterns, and diverse thermal and social environments.

•The aim of this project is to measure Individually Experienced Temperatures (IETs) in a hot climate to better understand the distribution of heat exposure across urban neighborhoods.[3]

Research Q1: How does IET vary between neighborhoods?

Research Q2: How does heterogeneity vary between neighborhoods?

Methods

•In September 2014, 80 research participants were recruited from 5 Phoenix-area neighborhoods (see Table 1) that provided contrasts in heat-health vulnerability, geographic/microclimatic setting, demographic characteristics, and consistency with previous and ongoing research efforts.

•Participants were equipped with Thermochron iButton temperature sensors that recorded IETs at 5 minute intervals from 8PM 13-Sep to 8PM 20-Sep.[3]

•Participants completed background and daily surveys, engaged in activity log phone calls, and participated in exit interviews.

•The four hottest days during the study week were selected for analysis to represent average September conditions. This period included two weekdays and two weekend days.

•Average outdoor temperatures during this period spanned 28.6˚C to 37.0˚C.

Sevig, Singh, and Kuras stroll through a study neighborhood

Table 1. Selected traits of the study neighborhoods (* = CAP LTER study neighborhood)

Neighborhood	%White	Med HH Income	Important Trait
Coffelt *(Central City South)*	48.0%	$13,300	Public Housing
Encanto-Palmcroft* *(McDowell & 7th Ave)*	92.1%	$121,400	Historic Anglo Phoenix
Garfield *(Roosevelt & 7th St)*	47.2%	$27,600	Gentrifying
Power Ranch* *(in Gilbert)*	81.1%	$87,200	Master-planned
Thunderhill* *(in Ahwatukee)*	84.8%	$141,300	World's Largest Cul-de-sac

Results

Q1: Significant differences exist in mean IETs between neighborhoods for all hours with the exception of 6:00-10:00 (ANOVA, $p<0.05/24$; Figure 1).

Q2: In four of the neighborhoods, the pattern of heterogeneity was roughly similar throughout the 24 hour cycle. Thunderhill, the exception, had an inverse patterns with elevated variance in the period of 23:00-7:00 (Figure 2). This observation may be driven by A) two participants with relatively high IETs compared to their neighbors and B) a small sample size (n = 11).

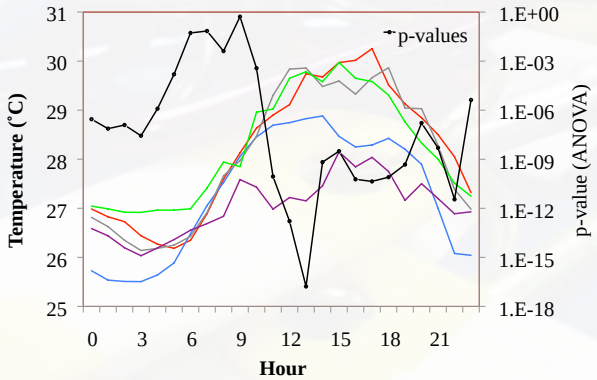

Figure 1. Mean neighborhood IETs during the analysis period (including ANOVA p-values)

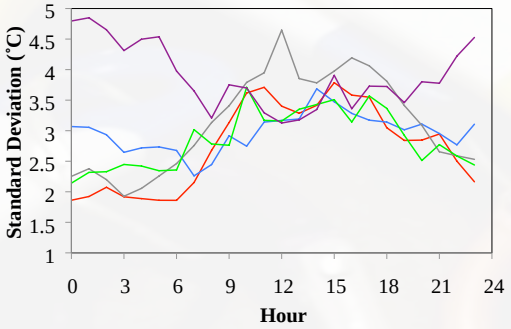

Figure 2. Standard deviation in neighborhood IETs during the analysis period

Discussion of Significance and Contribution

•Data collected in this study help explain how intra-city differences in outdoor temperatures manifest themselves into the heat exposure of urban residents.

•The pathway from extreme heat → human exposure → health and well-being outcomes is context-dependent on time and place. Such differences on the neighborhood scale are overlooked by outdoor air temperature measurements and should be better integrated into heat-health research and intervention strategies.

•Potential exists to synthesize IET information with long-term CAP data sets in three of the study neighborhoods (including PASS and microclimatic assessments).

The IET Lab Experience

•As part of a research-for-credit experience, 8 ASU undergraduates, ranging from freshman to senior, interviewed and were selected to assist with the project.

•Students were trained in field methods and data analysis and collaborated to finalize survey and interview questions.

•Focusing on specific study neighborhoods, students recruited participants, distributed iButtons, administered surveys, and conducted interviews.

•Each student developed an individual research question, processed and utilized appropriate data to narrow scope and address hypotheses, and wrote a 6-10 page research paper at the end of the semester.

•Students were asked to evaluate their experience and performance. Quotes are in *italics* and a word cloud was generated from responses.

"My personal research was where I really learned the most about the research process."

"I kept busy all semester and got a sense (at least a tiny bit) of what it takes to be a researcher and a scientist. I appreciate their work tenfold after I've had a taste of how time and effort consuming, yet exciting, it is."

"I am really proud of myself. The [interview] transcriptions were the hardest, but the most rewarding. I had trouble with GIS at first, but [another student's] help really did go a long way."

•IET methods provide opportunities for undergraduate students in to engage in interdisciplinary research and improve skills (e.g. Excel, GIS, research design, interactions with participants) through mentorship, motivation, and trial & error. The biggest challenge for students? Time management.

Bibliography

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