Extreme Heat and Power Failures: Understanding Household-Scale Risks

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INTRODUCTION

Extreme heat is a climate-sensitive health hazard of concern in many cities around the world. Heat vulnerability is higher in many lower-income neighborhoods where vegetation coverage is lower and land surface temperatures are higher. Future health impacts from long-term stressors like **global and urban-scale warming** along with shocks like **energy system disruptions** are expected to hit **resource-constrained populations** the hardest.

Our poster introduces a new project that aims **to improve regional hazard resilience**. Funded by an NSF Hazards-SEES grant, an interdisciplinary team of researchers at ASU, Georgia Tech, and University of Michigan are striving to uncover the specific **social and environmental mechanisms that determine urban vulnerability** when independent or coupled heat and power failure events occur. Our poster shares preliminary findings from summer 2016 data collection in Phoenix, which involved household surveys, semi-structured vignette interviews, and indoor, outdoor, and personal temperature sensors. Large contrasts in household experiences and coping strategies with heat are evident in these data, particularly with respect to **indoor temperature variance** and **anticipated emergency response strategies**.

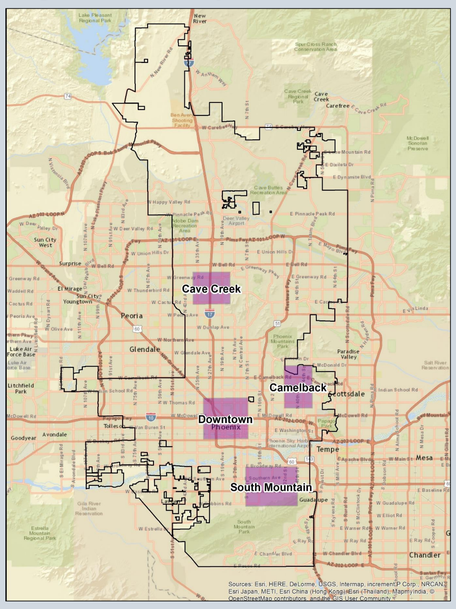
MATERIALS AND METHODS

Quantitative:

Temperature data loggers were placed inside the households of 46 participants. Data were recorded at 5-minute intervals for four weeks. We focus on nighttime temperatures (8pm-8am) as they are most likely to represent times at which the participant is at home and experiencing these temperatures.

Figure 1: HOBO UX100-011 Temperature Sensor

Figure 2: Study Sites



- Number of participants: 46
- Study period: 8/21-9/19

Qualitative:

Using **stratified random sampling**, we conducted 164 door-to-door **surveys** and 46 **semi-structured vignette interviews** to uncover:

1. *How do people keep themselves cool during normal power "on" conditions?*
2. *What would people do to stay comfortable during a prolonged regional blackout and concurrent heat wave?*

ACKNOWLEDGEMENTS

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RESULTS

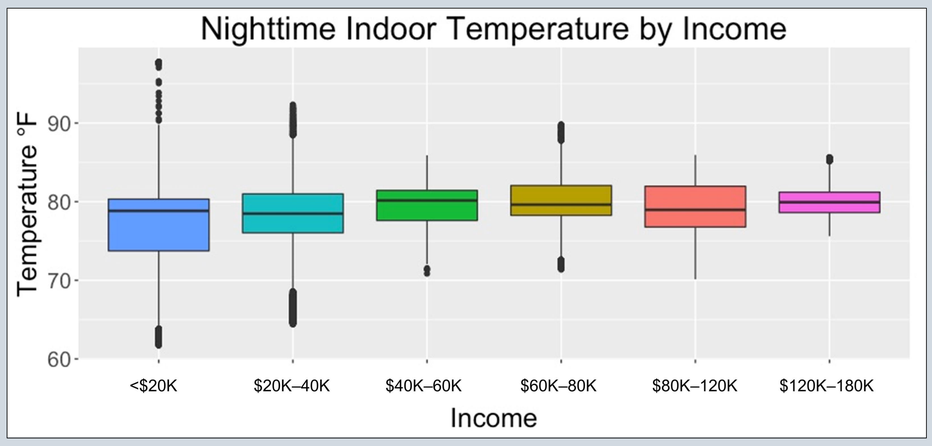


Figure 3: Boxplots of all nighttime (8pm-8am) observations over the entire study period (8/21-9/19) divided by income groups demonstrate variance at extremes but no clear trend in averages.

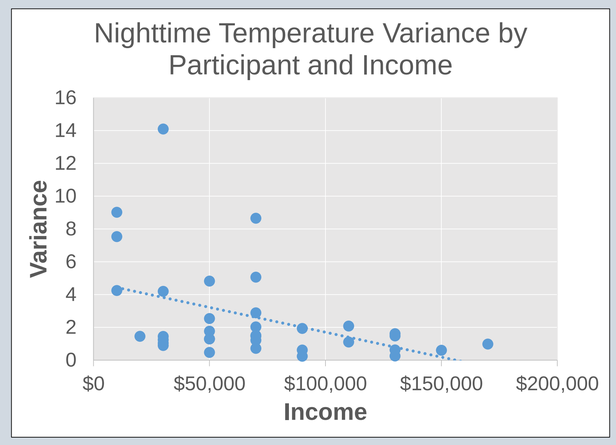


Figure 4: Nighttime (8pm-8am) variance by individual participant demonstrates clear trend and isolates individual households with the highest variance.

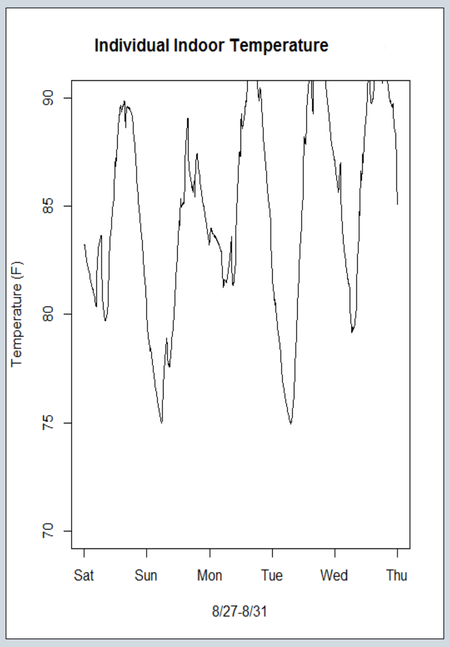


Figure 5: Participant 1
- Mean: 83.8
- 80th percentile: 87.8
- Variance: 20.0
- Household income: 20-40K
- Struggle to afford essentials: often
- Cost of electricity on AC usage: very limiting

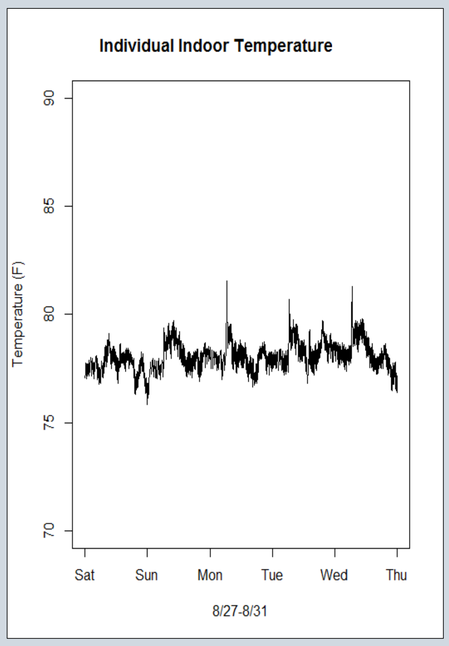


Figure 6: Participant 2
- Mean: 77.45
- 80th percentile: 78.1
- Variance: 0.6
- Household income: 100-120K
- Struggle to afford essentials: never
- Cost of electricity on AC usage: not too limiting

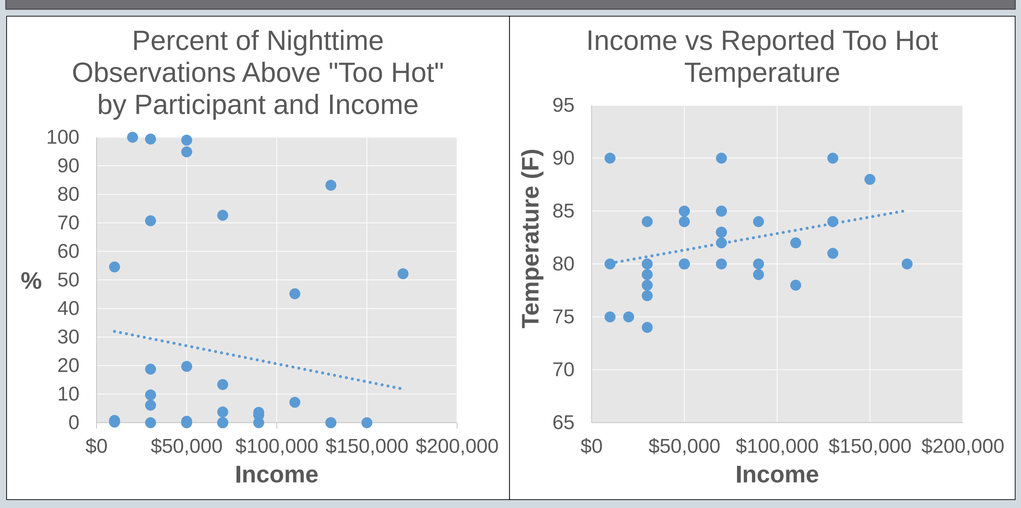
"In the last 5 years, have you landscaped the yard by adding grass or trees?"

"Was making your home cooler during hot weather an important reason you added grass or trees?"

Income (thsd's $)	not at all (n=7)	not too (n=6)	somewhat (n=9)	very (n=10)
<20		1		
20-40	2		2	2
40-60		1	2	1
60-80			1	
80-100	1			1
100-120	1			2
120-140		1		1
140-160		1	1	
160-180	1			
180-200		1		
>200	2			1
declined to answer		1	3	2

Table 1: Out of 102 homeowners surveyed, 33 responded that they had landscaped their yard by adding grass or trees. This table stratifies by income the level of importance placed on keeping cool in this decision.

"Too Hot": At what temperature inside your home in the summer do you start to feel **too hot** for your comfort?



Figures 7 & 8: Percent of time spent above individual's "too hot" threshold by income is shown by using both quantitative and qualitative data collection

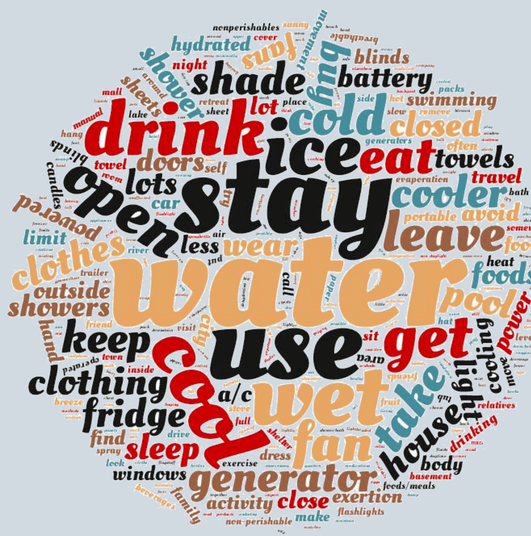


Figure 9: Word cloud of heat coping strategies to stay comfortable during blackout interview free listing exercise

CONCLUSION

Preliminary analysis suggests some connection between income and indoor temperature and comfort. Lower income households tended to have a higher temperature variance with most households that spent >70% of their time above "too hot" temperatures in a lower income bracket. This pattern was not evident in a direct comparison of mean or median temperatures and income. However, nearly as many lower income households have low temperature variance and spend <20% of their time above "too hot" temperatures. Our early analysis is challenging preconceived notions about AC usage and income, suggesting that indoor comfort is a commodity that many are unwilling to sacrifice.

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