Human vulnerability to heat in Phoenix and Chicago:
Spatial and temporal dimensions

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Introduction

Extreme hot weather conditions have become life-threatening natural events in many big cities around the world. Rapid urban population growth combined with more intense, frequent, and longer-lasting heat waves will exacerbate heat impacts on human health in the near future. This combination also challenge cities' emergency-preparedness and risk-management systems.

Human vulnerability to heat can be define a function of heat exposure, sensitivity, and coping capacities. A better understanding of human vulnerability to heat can help people to be prepared during extreme heat events and prevent heat impact on human health.

Objectives

We conducted a comparative analysis of two urban areas: Chicago, IL and Phoenix, AZ, in order to answered "how do the two cities respond differently to heat exposure due to different climate regimes, and urban structure in both spatial and temporal dimensions?" Our research examined the distribution of heat-stress emergency dispatches (heat-stress calls), as an indicator of heat-related illness, along with the in the summers between 2003 and 2006, to better understand how heat impact on human health in the two urban areas with different climate regimes.

Methodology

We used the negative binomial regression to model the relationship between temperature and heat-stress calls (heat slope). Using the heat slopes of the two cities, we estimate possible impacts when temperatures increase from 1 to 6.4 °C as climate model projected. In the spatial analysis, we used a spatial statistical approach (Getis-Ord Gi) to identify hot spots (clusters) of heat-stress calls.

Study Area

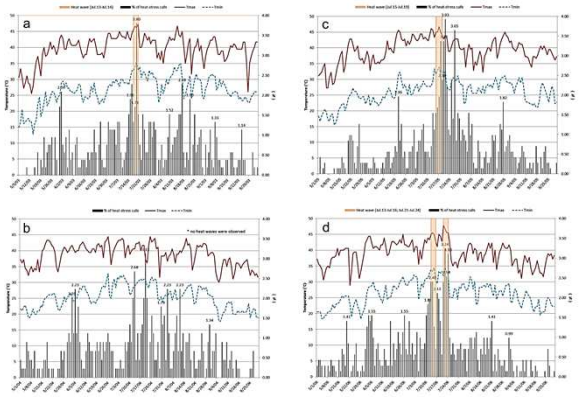
City of Phoenix : 517.2 km²
Population: 1.5 million
Density: 1181 people/km²
Race: 46% non-Hispanic white, 43% of Latino.
Avg. Max. Temp. in July: 41° C (106° F).

City of Chicago: 588.3 km²
Population: 3 million
Density: 4883.8 people/km²
Race: 45% non-Hispanic white, 33% Black.
Avg. Max. Temp. in July: 29.4°C (85° F).

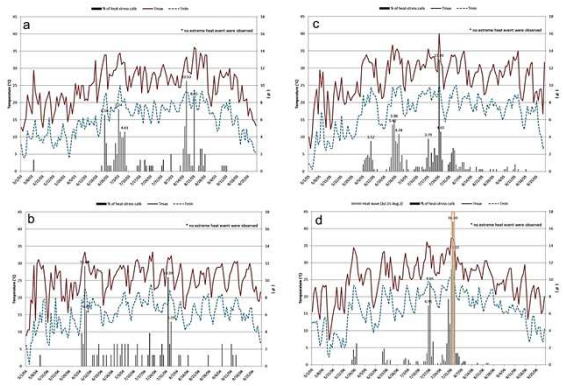
Analysis & Results

(1) Temporal distribution of heat stress calls in the two cities

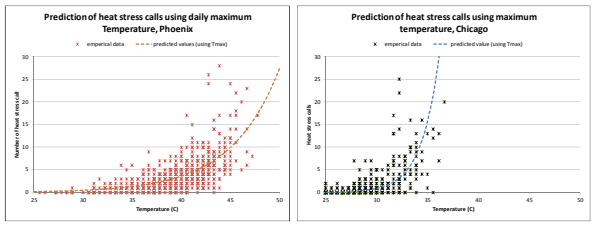
A. Phoenix



B. Chicago



(2) Negative binominal model results



(3) Impacts of temperature increase from 1 to 6.4 °C

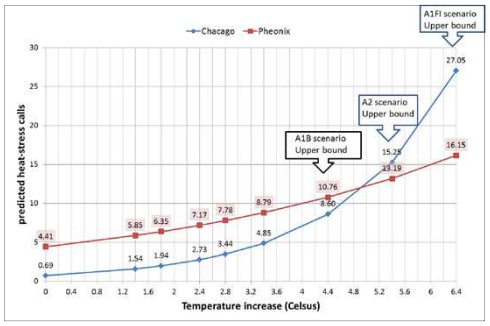
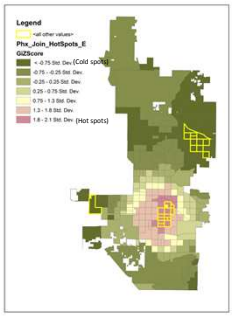


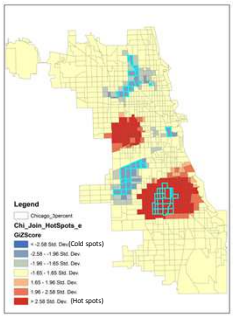
Figure 5. Estimation of heat-stress calls when temperatures increase from 1 to 6.4 °C in several climate-change scenarios. A1FI: Fuel intensive. A2: High population growth. A1B: balanced.

(4) Hot/Cold Spots of heat-stress calls in the two cities

A. Phoenix



B. Chicago



Conclusion

1.Heat-stress calls increase with maximum temperature much faster in Chicago than in Phoenix. Phoenicians are more acclimatized or adapted to heat.
2.Phoenix has a higher critical threshold (when heat-stress calls=1) for maximum temperature than Chicago does (33.7°C in Phoenix versus 30.2°C for Chicago). The cities' thresholds for heat index are different (29.8 °C for Phoenix versus 35.3°C for Chicago), presumably due to the low humidity in Phoenix.
3.Chicago will be more dramatically affected by climate change than Phoenix, when temperature increases more than 5°C.
4.Calls in Phoenix are spread throughout the summer, while in Chicago they cluster during heat waves. But Phoenix has more calls than Chicago does, despite its smaller population.
5.Heat stress calls concentrated in Central Phoenix and the south side of Chicago. These hot spots are low-income neighborhoods, and have high percentage of Hispanic (in Phoenix) or Africa American population (in Chicago).

Slide 1

KK2 Cross-site comparative analysis is redundant. Comparative anaysis of two urban areas is enough.
Kathryn, 1/8/2013

KK3 You don't need to mention spatial and temporal dimensions here, since you mention them in the next sentenc.
Kathryn, 1/8/2013