A historical analysis of threshold temperatures in Phoenix, AZ

School of Geographical Sciences and Planning, and School of Sustainability
Decision Center for a Desert City

Desirae Hoffman, Omaya Ahmad, Darren Ruddell, and Anthony Brazel

The Study

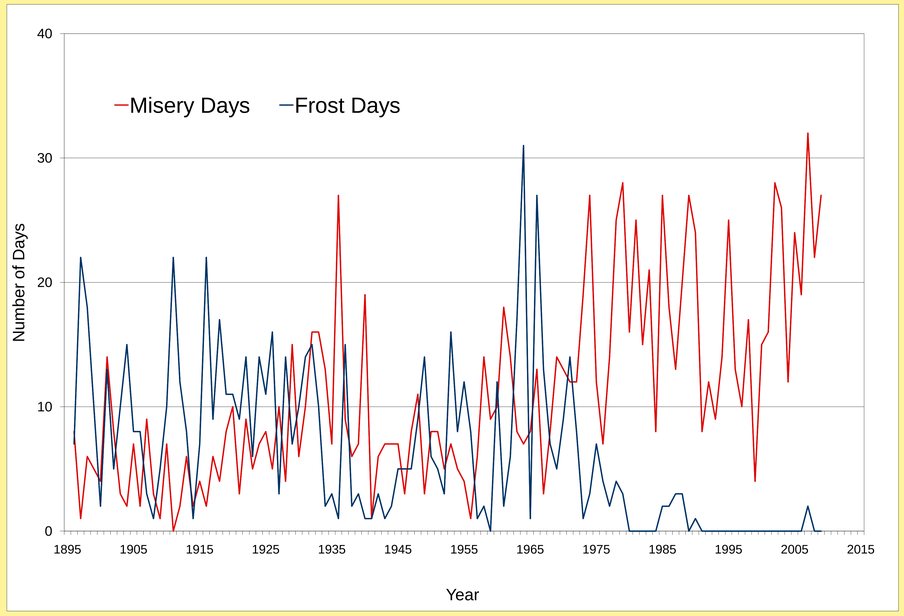
As the population of the Phoenix Metropolitan area grows, increasing temperatures have been found to have significant impacts on human health and environmental systems. Building upon the work of Meehl et al. (2004), this study analyzes the annual number of frost, and misery days recorded at the Phoenix regional weather station for the complete historical temperature record.

Frost days defined: nighttime minima temperature < freezing (32°F). Frost days help regulate pest and disease outbreaks by maintaining seasonal breeding cycles.

Misery days defined: daily maximum temperature ≥ 110°F. Misery days have adverse impacts on human health and well being as well as economic and environmental systems.

- What are the annual and decadal number of frost days and misery days for the Phoenix regional weather station between 1896-2009?
- If threshold temperatures are increasing, what environmental and social tradeoffs should be addressed?

Annual Historical Changes in Frost/Misery Days in Phoenix, AZ



Analysis of Frost and Misery Days

The analysis of frost days and misery days by decade shows two distinct patterns.

1) A natural oscillating trend in temperature variability between 1896-1970.
2) A pronounced departure from historical temperature patterns beginning in 1970 extending to present.

Decadal Occurrences of Frost and Misery Days (1896-2009)

Decade	Frost Days		Misery Days	
	N	Annual Average	N	Annual Average
1896-1900	59	11.8	24	4.8
1901-1910	78	7.8	56	5.6
1911-1920	120	12	44	4.4
1921-1930	104	10.4	72	7.2
1931-1940	66	6.6	130	13
1941-1950	51	5.1	61	6.1
1951-1960	67	6.7	69	6.9
1961-1970	118	11.8	106	10.6
1971-1980	46	4.6	172	17.2
1981-1990	11	1.1	214	21.4
1991-2000	0	0	127	12.7
2001-2009	2	0.2	206	22.9
Total	722	6.5	1,281	11.1

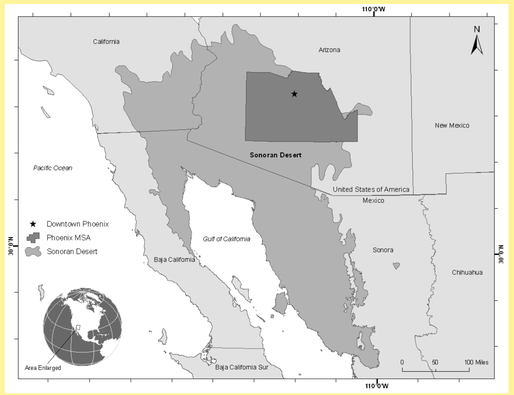
Research Methods and Data

Study Area

The Phoenix metropolitan area is located in the Southwestern United States. The large-scale population growth and urbanization of metropolitan Phoenix has been a mixed blessing: while growth has provided a valuable economic base for the city, the transformation of the fragile Sonoran Desert ecosystem into an urban metropolis has resulted in significant changes in regional temperatures, which, in turn, present serious risks and challenges to the health and well-being of local residents.

Phoenix sunset

Metropolitan Phoenix



Data

The data was provided by the Arizona State Climate Office and reflects temperature readings taken from the Phoenix weather station (operational from 1895-1999) as well as the weather station at Sky Harbor International Airport (1930-Present).

Methods

Daily temperature readings were collected from the Arizona State Climate Office. A literature review was conducted to define appropriate threshold temperatures for frost days and misery days. The temperature data was then organized to reflect the amount of threshold temperatures occurring each month. Finally, the amount of frost days and misery days were summarized per year, and per decade. The data has been represented in graphs and tables to depict the historical temperature trends in Phoenix from 1896-2009.

Conclusions

1. Frost/misery day analyses show: a) natural temperature variability from 1896-1970; b) a significant decrease in the number of frost days beginning in 1970; and c) a significant increase in the number of misery days beginning in 1970.
2. The substantial warming trend beginning in 1970 corresponds to the large-scale urban growth which occurred throughout metropolitan Phoenix.
3. Reflecting on the findings and literature used in this study, native plants in the Sonoran Desert may be negatively impacted as they rely on frost days for species dispersal; (see future research).

Future Research

1. Identify mitigation strategies to help reduce anthropogenic impacts on natural systems.
2. Maximize the efficient use of local resources (e.g., water, energy).
3. Use a rural neighborhood to conduct a similar study that investigates the evolution of the Urban Heat Island in Phoenix, AZ.

Acknowledgement

Thank you to Bethany Cutts, Katja Brundiers, and the 2009-2010 COURS class for their feedback and support. This material is based upon work supported by the National Science Foundation under Grant No. SES-0345945 Decision Center for a Desert City (DCDC). 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).

[1] Meehl GA , Tebaldi C, & Nychka D (2004). Changes in frost days in simulations of twentyfirst century climate. *Climate Dynamics*, (23), 495-511. [2] Meehl GA & Tebaldi C (2005) More Intense, More Frequent, and Longer Lasting Heat Waves in the 21st Century. *Science* 305:994-997.