**NASA DEVELOP National Program**



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Arizona Health & Air Quality II

Enhancing Extreme Heat Intervention and Preparedness Activities in Maricopa County, Arizona with NASA Earth Observations

**Technical Report** 

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# I. Abstract

[Placeholder - do not put anything here until the final draft submission. The abstract in the project summary is where the working draft of the abstract should “live”]

**Keywords**

Public Health, Urban Heat Island, MODIS, Land Surface Temperature, Landsat, OPeNDAP

# II. Introduction

**Community Concern and Study Area**

For over a decade, researchers have recognized the dangers that extreme heat pose to human health, and many studies have explored its effects as well as possible mitigation strategies (McMichael et al., 2008; Harlan et al., 2013). The desert Southwest is increasingly at risk of increased rates of heat related illness and death due to global climate change. Populations in arid climates can be more acclimated to elevated temperatures; however, the elderly, the poor, the homeless, non-native English speakers, and the socially isolated are all more vulnerable to heat related illness and death (MCDPH, 2014). In arid climates the majority of heat related service calls are made during the monsoon season in the later summer months of July and August when elevated temperatures and high humidity are most prevalent (Golden et al., 2008).

Maricopa County, Arizona was the focal area of this study since it contains the city of Phoenix and its surrounding metropolitan areas. The prevalence of impervious surfaces within the city, such as concrete and asphalt, trap heat from solar radiation in a phenomenon known as the Urban Heat Island (UHI) effect. In a typical UHI, heat trapped during the day will be released into the lower atmosphere at night. Thus, the effects of the UHI are relatively greater at night than during the day (Hardegree, 2006). Elevated temperatures within Maricopa County have an adverse effect on the health of its citizens. In addition to causing heat stroke, elevated temperatures can lead to cramps, exhaustion, heat syncope, and can exacerbate pre-existing respiratory and circulatory conditions (Scott et al., 2004). According to the Maricopa County Department of Public Health (MCDPH) 2013 annual report, there were 632 confirmed heat related deaths between 2006 to 2013.

**Project Affiliation and National Application**

In this study, the UHI effect in Maricopa County was analyzed using Aqua MODIS Land Surface Temperature data acquired during the summer months of April through October from 2006 to 2015. The project maintained a partnership with the Arizona Department of Health Services (ADHS), the Phoenix Heat Relief Network, the National Weather Service Phoenix Forecast Office, the Environmental Remote Sensing and Informatics Lab (ERSL) at Arizona State University (ASU), and the Center for Policy Informatics (CPI) at ASU. The project objectives allowed for the creation of an automated python tool that will download MODIS data in near real-time to create heat maps of Maricopa County. The partners will be able to use this tool to understand spatial and temporal patterns of extreme heat events, which will better inform their heat mitigation strategies.

# III. Methodology

**Data Acquisition**

Manual collection of Aqua MODIS MYD11A1 version 005 data and Landsat 8 imagery was available through NASA EarthData Search. This can be a long process if downloading a large temporal range of HDF files. A case study was conducted in conjunction with the Atmospheric Science Data Center (ASDC) to include OPeNDAP data collection. Connection to the data portal was made available through PyDAP code which allowed users of the python tool to acquire near real-time imagery for processing.

Multiple collections of heat anomalies were obtained from University of Utah’s Mesowest API. The same 285 weather stations from the previous study were referenced to establish a baseline of temperature anomalies. Shape files of Maricopa County were obtained from the Maricopa County Health Department.

It was essential to use the same data from the previous term for proof of concept and to establish a baseline for continued analysis during demonstrations of the tool.

**Data Processing**

Data were processed through the automation of a python tool that clipped the tiles against a .shp outline of Maricopa County. We determined the effectiveness of the clipped files by examining cloud coverage.

Scripts from the previous term were shared via Google Drive and used as a model for the development of the python tool. This helped ensure that results remained consistent between the two projects.

**Data Analysis**

All analysis will be completed in python to produce figures or a specific function will call on scripts written in R.

# IV. Results & Discussion

Insert images, graphs, maps, charts, etc. here. Choose the most important results to highlight here. No word cap, but two to six pages is a good range.

Things to discuss:

* Analysis of Results: What can you tell from your graphs, images, etc? What does this mean for your project?
* Errors & Uncertainty: What factors could you not account for, what things didn’t work out like you expected they would, etc.
* Future Work: If this project was to be selected for another term, what would be the focus? What other areas would be of interest?

# V. Conclusions

Final conclusions. Word count: 200-600 (~a page).

# VI. Acknowledgments

Insert here. Keep to a concise paragraph or bullets of names. End with the following sentence.

This material is based upon work supported by NASA through contract NNL11AA00B and cooperative agreement NNX14AB60A.

# VII. References

Insert references here. Only include articles/content cited in the body of text above. It’s great if you read many other articles, but they should not all be listed here unless they are being cited in this report.

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Hardegree, Lynn C. 2006. “Spatial Characteristics of the Remotely-Sensed Surface Urban Heat Island in Baton Rouge, LA: 1988-2003.” PhD diss., Louisiana State University.

Harlan, S.L., Brazel, A.J., Prashad, L., et al., 2006, Neighborhood microclimates and vulnerability to heat stress: Social Science & Medicine: v. 63, p. 2847-2863.

Golden, J.S., Hartz, D.H., Brazel, A, et al., 2008, A biometeorology study of climate and heat-related morbidity in Phoenix from 2001 to 2006: International Journal of Biometeorology, v. 52, p. 471-480, doi: 10.1007/s00484-007-0142-3.

Maricopa County Department of Public Health: Division of Disease Control: Office of

Epidemiology (MCDPH). 2014. “Heat-Associated Deaths in Maricopa County, AZ.” Final Report for 2013. Accessed February 2016. http://www.maricopa.gov/publichealth/Services/EPI/pdf/heat/2013annualrepor

t.pdf

McMichael AJ, Wilkinson P, Kovats RD, Pattenden S, Hajat S, Armstrong B, et al. 2008. International study of temperature, heat and urban mortality: the ‘ISOTHURM’ project. Int J Epidemiol 37:1121–1131.

Scott, Sheridan C., Kalkstein, Laurence S. 2004. “Progress in Heat Watch-Warning System Technology.” *American Meteorological Society* 85, no. 12 (June): 1931-1941. Accessed February 11, 2016. http://dx.doi.org/10.1175/BAMS-85-12-1931

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# IV. Appendices

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