How Environment and Elevation Affects Air Temperature & Heat Disorder Likeliness: A Microclimate Urban Heat Island Study In Urban Albuquerque NM

David Hoang, Micah Watkins, H. Scott, and M. Will-Cole

Central New Mexico Community College

Albuquerque, NM

Introduction and Motivation

The Urban Heat Island Effect (UHIE) is the phenomenon where urban areas experience higher temperatures than their rural surroundings. This effect results from the replacement of vegetation with materials that have low reflectivity and high heat retention. While previous studies have predominantly focused on UHIE in flat terrains and surface temperatures, there is limited research on its impact in elevated terrains or its correlation with the effective air temperature (T_{AIR}) that humans experience in daily life in association to the UHIE. This study aims to investigate height-to-width ratios of greenspaces and buildings, along with elevation, and examine their correlation with T_{AIR} experienced by people. This study aims to explore the relationship between the height-to-width (H/W) ratios of green spaces and buildings, elevation, and their influence on T_{AIR}.

Methodology

- Where?
  Oldtown, Urban Albuquerque, NM
- When?
  2x a week on Wednesdays and Sundays; 3x a day at 8:00-9:00 AM, 2:00-3:00 PM, and 7:00-8:00 PM.
- What?
  Collected air Temperature Data, Humidity, and Meta data (elevation, and building height/width ratios via Google Earth)



Continuous T_{AIR} measurements were recorded using an Airbeam-3 sensor. Airbeam T_{AIR} data was calibrated by a Kestrel-3000 environmental sensor.

The transect was divided into 12-stations 5-minutes apart, where Kestrel T_{AIR} data was collected. Final T_{AIR} values found using a 2nd degree curve fit from the Airbeam data to the Kestral data.

Elevation data for each station was obtained from google earth. Pearson's correlation coefficient is used to analyze the correlation between T_{AIR}, elevation, green H/W ratios, and building H/W ratios.

Results and Analyses

This study was designed to answer three research questions (RQ):

(RQ1): How does the H/W ratio of green spaces and buildings affect air temperature?

(RQ2). How does elevation affect air temperature?

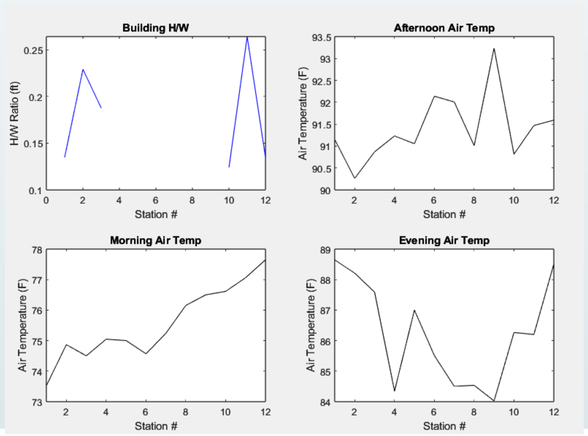
(RQ3). How does the urban environment affect risk for heat-related disorders?

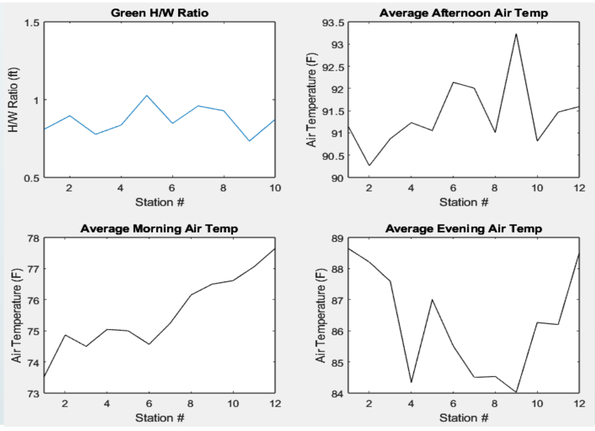
Comparison Variables	Morning	Afternoon	Evening
Elevation	0.25945	0.59258	-0.41488
Green H/W	0.35706	-0.58315	-0.029369
Building H/W	0.048749	-0.14494	-0.31597

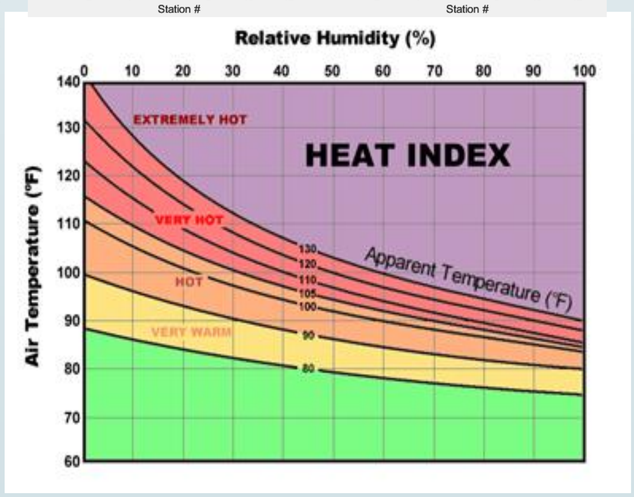
Figure 2: Average T_{AIR} to Elevation, Green H/W, and Building H/W Correlation Coefficient Table

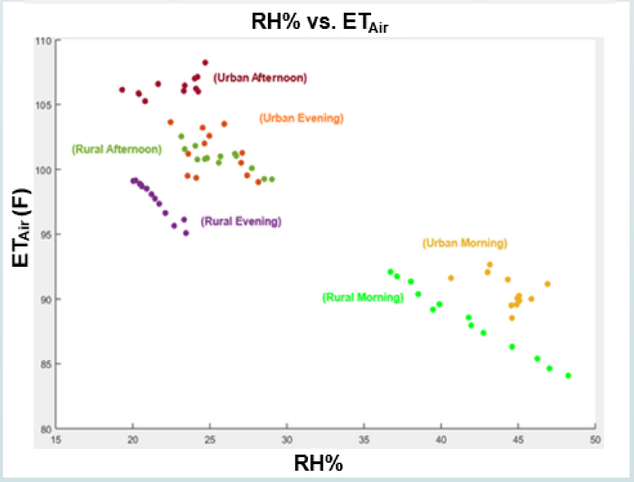
I	Extremely Hot	130°F or Higher	Heat/Sunstroke **HIGHLY LIKELY** with continued exposure
II	Very Hot	105°F - 130°F	Sunstroke, heat cramps, or heat exhaustion **LIKELY**, and heatstroke **POSSIBLE** with prolonged exposure and/or physical activity
III	Hot	90°F - 105°F	Sunstroke, heat cramps, or heat exhaustion **POSSIBLE** with prolonged exposure and/or physical activity
IV	Very Warm	80°F - 90°F	Fatigue **POSSIBLE** with prolonged exposure and/or physical activity

Figure 2: NOAA Heat Index Table









Conclusions

- H/W ratios of green spaces and buildings alone do not strongly correlate with T_{AIR}.
- Combining proximity with H/W ratios shows a higher correlation.
- Elevation has a weak correlation with H/W in the mornings & evenings but weaker in the mornings due to sun rise.
- In the afternoon, elevation correlates to increased T_{AIR} due to greater solar-radiation exposure, while a fair-negative correlation is seen in the evening as the sun sets.
- Urban T_{AIR} & relative humidity pose significant health risks, which vary with proximity to green spaces, time of day, and elevation.

References

Marcel, C., *et al.* 2024: The relation between proximity to and characteristics of green spaces to physical activity and health: a multi-dimensional sensitivity analysis in four European cities. *Environmental Research,* 241,117605.

Tang, J., *et al.* (2022): Estimation of urban-rural land surface temperature difference at different elevations in the qinling-daba mountains using modis and random forest model. *Int. J. of Environ. Res. Public Health*, 19,11442.

Acknowledgements

This work was funded by NSF grant award 2246468. Heather Fox-Gardner for collecting rural data.