



Spatial Analysis of Extreme Nighttime Heat Events, Social Vulnerability, and Environmental Social Injustice in Madison, Wisconsin



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I. Introduction

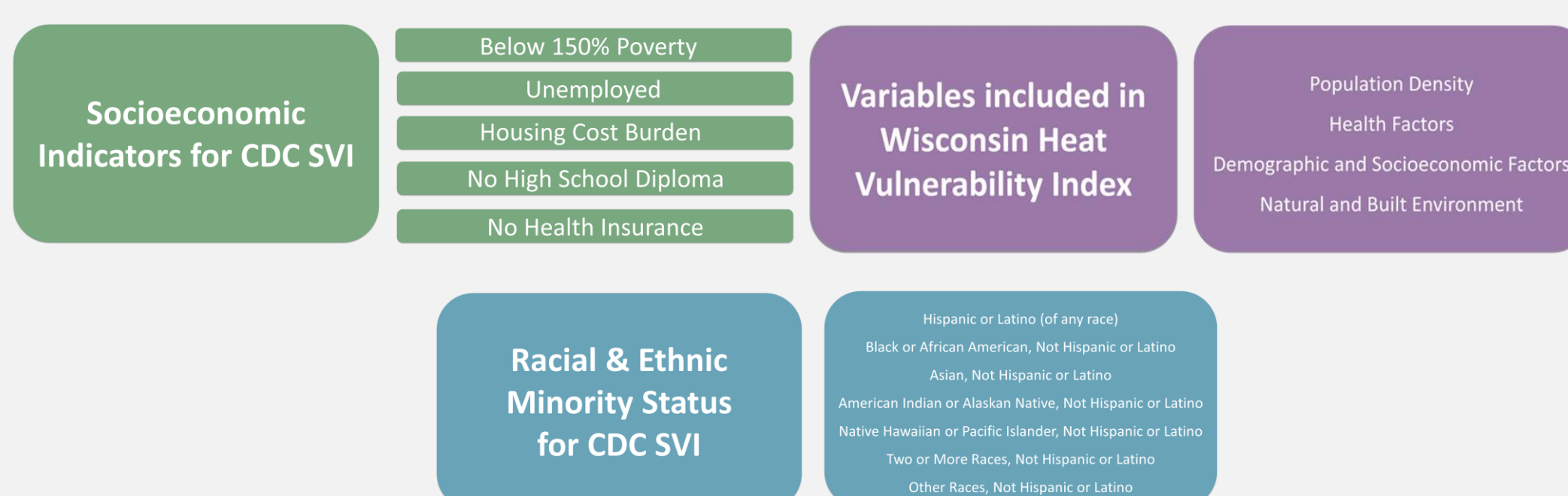
- The urban heat island (UHI) effect has been observed in Madison, Wisconsin, showing a spatial relationship between extreme heat, built environment, and population density¹
- Strong correlation values between UHI and certain demographics and impervious surfaces were found in Spokane, Washington²
- Extreme heat events disproportionately impact socially vulnerable populations³
- Identifying high-risk areas and populations aid in understanding and providing support during extreme heat events³

II. Objectives

- Identify correlations between extreme nighttime heat events, metrics of social vulnerability, and environmental social injustice

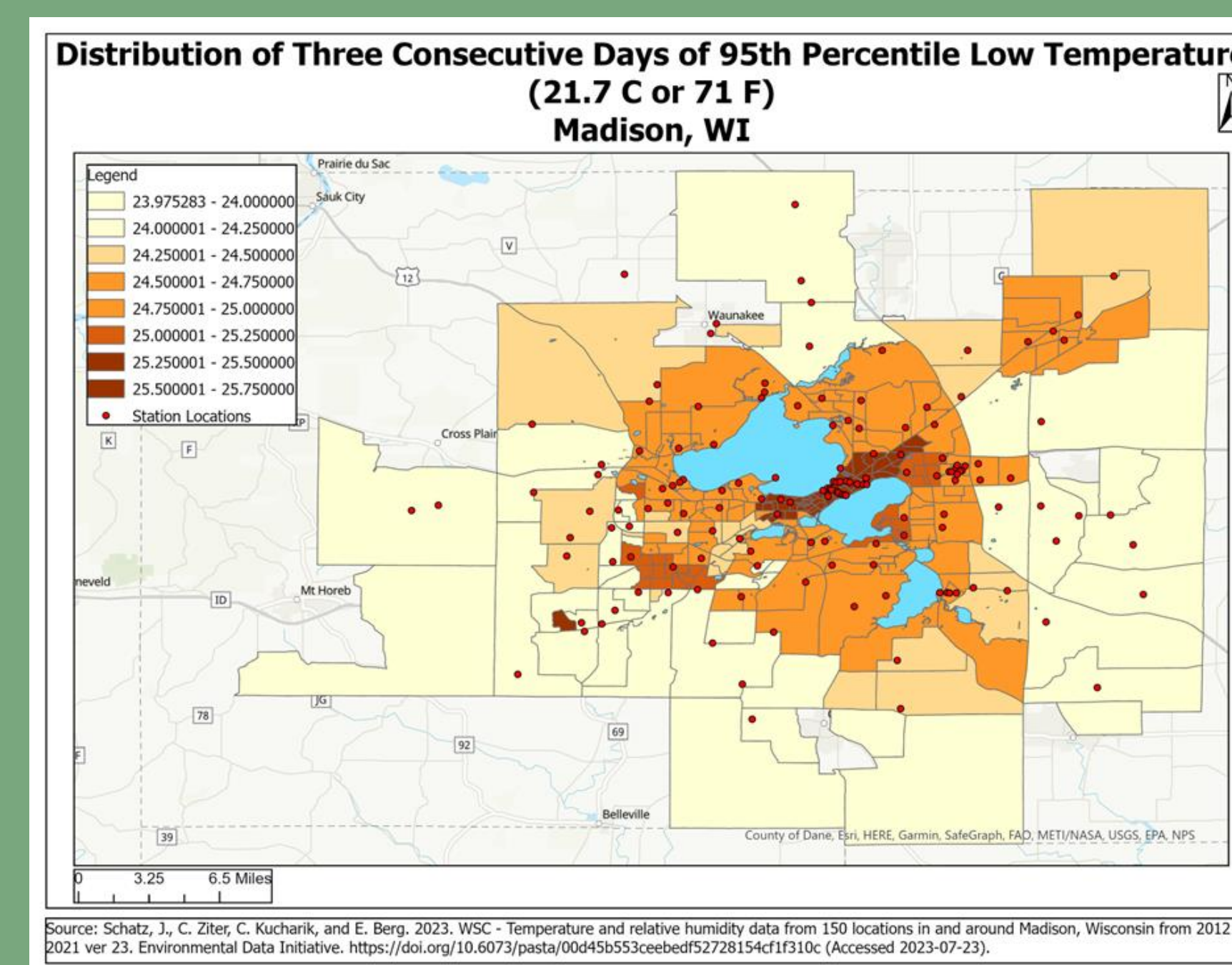
III. Methods

- Composited 2012-2021 temperature data from 150 stations around Madison for extreme nighttime heat events (T_Min), defined as 3 or more consecutive nights when nighttime minimum temperatures at Dane County Regional Airport remain above the 95th percentile
- Utilized ArcGIS to remap temperature composites into Dane County census tracts to compare with social vulnerability factors defined by the CDC (SVI) and the Wisconsin Department of Health Services (DHS)
- Following the Spokane study, calculate correlations between the spatial distribution of extreme heat, socioeconomic indicators, demographics, and built environments
- Interview with Wisconsin DHS to identify significant variables and communities to analyze in the study



IV. Results

Extreme Nighttime Heat Events show a Hot Spot on the Madison Isthmus, Extreme Nighttime Heat is Correlated with Built Environment, Socioeconomic Indicators; Not Correlated with Demographic Status



Minimum Temperature (T_Min) Correlation Values	
Impervious Surface Type	.547
Heat Vulnerability Index	.440
Socioeconomic Indicators	.350
Racial & Ethnic Minority Status	.035

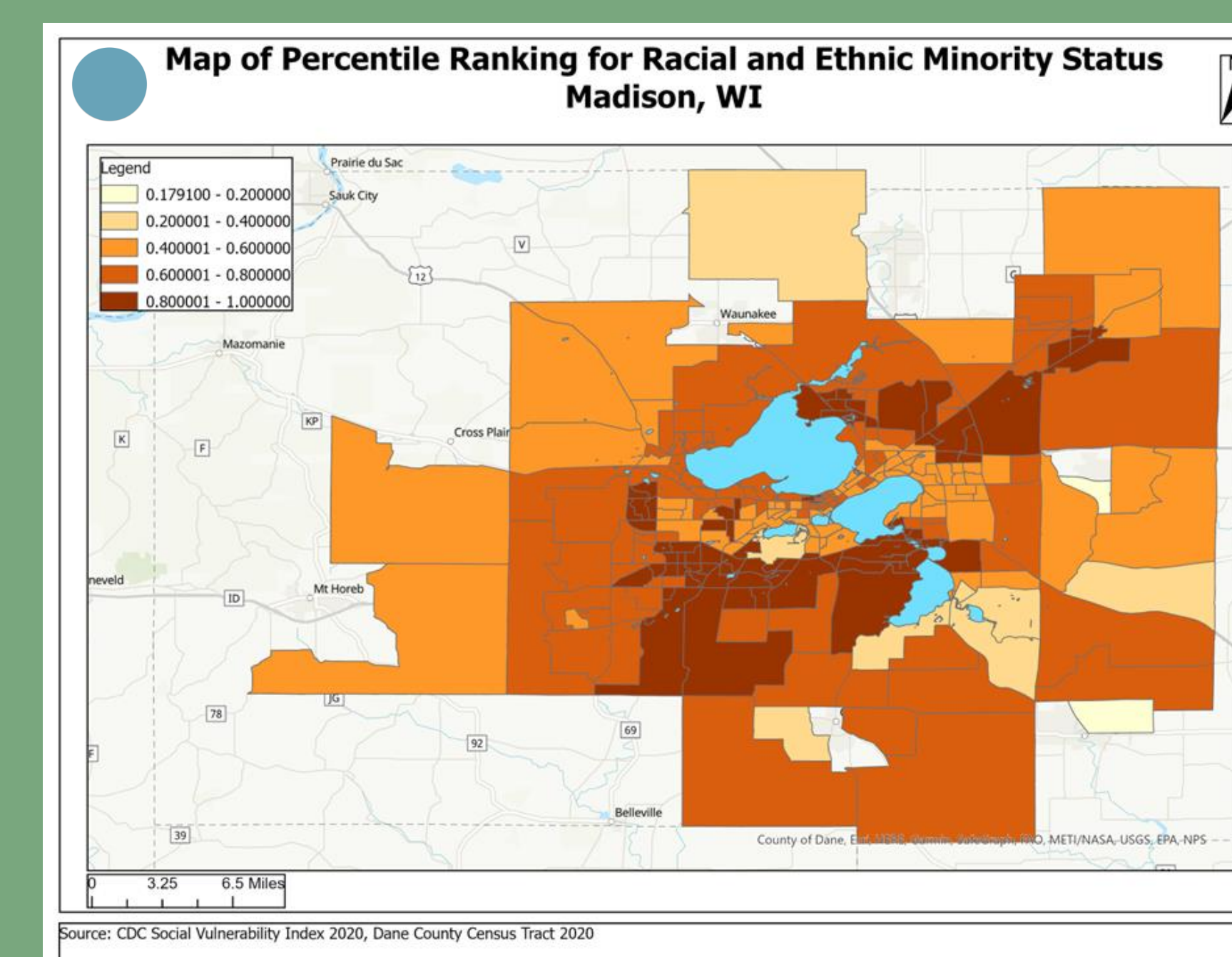
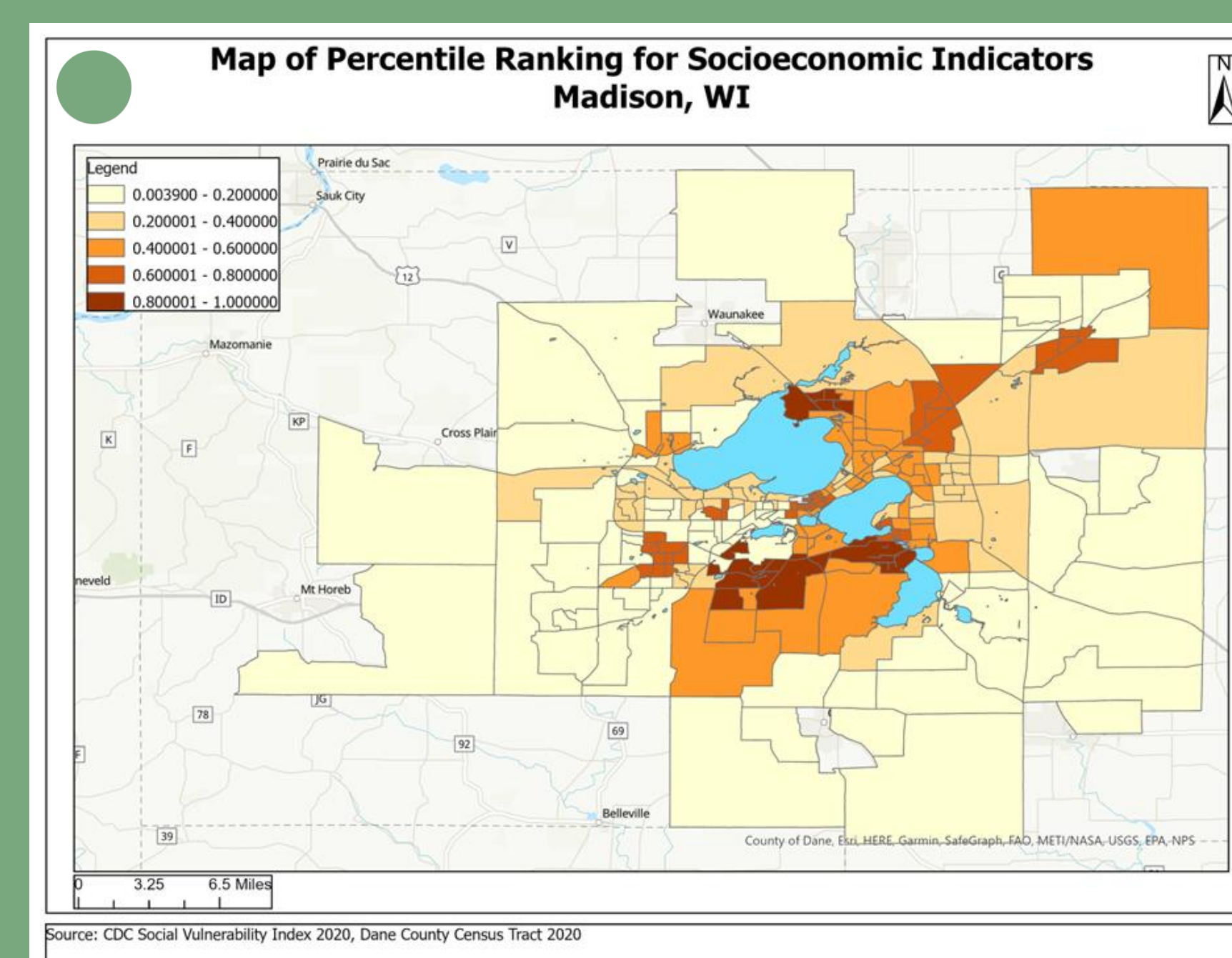
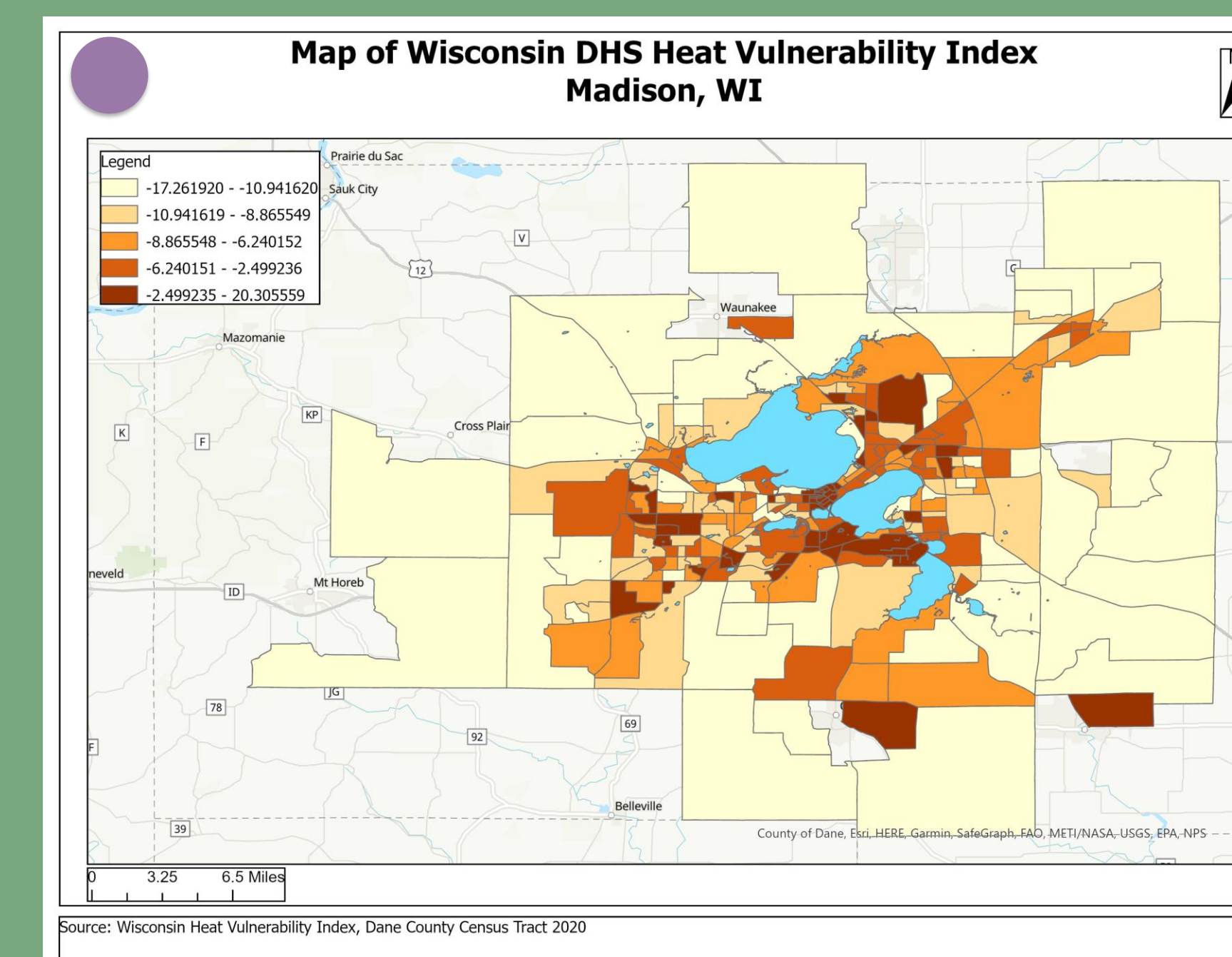
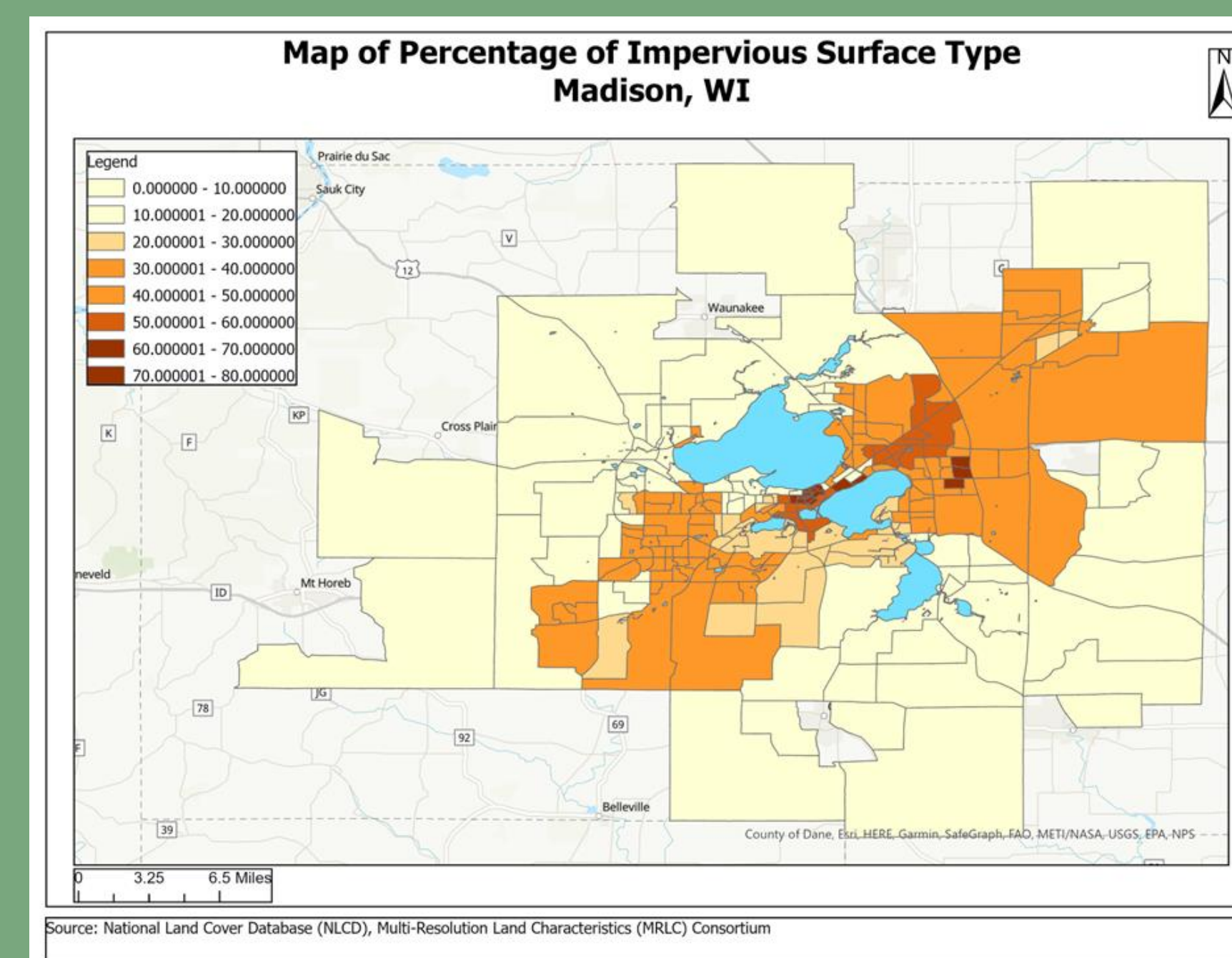
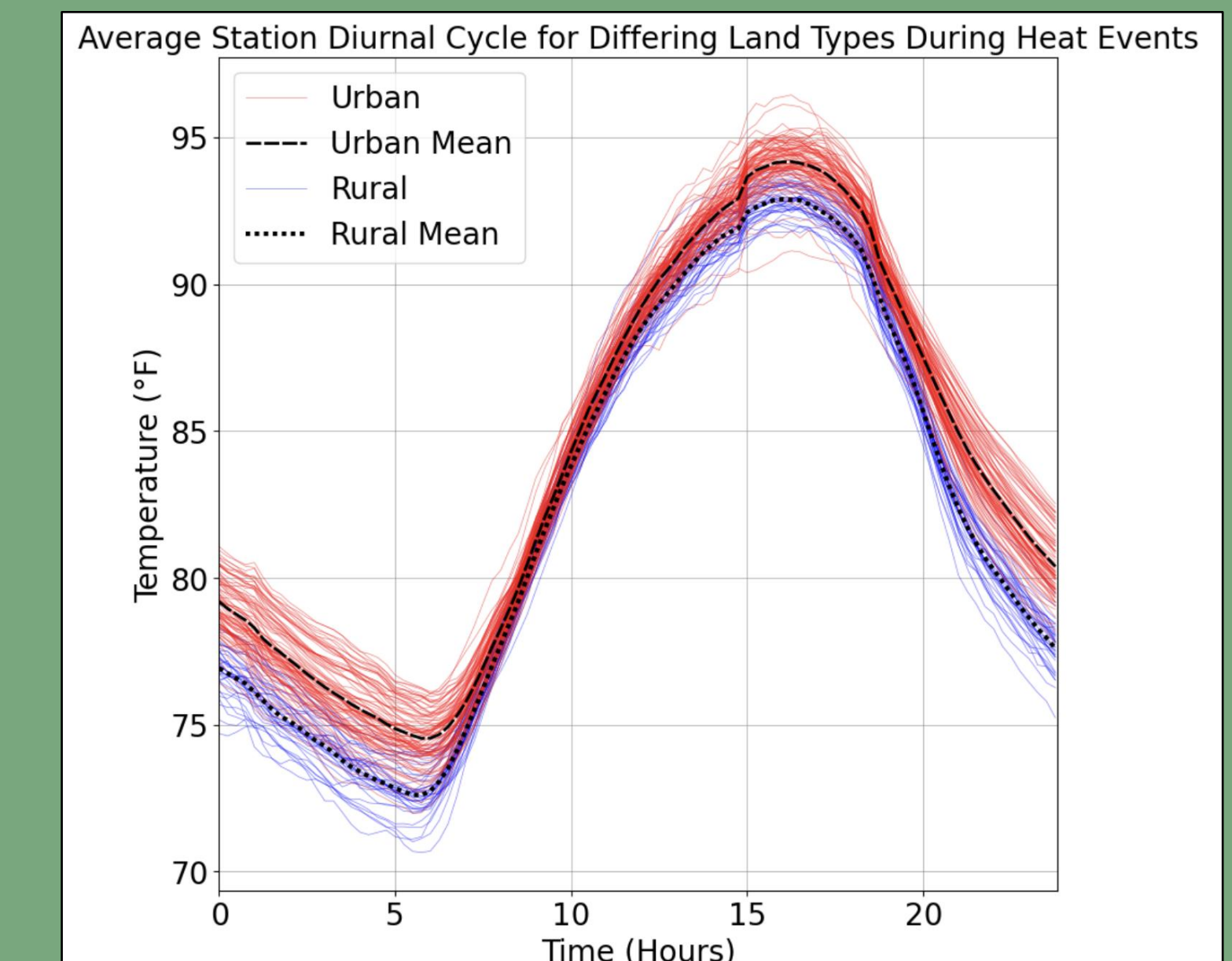


Figure 1 – Maps of spatial heat distribution, heat vulnerability, built environment, demographics, and socioeconomic indicators; table with correlation values between each variable and minimum temperature

Figure 2 – Composite of Station Diurnal Cycle



V. Conclusions

- Strong correlation values between T_Max and T-Min suggest areas prone to extreme daytime heat values are also areas that receive no nighttime heat relief
- Socioeconomic indicators correlated with nighttime heat events are mainly influenced by those living with a housing cost burden and those living below the 150% poverty line
- Nighttime heat events have a strong correlation with the built environment, specifically impervious surfaces, which leads to hot spots along the isthmus where the built environment is the most significant
- While the correlation between racial and ethnic minority status and T_Min is weak, that does not mean there is a lack of impact due to nighttime heat stress

VI. References

- Jason Schatz and Christopher J Kucharik 2015 *Environ. Res. Lett.* 10 094024
- Henning, B.G., K. Ducken, K. Honebein, C. Farho, B. Brown, 2023. "Spokane Beat the Heat: Correlations of Urban Heat with Race and Income in Spokane, WA." Report prepared by the Center for Climate, Society, and the Environment, Gonzaga University, Spokane, WA. <https://doi.org/10.33972/ccse.2023.01>
- Phillips, J. (2014, October). *Wisconsin's heat vulnerability index, P-00882 - Wisconsin Department of Health Services Wisconsin Heat Vulnerability Index.* <https://www.dhs.wisconsin.gov/publications/p0/p00882.pdf>
- Interview with Margaret Thelen, MPH, Climate and Health Program Manager, Wisconsin DHS