Unequal Heat: Identifying and Addressing Urban Heat Vulnerability in Philadelphia's Communities

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Background

The Urban Heat Island (UHI) effect, where urban areas experience significantly higher temperatures than surrounding rural or suburban areas, is intensified in densely populated cities and disproportionately impacts vulnerable communities. Rising global temperatures exacerbate this effect, as seen in cities like Philadelphia, where extreme heat events have increased from about 4 days annually in 1980 to nearly 12 days in 2013. In contrast, suburban areas have remained relatively constant, averaging 5 extreme heat days per year (Weber et al., 2015, p. 235). Philadelphia's transition from a major industrial hub to a service-based economy (Tian et al., 2022, p. 537) has left a legacy of impervious surfaces, dense urban development, high population concentrations, and limited greenspaces, all of which exacerbate UHI effects. However, extreme heat cannot be addressed without considering equity. It impacts low-income communities and people of color the most, due to systemic inequities like racist housing policies and historic disinvestment. These groups often live in hotter areas with fewer resources to manage heat, making them more vulnerable. This systemic inequity shows the need for targeted analysis and interventions.

Goals

Despite these challenges, research gaps remain in understanding the micro-scale dynamics of the UHI effect in vulnerable neighborhoods of Philadelphia. This study aims to identify the most vulnerable areas at the city scale, understand the contributing socioeconomic factors that lead to higher UHI effects, and conduct a micro-scale analysis at the neighborhood level. Focusing on the yellow areas (Figure 1), which include census tracts in Upper and Lower North Philadelphia as well as West Philadelphia, were identified as the most susceptible to the health impacts of heat from 2017 to 2019. The findings propose evidence-based mitigation strategies aiming to serve municipal government agencies, local communities, and advocacy groups.

Research Questions

1. What environmental, infrastructural, historical, and socioeconomic factors drive the higher UHI effect in Philadelphia's most vulnerable areas, and how do these factors correlate with income, housing prices, and economic disparities?
2. Which populations/demographics in Philadelphia's most vulnerable areas are at greatest risk from urban heat and what drives their vulnerability?
3. What patterns in urban heat distribution can help guide effective, targeted mitigation strategies, and what insights could reveal unknown recommendations or solutions?
4. How do variations in urban heat intensity influence crime rates and patterns? (Optional)

Milestones and Management

This three-week project will be organized into key sub-portions, allowing flexibility to prioritize tasks and adjust if the deadline approaches. Team members will each focus on specific analysis tasks, coding separately initially and collaborating later to integrate work, ensuring shared scripts are well-documented with explanatory comments.

Timeline		
W1 (17-23 Nov)	W2 (24-30 Nov)	W3 (01-09 Dec)
● Source, clean and process data ● Develop initial maps and tables for socioeconomic, health, and environmental factors. ● Draft and test regression model for significant influence on UHI	● Conduct pre-spatial clustering (Moran) ● Create overlay maps ● Define key yellow areas ● Regression model for significant influence on UHI	● Brainstorm mitigation strategies from the analysis ● Draft descriptive tables ● Finalize visuals and prepare the presentation ● Summary Narrative

Data Collection & Analysis

Spatial and Non-Spatial Deliverables	**Data Collection**
Urban Heat Map	● Heat Vulnerability: Data by census tract to identify areas most affected by extreme heat.

Overlay Maps: Overlay environmental, socioeconomic, and health variables to identify geographical correlations	• Geospatial: Shapefiles for Philadelphia County and neighborhoods. • Environmental: tree canopy coverage, impervious surfaces, green spaces, and air quality metrics. • Socioeconomic: income, housing conditions, poverty rates, and population density. • Health: age groups at risk, common causes of death, prevalence of chronic conditions, disability data. • Crime Data: Incident reports to explore correlations with urban heat intensity.
Demographic graphs: Socioeconomics and Health	
Descriptive Statistic Tables: Mean, median, and distribution of key variables	
Regression Model Correlation Tables: Outputs showing the predictors (e.g., greenspace, impervious surface) most strongly correlated with UHI	
Pattern Analysis Model (Moran I): Identify "hotspots" of vulnerability	

Data Collection Contingencies: If neighborhood-level socioeconomic data is unavailable, city or county datasets will be used. Assumptions made in extracting relevant information will be clearly documented for transparency.

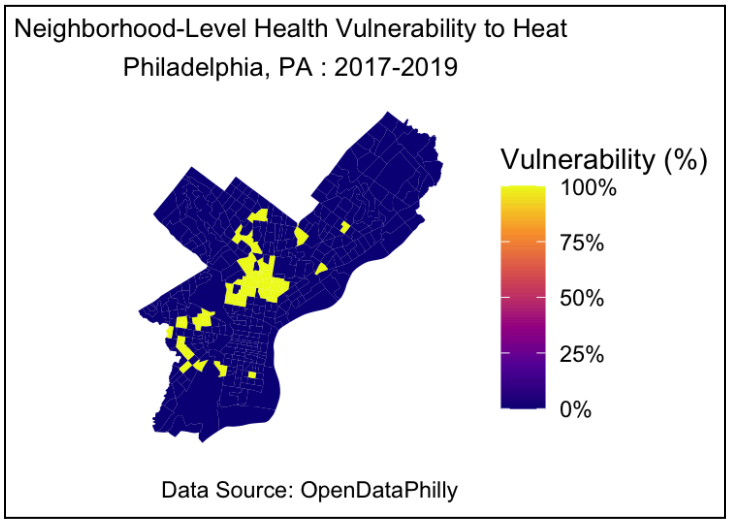

Figure 1

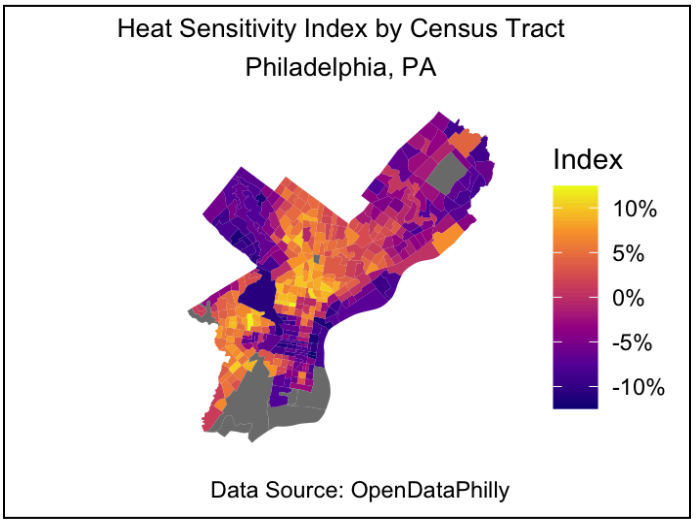

Figure 2

References

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