HEAT WAVES

Designing a Heat Action Plan to Mitigate Disproportionate Impacts of Urban Heat Island Effect in Underserved Communities in Omaha, NE

Quarterly Report 1 - 4/25/2023

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1. EXECUTIVE SUMMARY

Abstract

This study builds on a transdisciplinary collaboration between the City of Omaha, University of Nebraska Medical Center, University of Nebraska - Lincoln College of Architecture, and Community-based Organizations to develop a Heat Action Plan to mitigate the disproportionate impacts of urban heat island effect in underserved communities in Omaha, NE.

Research Problem Statement

Extreme heat kills more people in the United States than any other natural disaster. These effects are more pronounced in urban environments, where buildings, roads, and other infrastructure absorb and re-emit the sun's heat, otherwise known as urban heat island effect. The increasing intensity, duration, and frequency of heat waves disproportionately impact underserved populations in a heightened state of precarity. There is a significant gap in the research on applied approaches to integrating mitigation and adaptation strategies for addressing extreme heat, particularly in underserved communities. Omaha, NE, a 'hypersegregated' city, would benefit from a transdisciplinary Heat Action Plan.

First Quarterly Task

In the first quarter, the research team focused on gathering resources to assist in the development of a heat action plan as well as produce a booklet of relevant heat mitigation and adaptation strategies.

2. INTRODUCTION

Urban heat resilience is a growing issue as extreme heat kills more people in the United States than any other natural disaster (Berko, 2014). The earth consistently faces increased heat waves, in which 15 of the 16 warmest years on record have occurred during this century. This year, 2022, is expected to rank among the 10 hottest years in annual global temperature readings (NOAA, 2022). Rising temperatures contribute to the intensification of environmental threats, such as drought and rising sea levels. Higher average temperatures also raise health risks by leading to increased energy use and subsequently pollution. According to the Intergovernmental Panel on Climate Change (IPCC), we face longer continuous stretches of higher temperatures that pose greater health risks than isolated extreme heat events. Heat-related illnesses, such as heat stress, asthma, and malaria, are expected to claim an additional 250,000 lives between 2030 and 2050 (Neira, 2016). These effects are more pronounced in urban environments, where buildings, roads, and other infrastructure absorb and re-emit the sun's heat—a phenomenon known as urban heat island effect (EPA, 2022).

Today, researchers think of the heat island as more of an archipelago, where hot spots are heterogeneously distributed throughout a city in locations with higher concentrations of concrete and asphalt, whereas cooler temperatures can be found around trees, parks, or other open space (Borunda, 2021). The increasing intensity, duration, and frequency of heat waves have been found to disproportionately impact underserved populations in a heightened state of precarity. In a study of 108 urban areas nationwide, the formerly redlined neighborhoods of nearly every city studied were hotter than the non-redlined neighborhoods, some by nearly 13 degrees Fahrenheit (Hoffman, 2020). Redlining is the historical discriminatory practice of refusing home loans or insurance to whole neighborhoods based on a racially-motivated perception of safety for investment.

Omaha, NE is one such example of a city that suffers from the lingering impacts of redlining, consistently rated among the top 50 most segregated cities in the US (UC Berkeley, 2020). The Omaha metropolitan area has been categorized as a 'hypersegregated' city, which is a term used to describe metropolitan areas in which African Americans were highly segregated in at least four of five dimensions of segregation: unevenness, isolation, clustering, concentration, and centralization (Massey, 2015). An ongoing study of extreme heat in Omaha has found a 10 degree difference in historically redlined neighborhoods (Abdoulaye, 2022). Along with disproportionate heat intensity, redlined neighborhoods in Omaha are also faced with increased levels of lead and coal contamination. In 1999, the EPA found that residential yards in eastern Omaha, including the historically redlined and segregated Black community of North Omaha, had high concentrations of lead due to

historic industrial air emissions; as a result, this area was designated as a Lead Superfund Site (EPA, 2017).

These environmental injustices have not gone without notice. The EPA has since remediated more than 13,000 residential properties at the superfund site between 1999 and 2015 (EPA, 2017) and recently, the City of Omaha has announced plans to develop a climate action plan to be completed by June 2024. According to Omaha Mayor, Jean Stothert, tackling extreme heat is among the goals of the plan. Heat action plans have been gaining traction as a process for identifying both mitigative and adaptive strategies for countering heat intensity, especially as a form of addressing environmental injustices (TNC, 2019)(Guardaro, 2020). Mitigating the inequitable distribution of intense surface temperatures requires a multifaceted approach incorporating policy, public health, urban planning, and landscape strategies. Designing resilient cities requires an understanding of how they can "persist, adapt, and transform in the face of stress, while maintaining their function and identity" (Meerow & Newell, 2016).

This study aims to build upon a collaborative partnership between the City of Omaha Planning Department, University of Nebraska Medical Center, and the University of Nebraska - Lincoln College of Architecture to develop a Heat Action Plan. There are a myriad of potential solutions to extreme heat, but there is no one-size-fits-all approach. It is crucial to recognize that impactful collaborations require the "collective capacity of academic, health, and environmental leaders, along with the communities themselves" to develop a coordinated plan that transcends silo-based actions and limited nature-based solutions (NbS) (Kabisch, 2016)(Guardaro, 2020).

Developing a Heat Action Plan through a participatory process will contribute to the development of mitigation and adaptation strategies that work for a particular context. Urban heat solutions generally fall into two categories, mitigation and adaptation (TNC, 2019). Mitigation involves reducing the heat of the urban environment through a variety of nature-based and architectural interventions, including increasing shade through tree planting, using high albedo surfaces, and reducing greenhouse gas emissions. Adaptation is the adjustment to environmental conditions by changing behavior to deal with the increased intensity of extreme heat. These can include strategies such as taking alternative forms of transportation, providing free public drinking water, and opening a cooling center. Equitable access to shade and sensible microclimates are often perceived as an amenity, but should be considered a public health concern (Bloch, 2019). As deadly heat waves become commonplace, we must consider it as a civic resource shared by all.

3. METHODS

3.1 Study area

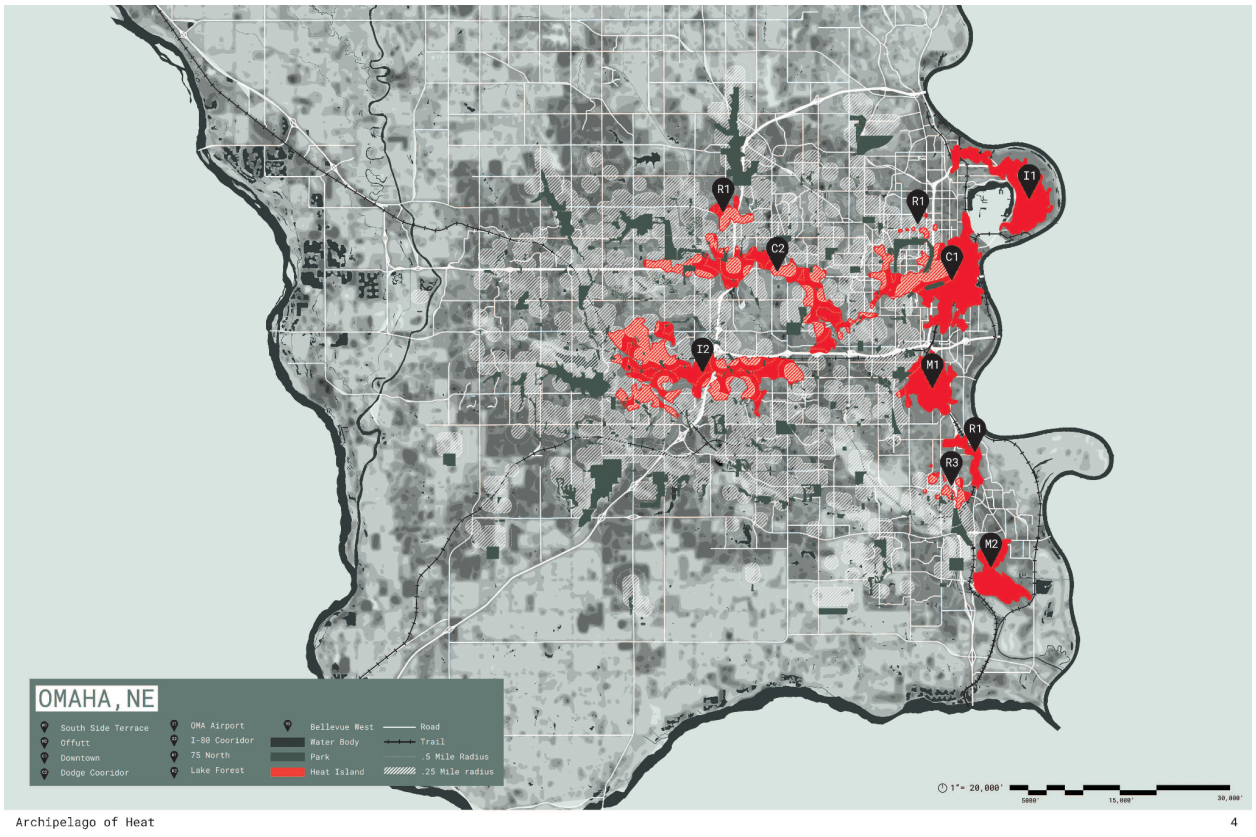

Figure 1. Sarpy and Douglas County area delineation with Landsat9 Land Surface Temperature data.

The study area includes Sarpy and Douglas County which encapsulates the municipal boundary of the City of Omaha (See Figure 1.). The Heat Action Plan focuses on the identification of the heat archipelago as a form of vulnerability assessment. Sarpy and Douglas County were used as a form of delineation due to readily available Geographic Information Systems (GIS) Data. The City of Omaha ranges in average high temperatures of 33°F (January) to 87°F (July)(See Figure 2.)(US Climate Data, 2023).

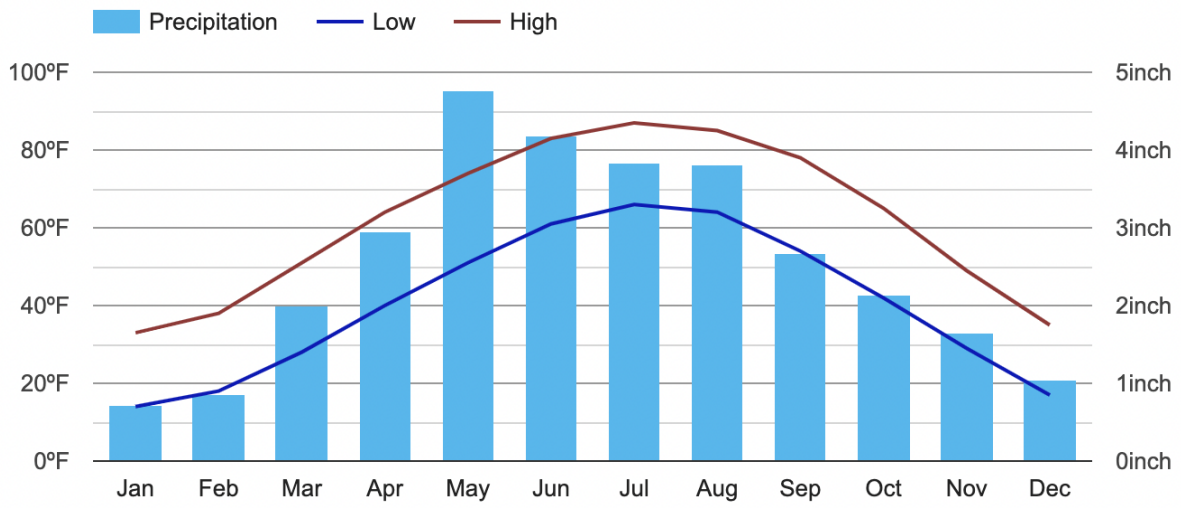

Figure 2. Omaha Climate Graph (US Climate Data, 2023).

3.2 Identifying Heat Resources

To guide the development of a heat action plan, the team began by compiling available resources and literature. It is not within the scope of this research to conduct a comprehensive literature review, although we found it necessary to develop a baseline understanding of available resources. A full list of references can be found at the end of this document. Two particular documents were referenced as primary sources to help guide this process: “Planning for Urban Heat Resilience” by Keith and Meerow, 2022 and “The Heat Action Platform” by the Adrienne Arsht-Rockefeller Foundation Resilience Center.

Figure 3. Adaptation Strategies.

By investigating these two resources, students in the third-year LARC 311 Design Studio IV: Ecological and Cultural Landscape Systems compiled strategies and case studies into a Thermal Tactics booklet (See Figure 3.). Additionally, the team conducted research into Heat Action Plan case studies, including: Greater Phoenix Heat Action Planning Guide (2019), Karachi Heat Action Plan (2017), Western Sydney Heat Action Plan (2018), and the Ahmedabad Heat Action Plan (2019). In the Greater Phoenix Heat Action Planning Guide, we found that urban heat solutions generally fall into two categories, mitigation and adaptation (TNC, 2019) (See Table 1.). Mitigation involves reducing the heat of the urban environment through a variety of nature-based and architectural interventions, including increasing shade through tree planting, using high albedo surfaces, and reducing greenhouse gas emissions. Adaptation is the adjustment to environmental conditions by changing behavior to deal with the increased intensity of extreme heat. These can include strategies such as taking alternative forms of transportation, providing free public drinking water, and opening a cooling center.

	Adaptation		Mitigation
Community	Energy bill assistance	Material	Permeable pavement
	Establishing urban forestry, tree, and landscape program		Public Shading Structures
	Heat awareness campaign		Heat resilient building materials
	Providing incentives and awards		Light pavement
	Thermal comfort policies	Architecture	Building orientation and massing
Emergency	Chief heat officers		Passage space under building
	Cool hospital preparedness mandate		Cool roofs / walls
	Heat emergency response plan		Exterior building shading
	Heat hotlines		Green building
	Public transit services during heat waves	Green Infrastructure	Tree protection
	Wellness check programs		Urban forests
Infrastructure	Building materials and standards		Open space
	Building waste heat limits		Water features
	Green building and energy efficiency standards and codes		Greenroofs
	Heat design guidelines		Community gardens
Assessment	Building energy benchmarking		Stormwater Retention
	Catastrophe (CAT) bond	Energy	Walkability
	Conduct a heat vulnerability assessment		Electric Vehicle Infrastructure
	Design a heat management plan		Waste heat reduction
	Heat-resilient environmental impact assessments		Microgrids

Table 1. Adaptation and Mitigation Strategies.

4. NEXT TASKS

The next tasks for the second quarterly report will focus on traveling to Arizona to meet with heat researchers at the University of Arizona and Arizona State University as well as documenting built examples of heat mitigation strategies. Additionally, a heat vulnerability assessment will be conducted to identify locations for design prototypes in the City of Omaha. The team will weigh each criterion based on importance and use the top five criteria for selecting neighborhoods. By consensus, the core team will select three neighborhoods with challenges and opportunities for growth. The criteria for neighborhood and pilot project selection are adapted from The Nature Conservancy (2019) including heat, usage, history and opportunity, community cohesion, and health and vulnerability (Table 2.).

Categories	Potential Criteria
Heat	Vegetation coverage Vegetation index Surface temperature
Usage	Use of public spaces Transit usage
History and Opportunity	Land vacancy Community presence Slated housing, renovation, or capital improvement projects
Community	Sense of community identity Potential for mutual learning History of engagement
Health and Vulnerability	Rate of heat deaths/heat-related illnesses Household income Rates of self-reported heat concerns Availability of heat-related infrastructure

Table 2. Adapted from The Nature Conservancy's "Heat Action Planning Guide."

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