**Wichita Climate**

*Using Satellite Data to Identify Neighborhoods Vulnerable to Extreme Heat for Equitable Climate Mitigation and Planning*

**Project Team**

***Project Team:***

Brooke Laird (Project Lead)

Melissa Ashbaugh

Muskaan Khemani

Sadie Murray

***Advisors & Mentors:***

Dr. Kenton Ross (NASA Langley Research Center)

Lauren Childs-Gleason (NASA Langley Research Center)

***Team Contact:*** Brooke Laird, brookelaird10@gmail.com

***Partner Contact:*** Nina Rasmussen, nrasmussen@wichita.gov

**Project Overview**

***Project Synopsis:*** The Wichita Climate project used NASA Earth observations and demographic data to map heat exposure, tree canopy, and heat risk in Wichita, KS. The project was conducted in partnership with the City of Wichita, with the goal of informing the city’s heat mitigation efforts, including their Climate Adaptation and Mitigation Plan. This project will help the city government decide where to concentrate resources to alleviate environmental injustice and lessen heat burdens in areas where residents are most at risk of negative heat impacts.

***Abstract:***

Wichita, Kansas is facing a host of climate threats, one being extreme heat manifested through the urban heat island (UHI) effect. The uneven distribution of heat risk in Wichita across socioeconomic status is an environmental justice issue. We worked with the City of Wichita to map heat exposure, tree canopy, and heat risk. To visualize heat exposure, we quantified and mapped average summer heat from 2013-2021 using Landsat 8 OLI/TIRS derived Land Surface Temperature (LST) and Aqua Moderate Resolution Imaging Spectroradiometer (MODIS) derived night-time LST. To understand tree canopy cover gaps, we created a tree canopy map using high resolution 2021 PlanetScope imagery, which identified 20% more trees than the US Geological Survey’s (USGS) National Land Cover Database (NLCD) tree canopy coverage estimates for Wichita. To characterize high risk areas, we used socioeconomic census data and existing social vulnerability indices, highlighting populations that were exposed and vulnerable to extreme heat. The spatial analyses demonstrated that heat exposure is concentrated in the city center and southwest Wichita, areas that are also low in tree canopy cover. The three census block groups and 17 census tracts with the highest heat risk primarily circle the city center, in areas home to more socially vulnerable populations and near enough to the dense urban center to feel significant urban heat island effects.

Wichita, Kansas is facing a host of climate threats, one being extreme heat that is manifested through the urban heat island (UHI) effect. Varying heat exposure and vulnerability mean that heat risk is not evenly spatially distributed, which is an environmental justice issue. We worked with the City of Wichita to map heat exposure, tree canopy, and heat risk. To visualize heat exposure, we quantified and mapped average summer heat from 2013–2021 using Landsat 8 Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS) Land Surface Temperature (LST), and Aqua Moderate Resolution Imaging Spectroradiometer (MODIS) derived night-time LST. To understand tree canopy cover gaps, we created a tree canopy map using 2021 PlanetScope imagery, which identified 20% more trees than the US Geological Survey’s (USGS) National Land Cover Database (NLCD) tree canopy coverage estimates for Wichita. To characterize high risk areas, we used socioeconomic census data and existing social vulnerability indices, highlighting populations that were exposed and vulnerable to extreme heat. The spatial analyses demonstrated that heat exposure is concentrated in the city center and southwest Wichita, areas that are also low in tree canopy coverage. The three census block groups and 17 census tracts with the highest heat risk primarily circle the city center, in areas home to more socially vulnerable populations and near enough to the dense urban center to feel significant urban heat island effects.

**Key Terms**: environmental justice, tree canopy cover, Urban Heat Island, heat vulnerability, climate, Landsat, Planet

***National Application Areas Addressed:*** Climate

***Study Location:*** Wichita, KS

***Study Period:*** 2013 to 2021 (May to September)

***Community Concerns:***

* Wichita residents are experiencing increased heat linked to anthropogenic climate change and loss of tree canopy cover. Higher temperatures and more extreme heat events impact health, energy burden, economic vitality, infrastructure performance, and quality of life.
* The impacts of increasing heat burden and loss in tree canopy are not equally distributed throughout the city because of varying heat exposure and socioeconomic vulnerability. Additionally, the economic burdens on this city are exacerbated considering the median income of residents is lower than the national average.
* The City of Wichita requires data to inform their Climate Adaptation and Mitigation Plan, which will guide future climate action efforts. Maps and quantitative data that highlight the most marginalized and at-risk populations in the city are necessary for equitable distribution of city resources.

***Project Objectives:***

* Map heat exposure, tree canopy coverage, and climate-related social vulnerabilities to improve the city’s knowledge of heat risk
* Formulate deliverables that are clear and easily digestible for a non-expert audience to understand heat impacts
* Establish a path for the City of Wichita to partner with community organizations and individuals to reduce heat burden disparities

**Partner Overview**

***Partner Organization:***

|  |  |  |
| --- | --- | --- |
| **Organization** | **Contact (Name, Position/Title)** | **Partner Type** |
| **City of Wichita** | Nina Rasmussen, Environmental Quality Specialist | End User |

***Decision-Making Practices & Policies:***

The City of Wichita has a GIS team that creates and distributes maps and geospatial datasets. Flooding has been the primary focus of the GIS team and is a major concern for the city. The local government monitors pollution and tries to maintain carbon and particulate matter pollution within National Ambient Air Quality Standards (NAAQS). While no local laws or state heat exposure standards currently exist, heat exposure levels are federally regulated by the Occupational Safety and Health Administration (OSHA). Currently, Wichita does not regularly use remote sensing assets. They are interested in the data and context that satellite imagery would provide to inform their climate adaptation strategies and to support grant applications, especially related to adverse impacts on marginalized communities.

**Earth Observations & End Products Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter(s)** | **Use** |
| **Landsat 8 OLI / TIRS**  | LST | This LST dataset was used to generate heat exposure and risk maps.  |
| **Aqua MODIS** | LST | This LST dataset was used to generate heat exposure and risk maps. |
| **PlanetScope** | Surface reflectance | This high-resolution Planet imagery was used to map land cover in Wichita and create a tree mask layer.  |

***Ancillary Datasets:***

* US Census Bureau American Community survey 5-year data (2009–2020) – population and demographic data by census tract for mapping social vulnerability and heat risk
* USGS National Land Cover Database (NLDC) – national tree canopy map for comparison to tree mask created through Planet imagery
* Centers for Disease Control Social Vulnerability Index – population and demographic data by census tract for mapping social vulnerability and heat risk
* Council on Environmental Quality Climate and Economic Justice Screening Tool – population and demographic data by census tract for identifying disadvantaged communities and mapping social vulnerability and heat risk

***Modeling:***

* NASA DEVELOP UHEAT 1.0 (Contact: Dr. Kenton Ross, Langley Research Center) – compile and average surface temperatures

***Software & Scripting:***

* Google Earth Engine API – heat exposure mapping via UHEAT 1.0
* Esri ArcGIS Pro v10.8.1 – tree canopy, heat exposure, and heat risk mapping
* Esri ArcMap – story map visualization
* Adobe Illustrator – data visualizationR v4.04 – census data acquisition

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Product** | **Earth Observations Used**  | **Partner Benefit & Use** | **Software Release Category** |
| **Map of Heat Exposure**  | Landsat 8 OLI,Aqua MODIS | This map will inform partners which areas are most exposed to higher-than-average temperatures.  | N/A |
| **Map of Tree Canopy Cover** | PlanetScope | This map will inform the city where gaps in tree canopy cover are concentrated so they can equitably allocate resources.  | N/A |
| **Map of Heat Risk** | Landsat 8 OLI | This map shows the connection between heat exposure and social vulnerability data from an environmental justice perspective and will help the city prioritze vulnerable populations in their environmental efforts.  | N/A |
| **Impact Poster** | Landsat 8 OLI,PlanetScope | This poster will serve as a public education tool to convey which communities in Wichita are most vulnerable to extreme heat. | N/A |
| **ArcGIS Story Map** | Landsat 8 OLI,Aqua MODIS,PlanetScope | This map will conveys the main findings in an interactive, accessible, and digestible format for continued use by the City of Wichita.  | N/A |

***Product Benefit to End User:***

Our project will provide the City of Wichita with the data necessary to equitably mitigate and adapt to extreme heat. Our map of tree canopy cover can help the city understand areas in need of additional tree planting or maintenance. Our heat exposure and risk maps identify priority areas which future programs can focus on to alleviate disproportionate burdens from heat. In addition, our methodology can serve as a framework for future analysis and identification of hazard risk at the census block and tract level. Together, our end products will help city officials understand how heat is impacting Wichita residents and will support the city’s incorporation of environmental justice into GIS work and decision-making.

***Project Continuation Plan:***

At the end of this term, the partner will have geospatial layers that demonstrate heat exposure, tree canopy coverage, and heat risk. We anticipate that the Fall 2022 Wichita Climate team will use the InVEST model to assess urban cooling scenarios, along with investigating air temperature and regional air quality. Deeper community engagement and additional incorporation of partner concerns will guide the project’s objectives around air quality and heat risk indices.

**References**

Hoffman, J. S., Shandas, V., & Pendleton, N. (2020). The effects of historical housing policies on resident exposure to intra-urban heat: A study of 108 US urban areas. *Climate, 8*(1), Article 12. <https://doi.org/10.3390/cli8010012>

The Wichita/Sedgwick County Metropolitan Area Planning Department. (2021). *2020 Census—Initial Report* (p. 26). <https://www.wichita.gov/Planning/PlanningDocument/2020%20Census%20Initial%20Profile.pdf>

*U.S. Census Bureau QuickFacts: Wichita City, Kansas*. US Census Bureau. (n.d.). Retrieved June 16, 2022, from <https://www.census.gov/quickfacts/wichitacitykansas>