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Problem Statement & Research Question

Problem Statement: Increased daytime temperatures, reduced nighttime cooling, and higher air pollution levels associated with urban heat islands can affect human health by contributing to general discomfort, respiratory difficulties, heat cramps and exhaustion, non-fatal heat stroke, and heat-related mortality.

Principal Research Question: Can we integrate local weather station data and satellite data to create an application for residents of the borderland to monitor dangerous heat conditions caused by the Urban Heat Island(UHI) Effect?

Background

The term "heat island" describes built up areas that are hotter than nearby rural areas. The annual mean air temperature of a city with 1 million people or more can be 1.8–5.4°F (1–3°C) warmer than its surroundings. In the evening, the difference can be as high as 22°F (12°C) [1, 2]. Heat islands can affect communities by increasing summertime peak energy demand, air conditioning costs, air pollution and greenhouse gas emissions, heat-related illness and water pollution [3].

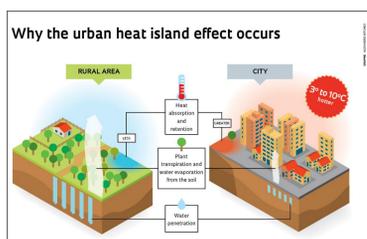


Figure 1: Reasons behind UHI

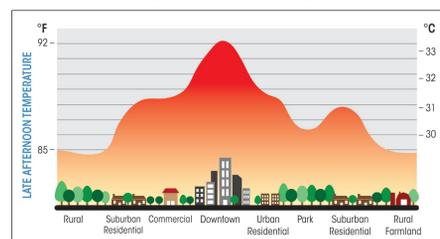


Figure 2: UHI effect in different areas

Project Scope

The scope of this project is to integrate the local metrological data and surface temperature data from satellite to analyze the heat island effect. In summary, the main purpose is to help residents living in borderland (*El Paso, TX, USA* and *Ciudad Juarez, Mexico*) to monitor the heat conditions caused by the Urban Heat Island Effect and visualize the vulnerability map of the borderland areas.

Concept Map & Data Sources

- Earth Data – NASA
- Google Earth Engine
- Dark Sky Net API
- TAMIS Web Interface
- UACJ Web Interface

Figure 3: Data Sources

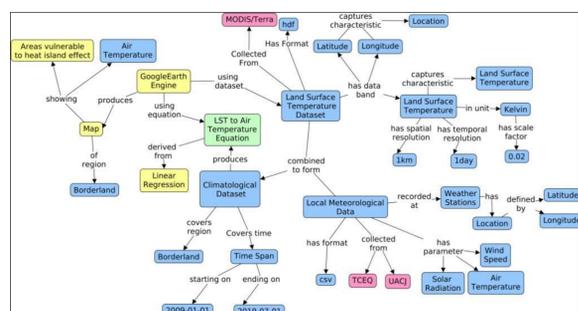
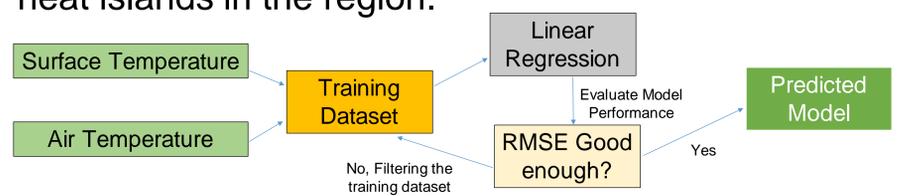


Figure 4: Concept Map

Methodology

Historical satellite data and observed meteorological data were collected and filtered for the El Paso-Juarez region during summertime months (May-September) from 2002-2019. A formula was determined based on scientific literature to visualize historical vulnerability maps of the urban heat island effect and yield a temperature difference between heat islands and non-heat islands in the region.



Results



Figure 5: Heat Index Prediction by locations

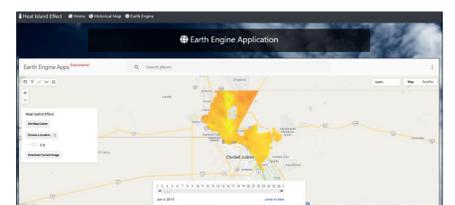


Figure 6: Google Earth Engine Application

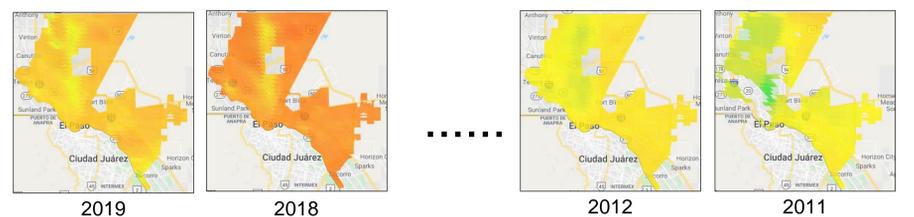


Figure 7: Historical vulnerability map in summertime (each year)

Conclusion

Cities are often warmer than their suburb and rural areas because of the "heat island effect" phenomena. Our project serves as a monitoring system for residents of the El Paso-Juarez metroplex and aims to identify intense heat exposure. This project can be extended using data of different cities to further assess the heat island effect, especially in desert cities and arid regions.

References

- [1] Mirzaei, P. A. (2015). Recent challenges in modeling of urban heat island. *Sustainable cities and society*, 19, 200-206.
- [2] Heat Island Effect, <https://www.epa.gov/heat-islands>.
- [3] Heaviside, C., Macintyre, H., & Vardoulakis, S. (2017). The urban heat island: implications for health in a changing environment. *Current environmental health reports*, 4(3), 296-305.