**Los Angeles Urban Development**

*Utilizing NASA Earth Observations to Evaluate the Impact of Tree Coverage on Urban Heat Mitigation*

**Project Team**

***Project Team:***

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**Project Overview**

***Project Synopsis:***

This project aims to use remote sensing methodologies to characterize the relationship between tree coverage and urban heat islands throughout the Greater Los Angeles Area. By comparing land surface temperature, normalized difference vegetation index values, and tree canopy across distinct census tracts within the County, this study highlights the value of local tree planting initiatives in areas with increased urban heat.

***Abstract:***

Over the last several decades the city of Los Angeles, California, has been experiencing increased temperatures resulting from the urban heat island effect. This is largely due to the expansion of developed areas which allow for the trapping of heat, posing dangerous health risks. As a solution, many organizations have turned to urban greening and tree planting initiatives to help cool vulnerable communities. NASA DEVELOP has partnered with City Plants and the City of Los Angeles, Office of Forest Management to study the role of trees in urban environments and their relation to the mitigation of local urban heat islands. This team used NASA Earth observation data spanning from 2016 to 2022, including land surface temperature and Normalized Difference Vegetation Index (NDVI) data collected from Landsat 8 Thermal Infrared Sensor (TIRS) and ISS ECOsystem Spaceborne Thermal Radiometer Experiment on Space Station (ECOSTRESS), respectively. Data from the National Agriculture Imagery Program (NAIP) were also used to obtain a supervised classification of tree canopy cover. Our analysis reveals a spatial and temporal connection between temperature and vegetation, suggesting that areas with more vegetation are less likely to suffer high summertime temperatures. Results also highlight the impacts of tree planting programs, such as the Vermont Corridor planting project, which increased tree canopy cover by up to 5% in the community between 2016 and 2022. These findings support the implementation of urban greening practices and inform residents and officials about how investing in trees will help mitigate increasing heat within Los Angeles.

***Key Terms:***

Urban heat island, heat vulnerability, urban greening, tree planting initiatives, Landsat 8 TIRS, ECOSTRESS, NAIP

***National Application Area Addressed:*** Urban Development

***Study Location:*** Los Angeles County, CA

***Study Period:*** 2016 - 2022 (June to August)

***Community Concerns:***

* Continuous urbanization throughout Los Angeles County has increased the prevalence and intensity of urban heat islands (UHIs). UHIs occur in areas with high impervious surface cover, which is known to absorb and retain heat more effectively than other types of natural land cover. This heat retention leads to an overall rise in urban diurnal temperatures and contributes to elevated risks of heat stroke and other heat-related health effects amongst inhabitants.
* Tree planting initiatives are a promising urban heat mitigation strategy, and many have been undertaken throughout Downtown Los Angeles. However, the long-term impact of such initiatives on regional and local heat intensity across the county has not been investigated. Since green spaces are predominantly confined to affluent neighborhoods, the distribution of urban heat islands is both a socioeconomic and environmental justice concern.
* In studying the relationship between vegetative cover and temperature through time, we can improve our ability to address and prevent urban heat islands in the County. This has the potential to reduce the instances of heat-related illnesses and the amount of “thermal pollution” that plagues highly urbanized, low-income sections of the greater Los Angeles area.

***Project Objective:***

* Provide a macro and micro scale analysis of urban heat islands and the effects of trees in Los Angeles through the creation of accessible data visualizations of heat distribution and tree cover in the city and assessing the impact of tree planting programs on urban heat mitigation for the community

**Partner Overview**

***Partner Organizations:***

|  |  |  |
| --- | --- | --- |
| **Organization** | **Contact (Name, Position/Title)** | **Partner Type** |
| **City of Los Angeles, Department of Public Works, Office of City Forest Management** | Rachel Malarich, City Forest Officer | End User |
| **City Plants** | Rachel O’Leary, Executive Director | End User |

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

The Office of City Forest Management is working alongside non-profit organization City Plants on a series of tree-planting initiatives throughout heavily urbanized areas of Los Angeles. They have a particular interest in low-income communities, which are often associated with a high proportion of heat-retaining impervious surfaces as well as minimal vegetation and greenery. However, limited community awareness and government funding constraints have prevented many of these initiatives from moving forward. Our partners believe that a significant reason for this is the lack of available data to highlight the efficacy of tree-planting for mitigating urban heat islands. Our partners hope that such a study will raise awareness about the value of street trees and “urban forests” to both the general public and local government officials.

**Earth Observations & End Products Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter** | **Use** |
| **Landsat 8 OLI** | Normalized Difference Vegetation Index (NDVI) | NDVI from Landsat 8 OLI data was used to assess urban vegetation cover. |
| **Landsat 8 TIRS** | Land Surface Temperature (LST) | Daytime LST data from Landsat 8 TIRS were used to assess urban heat |
| **ISS ECOSTRESS** | LST | Nighttime LST data from ISS ECOSTRESS were used to assess urban heat |

***Ancillary Datasets:***

* National Agriculture Imagery Program (NAIP) – High resolution optical imagery used for tree canopy cover classification
* City of Los Angeles Geohub - County, Census Tracts, and urban boundary shapefiles, used to assess impacts of urban heating and tree canopy cover at multiple scales

***Software & Scripting:***

* Google Earth Engine (GEE) - Loading Landsat 8 imagery, calculating mean LST and NDVI for specified areas of interest, exporting csv file, and performing a supervised classification with NAIP imagery to calculate tree canopy cover
* Python 3.10 – Creating plots of LST and NDVI, calculating statistical analyses (through Jupyter Notebook)
* ArcGIS Pro 3.0 – Calculating percentage change and making maps
* QGIS 3.28 – Creating Summer composites and making maps

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Product** | **Earth Observations Used**  | **Partner Benefit & Use** | **Software Release Category** |
| **Time Series of LST Between 2016 and 2022 for Areas of Interest****(Daytime and Nighttime)** | Landsat 8 TIRSISS ECOSTRESS | The LST time series will be used to show the change in temperature for areas of interest through time. Specifically highlights that areas which have been identified in need of tree planting are in fact hotter.  | N/A |
| **LST Map** | Landsat 8 TIRS | Provides a visualization for LST per census tract showing that urban areas of South Los Angeles experience higher temperatures.  | N/A |
| **Time Series of NDVI Between 2016 and 2022 for Areas of Interest** | Landsat 8 OLI | The NDVI time series will be used to show the change in overall vegetation for areas of interest through time. Specifically highlights that some areas have less vegetation than others. | N/A |
| **NDVI Percent Difference Map** | Landsat 8 OLI | Provide a visualization for the percent difference of NDVI between 2016 and 2022. | N/A |
| **Tree Canopy Percent Difference Map** | N/A | Show the change in tree canopy coverage between 2016 and 2022 using NAIP imagery. This would help show the impact of tree planting initiatives for areas that have seen a change in tree canopy cover. | N/A |

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

Our end users, City Plants and the City of Los Angeles’ Office of City Forest Management, can use our results to inform the public and policymakers on the importance of trees in heat mitigation. Our project found that tracts with low tree cover were statistically correlated with increased summer land surface temperatures. This is especially true for census tracts within the Vermont Corridor and Central Alameda, where summer daytime land surface temperatures regularly exceeded 115**°**F. These findings will help our partners identify areas with increased vulnerability to the effects of urban heat islands and narrow down locations for future tree-planting initiatives. We also hope that these data-driven results will provide a scientific foundation for increased government funding and public support for related urban forestry projects.

***Project Continuation Plan:***

Current discussions to pursue this project in future terms (potentially Spring 2024) are in progress. Products to be handed off to future teams includes plots of daytime summer land surface temperatures and associated GEE code, plots of nighttime summer land surface temperatures and associated Python code, as well as land cover classification data and associated GEE code. This will be stored in a OneDrive folder accessible by the JPL node Fellow. Incorporation of high resolution HyTES thermal imagery would be a great addition to this project and aid in quantifying the contribution of planting initiatives to heat distribution on the street-scale.

**References**

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