Summer 2022 Project Summary

Albuquerque Urban Development

Enhancing Urban Cooling Interventions by Modeling Urban Forestry through NASA Earth Observations in Albuquerque, New Mexico

Project Team

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Project Overview

Project Synopsis:
The Environmental Protection Agency projects that Albuquerque, New Mexico will see four times the annual days over 100°F by 2040 compared to baseline studies from 1950-1999. This project addresses the increasing urban heat island effect experienced by the city of Albuquerque. End products such as heat maps, vulnerability maps, and environmental modeling aim to maximize the City's data-driven decision making by delineating priority areas for increasing urban tree canopy. These findings will help facilitate the "Let's Plant Albuquerque!" initiative that aims to plant 100,000 new trees by 2030.

Abstract:
The city of Albuquerque, New Mexico is experiencing increasing urban heat island (UHI) effects, which impact the health, safety, and comfort of the community. In partnership with the City of Albuquerque Department of Environmental Health, Department of Parks and Recreation, and Let's Plant Albuquerque!, this project used satellite Earth observations from April 2016-August 2022 to model increases in tree canopy within the city of Albuquerque to help combat the urban heat island in the city's warmer areas over the next decade. Using Landsat 8's Thermal Infrared Sensor (TIRS) and the Ecosystem Spaceborne Thermal Radiometer Experiment on the International Space Station (ECOSTRESS), along with the Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST) Urban Cooling and ENVI-Met models, the team modeled tree cover interventions and created land surface temperature maps. These outputs will help the city make data-driven decisions for their tree planting goal in a targeted approach.

Key Terms:
remote sensing, urban heat island, urban development, tree canopy, land surface temperature, ECOSTRESS, InVEST, ENVI-met

National Application Area Addressed: Urban Development
Study Location: Albuquerque, New Mexico, USA
Study Period: April 2016 – August 2022

Community Concerns:

- As global temperatures rise, the city of Albuquerque, New Mexico is experiencing increased vulnerability to extreme heat. Albuquerque's urban environment naturally contributes to elevated temperatures as a result of impervious surfaces, lack of vegetation, and high surface reflectance.
- Without a robust urban canopy, shade availability is limited, making the "feels like" environment of the city uncomfortable and potentially hazardous for community members.
- Certain areas of the city will lose a generation of large trees that provide shade due to several factors including age, city development, and disease. The community needs continued tree planting efforts to ensure a new canopy can replace the older canopy.
- Reducing the temperature for residents helps to keep people out of the hospital from heat-related illnesses such as heat cramps, heat exhaustion, and heat stroke, which in turn reduces health care costs. Between 2013 and 2017, there were a total of 1,416 emergency room visits for heat-related illness.

Project Objectives:

- Calculate thermal comfort, microclimate, and a heat mitigation index at a neighborhood and city-wide scale
- Produce feasibility maps showing micro and macro tree canopy scenarios at the neighborhood and city-wide scale
- Produce land surface temperature (LST) maps at the neighborhood and city-wide scales
- Create a Standard Operating Procedure, for the city for future tree planning and modeling
- Create a public-facing brochure to communicate project results effectively to community members
- Create a 1-page executive project summary for the partners to use in communications with city government members

Partner Overview

Partner Organizations:

Organization	Contact (Name, Position/Title)	Partner Type
City of Albuquerque, Department of Environmental Health	Denise Castillo, Sustainability Specialist	End User
City of Albuquerque, Department of Parks and Recreation	Sean O'Neil, Assistant City Forester	End User
Let's Plant Albuquerque!	Sean O'Neil, Liaison	Collaborator

Decision-Making Practices & Policies:

Various organizations within Albuquerque contribute to its urban heat policies. Currently, the city of Albuquerque uses GIS layers and *in situ* data to analyze the urban tree canopy and integrate its findings into its urban forestry plans. In 2021, the Climate Adaptation Planning + Analytics (CAPA) Urban Heat Watch program created heat maps of the city with *in situ* and satellite data to visualize urban heat. Let's Plant Albuquerque! uses an interactive map to connect the community to its current tree inventory and other urban canopy related datasets. Different departments within the city control tree planting throughout the city, depending on the type of property.

Earth Observations & End Products Overview

Earth Observations:

Platform & Sensor	Parameters	Use
Landsat 8 TIRS	Land surface temperature	The Analysis-Ready Surface Temperature product was used to calculate daytime LST hotspots for 2016–2022
ISS ECOSTRESS	Land surface temperature, evapotranspiration	Nighttime measurements of LST from ECOSTRESS were used to enhance the partners' understanding of urban heat dissipation and consequent neighborhood-level health concerns.

Ancillary Datasets:

- National Integrated Heat Health Information System CAPA Urban Heat Island Map – UHI dataset was used to help validate and provide *in situ* land surface temperature
- University of New Mexico LiDAR – LiDAR data were used to determine shade throughout Albuquerque
- City of Albuquerque Building Footprints – Building footprint data were used as an input for building intensity in the InVEST urban cooling model
- National Oceanic and Atmospheric Administration (NOAA) National Weather Service (NWS) Real Time Mesoscale Analysis (RTMA) – Meteorological inputs used for ENVI-Met parameters including temperature, wind speed, and wind direction
- MultiResolution Land Characteristics Consortium – Environmental variables, including tree canopy cover and developed imperviousness, used as inputs for InVEST and ENVI-Met
- United States Geological Survey National Land Cover Database (NCLD) – Land cover and materials such as impervious surfaces were used as an input for the InVEST and ENVI-Met models
- University of Utah MesoWest – *In situ* meteorological data used for ENVI-Met meteorological input parameters such as temperature, relative humidity, dew point, pressure, wind speed, and wind direction

Modeling:

- Natural Capital Project InVEST Urban Cooling Model (Contact: Dr. Kenton Ross, NASA Langley Research Center) – Used to calculate index of heat mitigation based on shade, evapotranspiration, and albedo.
- ENVI-Met Climate Model (Contact: Dr. Peter Crank, Arizona State University) – Used to calculate thermal comfort and microclimate from cooling interventions based on solar radiation, wind, air temperature, and humidity.

Software & Scripting:

- Google Earth Engine – Processing of satellite imagery and derivation of land surface temperature
- ArcGIS Pro 3.0.0 – Data processing and map creation

End Products:

End Product	Earth Observations Used	Partner Benefit & Use	Software Release Category
Thermal Comfort Analysis and Street	Landsat 8 TIRS ISS ECOSTRESS	Results of thermal comfort analysis can be used to understand the microclimates of	N/A

Cooling Intervention Models		street-level heat and "feels like" temperatures of proposed areas for increased canopy.	
City of Albuquerque Heat Mitigation Model for Future Tree Canopy and Standard Operating Procedure	Landsat 8 TIRS ISS ECOSTRESS	Partners can use feasibility maps from a calibrated model to understand the relative benefits of current and proposed tree canopy interventions. The end product includes a standard operating procedure for the city to be able to gather inputs and run models on their own with changing tree planting objectives.	N/A
Albuquerque Urban Heat Maps	Landsat 8 TIRS ISS ECOSTRESS	Partners can use land surface temperature maps to understand spatial and temporal heat dynamics across Albuquerque and identify priority areas for cooling tree planting campaign and other cooling interventions	N/A

Product Benefit to End User:

The end results of this project will help our partners make convincing evidence-based arguments to policymakers and inform the community of the usefulness of remote sensing for urban heat analysis. The maps and graphics will provide clear visuals that show land surface temperature and tree canopy intervention benefits, which will help the City and Let's Plant Albuquerque! continue to plan and implement their tree planting goals. The models will demonstrate the connections between urban heat and tree canopies to communicate the importance of trees in future heat mitigation planning.

References

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