**NASA DEVELOP National Program**

**2020 Fall Project Proposal**

**Virginia – Langley**

**Sacramento Urban Development**

*Quantifying and Mapping Urban Heat to Support Urban Planning Initiatives in Sacramento, California*

**Project Overview**

***Project Synopsis*:** The City of Sacramento, California is in the process of updating the City’s General Plan, Climate Action Plan, and Master Environmental Impact Report, which include strategies to combat the urban heat island effect. The City of Sacramento and urban planning firm Dyett & Bhatia are seeking quantitative, high-resolution spatial information about urban heat and heat-vulnerable populations in Sacramento to prioritize infrastructure development most efficiently. This project will use Landsat 8 OLI Provisional Surface Temperature products to map urban heat at the corridor or neighborhood scale. These maps, integrated with sociodemographic data provided by the City, will help planners prioritize cooling interventions. By comparing temperature anomalies during peak summer months throughout major transit corridors and neighborhoods, the planning team will be able to calibrate their intervention methods to each unique locality within the city based on quantitative metrics that are not currently available at this fine geographic scale.

***Community Concern:*** Sacramento is California’s fastest-growing city in terms of population; City officials anticipate growth of nearly 200,000 people in the near term. The City wants to ensure that this growth is sustainable, equitable, and inclusive. As one component of broader sustainability goals, the City hopes to better adapt to the urban heat island effect, which will likely be exacerbated by warmer temperatures in the next two decades. Older adults, low-income populations, non-Hispanic Black residents, and those with pre-existing health conditions are all more susceptible to heat-related illness or death. Some crucial steps to increase community resiliency and promote equity include planting urban vegetation and strategically prioritizing the implementation of green infrastructure, particularly in transit corridors or neighborhoods with a high proportion of vulnerable populations.

***Source of Project Idea:*** This project originated from conversations between Dyett & Bhatia and the Langley Fellow, who were introduced by Janice Barnes, a collaborator on the Hampton Roads Urban Development II project in Summer 2019.

***National Application Area Addressed:*** Urban Development, Transportation & Infrastructure

***Study Location:*** Sacramento, CA

***Study Period:*** 2018 – 2020 (May – September)

***Advisor:*** Dr. Kenton Ross (NASA Langley Research Center)

**Partner Overview**

***Partner Organizations:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| **City of Sacramento** | TBD – will be identified in next meeting | End User | No |
| **Dyett & Bhatia** | Gabriella Folino, Senior Urban Designer; Jossie Ivanov, Associate | Collaborator | No |

***End User Overview***

***End User’s Current Decision-Making Process:***The City of Sacramento is equipped with an array of tools to effect change in the built environment, including street design, zoning requirements, urban tree planting, amount of impervious surfaces, and building and rooftop albedo, to name a few. It is up to the City and planning team at Dyett & Bhatia to balance the social, economic, and environmental costs and benefits of these decisions. Currently, the City does not incorporate remote sensing data in these decisions. The County of Sacramento completed an urban heat island study in 2017 on a 2km grid that indicated the northern portions of Sacramento were warmer due to high concentrations of impervious surfaces and lack of tree canopy cover. However, they lack an understanding of urban heat on a finer scale.

***End User’s Capacity to Use NASA Earth Observations:***

*City of Sacramento* – The City of Sacramento uses a variety of spatial data and analyses, but does not currently use NASA Earth observations in its planning or decisions. The City has a robust GIS department, including an Open Data Portal with map layers, printable maps, and links to other open data sources that may be of interest to users.

***Collaborator & Boundary Organization Overview***

***Collaborator Support:***

*Dyett & Bhatia* – Dyett & Bhatia is the urban planning firm tasked with updating Sacramento’s General Plan. The team at Dyett & Bhatia will provide the DEVELOP team with maps of building footprints, population density, transit priority areas, and areas of anticipated future growth to aid in the team’s analyses. Dyett & Bhatia will also provide expert local knowledge and advice to the team throughout the term.

***Project Communication & Transition Overview***

***In-Term Communication Plan*:** The team will communicate with the partners via email or teleconference on a biweekly basis throughout the term. One or multiple participants will serve as a partner point-of-contact throughout the course of the project. The team will determine this point of contact during the first week of the term.

***Transition Plan*:** At the conclusion of the term, the team will conduct a handoff presentation via videoconference where they walk through the methods, challenges, and conclusions reached throughout the term, and address how the handoff package will be organized and delivered. The team will also outline future communication and points-of-contact for the partners following the term.

**Earth Observations Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameters** | **Use** |
| **Landsat 8 TIRS** | Provisional Surface Temperature product | The Analysis-Ready Provisional Surface Temperature product will be used to calculate daytime land surface temperature and hotspots for 2018-2020. |
| **ISS ECOSTRESS** | Land Surface Temperature | Nighttime measurements of land surface temperature will be gathered from ECOSTRESS to enhance the partners’ understanding of urban heat dissipation and consequent neighborhood-level health concerns. |
| **Suomi-NPP VIIRS** | Land Surface Temperature | Nighttime measurements of land surface temperature from VIIRS will serve as an alternative to ECOSTRESS to supplement the analysis of urban heat dissipation. |

***Ancillary Datasets:***

* City of Sacramento City Maintained Trees GIS layer – Urban tree canopy maps will be used to analyze the correlation between canopy cover and identified hotspots
* City of Sacramento Zoning GIS layer – Zoning information will be used to analyze the correlation between zones and identified hotspots
* City of Sacramento Community Plan Areas GIS layer – The Community Plan Areas, as established by the 2030 General Plan, will be used to delineate more fine-grained study areas for aggregated heat analyses of the entire city
* City of Sacramento General Plan GIS layer – The General Plan feature layer will be used to identify the physical boundaries and properties of different neighborhoods throughout the study area
* City of Sacramento Census 2010 Block Population GIS layer – Census block population and race/ethnicity data collected by the City of Sacramento will be used to help identify the location of vulnerable populations

***Software & Scripting:***

* Esri ArcGIS Pro – Map production and vector analysis
* Python – Data processing and raster analysis

**Decision Support Tool & End Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Product** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| **Sacramento County Urban Heat Maps** | Partners will use maps of urban heat and hot spots to identify priority areas for cooling initiatives and additional green infrastructure, as outlined in the General Plan. | Landsat 8 OLI Provisional Surface Temperature data products will be used to map urban heat, and identify anomalous heat areas, or ‘hotspots,’ across the county. ECOSTRESS and VIIRS nighttime surface temperature data will be used to contextualize these daytime temperatures with additional information about nighttime heat retention in the city’s hottest areas. | N/A |
| **Sacramento County Heat Vulnerability Map** | Partners will use heat vulnerability maps to identify neighborhoods or corridors with highly susceptible populations to better prioritize cooling initiatives that will have the greatest societal benefit. | GIS layers provided by the City of Sacramento will be used in tandem with Urban Heat Maps created in this study to geolocate highly susceptible and vulnerable populations. | N/A |

***End User Benefit*:** The results of this work will be folded into the City of Sacramento General Plan in the form of specific policies and standards, including interventions such as cool paving or tree canopy coverage in transit priority areas, to help this growing city adapt to increasing urban heat. A spatial analysis of temperature disparities during peak summer months will help the planning team at Dyett & Bhatia understand the implications of these interventions and prioritize areas of the city that are home to a high proportion of vulnerable populations or are most likely to experience rapid growth.

**Project Timeline & Previous Related Work**

***Project Timeline:*** 1 Term: 2020 Fall

***Related DEVELOP Work:***

2020 Summer (MA) – Cambridge Urban Development: Quantifying Changes in Urban Albedo with NASA Earth Observations to Reduce the Urban Heat Island Effect in Cambridge, Massachusetts

2020 Spring (AZ) – Philadelphia Health & Air Quality: Assessing Land Surface Temperature, Vegetation Cover, and Compounding Vulnerability Factors to Identify High Priority Areas for Cooling Initiatives in Philadelphia, Pennsylvania

2019 Fall (LaRC) – New York City Urban Development: Mapping Hotspots using NASA Earth Observations to Inform Future Green Initiatives in New York City

2018 Summer (LaRC) – Richmond Health & Air Quality: Synthesizing Temperature, Reflectance, and Socioeconomic Data to Provide Spatial and Temporal Temperature Analyses in Richmond, Virginia

2018 Summer (AZ) – Washoe County Urban Development: Utilizing NASA Earth Observations to Assess Urban Heat Island Reduction Strategies in Washoe County, Nevada

**Notes & References:**

The team may wish to explore the InVEST urban cooling model, which could provide interesting and unique outputs for the partners as they consider the most effective interventions based on the findings of this project: <https://storage.googleapis.com/releases.naturalcapitalproject.org/invest-userguide/latest/urban_cooling_model.html>

ECOSTRESS LST data is in swath format, so for complete processing, the team will need not only the LST product but the geolocation product and the cloud mask, along with some simple code to batch process these data. Helpful tools are provided by researchers at JPL, the LPDAAC, and the EROS Center here: <https://git.earthdata.nasa.gov/projects/LPDUR/repos/ecostress-workshop/browse>

ECOSTRESS data can be searched and clipped using AppEARS from the LPDAAC: <https://lpdaac.usgs.gov/products/eco2lstev001/>

City of Sacramento GIS data can be found at this portal: <http://data.cityofsacramento.org/search>