**NASA DEVELOP National Program**

**2020 Summer Project Proposal**

**Alabama – Marshall**

**Huntsville Urban Development**

*Using NASA Earth Observations to Evaluate Urban Tree Canopy and Land Surface Temperature for Green Infrastructure Development and Urban Heat Mitigation in Huntsville, AL*

**Project Overview**

***Project Synopsis*:** Huntsville is the fastest growing city in Alabama and as expansion continues, a loss of trees can have negative effects on the environment and the community. Partnering with the City of Huntsville, the team will map tree canopy cover in order to help the city plan further development with fewer environmental impacts. Landsat 7 ETM+ and Landsat 8 OLI will be used along with GEDI LiDAR data to examine forest canopies. Landsat 8 TIRS land surface temperature data will be used to study urban heat. These maps and products will help the city of Huntsville with future planning and management decisions.

***Community Concern:*** An unchecked loss of trees in Huntsville could have negative effects on the environment and the community. With the city’s expansion, the effects of tree canopy loss could enhance an urban heat island effect. This could pose health risks to vulnerable populations within the city. It is important to understand how green infrastructure is changing and what effects this change could have. This research can help decision makers mitigate tree loss and analyze current urban heat island effects taking place within the city.

***Source of Project Idea:*** This project idea originated with a member of the Huntsville City Council. The end user reached out to Dan Irwin from the SERVIR Science Coordination Office who asked the DEVELOP MSFC Lead/Fellow whether this would be a feasible project for DEVELOP.

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

***Study Location:*** Huntsville, AL

***Study Period:*** January2010 – May 2020

***Advisors:*** Dr. Robert Griffin (The University of Alabama Huntsville), Dr. Jeffrey Luvall (NASA Marshall Space Flight Center),

**Partner Overview**

***Partner Organizations:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| **City of Huntsville** | Shane Davis, Director of Urban and Economic Development; Amy Kenum, Interim GIS Managaer; Marc Byers, City Arborist; Paige Colburn, City Planner; Frances Akridge, City Council Member | End User | No |

***End User Overview***

***End User’s Current Decision-Making Process:***The city administration is an interdisciplinary team of department managers involved in long-range planning, engineering, landscape management, public works, and other city operations, led by a city manager. The Huntsville City Council is comprised of 5 members whose management practices include approving cost/benefit analysis and business topics. The city staff will be choosing areas of emphasis for all city tree initiatives totaling over $2 million annually to assure resources are allocated efficiently and effectively. This includes development inspections, site plan review, tree trimming, planting, maintenance, beautification, design standards, flood mitigation, identifying areas for sustainable green space, parks and recreation enhancements, and bonding requirements for commercial project management. The city does not currently have the capacity to use remote sensing.

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

*City of Huntsville* – The city does not currently use NASA Earth observations, but they are aware of NASA SERVIR’s and DEVELOP’s ability to use satellite data for environmental decision making. This project will help to build intra-governmental collaboration and professional development for staff members to gain experience with new data and tools.

***Project Communication & Transition Overview***

***In-Term Communication Plan*:** Communication between the DEVELOP team and the partner will take place bi-weekly over teleconference or video call. Video meetings with science advisors will be as needed. The Fellow will be the POC at the start of the term and communication, with supervision, will transition to the DEVELOP team Project Lead after the first meeting.

***Transition Plan*:** End products and deliverables will be handed off via Google Drive link, after export control at the end of term. The DEVELOP team will host a handoff presentation via web conference (Skype or WebEx). During this meeting, the team will present the results of the project to the partners and answer any questions. Software release will be required, and the tool will be shared with the partner following its release.

**Earth Observations Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter** | **Use** |
| **Landsat 7 ETM+** | Normalized Difference Vegetation Index (NDVI) | Landsat 7 ETM+ data will be used to calculate and visualize NDVI over the study region from 2010-2013.  |
| **Landsat 8 OLI** | NDVI | Landsat 8 OLI data will be used to calculate and visualize NDVI over the study region from 2013-2020.  |
| **Landsat 8 TIRS** | Land Surface Temperature | Landsat 8 TIRS data will be used to measure LST values over the region. |
| **Sentinel-2 MSI** | NDVI | Sentinel-2 MSI data will be used to identify urban areas as well as vegetation difference. These results will be compared to those of Landsat 8 OLI. |
| **ISS GEDI** | Ecosystem LiDAR | GEDI data will be used to map tree canopy density over the city. |

***Ancillary Datasets:***

* USGS North American Land Data Assimilation System (NLDAS-2-FORA) – Climate datasets
* US Census Bureau Topologically Integrated Geographic Encoding and Referencing (TIGER)/Line Shapefiles – US Census Bureau population data for Madison Country, AL

***Software & Scripting:***

* Google Earth Engine API – Data acquisition and manipulation, image processing, and tool development
* Esri ArcGIS Map 10.5 – Raster manipulation, map generation, and image classification development
* NASA GISS Panoply 4.10.4 – Analysis of climate datasets

**Decision Support Tool & End Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Product** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| **Urban Heat Island Tool** | Partners will use this tool for further planning decisions, such as subdivisions and land use ordinances, as the city continues to expand its footprint and density. This tool will also be used by the partner to help mitigate the urban heat island effect.  | This product will be created in Google Earth Engine. It will incorporate data from Landsat 7 ETM+, Landsat 8 OLI, and Sentinel-2 MSI for NDVI and Landsat 8 TIRS for LST. | III |
| **Tree Canopy/Green Infrastructure Map** | This product will allow for planning of possible planting projects to mitigate the effects of the urban heat island effect by evaluating tree loss. It will also help with setting target goals for adding trees, design standards, benchmarks for new developments.  | The Tree Canopy/Urban Infrastructure Map will be created in ESRI ArcGIS using tree cover extent and tree canopy height data from Landsat 8 OLI and ISS GEDI.  | I |
| **Huntsville Urban ArcGIS StoryMap** | A StoryMap will give the partner an educational, user-friendly tool to inform the public of tree canopy change using simplified and animated representations of project results. | The ESRI ArcGIS StoryMap will be created using the online StoryMap platform. This will include results from other end products to provide a full understanding of the project to the general public. | N/A |

***End User Benefit*:** Citizens in Huntsville want confirmation the city is doing what it can to protect tree canopy. The end products will facilitate greater collaboration between departments at the City of Huntsville and improve public awareness for tree conservation. With the high costs of proprietary software, the city GIS department has been limited in performing a study in-house. A comparable study for the city would be cost-prohibitive to undertake without the support of the NASA DEVELOP Program.

**Project Timeline & Previous Related Work**

***Project Timeline:*** Terms: Summer 2020 to Fall 2020

***Multi-Term Objectives:***

* **Term 1(Proposed Term):** 2020 Summer (MSFC) – Huntsville Urban Development
	+ The goal of this first term is to analyze green infrastructure in the City of Huntsville. This will allow for a better understanding of the current green space and urban heat island effects over the city. The partner has also shown interest in looking at flood risk and storm water runoff mapping. Allowing for a second term to study flood risk in the area by building on results from the first term’s tree cover maps.
* **Term 2:** 2020 Fall (MSFC) – Huntsville Urban Development II
	+ The second term of this project will focus on flood risk and stormwater runoff mapping related to urban expansion. It will build off the first terms green infrastructure analysis to better aid the city in planning decisions. This project will have similar partners but will incorporate multiple members of the city. The final handoff will be like that of the first term’s and will include any extra tutorial or educational materials for both projects.

***Related DEVELOP Work:***

2017 Summer (AZ) – Assessing Urban Heat as it Relates to Social Vulnerability and Land Use Changes in Las Cruces, New Mexico

2019 Fall (NC) – Asheville Urban Development: Using NASA Earth Observations to Quantify the Impact of Urban Tree Canopy Cover on Urban Heat and Identify Community Vulnerability in Asheville, North Carolina

2019 Summer (AL) – Mobile Urban Development: Evaluating Urban Heat Islands and Flooding to Enhance Green Infrastructure in Coastal Communities in Mobile, Alabama

2019 Spring (LaRC) – Providence & Elizabeth Urban Development: Utilizing NASA Earth Observations to Explore Heat & Flood-related Vulnerability in Urban Settings

**Notes & References:**

***Notes*:** This project will be highly beneficial to the City of Huntsville, Alabama, as it is the fastest growing city in Alabama. The project provides us a unique opportunity to give back to a city co-located with a DEVELOP location. The partner is very enthusiastic, communicative, and is pooling support from the acting city GIS manager, city arborist, and city planner.

***References:***

Armenakis, C., Du, E., Natesan, S., Persad, R., & Zhang, Y. (2017). Flood risk assessment in urban areas based on spatial analytics and social factors. *Geosciences, 7*(4), 123. https://doi.org/10.3390/geosciences7040123

Chieppa, J., Bush, A., & Mitra, C. (2018). Using “local climate zones” to detect urban heat island on two small cities in Alabama. *Earth Interactions, 22*(16), 1-22. https://doi.org/10.1175/EI-D-17-0020.1

Dong, L., Mitra, C., Greer, S., & Burt, E. (2018). The dynamical linkage of atmospheric blocking to drought, heatwave and urban heat island in Southeastern US: A multi-scale case study. *Atmosphere, 9*(1), 33. doi: 10.3390/atmos9010033