**NASA DEVELOP National Program**

**2019 Spring Project Proposal**

**North Carolina – NCEI**

**Texas Water Resources**

*Analyzing Drought-related Impacts on Urban Tree Inventory Conditions and Recovery in Texas*

**Project Overview**

***Project Synopsis*:** This project will work with the Texas A&M Forest Service (TFS) Sustainable Forestry Department, the TFS Forest Resource Protection Division, and the USDA Forest Service (USFS) Southern Research Station Threat Assessment Center to develop a methodology that incorporates aerial imagery, field-based data, and Earth observations to analyze urban tree condition and recovery in response to the historic 2011 Texas drought. This project will use long-term AVHRR and Landsat 5 NDVI data of tree inventories in the cities of Austin and Houston, as well as Sentinel-2 MSI and Landsat 8 OLI data to provide high resolution, post-drought recovery information. Project results will provide information on urban tree recovery patterns to federal and state forestry agencies to better inform management practices in the face of future drought events.

***Community Concern:*** Trees provide a number of ecosystem services to urban spaces in Texas, including reduced energy costs from shading and benefits to stormwater management, but prolonged drought events can inflict significant damage to urban tree inventories. The historic 2011 drought resulted in the death of more than 5 million trees throughout the urban areas in the state, costing more than $500 million for hazardous tree removal. Field-based data collection of tree condition can be costly and time-consuming, so Earth observations can enhance monitoring practices, especially for long-term analyses of urban tree recovery following drought events.

***Source of Project Idea:*** USFS Southern Research Station and the DEVELOP North Carolina – NCEI node leadership began communication in response to observed impacts of extreme weather events on urban tree inventories. The USFS previously partnered with NASA DEVELOP for rapid-feasibility studies of wildfire disasters in Texas. This project focused on the impact of drought on urban tree inventories fits well within the expertise of the DEVELOP North Carolina – NCEI node and its partnership with NOAA’s National Integrated Drought Information System (NIDIS).

***National Application Area Addressed:*** Water Resources

***Study Location:*** TX

***Study Period:*** January 2010 – January 2019

***Advisor:*** Jessica Matthews (North Carolina Cooperative Institute for Climate Studies)

**Partner Overview**

***Partner Organizations:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| **Texas A&M Forest Service, Sustainable Forestry Department** | Burl Carraway, Sustainable Forestry Department Head | End User | No |
| **Texas A&M Forest Service, Forest Resource Protection Division** | Tom Spencer, Predictive Services Department Head | End User | No |
| **USDA Forest Service, Southern Research Station Threat Assessment Center** | Steve Norman, Research Ecologist | Collaborator | Yes |

***End-User Overview***

***End-User’s Current Decision-Making Process:*** The Texas Forest Service currently utilizes time- and resource-intensive observation methods, including a combination of field surveys, aerial imagery, and various *in situ* datasets, to inform and manage forest inventories. They have expressed interest in expanding their methods to include Earth observations that enhance the information available to analyze and monitor tree condition at high spatial resolution and over long periods of time.

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

*Texas A&M Forest Service, Sustainable Forestry Department* – The Texas A&M Forest Service is familiar with GIS and NASA Earth observations but wishes to build capacity in utilizing NASA Earth observations to manage urban tree inventories.

*Texas A&M Forest Service, Forest Resource Protection Division* – The Texas A&M Forest Service is familiar with GIS and NASA Earth observations. The organization previously partnered with NASA DEVELOP to analyze wildfire conditions and water resources in 2015 and 2016 respectively, but wishes to build capacity in utilizing NASA Earth observations to manage urban tree inventories.

***Collaborator & Boundary Organization Overview***

***Collaborator Support:***

*USDA Forest Service, Southern Research Station Threat Assessment Center* – Southern Research Station Threat Assessment Center personnel will serve as mentors for the team. Steve Norman will connect the team with necessary datasets and literature review materials in addition to contacts within the broader USFS community and locally at the Southern Research Station.

***Dissemination by Boundary Organizations*:**

*USDA Forest Service, Southern Research Station Threat Assessment Center* – The Southern Research Station Threat Assessment Center is interested in disseminating the results across the US Forest Service as well as to state and local forestry specialists. The organization plans on immediately distributing project results to USFS contacts in other urban regions experiencing drought.

***Project Communication & Transition Overview***

***In-Term Communication Plan*:** The Project Lead will communicate with end users and collaborators via bi-weekly teleconferences and video conferences. Team members will share project updates and progress via weekly emails.

***Transition Plan*:** Participants will be able to meet with project partners via video conference before the end of the term to give an overview or tutorial of the use of this project’s end products. The team will share their presentation and end products with end users during this in-person meeting or video conference and send the handoff package digitally via Google Drive. Future applications across the region will also be discussed with project partners and the NASA DEVELOP leadership at the North Carolina – NCEI node.

**Earth Observations Overview**

***Earth Observations:***

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| --- | --- | --- |
| **Platform & Sensor** | **Parameter** | **Use** |
| **Sentinel-2 MSI** | Normalized Difference Vegetation Index (NDVI)  | NDVI will be used to assess local vegetation health in post-drought years.  |
| **Landsat 8 OLI** | NDVI, spectral radiance | NDVI and false color composite images will be used to assess localized vegetation health and land cover in post-drought years.  |
| **Landsat 5 TM** | NDVI, spectral radiance | NDVI and false color composite images will be used to assess vegetation health and land cover in before-drought years. |
| **AVHRR** | NDVI, Leaf Area Index, Fraction of Absorbed Photosyntechically Active Radiation  | AVHRR data will provide broad-scale, long-term indices and canopy characterizations to establish baselines for vegetation health. |

***Ancillary Datasets:***

USGS National Land Cover Dataset (NLCD) – historic land cover data to analyze land cover trends

USFS ForWarn – study departure from normal seasonal greenness due to extreme weather events

USFS Urban Forest Inventory and Analysis (Urban FIA) – access urban tree inventories for the cities of Houston and Austin

USDA National Agriculture Imagery Program (NAIP) – high resolution aerial imagery to validate satellite datasets and imagery

***Software & Scripting:***

Esri ArcGIS – data visualization and map creation

Python – data processing and analysis

ERDAS Imagine – land classification of Landsat imagery and processing

TerrSet – model vegetation type specific phenology

**Decision Support Tool & End Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Product** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| **Texas Urban Tree Inventory Condition Analysis** | This analysis will help partners better understand the long-term recovery of urban tree inventories in the years following the 2011 drought. Data on vegetative health and land cover will highlight priority areas for partners’ management efforts.  | AVHRR, Sentinel-2 MSI, Landsat 5 TM, and Landsat 8 OLI data will be used to analyze urban tree condition before drought and analyze patterns of post-drought recovery via deriving vegetative health indices and incorporating aerial imagery and field data. | I |

***End-User Benefit*:**

The end product can be integrated into the Texas A&M Forest Service’s current management plans in order to improve tree inventory monitoring in post-drought years. This analysis will be used in conjuction with the Urban FIA and related applications to better assess urban forest vulnerabilities and priority management areas. This project will help to increase our partners’ understanding of the health of urban trees in the Houston and Austin metro areas and demonstrate techniques for further integration of NASA EO data into US Forest Service tools nationally.

**Project Timeline & Previous Related Work**

***Project Timeline:*** 1 Term: 2019 Spring

***Related DEVELOP Work:***

Spring 2018 (AZ) – Ajax Urban Development: Utilizing NASA Earth Observations to Assess Urban Forestry

as an Adaptation Strategy for Extreme Heat in Ajax, ON, Canada

Fall 2018 (AZ) – Tempe Urban Development: Utilizing NASA Earth Observations to Assess Thermal

Landscapes and Prioritize Greening Initiatives in Tempe, Arizona

**Notes & References:**

***Notes*:** N/A

***References:***

Carraway, B. (2011). *Drought in Texas Forests: Forest Resource Development*. College Station, Texas: Texas A&M Forest Service – Sustainable Forestry Department.