**NASA DEVELOP National Program**

**2017 Summer Project Proposal**

**University of Georgia**

**Southern Appalachia Disasters II**

*Using NASA Earth Observations to Monitor Wildfire Vulnerability, Damage, and Forest Recovery in the Appalachian Forests*

**Project Overview**

***Project Synopsis*:** The proposed DEVELOP project will explore ecological and social vulnerability to heightened fire susceptibility during dry conditions and monitor vegetation changes before and after the 2016 wildfires in the Southern Appalachians. This project will use and produce regional geospatial mapping products from MODIS and Landsat data to accurately monitor changing vegetation conditions and forest recovery throughout the southeastern US with a focus on areas that suffered the most damage in recent fires.

***Community Concern:*** At the end of 2016, dozens of wildfires burned across the Southeast United States, destroying forests and residential areas. Over 15,000 acres are estimated to have burned within Great Smoky Mountains National Park, a designated UNESCO World Heritage Site and one of the world’s most biologically diverse and intact forests. The adjacent popular tourist areas of Gatlinburg and Pigeon Forge are estimated to have burned over a two-day period (28-29 November 2016) due to fires spread by 90 mph winds, low humidity, increased fuel loading, and prolonged drought conditions. Nearly 60 individual wildfires burning in seven states surrounding the Southern Appalachian Mountains (Georgia, Tennessee, North Carolina, South Carolina, Kentucky, West Virginia, Virginia) damaged hundreds of buildings, caused power outages, and led to the evacuation of several populated areas. Forest resource agencies require a thorough understanding of vulnerability, damage, and recovery related to wildfires in remote and economically-depressed areas such as Southern Appalachia.

***Source of Project Idea:*** This project idea was formed during the fall 2016 term when wildfires swept through the north Georgia mountains. Heavy smoke was noticeable as far south as Atlanta. UGA participants, the ACL, and CL simultaneously thought of projects to assess the fire. After a massive wildfire burned over 15,000 acres within Great Smoky Mountains National Park, UGA’s Center Lead approached NPO with the project idea. UGA’s Center for Geospatial Research has established relationships with the partner organization and UGA DEVELOP assisted them in mapping Hemlock decline in the past. UGA’s Center Lead, Fellow, Lead Science Advisor, US Forest Service partner and NPO worked together to outline this project’s goals and potential end products.

***National Application Area Addressed:*** Disasters

***Study Location:*** GA, TN, SC, NC

***Study Period:*** June 2015 - June 2017

***Advisor:*** Dr. Marguerite Madden (University of Georgia)

**Partner Overview**

***Partner Organizations:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| USDA, US Forest Service, Southern Research Station | Dr. Cassandra Johnson Gaither, Research Social Scientist | End-User | No |
| USDA, US Forest Service, Eastern Forest Environmental Threat Assessment Center | Dr. Steve Norman, Research Ecologist, William Christie, Biological Scientist GIS/Remote Sensing Analyst, William W. Hargrove, Research Ecologist | Collaborator | No |

***End-User Overview***

***End-User’s Current Decision-Making Process:***The end-user organizations are eager to incorporate remote-sensing data into their decision-making processes. While they are familiar with GIS, both organizations are particularly interested in the current data that NASA Earth observations collect so they can examine the impacts of the recent drought and wildfire to manage forest recovery efforts. The US Forest Service is especially interested in the role of heirs’ property located adjacent to large tracts of conservation land. Lacking clear titles of ownership, and often over-gown or undermanaged, heirs’ properties often contain uninhabited shrub land and downed woody debris which contribute to ground fuels and increase the risks for wildfire ignition and spread.

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

*USDA, US Forest Service, Southern Research Station* – The Forest Service is familiar with GIS and NASA Earth observations. However, this is our first partnership with the Forest Service Southern Research Station in Athens, GA.

***Collaborator & Boundary Organization Overview***

***Collaborator Support:***

*USDA, US Forest Service, Eastern Forest Environmental Threat Assessment Center* – Staff at the Forest Service will continue to mentor the team and provide data (e.g., ForWarn) to assist in the creation of a fire risk model.

***Project Communication & Transition Overview***

***In-Term Communication Plan*:** In-person meetings with Dr. Johnson Gaither will be organized as often as possible. The Team Lead will serve as the primary contact.

***Transition Plan*:** Deliverables will be shared with partners through Google Drive (or NASA LFT, if necessary) and an in-person presentation to the local partners will summarize the results of this project. Final results will be used immediately to increase understanding of these wildfire events, vulnerable communities, and manage forest recovery efforts.

***Letters of Support*:** Dr. Cassandra Johnson Gaither,Research Social Scientist and Project Leader, U.S. Forest Service.

**Earth Observations Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter(s)** | **Use** |
| **Landsat 8 OLI** | Land cover | Data will be used for vegetation phenology and time lapse of burn scars before, during, and after the fire. |
| **Terra MODIS** | Spectral vegetation indices and phenology products | ForWarn data will be used for vegetation phenology. |
| **Aqua MODIS** | Spectral vegetation indices and phenology products | ForWarn data will be used for vegetation phenology. |

***Ancillary Datasets:***

UGA Center for Geospatial Research – Pre-fire Vegetation Database and Detailed classification of overstory and understory vegetation polygons for Great Smoky Mountains National Park and Foothills Parkway – Data will be used as training points for vegetation classification of pre-fire conditions and the location of potential fuel loading from Eastern hemlock forests damaged approximately 10 years ago by the exotic invasive hemlock wooly adelgid (*Adelges tsugae*).

US Forest Service – Pre-fire Anderson Fire Fuel Model Database and U.S. Forest Service Anderson Fire Fuel Model Classifications – U.S. Forest Service Anderson Fire Fuel Models for Great Smoky Mountains National Park derived from pre-fire vegetation types and density will be correlated with fire damage identified from current NASA EO data.

Computer-Assisted Mass Appraisal (CAMA) Data – Potential heirs’ properties in counties adjacent to preserved forest lands – Information on parcels with multiple owners and no recent changes in ownership indicate high probability of heirs’ property and fuel loading.

US Census Bureau Census Tract Data – Socio-economic Data – Indicators of economically depressed areas are correlated with increased probability of heirs’ properties, fuel loading, and social vulnerability.

Community Wildfire Protection Plan (CWPP) – Data Preparedness for wildfire, resilience and improved recovery – The presence or absence of CWPPs may be an indicator of social and ecological vulnerability to wildfires.

***Software & Scripting:***

Exelis ENVI 5.0 – visualization and digital number extraction, stacking and processing of hyperspectral AVIRIS and MASTER imagery (e.g. vegetation/burn severity indices, contrast enhancement, change detection)

Esri ArcGIS 10.2 – raster manipulation and analysis, image enhancement, and map creation of Landsat 8 OLI, Aqua MODIS, and Terra MODIS

**Decision Support Tool & End Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Product(s)** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| **Vegetation and Fuel Loading Change Maps** | Allocation of wildfire management and community preparedness resources | MODIS and Landsat data will be processed to create geospatial products depicting forest phenology as it relates to fuel loading and wildfire risk. | N/A |
| **Social and Ecological Vulnerability Index** | Assess both the risks and the impacts of wildfires Heirs Properties bordering and potentially connecting conservation lands | Index of Social and Ecological Vulnerability will be modeled from CAMA, Census Tract and CWPP data, combined with drought, aerosol transport, vegetation change and fuel loading model datasets. | N/A |
| **Post Fire Vegetation Recovery Assessment** | Time series illustrating changes in the areas affected by recent wildfires | Landsat 8 OLI and MODIS data will be used to create time series maps for the Southeast US. | N/A |

***End-User Benefit*:** This project will enhance our partners’ management efforts in this region by demonstrating the use of NASA data for assessing social and ecological vulnerability in an economically depressed area while monitoring effects of wildfire and post-fire decision support.

**Project Timeline & Previous Related Work**

***Project Timeline:*** 2 Terms: 2017 Spring (Start) to 2017 Summer (Completion)

***Multi-Term Objectives:***

* **Term 1:** 2017 Spring (University of Georgia) – Southern Appalachia Disasters
	+ During the first term of this project, the team explored ecological and social relationships to heightened fire susceptibility in the Southern Appalachians. Additionally, the team monitored vegetation changes (greenness and phenology) throughout areas most affected or damaged by the 2016 wildfires using Terra MODIS, Terra ASTER, and Landsat 8 OLI data.
* **Term 2 (Proposed Term):** 2017 Summer (University of Georgia) – Southern Appalachia Disasters II
	+ The Socio-Ecological Vulnerability Index and Post Fire Vegetation Recovery Assessment will be completed during the second term. The Center Lead and Lead Science Advisor plan to organize an in-person hand-off at the U.S. Forest Service office.

***Previous Terms:***

2017 Spring (University of Georgia) – Southern Appalachia Disasters

***Related DEVELOP Work:***

2015 Summer (NASA John C. Stennis Space Center) -Texas Disasters: Utilizing NASA Earth Observations to Assist the Texas Forest Service in Mapping and Analyzing Fuel Loads and Phenology in Texas Grasslands

2015 Summer (NASA John C. Stennis Space Center) -California Disasters II: Assessing the Effectiveness of Simulated HyspIRI Data for Use in USDA Forest Service Post-Fire Vegetation Assessment and Decision Support

2014 Spring (University of Georgia) - Great Smoky Mountains Ecological Forecasting: Utilizing NASA Earth Observations to Monitor Long Term Hemlock Decline Caused by Invasive Hemlock Woolly Adelgid in Great Smoky Mountains National Park

**Notes & References:**

***Notes*:** Detailed data available for the Great Smoky Mountains National Park and adjacent Foothills Parkway will be used to inform vegetation, fuel loading, vulnerability, fire damage and recovery in a multi-state area surrounding the Southern Appalachian Mountains.