**NASA DEVELOP National Program**

****The University of Georgia

*Summer 2017*

**Short Title: Southern Appalachia Disasters II**

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

**VPS Title:** In the Line of Fire: Exposing the Vulnerable in Appalachia

**Project Team**

**Project Team:**

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**Project Overview**

**80-100 Word Objectives Overview:**

The objective of this project was to complete a more in-depth analysis of the social relationships that residents have to heightened fire susceptibility in the Southern Appalachians. Additionally, the team monitored vegetation changes as a result of the wildfires that occurred at the end of 2016 in this region. This project used Terra MODIS, Terra ASTER, and Landsat 8 OLI data to monitor changing vegetation conditions, such as greenness and phenology, throughout areas most affected or damaged by the wildfires. This project contributed to existing management programs and on-going work to aid in community preparedness, land management practices, and protection of fire-sensitive properties.

**Abstract:**

Wildfires in the southeastern US are understood less than those in other portions of the nation. In October and November 2016, over sixty individual wildfires ignited among seven states in the Southern Appalachian region. These fires damaged hundreds of buildings, caused numerous power outages, and resulted in fatalities. These unusually destructive events highlight the need to improve awareness of fire susceptibility and risk in the southeastern US. The US Forest Service requires a thorough understanding of wildfire vulnerability, damage, and recovery to effectively help local communities respond to and prepare for these events. The University of Georgia NASA DEVELOP team partnered with US Forest Service Southern Research Station to assess vegetation dynamics before and after the 2016 wildfire events, focusing on GA, NC, and TN. This was accomplished by utilizing Landsat 8 OLI, Terra ASTER, and Terra MODIS data to evaluate land cover changes from October to December 2016 and assess the severity of these fires. In addition, this project incorporated demographic data to examine the association between fire risk and under-managed lands, such as heirs’ properties, and to construct a model of social vulnerability to wildland fire hazards in the study area. The results of this project provided researchers at the US Forest Service with an increased understanding of how property ownership and community management practices can affect future wildfires, as well as how the spatial distribution of socioeconomic variables affects residents’ ability to adapt and recover.

**Keywords:**

Remote sensing, MODIS, Landsat 8, wildfire vulnerability, heirs’ property, NDVI, CWPP, Firewise communities

**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  Benjamin S. Hornsby, Fire Research Specialist | 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 |

**Community Concerns:**

* In November of 2016, nearly 60 individual wildfires in the Southern Appalachian Mountains damaged hundreds of buildings, caused power outages, and led to the evacuation of several populated areas.
* Over 15,000 acres within Great Smoky Mountains National Park (a designated UNESCO World Heritage Site and one of the world’s most biologically diverse and intact forests) and 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, presence of fuel loads, and drought.
* There is a need for US Forest Service agencies to have a thorough understanding of vulnerability, resilience, and recovery related to wildfires in remote and economically depressed areas such as Southern Appalachia to help with planning and mitigation efforts.
* Under-managed or poorly maintained properties can pose a risk for build-up of fuel loads, especially in drought conditions.

**Current Decision-Making Practices & Policies:**

The US Forest Service is currently investigating methods to properly treat areas of concern through restoration, regeneration, and fuel reduction in the southern Appalachians. Additionally, the US Forest Service has performed thinning treatments and prescribed burns to areas in southeastern US where there have been multi-year droughts. Studies conducted by the US Forest Service Southern Research Station have focused on excessive fuel loading, management policies related to human alteration of local ecosystems, and both the use and effectiveness of prescribed burns. These studies are long-term and require additional field observations to determine forest sustainability.

**Decision Support Tools & Benefits:**

|  |  |  |  |
| --- | --- | --- | --- |
| **End Product** | **Earth Observations Used** | **Partner Benefit & Use** | **Software**  **Release** |
| Vegetation and Fuel Loads Change Maps | Landsat 8 OLI, Terra ASTER, and Terra MODIS | Will be used by the Forest Service to identify properties with unclear ownership and assess land management practices | N/A |
| Fire Event Time Series | Landsat 8 OLI | Will provide the Forest Service with Landsat-based time series animations of the 2016 wildfires in TN, GA, and NC | III |
| Google Earth Engine Time Series Scripts | N/A | GEE scripts to generate animations of images or a short time-lapse video of the study area | III |
| Fire Vulnerability Matrix | Landsat 8 OLI, Terra ASTER, and Terra MODIS | Will integrate environmental and socioeconomic factors to aid the US Forest Service in identifying at-risk locations and vulnerable communities | N/A |
| Pilot Vulnerability Model for Rabun County, Georgia | Landsat 8 OLI, Sentinel 2 | Will produce a higher, 10m resolution vulnerability and exposure based on imagery and property data | N/A |

**Project Benefit to End User**:

The US Forest Service Southern Research Station is currently investigating the role of properties lacking clear title of ownership (also known as heirs’ properties) in contributing to wildfire risk, as well as the role of social indicators in disaster resilience. This project provides a geospatial perspective on these issues to complement data collected by the Forest Service. Examining the potential effects of heirs’ properties and the spatial distribution of social vulnerability to wildfires can aid in the development of more inclusive and effective plans for community resilience and recovery.

**Project Details**

**Applied Sciences National Application Addressed:** Disasters

**Study Area:** Southern Appalachia Mountains: GA, TN, NC

**Study Period:** January 2000 – June 2017

**Earth Observations & Parameters:**

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter(s)** | **Use** |
| Landsat 8, Operational Land Imager (OLI) | Spectral vegetation indices, Land Cover | Spectral vegetation and land cover will provide the Forest Service with Landsat-based time series animations of the 2016 wildfires in TN, GA, and NC. In addition GEE scripts will create future animations and time-laps videos of the study area. |
| Terra MODIS | Decadal change and phenoregions | Decadal changes and phenoregions will be used by the Forest Service to identify properties with unclear ownership and assess land management practices. |
| Aster MODIS | DEM | A DEM will be used by the Forest Service to identify properties with unclear ownership and assess land management practices. |

**Ancillary Datasets Utilized:**

* State Departments of Assessments and Taxation Computer-Assisted Mass Appraisal (CAMA) Data – property ownership and management information
* American Community Survey 2011–2015 Five Year Estimates (ACS) – demographic indicators of social vulnerability
* Forest and Rangelands Community Wildfire Protection Plans (CWPP) – identification of communities with fire protection plans
* Firewise Communities Maps – spatial information about areas with fire protection plans
* USGS National Land Cover Database (NLCD) – land cover
* National Elevation Dataset – digital elevation model
* USGS National Map – fire stations and road network

**Models Utilized:**

* Soil and Water Assessment Tool (SWAT) model

**Software Utilized:**

* Google Earth Engine API – Landsat time series creation
* Esri ArcGIS – image processing, NDVI calculations, and map creation
* R – data cleaning and standardization, summary statistics, PCA
* SNAP – Sentinel-2 image processing
* QT Modeler – LiDAR data processing

**Project Handoff Package**

**Transition Plan:**

The handoff for this project will occur at an end of the term “brown bag” session held at the Southern Research Station with attendees from the Forest Service and interested individuals.

*Software Release Plan*: With the aid of our science advisors, partners at the Forest Service understand how the Google Earth Engine (GEE) platform works and can be applied to future studies. Partners are aware that the Software Release process means that all GEE code will be delivered at a later date. All GEE code will be shared through a direct Google link with collaborators at the Forest Service. The team will conduct a teleconference to explain the code and provide a tutorial on how to use GEE. The team POC will follow-up will partners on the software if any questions arise.

**Team POC:** Amanda Aragon, AmandaAragon@gmail.com

**Software Release POC:** Matthew Hevert, Matt.Hevert@gmail.com

**Partner POC:** Steve Norman, PhD, stevenorman@fs.fed.us

**Handoff Package:**

* Fire vulnerability maps
* Pilot vulnerability study of Rabun county, GA
* Final draft deliverables
* Project video