**NASA DEVELOP National Program**

**2020 Fall Project Proposal**

**Colorado – Ft. Collins**

**Southern Colorado Disasters**

*Using NASA Observations to Map Aspen Extent and Recovery Due to Wildfire*

**Project Overview**

***Project Synopsis*:** The 2018 Spring Fire burned 108,000 acres in southern Colorado, including thousands of acres of forest with quaking aspen (*Populus tremuloides*). The goal of this project is to map aspen extent before and after the Spring Fire and to evaluate patterns of aspen recovery. The team will employ Landsat 8 OLI, Sentinel-2 MSI, SRTM, and National Agriculture Imagery Program (NAIP) data to produce maps of aspen extent before and after the fire, identify where aspen is recovering or failing to recover, and analyze spatial patterns in post-fire aspen extent relative to pre-fire extent and forest management decisions. Findings can help project partners at Trinchera Ranch and the Colorado State Forest Service to understand aspen’s role in forest recovery after fire and to target forest management.

***Community Concern:*** The western United States is facing a future with more frequent and severe wildfire. Communities are concerned about the impacts this will have on forests and the associated services they provide for water quality, wildlife, recreation, carbon storage, and economies. Aspen is a species of particular interest to communities and managers because it resprouts following disturbance and can be one of the first species to recover after fire. The quick re-establishment of aspen can help stabilize watersheds and serves as important wildlife habitat. Partners at Trinchera Ranch actively manage for aspen and are interested in how their past management and the Spring Fire are shaping forests and aspen in particular. The Colorado State Forest Service works with landowners in burned landscapes across the state and is interested in understanding the resilience of forests to fire and in communicating lessons from past fires to the landowners they serve.

***Source of Project Idea:*** This project arose through conversations over the last year between science advisors and project partners about how the Spring Fire impacted aspen distribution. The DEVELOP CO node has worked with Trinchera Ranch previously and fostered a good relationship.

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

***Study Location:*** Southern Colorado (between Fort Garland and La Veta, CO)

***Study Period:*** June – October (2017 – 2020)

***Advisors:*** Dr. Paul Evangelista (Colorado State University, Natural Resource Ecology Laboratory), Dr. Catherine Jarnevich (USGS, Fort Collins Science Center), Dr. Anthony Vorster (Colorado State University, Natural Resource Ecology Laboratory), Peder Engelstad (Colorado State University, Natural Resource Ecology Laboratory), Nicholas Young (Colorado State University, Natural Resource Ecology Laboratory)

**Partner Overview**

***Partner Organizations:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| **Trinchera Ranch** | Aaron Swallow, Environment and Forest Manager | End User | No |
| **Colorado State Forest Service** | Dr. Amanda Fordham West, Manager of Science Information | Collaborator | Yes |

***End User Overview***

***End User’s Current Decision-Making Process:***Currently, Trinchera Ranch and the Colorado State Forest Service are working to improve forest health and land management in southern Colorado. To track progress towards these management goals, the ranch currently utilizes costly field observation to monitor fuel loads and forest composition and structure. In addition, these field surveys are spatially limited due to inaccessible, remote terrain. The ranch has implemented a variety of silvicultural treatments to spur aspen regeneration and to protect the aspen from elk browsing. Knowledge of how aspen extent has been impacted by the Spring Fire will supply the managers and cooperating agencies with information to assist with improving management strategies. The partners recognize the utility of remote sensing to inform their management and are looking to this partnership with DEVELOP to increase their capacity for incorporating NASA Earth observations into their decision-making processes.

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

*Trinchera Ranch* – The Environment and Forest Management team of the ranch have limited experience using NASA Earth observations in their management practices. This project will build capacity for the end user by highlighting the use and application of NASA Earth observations in generating meaningful maps that impact management decisions.

***Collaborator & Boundary Organization Overview***

***Collaborator Support:***

*Colorado State Forest Service* – The mission of the Colorado State Forest Service is to achieve stewardship of Colorado’s diverse forest environments for the benefit of present and future generations. The partner will provide expert knowledge of the landscape.

***Dissemination by Boundary Organizations*:**

*Colorado State Forest Service* – The Colorado State Forest Service has a dedicated communication and education mission. It produces a variety of products that are disseminated using multiple media types including print, social media, and online resources. The results of this project would be of interest to multiple audiences across Colorado including landowners, academic personnel, and local government agencies.

***Project Communication & Transition Overview***

***In-Term Communication Plan*:** The team will communicate with partners and collaborators bi-weekly throughout the term via teleconference meetings. Between those meetings, the team and partners will communicate via email. The Fellow and Project Lead will be the primary points of contact with the partner organizations.

***Transition Plan*:** At the end of the term, the team will host a webinar for the partners to disseminate project results. A handoff package will be sent to the end users via email. There is no software release required for this project.

**Earth Observations Overview**

***Earth Observations:***

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| --- | --- | --- |
| **Platform & Sensor** | **Parameter(s)** | **Use** |
| **Landsat 8 OLI** | Spectral vegetation indices | Landsat imagery will be used to detect aspen before and after the spring fire. Seasonally differenced Landsat images will distinguish aspen using its distinct phenology. |
| **Sentinel-2 MSI** | Spectral vegetation indices | The ability of Sentinel-2 to detect aspen will also be evaluated. The temporal and spatial resolution may prove helpful for detecting aspen. |
| **SRTM** | Elevation, topographic position index, slope, aspect | SRTM topographic indices will be utilized in the analysis of aspen recovery patterns. |

***Ancillary Datasets:***

* National Agriculture Imagery Program (NAIP) – aerial imagery to serve as a visual reference of past and current forest condition
* Natural Resource Ecology Laboratory shapefile of Spring Creek fire – shapefile used to delineate fire extent in analysis
* NASA DEVELOP burn severity raster created by fall 2018 Colorado & New Mexico Disasters team – evaluate changes in aspen extent by burn severity
* Natural Resource Ecology Laboratory forest inventory field data collected during the summer of 2020 in the Spring Fire – field data to train models
* U.S. Department of Agriculture Forest Service and U.S. Department of the Interior LANDFIRE, Existing Vegetation Cover – vegetation dataset to locate pre-fire forest types likely to have an aspen component
* Trinchera Ranch forest management shapefiles – spatial data showing where forest management has occurred since 2014

***Modeling:***

* Random Forest (RF) (POC: Dr. Catherine Jarnevich, USGS Fort Collins Science Center) – machine learning algorithm used for aspen detection model generation

***Software & Scripting:***

* Esri ArcGIS – image processing and end product generation
* R – statistical analyses and raster processing
* Google Earth Engine API – large-scale image analysis

**Decision Support Tool & End Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Product** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| **Pre- and Post-Fire Aspen Extent** | These maps of aspen extent just before the fire and two years after the fire will give managers more complete information about aspen extent on the property and how it has changed to guide management and monitoring efforts. | We will use a random forest model with forest inventory surveys and Landsat 8 OLI and SRTM to map the extent of aspen in 2017 (before the Spring Fire) and 2020 (two years after the fire). Phenology differences between aspen and other vegetation types will inform scene selection. | N/A |
| **Aspen Change Maps** | Understanding how the Spring Fire impacted aspen distribution will inform the ranch’s approach to aspen management moving forward. This will provide information about trends in the aspen population. | We will analyze the pre- and post-fire aspen extent rasters to show the following categories of aspen recovery: areas that had aspen before and after the fire, areas that have aspen after the fire but did not have aspen before the fire, and areas that were aspen before the fire but are not returning as aspen. | N/A |
| **Analysis of Aspen Recovery Patterns** | Management of forest regeneration in burned areas requires an understanding of the drivers of aspen regeneration, including past forest management. Why is aspen regenerating in some areas but not others? | We will characterize categories of aspen recovery identified by the Aspen Change Maps using a random forest model and spatial layers of topography, forest type, burn severity, distance to nearest pre-fire aspen pixel, and management (i.e., elk exclosure, thinning, clearcut).  | N/A |

***End User Benefit*:** This project will provide valuable data to project partners to characterize post-fire forest recovery, the impacts of the Spring Fire on aspen distribution, and potential drivers of these changes. The products will provide comprehensive maps across this difficult to access terrain and will harness the temporal power of remote sensing to identify where aspen was distributed before the fire. This will help end users evaluate the impact of their forest management before and after the fire to promote aspen growth, one of their primary management objectives. They will also be able to better target forest management moving forward.

**Project Timeline & Previous Related Work**

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

***Related DEVELOP Work:***

2020 Summer (CO) – Rocky Mountain Disasters: Using NASA Earth Observations to Monitor Post-Fire Vegetation Recovery

2018 Fall (CO) – Colorado & New Mexico Disasters: Utilizing NASA Earth Observations to Quantify Forest Mortality and Burn Severity to Inform Management on Ranches and Open Lands

**Reference:**

Romme, W.H., Turner, M.G., Wallace, L.L., Walker, J.S. (1995). Aspen, elk, and fire in northern Yellowstone National Park. *Ecology, 76*, 2097–2106.