**Front Range Wildland Fires**

*Evaluating the Efficacy of Remote Sensing Imagery in Monitoring Forest Fuels Treatment Methods*

**Project Team**

***Project Team:***

Nora Carmody (Project Lead)

Lillian Gordon

Nate Teich

Josh Virene

***Advisors & Mentors:***

Nicholas Young (Colorado State University, Natural Resource Ecology Laboratory)

Dr. Tony Vorster (Colorado State University, Natural Resource Ecology Laboratory)

Chris Choi (Colorado State University, Natural Resource Ecology Laboratory)

Dr. Paul Evangelista (Colorado State University, Natural Resource Ecology Laboratory)

Dr. Catherine Jarnevich (United States Geological Survey)

***Fellow:***

Sarah Hettema (Colorado - Fort Collins)

***Team Contact:*** Nora Carmody, nora.carmody@du.edu

***Partner Contact:*** Jackie Edinger, jackie.edinger@colostate.edu

**Project Overview**

***Project Synopsis:***

The Front Range Wildland Fires project aimed to map canopy cover along Colorado’s Front Range, exploring model parameters such as image resolution, image quality, and number of training points to determine which model parameters lead to the most accurate model output. By creating a model that effectively maps canopy cover over large, forested regions, project partners at the Colorado Forest Restoration Institute and the Colorado State Forest Service will be able to more efficiently monitor their forest treatments, leading to better adaptive management and better forest health.

***Abstract:***

Over the last several decades, wildfire frequency and severity in forested areas along Colorado’s Front Range have increased due to a buildup of fuels. This has led to an increase in forest treatments, as well as an increased need to evaluate the success of these treatments. Remote sensing products offer an efficient and cost-effective way to monitor forest treatments; however, not all remote sensing products and analysis techniques have been explored by Coloradan land managers. Specifically, project partners at the Colorado State Forest Service (CSFS) and the Colorado Forest Restoration Institute (CFRI) were interested in using an effective and streamlined method of mapping canopy cover to better monitor forest treatment success. To support their needs, the NASA DEVELOP Front Range Wildland Fires team explored National Agricultural Imagery Program (NAIP) imagery at different spatial resolutions and numbers of training points with NASA’s Shuttle Radar Topography Mission (SRTM) Data Elevation Model (DEM) as a predictor in addition to NAIP imagery spectral predictors. From this analysis, we created classified canopy cover rasters, and compared accuracy metrics across model iterations. We also determined that the best performing model, with an overall accuracy of 90%, uses 2021 NAIP imagery at 2-meter resolution, 800 training points, 200 testing points, does not use topographic predictors, and reclassifies shadow pixels via a pre-selected NDVI threshold.

***Key Terms:***

Remote Sensing, NAIP, Google Earth Engine, Random Forest, ocular sampling, shadow

***National Application Areas Addressed:*** Wildland Fires

***Study Location:*** Greater Ben Delatour Scout Ranch (BDSR) region and Upper Monument Creek (UMC) region, CO

***Study Period:*** January 2013 to December 2013, January 2019 to December 2019, January 2021 to December 2021

***Community Concerns:***

* Fires along the Front Range of Colorado are becoming more frequent and more severe, burning forests, destroying structures, and heavily impacting local ecosystems.
* An increase in large-scale, severe fires has led to an increase in forest treatments and an increased need to monitor the efficacy of these treatments.
* Remote sensing products and methods, which offer an efficient and cost-effective way to monitor treatments, have not all been explored by land managers.

***Project Objectives:***

* Explore imagery parameters such as scale, resolution, and training point minimums
* Compare the efficacy between different classification approaches using optical imagery
* Provide partners with a tested and reproducible methodology for canopy cover mapping

**Partner Overview**

***Partner Organizations:***

|  |  |  |
| --- | --- | --- |
| **Organization** | **Contact (Name, Position/Title)** | **Partner Type** |
| **Colorado Forest Restoration Institute** | Jackie Edinger, GIS Specialist; Stephanie Mueller, GIS Specialist | End User |
| **Colorado State Forest Service**  | Ethan Bucholtz, Forest Monitoring Program Manager; Amanda Fordham, Associate Director | End User |

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

CFRI is a research institute that provides scientific knowledge to improve forest management practice for researchers, managers, and stakeholders. Before partnering with DEVELOP, they had a robust remote sensing capability for forest treatment monitoring. Using data from the high spatial resolution satellites WorldView-02, GeoEye-01, and Quickbird-02 to monitor canopy cover, they uploaded their data to ArcGIS Pro and rescaled to a 3-m resolution before processing their imagery in R. While this approach has provided meaningful results, CFRI has expressed needs for a more streamlined approach (i.e., completing the entire analysis within a single GIS software, like Google Earth Engine) using imagery with higher spatial and temporal resolution and better spatial coverage. CSFS is a state governmental agency whose mission is aimed at providing technical expertise and finding new approaches to adaptive management in Colorado forests. It had limited use of remote sensing practices in their treatment monitoring and expressed an interest in building capacity to use more geospatial data.

**Earth Observations & End Products Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameters** | **Use** |
| **Shuttle Radar Topography Mission (SRTM)** | Slope, aspect | SRTM slope and aspect data were utilized to generate predictor variables that our model used to generate canopy cover classifications. |

***Ancillary Datasets:***

* CFRI LiDAR Classification (2013) – Used for model comparison between team outputs and CFRI’s model output
* National Agricultural Imagery Program (NAIP) - Used to visualize study regions and the classification points. NAIP bands were used to generate additional predictor variables to train the model

***Modeling:***

* Google Earth Engine Random Forest Classifier – Used to generate classified rasters using training point data with predictor variables

***Software & Scripting:***

* Google Earth Engine – NAIP derived canopy classification
* ArcGIS Pro 2.8.1 – Map visualization
* RStudio 4.2.2 – Histogram and graph visualizations

***Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Product** | **Earth Observations Used**  | **Partner Benefit & Use** | **Software Release Category** |
| **Classified Canopy Cover Rasters for the Greater BDSR and UMC Study Areas** | STRM | The classified rasters produced by our random forest classifier can be used to produce more detailed forest structure maps. These maps can be used to monitor forest treatments. | N/A |
| **Comparison of Model Outputs** | STRM | A comparison of all model outputs provided our partners with an overview of the parameters that produce the most accurate model as well as an assessment of how much each model parameter affects accuracy. | N/A |

***Product Benefit to End User:***

By creating classified canopy cover rasters for the greater BDSR and UMC regions and comparing all model outputs produced, we will support our partner’s objectives testing different imagery parameters such as image quality, resolution, shadow reclassification, and number of training points to determine what makes a successful classification model. This model output comparison will allow our partners to see how the different parameters affect model accuracy and allow them to select their desired parameters efficiently. This tested and reproducible methodology will let them generate their own canopy cover classification rasters, which in turn will enable them to create detailed forest structure maps that can then be used to monitor forest treatments.

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