NASA DEVELOP National Program 2021 Spring Project Proposal

Colorado – Fort Collins

Colorado Front Range Disasters

Understanding the Impact of Forest Management on the Cameron Peak and Calwood Fires

Project Overview

Project Synopsis: The DEVELOP team will evaluate the influence of fuel reduction treatments (e.g., mechanical thinning and prescribed burning) on the 2020 Cameron Peak and CalWood Fires. The team will use Landsat 8 OLI and Sentinel-2 MSI data to map burn severity, and then will analyze burn severity patterns in forests that were treated before the fires compared to similar untreated areas. They will determine the conditions in which fuels reduction treatments reduced burn severity. The partners will apply these lessons to continued forest restoration work, and to communicate the effectiveness of past fuels reduction efforts to community stakeholders. Partners include the Coalition for the Poudre River Watershed, The Nature Conservancy, Ben Delatour Scout Ranch, and Colorado State University Department of Forest and Rangeland Stewardship. Improved understanding of fuels reduction treatment effectiveness and community support for forest restoration can help foster forests resilient to future fire.

Community Concern: Communities along the Colorado Front Range rely on forests for many services, including for clean drinking water, recreation, and carbon storage. While fire is an important process in these forest ecosystems, severe fires can also threaten structures and the services these forests provide. The Front Range montane forests are denser and more prone to severe fire than they were historically due to fire suppression policies. Communities across the Front Range have tried to be proactive about restoring these forests and reducing fuel loads to decrease the likelihood of widespread, severe fire. The recent Cameron Peak and CalWood Fires burned large areas along the Front Range, including large areas where past forest management occurred. This is a timely opportunity to evaluate the effectiveness of past forest mitigation work so communities can adapt their forest management accordingly.

Source of Project Idea: The Colorado – Fort Collins node was initially planning a project looking at prescribed burns completed last year in northern Colorado. Once the Cameron Peak Fire burned into areas where the partners have been working to reduce fuels and susceptibility to catastrophic fire, this current project took shape and took priority.

National Application Areas Addressed: Disasters

Study Location: Northern Front Range, CO Study Period: July 2019 – November 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), Brian Woodward (Colorado State University, Natural Resource Ecology Laboratory), Nicholas Young (Colorado State University, Natural Resource Ecology Laboratory), Peder Engelstad (Colorado State University, Natural Resource Ecology Laboratory)

Partner Organizations:						
Organization	POC (Name, Position/Title)	Partner Type	Boundary Org?			
Coalition for the Poudre River	Daniel Bowker, Forest and Fire	End User	No			
Watershed	Project Manager					

Partner Overview

The Nature Conservancy,	Rob Addington, Research Scientist	End User	No
Colorado Chapter			
Ben Delatour Scout Ranch	Robert Sturtevant, Conservation	End User	No
	Chair		
Colorado State Forest Service	TBD	End User	No
Colorado State University,	Wade Tinkham, Assistant Professor	Collaborator	No
Department of Forest and			
Rangeland Stewardship			

End User Overview

End User's Current Decision-Making Process: Forest restoration work along the Front Range is based on extensive forest ecology work to identify the historic range of variability, fire regimes, and best practices for reducing fire risk. The partners, such as the Coalition for the Poudre River Watershed (CPRW), The Nature Conservancy (TNC), and the Colorado State Forest Service (CSFS), work with landowners, such as the Ben Delatour Scout Ranch (BDSR), to adapt these forest treatments to work for each landowner's social and economic context. They collectively publish best management practices (TNC, CSFS, and Colorado State University (CSU)), target priority treatment areas (CPRW, TNC, BDSR, CSFS), build collaborations (all partners), and work with landowners and stakeholders to implement fuels reduction work (CPRW, TNC, and CSFS). There have been few opportunities to evaluate the effectiveness of these treatments in slowing the spread of wildfire, protecting values, and reducing burn severity. These fires are ongoing, so partners have not had the opportunity and do not have resources or the training to formally study the interactions of wildfire and treatments using remote sensing. Lessons learned from the effectiveness of past treatments can be used as these organizations move forward to communicate the importance of their work to stakeholders, adapt forest restoration best practices, and understand areas on the landscape to prioritize for future work.

End User's Capacity to Use NASA Earth Observations:

- *Coalition for the Poudre River Watershed* The end users utilize geospatial technologies in their work and rely upon existing datasets to prioritize forest restoration sites with public and private landowners. They do not have the capacity to create custom products from NASA Earth observations, and will be learning the strengths and limitations of NASA Earth observations for informing their work. They also hope to learn how NASA Earth observations can be used to evaluate the effectiveness of their past forest restoration work.
- *The Nature Conservancy* The Nature Conservancy has strong geospatial capabilities, but do not fully utilize NASA Earth observations for mapping and monitoring fire impacts. This project will expose them to some common burn severity mapping techniques and easily-accessible approaches that they may wish to replicate.
- Ben Delatour Scout Ranch The Ben Delatour Scout Ranch does not have capacity to utilize NASA Earth observations, and will better understand the strengths and limitations of remote sensing through this project.
- Colorado State Forest Service Like some of our other partners on this project, the Colorado State Forest Service has strong geospatial capacities but does not apply NASA Earth observations in their workflows.

<u>Collaborator & Boundary Organization Overview</u> Collaborator Support:

Colorado State University, Department of Forest and Rangeland Stewardship – They will support this project by providing technical support and geospatial datasets needed for this project.

Project Communication & Transition Overview

In-Term Communication Plan: The team will communicate with partners through web conferences at least three times throughout the term. The project mentors, Fellow, and Team Lead of this project 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-based seminar to disseminate project results to interested members of the public and to the partners. All end products and reports will be provided digitally to partners.

Earth Observations:				
Platform & Sensor	Parameter(s)	Use		
Landsat 8 OLI	Burn severity	Landsat 8 OLI will be used to map burn severity using multiple methods, i.e. NBR, DNBR, etc., to be compared to field observations.		
Sentinel-2 MSI	Burn severity	Sentinel-2 MSI will be used to map burn severity using multiple methods to be compared to field observations.		
GOES-17	Fire progression	GOES data will be used, if needed, to improve upon existing burn progression maps to more accurately show the days that each pixel burned.		
MODIS & VIIRS	Active Fire Data	The active fire datasets will be used to augment other fire progression datasets available to the team.		
SRTM	Elevation, topographic position index, slope, aspect	SRTM topographic in dices will be utilized for analyses of burn severity and in comparisons of treated and untreated areas.		

Earth Observations Overview

Ancillary Datasets:

- Colorado State Forest Service Forest Treatment Polygons Shapefile showing location, method, year, and other information about forest treatments
- InciWeb Fire Progression Map Maps showing the daily spread of each fire to understand conditions under which each area burned
- Colorado State University Burn Severity Plots Field plots measuring burn severity in the Cameron Peak Fire to evaluate burn severity remote sensing maps
- Colorado State University Biomass Maps Aboveground forest biomass maps that cover this study area

Modeling:

• Random forests (POC: Anthony Vorster, Colorado State University) – Model will be used to predict expected burn severities across the landscape

Software & Scripting:

- ESRI ArcGIS Image processing, pixel matching, end product and map generation
- R Modeling execution, statistical analyses, raster processing
- Google Earth Engine Image processing and model execution

Decision Support Tool & End Product Overview

End Products:

End Product	Partner Use	Datasets & Analyses	Software Release Category
Cameron Peak and CalWood Fire Burn Severity Map	Partners will be able to better evaluate the burn severity of the fires with maps that are field- validated. Burn severity maps can be used to target restoration activities by partners.	The team will create burn severity maps from Landsat 8 OLI and Sentinel-2 MSI imagery using several methods, including methods to allow for comparison of burn severity between treated and untreated areas, and compare to field measured burn severity plots to evaluate accuracy.	N/A
Analysis of Treatment Impact on Burn Severity	Partners will have a better understanding of the efficacy of fuels reduction treatments, and the scenarios (weather conditions, topographic positions, etc.) where treatments can be expected (or not expected) to reduce burn impacts.	A variety of analyses will be used to evaluate the impact of treatment on burn severity. One method will be pixel matching, where pixels within treated areas are compared to pixels of similar topographic position, burn timing, and forest type in untreated areas. We will also use random forest to map expected burn severities based on topography, weather conditions, forest type, and biomass to evaluate how treated areas burned relative to expectations.	N/A
ArcGIS Online StoryMap	The story map will enable partners to share the team's findings about these fires and about treatment effectiveness. These visuals will help communication with a diversity of stakeholders interested in forest management.	The team will create a story map describing their findings on burn severity and treatment effectiveness, incorporating maps, photos, and other figures to effectively communicate the story.	N/A

End User Benefit: The project partners will be mitigating the impacts of these fires by reducing erosion and facilitating vegetation recovery in these burned areas. Calibrated burn severity maps are key for these efforts. Additionally, these end users are working with landowners and stakeholders who were alarmed by these recent fires and will be eager to accelerate forest restoration work to prepare for future fires. The findings from this project will help inform what sorts of treatments should be completed, where they should be targeted, and under what conditions they can be expected to be effective.

Project Timeline & Previous Related Work

Project Timeline: 1 Term: 2021 Spring

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

References:

Addington, R. N., Aplet, G. H., Battaglia, M. A., Briggs, J. S., Brown, P. M., Cheng, A. S., ... & Thinnes, J. (2018). Principles and practices for the restoration of ponderosa pine and dry mixed-conifer forests of the Colorado Front Range. RMRS-GTR-373. Fort Collins, CO: US Department of Agriculture, Forest Service, Rocky Mountain Research Station. 121 p., 373.

Parks, S. A., Holsinger, L. M., Koontz, M. J., Collins, L., Whitman, E., Parisien, M. A., ... & Boucher, Y. (2019). Giving ecological meaning to satellite-derived fire severity metrics across North American forests. *Remote Sensing*, *11*(14), 1735.