**Intermountain West Wildland Fires**

*Mapping Tree Mortality and Burn Patches using NASA Earth Observations to Determine Fire Risk and Inform Fire Management Practices*

**Project Team**

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**Project Overview**

***Project Synopsis:***

Monitoring fuel loads is a major concern for wildland fire management efforts within the intermountain west. To address this concern, we partnered with the U.S. Forest Service (USFS) to inform the agency which forested areas should be prioritized for prescribed burning and fuel reduction near human communities in the Bridger-Teton National Forest, Wyoming. We made burn maps, fuel load maps, and a tutorial document to identify forest impact trends and provide the partner with the tools to replicate project methods for expansion to other wildfire crisis strategy sites.

***Abstract:***

Within the intermountain west, monitoring vegetation fuel loads is a major component of wildland fire management efforts. To address this concern, we partnered with the U.S. Forest Service to inform the agency which forested areas should be prioritized for prescribed burning and fuel reduction near human communities in the Bridger-Teton National Forest, Wyoming. We computed burn severity maps, fuel load maps, and a tutorial document to identify forest impact trends and provide the partner with the tools to replicate project methods for use in other wildfire crisis strategy sites. These end products were made using two NASA Earth observations: Landsat 8 Operational Land Imager and Shuttle Radar Topography Mission. Based on our random forest analysis, our maps identified 998 acres within the Wildland Urban Interface that are predicted to have high fuel loading and high burn severity within the Bridger-Teton National Forest. Forested areas closer to heavily populated areas such as Jackson, Kelly, Moran, New Forks Lake, and Star Valley Ranch should be prioritized for fuel reduction. However, our random forest model analysis was limited to using vegetation and topographical indices with no field data for model validation. Therefore, future studies should use field data for model validation to improve model accuracy and additionally incorporate Global Ecosystem Dynamics Investigation data into models to create better predictions of forested areas with high fuel load and high burn severity.

***Key Terms:***

Remote Sensing, Landsat, Fuel Loads, Burn Severity, Wildland Urban Interface, Bridger-Teton National Forest

***Application Area:*** Wildland Fires

***Study Location:*** Bridger-Teton National Forest, Wyoming

***Study Period:***

Pre-fire: June 1st to October 31st, 2017; June 1st to July 31st, 2018

Post-fire: August 1st to October 31st, 2018; June 1st to October 31st, 2019

Current: June 1st to October 31st, 2023

***Community Concerns:***

* As more homes are built in wildland urban interfaces, there is greater risk to people, their property, and urban infrastructure such as telephone lines and internet services. Several residences across the United States are within the wildland urban interface, including over 60% of Wyomingites.
* Monitoring fuel reduction projects is a major concern for wildland fire management efforts in the intermountain west. Areas along wildland urban interfaces can have high fuel loading areas and potential for high-severity fires.

***Project Objectives:***

* Map forested areas with high fuel loading and high severity
* Delineate priority areas for fuel reduction within the wildland urban interface
* Develop a methodology to replicate project methods to other wildfire crisis strategy sites

**Partner Overview**

***Partner Organization(s):***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization(s)** | **Contact (Name, Position/Title)** | **Partner Type** | **Sector** |
| **United States Department of Agriculture, USFS, Region 4** | Jed Gregory, Remote Sensing Program Manager Intermountain Region | End User | Federal Government |

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

The USFS developed a wildfire crisis strategy identifying priority sites for its decision-making and management practices. The crisis strategy seeks to reduce wildfire risk to people and create fire-resilient forests. The partner’s highest priority is fuel reduction work, determining areas of high fuel loads and monitoring forests after fuel reduction efforts as forest regeneration takes place. The project partner is interested in broadening their utilization of NASA Earth observations.

**Earth Observations & End Products Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter(s)** | **Use** |
| **Landsat 8 OLI** | Surface reflectance | Surface reflectance was used to calculate the Normalized Difference Vegetation Index (NDVI) to look at vegetation health in the area, Normalized Difference Moisture Index (NDMI) to look at the amount of moisture present in vegetation, and the Difference Normalized Burn Ratio (dNBR) to measure burn severity of the 2018 fires. Surface reflectance was also used to calculate several tasseled cap indices such as brightness, greenness, and wetness help differentiate water from vegetation and soil on the landscape. |
| **SRTM** | Digital Elevation Model (DEM) | From this DEM we were able to use and understand elevation of the Bridger-Teton area. |
| **SRTM** | Slope | We were able to calculate the slope from the DEM gathered from SRTM. Slope was used to understand the ruggedness of the Bridger-Teton area. |
| **SRTM** | Aspect | We were able to calculate aspect from the DEM gathered from SRTM. Aspect was used in degrees with respect to different directions. |

***Ancillary Datasets:***

* United States Department of Agriculture Vegetation, Classification, Mapping, and Quantitative Inventory (VCMQ) – Canopy cover and tree size classes used to determine fuel load
* United States Geological Survey LANDFIRE – Canopy height data for random forest model
* United States Department of Agriculture Forest Service Geodata Clearinghouse Wildland Urban Interface Areas – Dataset of developed areas that overlap with wildland vegetation used to determine high risk areas in fuel load map

***Software & Coding Languages:***

* Google Earth Engine – Download Landsat imagery and calculate indices
* RStudio 4.3.2 – Perform machine learning supervised classification random forest model
* ESRI ArcGIS Pro 3.0.2 – Isolate geospatial variables and create maps

***End Products:***

|  |  |  |
| --- | --- | --- |
| **End Product** | **Earth Observations Used** | **Partner Benefit & Use** |
| **Burn Severity Map** | Landsat 8 OLI, SRTM | The burn severity map was overlayed with the Wildland Urban Interface to identify areas that had potential for low, medium, and high severity fires. These areas were recommended for pre-fire and wildfire fighting management practices to address community safety. |
| **Fuel Load Map** | Landsat 8 OLI, SRTM | The fuel load map was overlayed with the wildland urban interface to identify areas that had potential for low, medium, and high fuel loads. We calculated acres of each fuel type to inform our partner of areas that should be prioritized for fuel reduction. |

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

Our project informs the USFS how to best use Landsat 8 OLI and ancillary datasets to create burn severity and fuel loads maps, identify forested areas that are to be prioritized for fuel reduction via prescribed burning and mechanical thinning, and replicate project methodology to other national forests in the future. By overlaying the burn severity and fuel load maps and pinpointing areas that have both high fuel load and high burn severity, the USFS will be able to efficiently allocate its resources to wildfire forest management and minimize wildfire risk to human communities.

**References**

Radeloff, V. C., Hammer, R. B., Stewart, S. I., Fried, J. S., Holcomb, S. S., & McKeefry, J. F. (2005). THE WILDLAND–URBAN INTERFACE IN THE UNITED STATES. *Ecological Applications*, *15*(3), 799–805. <https://doi.org/10.1890/04-1413>