**Oregon Wildfires**

*Integrating ECOSTRESS to Map and Analyze Vegetation Moisture for Wildfire Modeling*

**Project Team**

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**Project Overview**

***Project Synopsis:***

On July 5th - August 15th 2021, the Bootleg Fire devastated nearly 1675 km2 of the southern Oregon landscape and is a prime example of how wildfire severity is increasing in the western USA. In partnership with the US Forest Service and the Pacific Northwest National Laboratory, this project explored the application of ECOsystem and Spaceborne Thermal Radiometer Experiment on Space Station (ECOSTRESS) daily evapotranspiration product as a potential vegetation moisture input to identify water-stressed areas within the Bootleg Fire. The results will allow the partners to assess if higher resolution vegetation moisture datasets from ECOSTRESS will improve wildfire modeling and identify water-stressed areas.

***Abstract:***

Wildfire season in the western USA is starting earlier and gaining in intensity. The Bootleg Fire in Southern Oregon began on July 6th, 2021, and burned over 1675 km2 before it was fully contained on August 15th, 2021. Evapotranspiration (ET) is one indicator of vegetation moisture and there is interest in using high-resolution ET products from ECOsystem and Spaceborne Thermal Radiometer Experiment on Space Station (ECOSTRESS) in future wildfire modeling. In partnership with the Pacific Northwest National Laboratory and US Forest Service, the team examined ECOSTRESS ET for the two years before the Bootleg Fire and assessed the relationship between ET, topography, and vegetation. Remotely sensed data from Shuttle Radar Topography Mission (SRTM) and Global Ecosystem Dynamics Investigation (GEDI) along with ancillary data from the National Land Cover Database (NLCD) and Landscape Fire Resource Management Planning Tools (LANDFIRE) were incorporated. The team examined data in relation to soil burn severity from the Burned Area Emergency Response (BAER) program. From ET median composites for April 1st – July 5th, 2021 and 2019, the Bootleg Fire area showed a 7 mm/day decrease in ET and a relative 75% decrease in ET between 2019 and 2021. Approximately 6% of the Bootleg Fire area was identified as having a high soil burn severity and these areas were found predominantly in the evergreen forest land cover class and northward facing slopes with a mean ET decrease of 3 mm/day between 2019 and 2021. The team also analyzed ECOSTRESS Water Use Efficiency products as an additional vegetation moisture indicator of pre-fire conditions in the study area. The end products will allow the partners to assess if higher resolution vegetation moisture datasets from ECOSTRESS will improve wildfire modeling for other susceptible areas.

***Key Terms:*** Evapotranspiration, water use efficiency, topography, aboveground biomass density, landcover classification, burn severity

***National Application Areas Addressed***: Wildfires

***Study Location:*** Klamath and Lake counties, Southern OR

***Study Period:*** Summer months (April 1st – July 5th) of 2019-2021

***Community Concerns:***

* Wildfires in the western USA are starting earlier and gaining in intensity as ongoing climate change exacerbates persistent environmental stressors leading to destruction of wildlife habitats and property.
* Water-stressed areas create more fuel for wildfires and may increase the chances of being ignited.
* Ongoing monitoring of vegetation moisture indicators has the potential to minimize the devastating ecological and economic impacts of future fires and can assist local authorities with planning and resource allocation efforts.

***Project Objectives:***

* Produce pre-fire vegetation moisture and structure maps characterizing evapotranspiration, biomass, vegetation cover, and topography for the Bootleg Fire and surrounding areas
* Identify structural and topographical characteristics of the Bootleg Fire area that are important to pre-fire vegetation moisture and land cover
* Determine the feasibility of incorporating ECOSTRESS ET as a vegetation moisture input for future wildfire modeling

**Partner Overview**

***Partner Organizations:***

|  |  |  |
| --- | --- | --- |
| **Organization** | **Contact (Name, Position/Title)** | **Partner Type** |
| **USDA, US Forest Service, Fire**  **and Aviation Management** | Rick Stratton, Fire Analyst | End User |
| **Pacific Northwest National Laboratory** | Andre Coleman, Senior Research Scientist; Lee Miller, Earth Scientist | Collaborator |

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

The US Forest Service works to sustain the health, diversity, and productivity of the nation's forests and grasslands. Essential to this effort is the management of wildfires on public lands. While wildfires are a natural and integral part of many ecosystems, providing numerous ecosystem services, they can also be a source of destruction depending on their location, intensity, severity, and frequency. With a warming climate and a growing wildland-urban interface, shifts in wildfire regimes and the increased potential of wildfire-related disasters are of growing concern. To address these wildfire issues, the US Forest Service is increasingly focusing on fire fuel management. The presence and characteristics of fire fuels – flammable organic materials that include trees, grasses, dead leaves, and fallen branches – can influence fire propagation and behavior. The US Forest Service currently uses LANDFIRE, a program that provides landscape scale geospatial products to support cross-boundary planning, management, and operations.

**Earth Observations & End Products & Overview:**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameters** | **Use** |
| **ISS ECOSTRESS** | Evapotranspiration (ET), Water Use Efficiency (WUE) | The team used daily ET and WUE to understand vegetation moisture conditions by identifying areas that were water-stressed in the Klamath and Lake counties that surrounded the Bootleg Fire. |
| **ISS GEDI** | Gridded land surface metrics | The team used biomass to understand soil burn severity areas inside the Bootleg Fire. |
| **SRTM** | Topography | The team used slope, elevation, and aspect to compare vegetation moisture inside the Bootleg Fire. |

***Ancillary Datasets:***

* Multi-Resolution Land Characteristics (MRLC) consortium (NLCD 2019 Land Cover CONUS). National Landcover Database (NLCD) – Analyze how the moisture of vegetation cover influences wildfire potential
* LANDFIRE (LF 2020 2.2.0). Existing Vegetation Type (EVT) – Analyze how the moisture of existing vegetation type influences wildfire potential
* US Forest Service, Geospatial Technology and Applications Center, Imagery Support Program. Burn Area Emergency Response (BAER) Soil Burn Severity Map – Identified unburned, low, moderate, and high burn severity areas within the Bootleg fire perimeter

***Software & Scripting:***

* Python 3.9 – batch-image downloading, processing, and analysis
* Esri ArcGIS Pro 2.9.3 – visualizing geospatial data and performing analysis

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Product** | **Earth Observations Used** | **Partner Benefit & Use** | **Software Release Category** |
| **Vegetation Moisture Maps and Time Series** | ISS ECOSTRESS | ET and WUE will be used to create median summer seasonal pre-fire vegetation moisture composites. ET differences, ET percent change maps and ET time series will be used to see how vegetation moisture changed before the Bootleg Fire. | N/A |
| **Topography Maps** | SRTM | Elevation, slope, and aspect will be used to compare vegetation moisture and soil burn severity to understand wildfire behavior. | N/A |
| **Vegetation Maps** | ISS GEDI plus ancillary datasets from NLCD and EVT |  | N/A |

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

This project will provide PNNL and USFS with an analysis of ECOSTRESS ET as a new higher resolution vegetation moisture input to understand wildfire burn severity and area. Early detection of wildfire potential will be key in mobilizing the proper allocation of resources amongst governing authorities in areas prone to wildfires, and can minimize further societal and economic harm caused by these disasters. The team used ECOSTRESS ET to indicate areas of water-stressed vegetation in the area of the Bootleg Fire and how it related to vegetation, topography, and burn severity. This will provide the partners with an example of how ECOSTRESS ET data can be leveraged and may be used to improve predictive modeling capabilities for wildfires in the western USA and elsewhere.

**References**

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