**Eastern Washington Disasters**

*Integrating NASA Earth Observations to Analyze Spatiotemporal Distributions of Lightning-Caused Wildfires in Eastern Washington*

**Project Team**

***Project Team:***

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**Project Overview**

***Project Synopsis:***

The number of large lightning-ignited fires has been increasing in Washington over recent decades. Notably, lightning ignited the Jolly Mountain Fire in 2017; the fire burned 36,808 acres over three months and blanketed the region with hazardous smoke for several weeks. This project partnered with The Nature Conservancy’s Washington Chapter to analyze spatiotemporal distributions of lightning-caused wildfires east of the Cascade crest in Washington. The team utilized a suite of NASA Earth observations and ancillary datasets to gather information on lightning and fire data, highlighting the implementation of the Lightning Imaging Sensor aboard the International Space Station. The project’s end products can inform land management practices, spread knowledge to community members about the risk and impacts of lightning-ignited wildfires, and add to future forecasting of Eastern Washington’s fire regime.

***Abstract:***

According to the Washington Department of Natural Resources, roughly 36% of large fires in the state since 2010 were caused by lightning. General trends also show a greater increase in the number of lightning-ignited fires over the last three decades. The NASA DEVELOP Eastern Washington Disasters team partnered with The Nature Conservancy’s Washington Chapter to analyze the relationship between lightning strikes and wildfire events in Eastern Washington, with an emphasis on Kittitas and Yakima Counties. Using the International Space Station Lightning Imaging Sensor, the Landsat 5 Thematic Mapper and Landsat 8 Operational Land Imager vegetation moisture index, and Washington Department of Natural Resources historical fire data, the team generated a lightning-caused fire vulnerability index for 2001-2019. Climatology maps of lightning, wildfire, and vegetation moisture of the study area, along with an Esri ArcGIS StoryMap, further communicated project findings. Results demonstrated spatiotemporal patterns of lightning-ignited wildfires in Eastern Washington to inform land management practices and better predict areas that may be more vulnerable to these events.

***Keywords:***

fire regime, land cover*,* Lightning Imaging Sensor, lightning-ignited wildfires, forest ecology, wildfire ecology, fuel moisture

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

***Study Location:*** Eastern Washington

***Study Period:***  2001 to 2019

***Community Concerns:***

* Eastern Washington’s economy has historically been tied to the timber and coal industry. Current and past land management practices, including fire suppression, have left the land vulnerable to severe wildfires.
* Lightning strikes have caused severe wildfires in the past, including the 2017 Jolly Mountain fire, which burned over 36,000 acres of land and forced evacuations in Kittitas County. Resulting poor air quality posed a public health hazard.
* Washington State is undertaking measures to restore the health of its forests, which includes reducing the frequency and severity of uncharacteristic fire events.

***Project Objectives:***

* Analyze the frequency and severity of lightning-caused wildfires
* Assess the risk of lightning-caused wildfire ignition in Kittitas County, Washington and the surrounding regions
* Create maps for multiple stakeholders to visualize and interpret data about Eastern Washington’s fire regime

**Partner Overview**

***Partner Organization:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| **The Nature Conservancy, Washington Chapter** | Brian Straniti, Central Cascades Community Coordinator | End User | Yes |

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

The Nature Conservancy (TNC), Washington Chapter manages millions of acres of land across the state. The organization works with several stakeholders including public, private, non-profit, and tribal groups to care for the collective landscape and actively restore forests. Restoration practices include prescribed burning and forest thinning that removes dense and dry underbrush. They provide education on fire adaptation to landowners across the region. They also employ geospatial methods to monitor land and use LiDAR to measure forest health and track the progress of blight.

***Project Benefit to End User:***

This project will introduce the use of remotely sensed lightning data to the partner, allowing them to examine trends in lightning caused wildfires across a larger geographic area. The fire, lightning, and vegetation moisture climatologies together, along with a final climatology composite, will highlight the relationships between these factors and lightning-ignited wildfires. A final vulnerability index map and ArcGIS StoryMap will provide the partner with outreach materials to increase the public’s awareness of lightning-ignited fires in the region.

**Earth Observations & End Products Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| Platform & Sensor | Parameter | Use |
| Aqua MODIS | Active Fire Product | MODIS derived fire products were used to validate fire events for 2001-2019. |
| Terra MODIS | Active Fire Product | MODIS derived fire products were used to validate fire events for 2001-2019. |
| ISS Lightning Imaging Sensor (LIS) | Total lightning flashes | ISS LIS climatology data were utilized to identify lightning strikes throughout Eastern Washington during the period of 2017-2019. |
| Landsat 5 TM | Vegetation water content | Landsat 5 TM was employed to calculate a normalized difference moisture index for vegetation for the period of 2001-2011. |
| Landsat 8 OLI | Vegetation water content | Landsat 8 OLI was employed to calculate a normalized difference moisture index for vegetation for the period of 2013-2019. |

***Ancillary Datasets:***

* Washington State Geospatial Open Data Portal *Washington Large Fires 1973-2018* – for historical fire perimeters from 2001 to 2019

***Software & Scripting:***

* Esri ArcGIS Pro 2.0 – raster manipulation and analysis, map creation
* Google Earth Engine API – image acquisition and preliminary processing, calculating NDMI
* Python 2.7 – batch extraction and processing of LIS data
* HDFViewView– software for viewing and querying LIS data in HDF format
* Esri ArcGIS Online StoryMaps – story map creation and publication

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Products** | **Earth Observations Used** | **Partner Benefit & Use** | **Software Release Category** |
| **Climatology of Fire Frequency** | Aqua MODIS  Terra MODIS | This product displays locations and severity of fires in Eastern Washington over the study period, which provided the partner with a comprehensive assessment of large-scale fire trends over time. | I |
| **Climatology of Lightning Frequency** | ISS LIS | This product analyzed locations of lightning strikes in Eastern Washington over the study period, which informed the partner of where lightning strikes occur more frequently for the past 3 years. | I |
| **Climatology of Vegetation Water Content** | Landsat 5 TM Landsat 8 OLI | This product visualized water content in the leaves of vegetation in the study area, informing the partners about vegetated areas and their likelihood to become fuel for wildfires. | I |
| **Lightning-ignited Fire Risk Index** | ISS LIS | A lightning-ignited Fire Risk Index provided partners with maps and statistics to identify areas that are historically prone to fires (high occurrences of strikes) and low vegetation moisture. Using these data, the partner can better understand fire risk from non-human ignition sources. | I |
| **Lightning-ignited Wildfires in Eastern Washington StoryMap** | N/A | This product featured the lightning and fire climatologies as well as the fire vulnerability index map in the context of Washington’s history and culture. The StoryMap also illustrated the relationship between lightning, vegetation moisture, fire, and the impact on the surrounding community. The StoryMap provided the partner with outreach material shareable to the public. | N/A |

**Project Handoff Package**

***Transition Plan:*** During week 10 of the term, the team participated in a virtual hand off with the project partner at the TNC Washington Chapter via a Google Hangout video call. This meeting included a presentation of the project, methodologies, results, and end products. Items listed below in the handoff package section, including deliverables, were shared with the partners following the term via NASA Large File Transfer (LFT).

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***Handoff Package:***

* Climatology of Fire Frequency
* Climatology of Lightning Frequency
* Lightning-Caused Fire Risk Index
* Lightning-ignited Wildfires in Eastern Washington StoryMap
* Project Summary
* Poster
* Presentation
* Technical Paper

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