**Idaho Wildfires II**

*Assessing the Relationship Between Drought Indicators and Fire Risk to Enhance Hazard Modeling and Inform Mitigation Planning*

**Project Team**

***Project Team:***

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**Project Overview**

***Project Synopsis:***

The Idaho Wildfires DEVELOP Team II collaborated with multiple Idaho state agencies to enhance the state wildfire hazard model to incorporate remotely-sensed drought metrics. Statewide, we utilized a combination of NASA Earth observation data to create a dynamic model that accounts for interactions between vegetation condition and soil moisture and describes wildfire potential as it changes through space and time. These temporally dynamic models will allow our partners to better assess wildfire and drought hazards in Idaho and help guide future mitigation measures and allocation of management resources across the state.

***Abstract:***

The western United States has experienced twenty years of increased and prolonged drought which have exacerbated wildfire hazards. These hazards jeopardize population centers through increased risks to ecosystem services, local economies, and livelihoods. The Idaho Office of Emergency Management, Water Resources, and Department of Lands are seeking methods to dynamically monitor these conditions and update models that inform hazard mitigation planning and allocation of management resources. Moving towards this goal, these state agencies partnered with NASA DEVELOP to produce drought-enhanced wildfire hazard models. As the second part of a two-term project, the team enhanced the state’s current wildfire hazard model with refined data layers and remotely-sensed drought indicators to reflect dynamic ecosystem responses to drought conditions and wildfire potential. The team distinguished between rangeland and forestland ecosystems, and investigated relationships between drought metrics and the Normalized Difference Vegetation Index using IDRISI TerrSet Earth Trends Modeler. This analysis determined that total precipitation at a 5-month interval (r2 = 0.72) and the Evaporative Stress Index (r2 = 0.69), and precipitation at a 5-month interval (r2 = 0.42) were important drivers for vegetation condition in rangeland and forestland, respectively. These variables were incorporated to create a 4-week temporal dynamic model. The team used linear regression to model these enhanced hazard ratings with wildfire frequency and compared them between models. For the case study year 2020, the enhanced model performance (p < 0.10, r2 = 0.01) had less statistical significance than the static model (p < 0.05, r2 = 0.03) but comparably low explanatory power, an indication that further research is required.

***Key Terms:***

wildfire, drought, MODIS, Landsat, hazard management, NDVI, ESI, landscape-scale modeling

***National Application Area Addressed:*** Wildfires

***Study Location:*** Idaho

***Study Period:*** 2010 - 2022

***Community Concerns:***

* Current wildfire and drought trends pose great risk to local communities, directly impacting human health and livelihoods, natural resources, and valuable ecosystem services. This increased risk also hinders the states’ ability to restore normal ecological function to human-inhabited, fire-prone landscapes.
* Managers need access to current data to facilitate habitat management for various types of sensitive and threatened animal and plant species that depend on natural fire regimes in rangeland and forestland ecosystems, such as the greater sage grouse and mesic vegetation communities.
* Post-fire ecosystem restoration is expensive and time-consuming. Managers need more reliable prediction tools to allocate resources efficiently to reduce the cost of pre- and post-fire management, to better prevent and mitigate wildfires, and streamline recovery. These enhancements reduce cost, which reduces economic strain on communities, and bolsters community wildfire resiliency.

***Project Objectives:***

* Assess the accuracy of the current Idaho state drought and wildfire hazard model and determine the most important dynamic variables to add to enhance the model.
* Integrate Landsat and Aqua & Terra MODIS data with existing landcover and hazard datasets to enhance the current Idaho State Hazard Mitigation Plan.
* Analyze remotely sensed vegetative stress and drought indices to determine which, if any, would be most useful in differentiating between vegetation communities and assessing statewide drought and wildfire trends
* Create an ArcGIS Pro ModelBuilder tutorial for recreating and maintaining the model

***Previous Term:***

Summer 2022 (ID) – ID Wildfires

**Partner Overview**

***Partner Organizations:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **Contact (Name, Position/Title)** | **Partner Type** | **Boundary Org** |
| **Idaho Office of Emergency Management** | Susan Cleverly, Mitigation Section Chief;Lorrie Pahl, Mitigation Planner;Mary Mott, Mitigation Program Assistant;Traci Stewart, Mitigation Program Assistant | End User | No |
| **Idaho Department of Water Resources** | David Hoekema, Hydrologist | End User | No |
| **Idaho Department of Lands** | Tyre Holfetz, Wildfire Risk Mitigation Program Manager | End User | No |

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

Partners at the Idaho Office of Emergency Management, Water Resources, and Department of Lands (IDL) are striving to reduce the risk posed by wildfires to human lives, property, and natural resources. To achieve this goal, the state uses the IDL wildfire hazard model to inform and guide allocation of state wildfire mitigation and management resources. This current model relies upon static GIS data layers of burn history, topography, wildland-urban interfacing, and vegetation-wildfire interactions to determine wildfire burn potential trends and forecast areas of concern for the state. This model is incorporated into the State of Idaho Hazard Mitigation Plan (SHMP), with the expressed goal that this method will lead to wildfire conscious communities, and ecologically secure, wildfire-adapted landscapes.

**Earth Observations & End Products Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameters** | **Use** |
| **Landsat 5 TM** |  | Assessed the relationship between contemporary and historic trends in vegetation, soil moisture, and evapotranspiration indices |
| **Landsat 8 OLI** | Normalized Difference Vegetation Index (NDVI), Modified Soil Adjusted Vegetation Index 2 (MSAVI-2) | Assessed the relationship between contemporary and historic trends in vegetation, soil moisture, and evapotranspiration indices |
| **Landsat 9 OLI-2** | NDVI, MSAVI-2 | Assessed the relationship between contemporary and historic trends in vegetation, soil moisture, and evapotranspiration indices.  |
| **Terra MODIS** | NDVI, MSAVI-2 | Historic vegetation data were used as an input in drought in drought condition, trend, and risk mapping and modeling |
| **Aqua MODIS** | NDVI, MSAVI-2 | Historic vegetation data were used as an input in drought in drought condition, trend, and risk mapping and modeling |

***Ancillary Datasets:***

* National Oceanic and Atmospheric Administration, Physical Science Laboratory: Evaporative Demand Drought Index (EDDI) – Drought index for analysis and input for fire model
* NASA SERVIR, MODIS Aqua & Terra: Evaporative Stress Index (ESI) – Drought index for analysis and input for fire model
* Idaho State University (ISU) GIS Training and Research Center (GIS TReC): Historic Fires Database (HFD) – Preliminary statistical and historical analysis and input for fire model
* Bureau of Land Management (BLM): Wildland-Urban Interface (WUI) – GIS layer that describes elevated wildfire hazard as proximity increases to urban landcover and is incorporated into model
* ISU GIS TReC: NASA RECOVER National Elevation Dataset (NED) - High resolution topographic dataset, used to incorporate elevation, slope, and aspect into model
* Earth Resources Observation and Science Center (EROS) United States Geological Survey, LANDFIRE, CONUS 2022 Existing Vegetation Type (EVT) – Preprocessed high-resolution landcover product used to analyze landcover and incorporate variables into the model

***Modeling:***

* New Simple Fire Hazard Model 2019 (POC: Andrew Mock & Tyre Holfeltz, Idaho Department of Lands) – Recreated by the previous team in ArcGIS Pro to compare performance of Idaho’s original model and the team’s updated version
* Drought Indicator-Modified Fire Hazard Model (POC: Jessica Hiatt, Colorado School of Mines) – Previous team’s model assessing fire susceptibility within the study area

***Software & Scripting:***

* ArcGIS 3.0.1 – Data analysis, map and model creation
* IDRISI TerrSet 19.0.6 – Raster and data analysis and vegetation index processing
* RStudio 2022.02.1.461 – Statistical analysis and data visualization
* Python 3.7.11 – Automation of data acquisition and analysis

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Product** | **Earth Observations Used**  | **Partner Benefit & Use** | **Software Release Category** |
| **Drought Indicator Analysis** | Landsat 8 OLILandsat 9 OLI-2Terra MODISAqua MODIS | This data investigates historic drought conditions throughout the study period and correlations with vegetative health, enabling the team to incorporate useful variables into the fire model that will better reflect burn fuel potential. | N/A |
| **Drought & Fire Susceptibility Maps** | Landsat 8 OLILandsat 9 OLI-2Terra MODISAqua MODIS | These maps show past and present drought and wildfire conditions and risk to assist partners in updating current mitigation plans. | N/A |
| **Tutorial for Recreating a Drought Indicator-Modified Wildfire Hazard Model** | N/A | This tutorial provides partners with instructions for interagency recreation of the updated fire hazard model, allowing partners to repeat monitoring and analysis across space and time | N/A |

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

The findings from this research will be used to enhance Idaho’s wildfire hazard model, which will inform updates to the state’s drought and wildfire mitigation plan as conditions change in space and time. The end results will allow our partners to better integrate Earth observation data into their wildfire potential monitoring, which will aid with efficient allocation of state resources and personnel.

**References**

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