**NASA DEVELOP National Program**

**2018 Summer Project Proposal**

**North Carolina – NCEI**

**Missouri River Basin Disasters**

*Utilizing NASA Earth Observations and NOAA Climate Data Records to Produce Climate Indicators of Rangeland Health and Wildfire Risk*

**Project Overview**

***Project Synopsis*:** This project will work with NOAA NCEI’s Regional Climate Services Director for the Central Region of the United States, the South Dakota School of Mines and Technology, and the Bureau of Indian Affairs (BIA), to develop tools for facilitating wildfire management decisions. This project will expand on the a previous DEVELOP project’s spatial and temporal trend analyses to derive indicators for rangeland health and wildfire risk from snow-water equivalence, soil moisture, and soil temperature in conjunction with satellite derived vegetative health and land-surface temperature from MODIS sensors, precipitation estimates from the PERSIANN-CCS, and soil moisture estimates from SMAP to enhance the wildfire risk tool.

***Community Concern:*** Areas within the Missouri River Basin are heavily impacted by both major flooding events and devastating droughts. In 2011, an unprecedented rain-on-snow event, following one of the snowiest winters in recorded history, led to massive floods in the Missouri River Basin (MRB). The following year, the MRB experienced extreme drought. By the end of 2012, approximately three-fourths of the central United States was still in D3 extreme drought conditions and more than a third was in D4 exceptional drought conditions according to the U.S. Drought Monitor. In a region with such extreme variation, there is a constant need for more robust monitoring of ecosystem vulnerabilities to drought. Drought leads to poor vegetative health, which can negatively impact vulnerable grasslands by overgrazing and wildfires. Currently, the Bureau of Indian Affairs (BIA) recognizes that changes in climate are leading to extended droughts and the intensification of certain extreme events such as wildfires. Therefore, the BIA is currently working to help Native American tribes build capacity in climate monitoring and water resources management.

***Source of Project Idea:*** The idea for this project originated during the finalterm of the spring of 2017 Missouri River Climate project. The project focused on run-off and flooding events in the Missouri River Basin by analyzing spatial and temporal changes in soil moisture, snow-water equivalence, and soil temperature over the past thirty years. At the completion of the project, Doug Kluck, the Regional Climate Services Director for the Central Region of the US, expressed interest in furthering the analyses by incorporating additional climate variables to provide a more specific analysis of these climate variables and their influence on water resources and drought, adapting the tool to run in ESRI ArcGIS, and modifying the study area to focus on fire risk areas in Nebraska, South Dakota, and North Dakota, specifically.

***National Application Areas Addressed:*** Disasters, Water Resources, Agriculture & Food Security

***Study Location:*** NE, SD, ND

***Study Period:*** January 1984 – August 2018

***Advisors:*** Mike Kruk (Earth Resources Technology)

**Partner Overview**

***Partner Organizations:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| **Bureau of Indian Affairs, Wildland Fire Management, Great Plains Region** | David Martin, Regional Assistant Fire Management Officer | End User | Yes |
| **South Dakota School of Mines and Technology** | Darren Clabo, South Dakota State Fire Meteorologist | End User | No |
| **NOAA NCEI Regional Climate Services, Central Region** | Doug Kluck, Central Region Director | Collaborator | Yes |

***End-User Overview***

***End-User’s Current Decision-Making Process:***

The BIA currently uses the rangeland health and wildfire risk Google Earth Engine tool from the spring 2017 Missouri River Climate II project in their decision making practices. They are familiar with the application of both NASA and NOAA Earth observations. The BIA in South Dakota also uses the US Drought Monitor and NOAA weather products to monitor conditions that increase fire potential in their region.

***End-User’s Capacity to Use NASA Earth Observations:***

*Bureau of Indian Affairs, Wildland Fire Management, Great Plains Region* – David Martin and the BIA Wildland Fire Management group for the Great Plains Regions currently use the rangeland health and wildfire risk Google Earth Engine tool from the spring 2017 Missouri River Climate II project in their decision making practices. Using results from the tool for the last year they have found improvements that could be made to the weighting of drought indices, the temperature threshold, and logistics such as generating results in the morning before dispatches and the tool running in ESRI ArcGIS rather than Google Earth Engine so their staff can make edits more easily.

*South Dakota School of Mines and Technology* – Darren Clabo and the South Dakota School of Mines and Technology, although familiar with NASA Earth observations, currently do not use NASA Earth observations in a near real-time capacity. Implementing a near real-time tool for assessing rangeland health and fire risk would integrate NASA Earth observations into the fire meteorology at the SD School of Mines and Technology.

***Collaborator & Boundary Organization Overview***

***Collaborator Support:***

*NOAA NCEI Regional Climate Service Director, Central Region* – As NOAA NCEI RCSD’s Director of the Central Region, Doug Kluck will serve as a mentor for the team. Doug will connect the team with necessary data, relevant past literature, and additional mentors.

***Dissemination by Boundary Organizations*:**

*NOAA NCEI Regional Climate Services Central Region* – The Climate Center for the Central Region is positioned to provide climate services to the Colorado, Wyoming, Kansas, Nebraska, South Dakota, & North Dakota. The rangeland health and fire risk tool would have easy distribution through the community of Great Plains states via the Central Region Climate Center’s already established network with federal, state, and local planners, universities, and NCEI field offices.

*Bureau of Indian Affairs, Wildland Fire Management, Great Plains Region* – In addition to providing direct wildland fire management and fuel monitoring, the BIA Wildland Fire Management works in concert with the National Interagency Fire Center (NIFC), the Intertribal Timber Council (ITC), the Department of the Interior (DOI), and the National Weather Service Fire Weather branch. Managing wildland fire risk and rangeland health in collaboration with these groups can assist in the broader distribution of NASA Earth observations to regional decision-makers.

***Project Communication & Transition Overview***

***In-Term Communication Plan*:** The project team will communicate with end users and collaborators via bi-weekly teleconferences and video conferences. Team members will share project updates and progress weekly via emails.

***Transition Plan*:** Participants will be able to meet with project partners, via video conference before the end of the term to give an overview or tutorial of the use of this project’s end products. The team will share their presentation with end users during this in-person meeting or video conference. Future applications across the region will also be discussed with project partners and NASA DEVELOP leadership at NCEI.

**Earth Observations Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter(s)** | **Use** |
| **Aqua MODIS** | Normalized Difference Vegetation Index (NDVI), Land Surface Temperature (LST)  | NDVI will be used to assess vegetation health and LST will be used to measure the influence of surface temperature on vegetation health. |
| **Terra MODIS** | NDVI, LST | NDVI will be used to assess vegetation health and LST will be used to measure the influence of surface temperature on vegetation health. |
| **PERSIANN-CCS** | Precipitation | PERSIANN will be used to provide near-real time precipitation estimates. |
| **SMA P** | Soil Moisture | SMAP will be used to measure soil moisture for variable weighting in drought index. |

***Ancillary Datasets:***

NOAA Global Historical Climatology Network (GHCN) – *in situ* precipitation data to validate satellite precipitation data

North American Land Data Assimilation System – to further study period of soil moisture using the same methodology as used in the first term

NOAA nClimGrid – Temperature – high resolution modeled temperature data to validate satellite LST

***Software & Scripting:***

Esri ArcGIS – data visualization and map creation

R – statistical analysis

Python – data processing and analysis

ENVI – band math to reflectance-derived fire index inputs

**Decision Support Tool & End Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Product** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| **Rangeland Condition Index** | This analysis will provide partners with information about the vegetative health of the grasslands, potentially allowing them to determine when to remove cattle if drought threatens. | Aqua & Terra MODIS (NDVI & LST), PERSIANN-CCS (precipitation) will be used to derive Scaled Drought Conditions Index (SDCI). SDCI will be combined with SMAP and NLDAS soil moisture to produce the rangeland index. | N/A |
| **Wildfire Risk Indicator**  | This analysis will take into account drought conditions, temperature, and fuel loading across the study area daily to identify high risk areas for wildfire spread.  | Terra MODIS (reflectance values for fuel load estimations and LST), and SMAP (soil moisture), as well as snow-water equivalence and soil moisture climatologies from the previous term are incorporated into an analysis predicting fire vulnerability.  | III |

***End-User Benefit*:**

These end products can be integrated into the BIA’s current management plans in order to improve rangeland management and health, as well as decrease their risk to drought. These end products will also help fire meteorologists from the South Dakota School of Mines Atmospheric Institute to better prepare for and respond to wildfire vulnerability. Both end results will help to increase our partners’ understanding of the health of grasslands in the Northern Plains. This project will offer practical applications that build off of the project outcomes of the previous DEVELOP term.

**Project Timeline & Previous Related Work**

***Project Timeline:*** 1 Term: 2018 Fall

***Related DEVELOP Work:***

2017 Spring (NC) – Missouri River Climate II: Utilizing NASA Earth Observations and NOAA Climate Data Records to Produce Climate Indicators of Rangeland Health and Wildfire

2015 Fall (NC) – Missouri River Climate: Using NASA and NOAA Satellite Observations to better understand Runoff in the Missouri River Basin for Improved River System Management and Decision Support

2016 Summer (LaRC) – Western United States Water Resources: Utilizing NASA Earth Observations to Analyze Vegetation Productivity Shifts Relative to Climate Change and Drought in Capital Reef National Park

2016 Fall (LaRC) – Western United States Water Resources II: Assessing Landscape Vulnerability to Drought and Changing Climate in National Parks of the Western United States

2016 Fall (NCEI) – Levant & Central America Climate II: Enhancing Drought Monitoring and Prediction Capabilities by the US Air Force, 14th Weather Squadron in Levant and Central America

**Notes & References:**

***Notes*:** Other ancillary *in situ* water resources data sets may be provided by our end users and incorporated into our project analyses.