**NASA DEVELOP National Program**

**2018 Summer Project Proposal**

**Maryland – Goddard**

**Kenai Peninsula Disasters**

*Evaluating Grassland Conversion and the Related Likelihood of Fire Disturbance to Enhance Fire Monitoring and Management in the Kenai Peninsula, Alaska*

**Project Overview**

***Project Synopsis*:** Forests on the Kenai Peninsula have been converting to grasslands following spruce beetle-induced forest mortality, thus increasing fire risk. DEVELOP will partner with the Kenai National Wildlife Refuge to identify areas where increasing grass cover is coupled with the likelihood of spring fire ignition on the Kenai Peninsula. The team will produce: (1) a methodology to detect grass cover using remote sensing and land classification, (2) a change detection analysis, and (3) a map of fire risk based on seasonal ignition and flammability. This work will help Kenai National Wildlife Refuge staff understand whether the grasslands are a new ecological trajectory in the region or a delayed ecological succession, which will eventually return to forest. Based on the results, refuge staff may decide to engage in active management to facilitate reforestation and reduce fire risk, such as tree planting and fuel reduction or to embrace the grassland with prescribed spring fires and the introduction of functional grazers (i.e. bison).

***Community Concern:*** Grasslands have established on the southern Kenai Peninsula following an unprecedented spruce beetle (*Dendroctonus rufipennis)* outbreak in the 1990s that triggered large-scale mortality of Lutz spruce. The emerging grasslands provide a new window of fire risk in the spring when frozen ground limits available water and the previous year’s growth is dry. More frequent (~10-year interval) spring fires in these grasslands would kill tree seedlings and provide a mechanism for maintaining the grassland ecosystem, thereby creating a new ecological regime, rather than delayed forest succession. The historical fire regime consisted of summer fires with a greater than 100-year fire return interval. This qualitatively different 10-year interval fire regime has implications for the timing and intensity of fire risk and to the habitats and wildlife available to communities in the region (moose habitat versus bison). A better understanding of the spatial extent of grasslands is necessary to understand the range of potential future ecological trajectories and determine viable fire management actions and adaptation pathways.

***Source of Project Idea:*** This project is part of an August 2017 request by prospective project partner Dawn Magness, Landscape Ecologist with the US Fish and Wildlife Service at the Kenai National Wildlife Refuge.

***National Application Areas Addressed:*** Disasters, Ecological Forecasting

***Study Location:*** Kenai Peninsula, AK

***Study Period:*** January 1985 – December 2017

***Advisors:*** Dr. John Bolten (NASA Goddard Space Flight Center), Dr. Adrianna Foster (NASA Goddard Space Flight Center, Universities Space Research Association)

**Partner Overview**

***Partner Organization:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| **US Fish and Wildlife Service, Kenai National Wildlife Refuge** | Dawn Magness, Landscape Ecologist | End User | Yes |

***End-User Overview***

***End User’s Current Decision-Making Process:***The end user of this product is the Kenai National Wildlife Refuge, which is administered by the US Fish and Wildlife Service. The refuge currently engages in fire management activities to increase the decision-space needed to allow wildfire while protecting the urban interface and local communities. The refuge’s biology staff are considering what, if any, management actions can influence the likelihood of deforestation. A shorter interval, spring fire regime will inhibit reforestation. The staff are considering tree plantings and are beginning common-garden experiments to understand which species will be viable. They are also conducting baseline inventories of biological diversity in grass-dominated areas. The refuge has not applied remote sensing methodologies to identify deforested areas with the grass biomass needed to carry litter fires in the spring.

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

*US Fish and Wildlife Service, Kenai National Wildlife Refuge* – The refuge has calculated empirical rates of vegetation change from historical data, but have not accessed remotely-sensed data sets for more spatially-comprehensive mapping and analysis of rates of change. Dawn Magness has visited the NASA Earth observations website to browse through the available datasets, but has not used the data in an analysis. This project will provide the necessary tools and build the capacity of Kenai National Wildlife Refuge staff to access data for regionally-scaled change detection. Refuge staff have GIS capabilities: the refuge maintains a geospatial database, and staff use Esri software.

***Dissemination by Boundary Organizations*:**

*US Fish and Wildlife Service, Kenai National Wildlife Refuge* – The Kenai National Wildlife Refuge will disseminate DEVELOP project results to land managers working outside the refuge boundary, such as the Chugach National Forest, Kenai Fjords National Park, Alaska Department of Natural Resources, and during the annual Kenai Peninsula Land Management Forum, which is used to share information to better coordinate management activities. DEVELOP results will also be shared with Kenai Peninsula Borough and the State of Alaska via the community wildlife protection planning processes and All Hands All Lands network that focuses on fire risk. Large landowners adjacent to the refuge that are affected, such as the Cook Inlet Regional Corporation and Ninilchik Native Association, would also be contacted.

***Project Communication & Transition Overview***

***In-Term Communication Plan*:** The Project Lead will serve as the primary point of contact for communication with the project partner. The team will communicate with project partners through tri-weekly teleconferences, and the team lead will email updates as necessary.

***Transition Plan*:** During week 10, end products will be transitioned remotely during a virtual handoff during which the team will discuss results and answer any questions regarding the products. Tools and scripts will be handed off after they have gone through the NASA software release process. A tutorial for the tools will be provided.

**Earth Observations Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter(s)** | **Use** |
| **Landsat 5 TM** | Spectral vegetation indices | Spectral bands and vegetation indices will be used to identify historical vegetation presence at the landscape scale, while aiding in tracking amounts of sudden change. |
| **Landsat 8 OLI** | Spectral vegetation indices | Spectral bands and vegetation indices will be used to identify historical vegetation presence at the landscape scale, while aiding in tracking amounts of sudden change. |
| **Sentinel-1 C-SAR** | Spectral vegetation indices | Spectral bands and vegetation indices will be used to identify current vegetation presence at the landscape scale, while aiding in tracking amounts of sudden change. |
| **Sentinel-2 MSI** | Spectral vegetation indices | Spectral bands and vegetation indices will be used to identify current vegetation presence at the landscape scale, while aiding in tracking amounts of sudden change. |
| **Suomi-NPP VIIRS** | Fire detection | Fire detection history will aid in the classification of the fire risk window. |
| **SMAP** | Freeze/thaw state | Freeze and thaw states will aid in the calculation of the fire risk window. |
| **G-LiHT** | Forest canopy height, surface temperature, moisture stress | Forest canopy height, surface temperature, and moisture stress will be used in vegetation classification and fire risk window calculations. |

***Ancillary Datasets:***

Kenai National Wildlife Refuge vegetation ground truth data – Ten grassland ground vegetation plots and 58 sited keyed to vegetation type

USFS Forest Inventory and Analysis plots – FIA vegetation plots sampled every 10 years beginning in 1990s, refuge has access to data and plot locations

Kenai National Wildlife Refuge fire polygons from 1708-2017 – Fire history layer

Kenai National Wildlife Refuge contiguous grassland polygon – Area delineated in 2015 via ground plots can be used for validation

Kenai National Wildlife Refuge high resolution aerial photos 2016 – Validation data

Alaska Department of Natural Resources forest health survey polygons 1989-2010 – Spruce beetle infestation overlay

Kenai Peninsula Borough parcel polygons – Land use data

Alaska Interagency Coordination Center historical lightning strikes – Ignition risk layer

USGS LANDFIRE Reference Database (LFRDB) – vegetation classification/height/succession, fire regime, and disturbance data

***Modeling:***

TerrSet Geospatial Monitoring and Modeling System Land Change Modeler (POC: Dr. James Toledano, Clark Labs)

***Software & Scripting:***

Esri ArcGis – Raster manipulation and analysis, map creation

Exelis ENVI – Raster manipulation and analysis

Python – Coding language for the Grass Cover Detection Tool

**Decision Support Tool & End Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Product** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| **Grass Cover Detection Tool** | This product will help the partner determine areas at risk of fire and measure change in habitat; will increase the capacity of the end user to conduct similar analyses in the future. | The tool will classify land cover based on imagery and spectral vegetation indices derived from Landsat 5 TM,  Landsat 8 OLI, Sentinel-2 MSI, Sentinel-1 C-SAR, and G-LiHT. | IV |
| **Grass Cover Detection Tool Tutorial** | This product will help the partner navigate and utilize the tool to its full capacity. | The tutorial will assist partners in using the tool to classify land cover based on imagery and spectral vegetation indices derived from Landsat 5 TM,  Landsat 8 OLI, Sentinel-2 MSI, Sentinel-1 C-SAR, and G-LiHT. | N/A |
| **Change Detection Analysis** | This product will help the partner understand the spatial extent and pattern of change. | Change detection will use a classification based on imagery and spectral vegetation indices derived from Landsat 5 TM,  Landsat 8 OLI, Sentinel-2 MSI, Sentinel-1 C-SAR, and G-LiHT. | I |
| **Ignition and Flammability-based Fire Risk Map** | Map of fire risk will be disseminated to other stakeholders and used in planning both short- and long-term fire management strategies. | The classification of fire risk will be based on imagery and spectral vegetation indices derived from Landsat 5 TM, Landsat 8 OLI, Sentinel-2 MSI. Data from Suomi-NPP VIIRS, and SMAP will be used to derive bioclimatic variables associated with fire risk. | I |

***End-User Benefit*:** The Grass Cover Detection Tool will allow refuge staff to monitor grassland cover in the years following the DEVELOP project. Grasslands may represent a regional ecological transition, but the scale and permanence grasslands is not known. Refuge staff need to track the emergence of grassland ecosystems as our climate continues to shift. The change detection analysis will help refuge staff understand the current extent of grasslands on the Kenai Peninsula and this will allow refuge staff to design new projects that are representative of this emerging ecosystem type. DEVELOP products can be used by refuge biologists to monitor grassland conversion and to plan research projects that accurately represent the range of conditions on the Kenai Peninsula. The fire risk map will help refuge fire staff prioritize what, if any, areas and management practices should be reevaluated to confirm that strategies are still relevant in a scenario where spring, grassland-fed fires are the new fire regime. Refuge fire managers will also use the map to communicate if and how fire risk is changing.

**Project Timeline & Previous Related Work**

***Project Timeline:*** 1 Term: 2018 Summer

***Related DEVELOP Work:***

Spring 2017 (GSFC) – Kenai Peninsula Ecological Forecasting: Mapping Tree-line Rise and Wetland Conversion in order to Supplement Resource Management Actions in a Changing Alaskan Climate

Summer 2016 (ID) – Eastern Idaho Disasters: Developing Fire Susceptibility Models Using Remote Sensing to Identify Wildfire Habitats in the sagebrush-Steppe Ecosystem Threatened by Wildfires

Fall 2015 (ID) – Southeast Idaho Disasters: Juniper Encroachment and Management in the western U.S. Relative to Catastrophic Wildfires

Fall 2014 (GSFC) – Idaho Disasters: Using NASA Earth Observations to Determine Wildfire Susceptibility and to Create a Comprehensive Data Atlas for Savannah Ecosystems in Idaho

Fall 2014 (ARC) – Great Basin Climate: A Geospatial Assessment of Fire Events in the Great Basin Ecoregion and Its Relation to Cheatgrass Spread Under Changing Climate Conditions

**Notes & References:**

***Notes:***

Kenai Peninsula Borough parcel polygons

(<http://www.kpb.us/gis-dept/kpb-data-downloads/cadastre>)

Alaska Interagency Coordination Center historical lightning strikes (<https://fire.ak.blm.gov/predsvcs/maps.php>)

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in south-central Alaska: A review of 30 years of research. *Forest Ecology and Management,* *227*(3), 195-206 <http://www.sciencedirect.com/science/article/pii/S0378112706001575>