**NASA DEVELOP National Program**

**Fall 2015 Project Proposal**

BLM at Idaho State University GIS Training and Research Center (TReC)

**Southeast Idaho Disasters**

Juniper Encroachment and Management in the Western U.S. Relative to Catastrophic Wildfires

**Objective:**

To utilize satellite and airborne imagery to improve the BLM and broader fire community’s access to information regarding Western Juniper land cover, tree density and frequency, and best practices and technology transfer for broad application of the techniques developed and refined by this research.

**Community Concern:**

Wildfire is a common hazard throughout semiarid savanna ecosystems. Following fire, ground vegetation is typically eliminated, leaving the landscape devoid of cover. These communities may then experience a series of adverse changes due to landslides, soil erosion, and invasive plant infestations. Wildfires have occurred for millennia, but various factors appear to be increasing their frequency and intensity, creating a demand for advanced wildfire decision support capabilities. More specifically, project end-users can use the results of these analyses to “allocate resources to regions that are more susceptible to fires” (Mike Kuyper, BLM) and plan pre-fire fuel load reduction activities.

**Partner Organizations:**

Bureau of Land Management, Idaho State Office and Cooperating District Offices (End-User, POC: Mike Kuyper, Natural Resource Specialist)

Idaho Department of Lands, Boise Field Office (End-User, POCs: Dixie Booker-Lair, GIS Analyst, and Robin Dunn, GIS Specialist)

RECOVER Project at NASA Goddard (Partner, POCs: John Schnase, Senior Computer Scientist, and Mark Carroll, SR. Support Scientist)

RECOVER Project at ISU (Partner, Boundary Organization; POC: Keith Weber, GIS Director)

The GIS TReC at Idaho State University has worked in close collaboration with the BLM since 1999 on a variety of rangeland research projects, with many focusing on the effect of wildfire on rangeland health. More recently (2012) similar collaborations have begun with Idaho Department of Lands. Since the beginning of DEVELOP’s Idaho Disasters project in the fall term of 2014, these relationships have only grown stronger.

Following a meeting with the BLM (Mike Kuyper and Brian Holmes) and Idaho Department of Lands (IDL) (Robin Dunn) a need was identified to improve management of Western Juniper (*Juniperus occidentalis*) throughout not only Idaho but the Great Basin and Intermountain West. Specifically, land managers at both the BLM and IDL need better information regarding Western Juniper land cover (as a proportion of management areas) as well as tree density and frequency. While these data can be sampled and estimated in the field, today’s land manager needs more precise information instead of generalized estimates.

**Decision Making Process:**

Juniper is an important tree species relative to fire. Over the past few decades, the western US has witnessed a steady expansion of Western Juniper principally across the foothills of the Rocky Mountains. Recent efforts by the BLM to manage Western Juniper have included thinning (removing a proportion of trees within a dense stand) and limbing (removing the lower limbs on all trees within a stand to reduce the potential for a fire to enter the crown). These efforts have met with limited success in part because pre- and post-treatment Western Juniper density and frequency is unknown, and consequently the effectiveness of the effort is unknown (e.g., were enough trees removed to reduce Western Juniper coverage to <20%).

This project will help the BLM address these questions with analytics derived from both satellite and airborne imagery platforms. This research will also provide the BLM (and other land management agencies like IDL) with new tools and techniques allowing them to apply this research directly into their decision making and management processes.

**Earth Observations:**

|  |  |  |
| --- | --- | --- |
| **Platform** | **Sensor** | **Geophysical Parameter** |
| **Landsat 5 and 8** | TM and OLI | NDVI, MSAVI2 |
| **Worldview** | Worldview | NDVI and panchromatic imagery |
| **NAIP** | Digital CIR | Aerial imagery |

**NASA Earth Observations Highlighted:**

Landsat 5 and 8 derived vegetation indices will be used to assess distribution change of Western Juniper across southeastern Idaho over the past decade. Worldview derived NDVI will be used comparatively with the Landsat results to better understand the capabilities and limitations of each observation and its application by land managers. Western Juniper will be discriminated using Classification Tree Analysis, which requires training sites to classification multispectral imagery. These training sites will be developed using high resolution imagery from Worldview and NAIP and used to classify spectral signatures of Western Juniper and other land cover types from Landsat and Worldview Earth observations.

**Ancillary Datasets:**

Historic Fire polygons – RECOVER Geodatabase, ISU GIS TReC

Caribou-Targhee NF Existing vegetation map – RSAC

National land Cover Database 2011 - MRLC

GAP - USGS

**Decision Support Tools & Analyses:**

|  |  |  |
| --- | --- | --- |
| **Proposed End Products** | **Decision to be Impacted** | **Current Partner Tool/Method** |
| Juniper Encroachment Map | Fire risk avoidance and allocation of resources | Field surveys |
| RECOVER Website Extension | Allocation of resources | Google imagery and field surveys. |

*Juniper Encroachment Map* – This end product will describe the distribution and density of Western Juniper in southeaster Idaho at present day and also show how these characteristics have changed over the past decade. The map will be derived from Classification Tree Analysis of Landsat and Worldview derived vegetation indices. Following successful development, this map will be updated as frequently as necessary in order to provide the best and most current information to support decision making regarding the management of Western Juniper.

*RECOVER Website Extension* – The juniper encroachment/management map will be integrated into the RECOVER DSS and available to aid fire managers during subsequent Idaho wildfire seasons. In addition, these data will be readily available to enable managers to plan fuel load reduction prescriptions following the 2015 fire season.

**Project Details:**

**National Application Area Addressed:** Disasters

**Source of Project Idea:** Following a meeting with the BLM (Mike Kuyper and Brian Holmes) and Idaho Department of Lands (IDL) (Robin Dunn) a need was identified to improve management of Western Juniper (*Juniperus occidentalis*) throughout not only Idaho but the Great Basin and Intermountain West. Specifically, land managers at both the BLM and IDL need better information regarding Western Juniper land cover (as a proportion of management areas) as well as tree density and frequency. While there certainly are limitations to Landsat’s ability to detect sub-pixel features, the questions addressed by this research will likely illustrate a broader applicability for Landsat than currently thought by many land managers. The reason for this is a misunderstanding of the ability of multispectral sensors to detect sub-pixel features using the unique spectral signatures of Western Juniper versus sagebrush as just one example. If this proves correct, land management agencies will be able to realize significant cost savings.

**Study Location:** Idaho

**Period being studied:** March 2006 – March 2015

**Advisors:** John Schnase (NASA GSFC), Mark Carroll (NASA GSFC), Keith Weber (ISU GIS TReC)

**Participants Requested:** 4

**Project Timeline:** 2 Terms: 2015 Fall to 2016 Spring

**Multi-Term Objectives:**

* **Term 1 (proposed term)** – The goal of this term is to determine the number of acres in southeast Idaho currently occupied by juniper. In addition, the team will determine the density of Western Juniper at several focused study sites (identified and prioritized by BLM) within the southeast Idaho study area.
* **Term 2** – The objective of this term is to continue the work initiated in term one by determining the number of acres in southeast Idaho occupied by Western Juniper ten years ago, quantify these changes and investigate driving forces that may be responsible for the observed changes. In addition, the team will create a management handbook identifying the imaging sensor and techniques required to answer the management questions.

**Previous Related DEVELOP Work:**

Fall 2014 (GSFC and BLM-ISU) - Idaho Disasters I: Using NASA Earth Observations to Create a Database and Determine Regional and Temporal Wildfire Susceptibility in Idaho Savannahs

Spring 2015 (GSFC and ISU GIS TReC) - Idaho Disasters II: Using NASA Earth Observations to Identify Savannah and Shrubland Vegetation in Southern Idaho

Summer 2015 (ISU GIS TReC and GSFC) - Idaho Disasters III: Use Landsat Earth Observations to identify heightened fire susceptible areas due to cheatgrass invasion

**Software & Scripting Requested:**

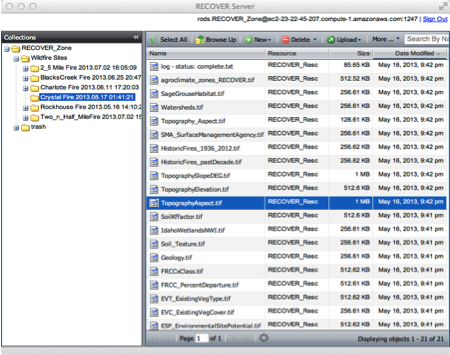
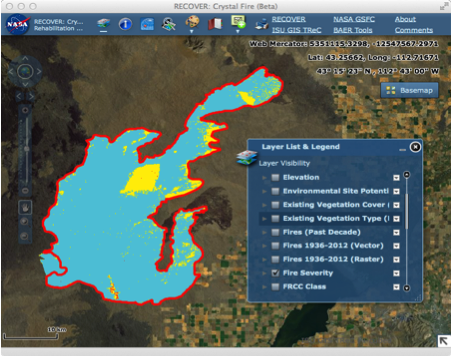
* ArcGIS 10.3 - Raster manipulation/analysis, map creation
* Python - Software integration
* IDRISI – Raster processing and classification tree analysis

**Notes:** RECOVER is a site-specific decision support system that automatically brings together in a single analysis environment all the information necessary for post-fire rehabilitation decision-making. In response to a fire detection event RECOVER, uses the rapid resource allocation capabilities of cloud computing to automatically collect Earth observational data, derived decision products, and historic biophysical data so that when the fire is contained, Burned Area Emergency Response (BAER) teams will have a complete and ready-to-use RECOVER dataset and GIS analysis environment that is customized for the target wildfire.

The RECOVER system was originally developed for use in savannah ecosystems and focused on the post-wildfire decision processes of the BAER teams. During RECOVER's evaluation phase, our agency partners recommended that the capabilities of the recovery system be extended to (1) enable RECOVER's use in forested ecosystems and (2) enable RECOVER's use in pre- and active-fire decision processes.

The RECOVER DSS is made up of a RECOVER Server and a RECOVER Client (Fig. 1). The RECOVER Server is a specialized Integrated Rule-Oriented Data System (iRODS) data grid server deployed in the Amazon Elastic Compute Cloud. The RECOVER Client is a full-featured Adobe Flex Web Map GIS analysis environment. When provided a wildfire name and geospatial extent, the RECOVER Server aggregates site-specific data from pre-designated, geographically distributed data archives. It then does the necessary transformations and re-projections required for the data to be used by the RECOVER Client. It exposes the tailored collection of site-specific data to the RECOVER Client through web services residing on the Server.

Figure 1. RECOVER Server and Client interfaces. For YouTube demonstrations, please see:  
 <http://www.youtube.com/watch?v=LQKi3Ac7yNU> RECOVER Server  
 <http://www.youtube.com/watch?v=SGhPpiSYpVE> RECOVER Client



In a typical scenario-of-use, RECOVER uses the rapid resource allocation capabilities of cloud computing to automatically gather various Earth observational and ancillary data products. Additional data can be added manually if needed, and the entire data collection is refreshed throughout the burn so that when the fire is contained, BAER teams have at hand a complete and ready-to-use RECOVER dataset that is customized for the target wildfire. The RECOVER server continues to gather data after the fire to support long-term monitoring of ecosystem recovery.

Our extensive use of web services allows RECOVER’s site-specific data to be consumed by state-of-the-art web-based GIS applications, such as the RECOVER’s Adobe Flex Client. This makes it possible for our agency partners to avail themselves of RECOVER’s analytic capabilities on any computer running a web browser, without having to acquire and maintain standalone GIS software. In addition, RECOVER’s web services architecture facilitates the future development of client applications that run on mobile devices. Most modern smart phones, tablets, etc. actually consist of just the display and user interface components of sophisticated applications that run in cloud data centers. This is the mode of work that RECOVER is intended to eventually accommodate.