**NASA DEVELOP National Program**

****USGS at Colorado State University - Fort Collins, CO

**Summer 2015**

**Colorado Agriculture II**

**Subtitle:** Reconstructing Forest Harvest History in Northern Colorado and Southern Wyoming Using the Landsat Time Series

**VPS Title:** Down to Earth: Reconstructing Forest Harvest History Using Landsat 1-8

**Project Team & Partners**

**Project Team:**

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**Advisors & Mentors:**

Dr. Paul Evangelista, Natural Resources Ecology Lab, CSU (Science Advisor)

Tony Vorster, Bioenergy Alliance Network of the Rockies (Mentor/End-User)

**Past or Other Contributors:**

Ryan Anderson

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**Partner Organizations**

Ben Delatour Scout Ranch (BDSR), End-User, POC: Mr. Robert Sturtevant

Bioenergy Alliance Network of the Rockies (BANR), End-User, POC: Mr. Tony Vorster

Colorado State Forest Service, End-User, POC: Mr. John Twitchell

**Project Details**

**Applied Sciences National Applications Addressed:**

Agriculture

**Study Area:** CO, WY

**Study Period:** August 1973 - September 2014

**Earth Observations & Parameters**

Landsat 1-3, Multispectral Scanner (MSS) - Atmospherically corrected surface reflectance; Tasseled Cap Brightness, Greenness, and Wetness (Tcap 1,2, and 3); single-band cloudmask image

Landsat 4-5, Thematic Mapper (TM) - Atmospherically corrected surface reflectance; Tasseled Cap Brightness, Greenness, and Wetness (Tcap 1, 2, and 3); single-band cloudmask image

Landsat 7, Enhanced Thematic Mapper Plus (ETM+) - Atmospherically corrected surface reflectance; Tasseled Cap Brightness, Greenness, and Wetness (Tcap 1, 2, and 3); single-band cloudmask image

Landsat 8, Operational Land Imager (OLI) - Atmospherically corrected surface reflectance; Tasseled Cap Brightness, Greenness, and Wetness (Tcap 1, 2, and 3); single-band cloudmask image

**Ancillary Datasets Utilized**

* USGS National Land Cover Database (NLCD) - Land cover
* Colorado State Forest (CSF) dataset? - Management boundaries
* Medicine Bow National Forest dataset? - Management boundaries
* Wyoming State Forest dataset? - Management boundaries

**Models Utilized**

* Landsat-based Detection of Trends in Disturbance and Recovery (LandTrendr, v. 3.0)
* Oregon State University and USDA Forest Service Pacific Northwest Research Station Tools for Calibration and Validation of LandTrendr, v. 3.0 (TimeSync)

**Software Utilized**

Exelis ENVI/IDL - Preprocess Landsat data through atmospheric corrections and cloud masking

ArcGIS v.10.1 - Preprocess Landsat imagery, manage field data, process spatial information, and manage model layers for input into LandTrendr

**Project Overview**

**80-100 Word Objectives Overview**

This project utilized NASA Landsat 1-8 (MSS, TM, ETM+, and OLI) imagery as inputs to the LandTrendr model to map historical timber harvests. The primary objective is to bridge the gaps in knowledge of timber harvest, both temporally and spatially, by providing new data on the timing, duration, and intensity of timber harvests in Northern Colorado and Southern Wyoming from 1984-2014. By creating a more thorough and comprehensive geographical record of timber harvest history, the results of this project will better inform forest management and future harvesting, while simultaneously improving the understanding of the ecological impacts of forest harvests.

**Abstract**

Timber harvests are interwoven into the forest history of Northern Colorado and Southern Wyoming. The success of local economies, health of the forests, and the diversity of the landscape are all contingent upon utilizing the forest resources. However, little is known about the precise location, exact timing, and fullest extent of the timber harvests. Incomplete records of past harvests highlight the lack of knowledge about the forest history and prevents adequate management of these forests. At the request of our project partners, Ben Delatour Scout Ranch (BDSR), Bioenergy Alliance Network of the Rockies (BANR), and Colorado State Forest Service, this project fills knowledge gaps associated with past timber harvests, which provide insight into the forest ecology and allows for better forest management. By accessing the Landsat archives, this project utilized 1984-2014 imagery from Landsat 1-3, Multispectral Scanner (MSS); Landsat 4-5, Thematic Mapper (TM); Landsat 7, Enhanced Thematic Mapper Plus (ETM+); and Landsat 8, Operational Land Imager (OLI). The collected scenes were atmospherically corrected for surface reflectance, masked for cloud cover, and stacked in a Tasseled Cap (Tcap) composite. The generated Brightness, Greenness, and Wetness bands (Tcap 1, 2, and 3) were run through the Landsat-based Detection of Trends in Disturbance and Recovery (LandTrendr) model to produce a visual representation of all categories and magnitudes of disturbances within the designated area. By prioritizing timber harvest as a key disturbance, an accurate delineation of forest harvest history in Northern Colorado and Southern Wyoming was created.

**Community Concerns**

* The primary community concern is the lack of a forest harvest history map for the forested areas of Northern Colorado and Southern Wyoming. Possessing an accurate representation of the past forest harvest history is imperative to planning sustainable and efficient future harvests.
* The forests are currently in a recovery phase due to droughts during 2001-2002, which triggered an unprecedented mountain pine beetle population outbreak. The excessive amount of dead wood exacerbates wildfires, flooding, and other ecological extremes in the western United States. The LandTrendr model has potential to delineate over 650,000 acres of native lodgepole and ponderosa pine trees that were destroyed by the mountain pine beetle in Northern Colorado alone.

**Current Management Practices & Policies**

The existing forest harvest maps and records that our project has improved upon are sporadic and incomplete. In order to provide a more accurate and comprehensive set of maps and records, the end-product of this project will contribute a 43 year forest disturabance history, ultimately providing data on extent of pine beetle mortality, as well as forest harvest in Northern Colorado and Southern Wyoming. The end product was requested by all three project partners: Ben Delatour Scout Ranch (BDSR), the Bioenergy Alliance Network of the Rockies (BANR), and the Colorado State Forest Service (CSFS). BDSR is a Boy Scout ranch responsible for the implementation and oversight of sound management practices on its lands, including general maintenance, invasive species management, and forest harvests. Financial and personnel limitations restrict the organization’s ability to conduct field measurements or harvest mapping. Therefore, the newly developed and refined timber harvest history map will greatly assist the implementation of sound management decisions in the future. BANR, our second project partner, is an organization primarily interested in exploring the use of mountain pine beetle kill wood along with other sources of forest biomass as a sustainable source of bioenergy. As of present, BANR does not possess a reliable spatial depiction of pine tree mortality in northern Colorado or southern Wyoming. The end-product they have requested will assist the organization to delineate and quantify the location and extent of dead biomass within the study area. Our third and final partner is the Colorado State Forest Service, an outreach agency of the Warner College of Natural Resources at Colorado State University whose mission is to achieve stewardship of Colorado’s forest environments. With the ultimate goal of implementing a sustainable model of forest management for both land managers and the public, the CSFS provides various educational and outreach opportunities meant to facilitate an inclusive process by which the public, students, and other invested parties can learn about and help facilitate the responsible and sustainable stewardship of Colorado’s forests. Currently, the CSFS does not have a reliable and comprehensive map of timber harvest history.

**Decision Support Tools & Benefits**

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| **End-Product** | **Earth Observations Used** | **Benefit & Impact** |
| Maps depicting location, extent, and year of timber harvests (as well as other disturbances)(GIS polygons, printed maps, Google Earth overlay) | Landsat 1-8 | These visual tools will assist partners in prioritizing locations for future timber harvests as well as developing a profitable yet ecologically sustainable plan for timber harvests. |
| A tutorial describing simplified pre-processing steps for LandTrendr | Landsat 1-8 | A step-by-step tutorial will help partners and future LandTrendr users to better navigate the model, allowing for the expedited use of the model. |

**Project Imagery**

**[Coming Soon!]**

**Caption:** [Coming Soon!] Image Credit: Colorado Agriculture Team.

**Image:** File Name (Please submit your image as a separate .jpeg as well as inserting it in this document)