**NASA DEVELOP National Program**

USGS at Colorado State University

*Spring 2017*

**Short Title: Nez Perce-Clearwater Energy**

**Subtitle:** Utilizing NASA Earth Observations to Estimate Dead Aboveground Biomass Following Pest and Disease Outbreaks in Central Idaho Forests

**VPS Title:** Biofueling the Future

**Project Team & Partners**

**Project Team:**

Emily Campbell (Project Co-Lead), emily.campbell1972@gmail.com

Emma Hatcher (Project Co-Lead), ezink29@gmail.com

Evan Gohring

**Advisors & Mentors:**

Dr. Paul Evangelista (Colorado State University, Natural Resource Ecology Laboratory)

Dr. Amanda West (Colorado State University, Natural Resource Ecology Laboratory)

Tony Vorster (Colorado State University, Natural Resource Ecology Laboratory)

**Past or Other Contributors:**

Brian Woodward

**Partner Organizations:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| Colorado State University, Natural Resource Ecology Laboratory (NREL) | Dr. Michael Falkowski, Professor/Research Scientist | End-User | No |
| Bioenergy Alliance Network of the Rockies | Tony Vorster, Feedstock Supply Team Manager | End-User | No |

**Project Details**

**Applied Sciences National Applications Addressed:** Energy

**Study Area:** Nez Perce-Clearwater National Forests, ID

**Study Period:** 1984 – 2016 (July – September)

**Earth Observations & Parameters:**

Landsat 4, Thematic Mapper (TM) – surface reflectance

Landsat 5, Thematic Mapper (TM) – surface reflectance

Landsat 7, Enhanced Thematic Mapper Plus (ETM+) – surface reflectance

Landsat 8, Operational Land Imager (OLI) – surface reflectance

Shuttle Radar Topography Mission (SRTM) version 3 – Compound Topographic Index (CTI), elevation, slope, aspect

**Ancillary Datasets Utilized:**

* Partner in situ data – Colorado State University, NREL aboveground total biomass map
* Partner in situ data – Colorado State University, NREL field plot measurement data
* US Forest Service Aerial Detection Surveys (ADS) – insect and disease presence
* USGS/USFS Monitoring Trends in Burn Severity (MTBS) – fire history maps

**Models Utilized:**

* Random Forest Classification Model

**Software Utilized:**

* ESRI ArcGIS – image processing, end product generation
* Interactive Data Language (IDL) – image calibration
* RStudio – statistical modeling
* LandsatLinkr (LLR) – Landsat imagery processing
* Landsat-based Detection of Trends in Disturbance and Recovery (LLR-LandTrendr) – disturbance metrics derived from LLR processed imagery

**Project Overview**

**80–100 Word Objectives Overview:**

In recent decades, central Idaho forests have been impacted by increasing frequency and severity of pest and disease outbreaks. This trend is consistent with the broader pattern of altered disturbance regimes as climate changes across western North American forests. This project aims to estimate dead biomass in central Idaho forests resulting from pest and disease disturbance using Landsat imagery, LiDAR derived total aboveground biomass maps, and forest inventory data as model inputs. Results will be used to assess the feasibility of extracting dead biomass from these forests to be utilized as a biofuel feedstock.

**Abstract:**

The magnitude and timing of forest disturbances have implications for global carbon cycles and forest ecosystem recovery. The carbon stored in central Idaho forests makes up a significant part of the overall carbon stocks in United States forests. Similar to the broader regional pattern of forest disturbance in the western United States, Nez Perce-Clearwater forests in central Idaho have been increasingly impacted by disturbances from insects, disease, fire, and clear-cutting activities in recent decades. This project estimated the distribution, timing, and drivers of dead biomass with an emphasis on tree mortality resulting from forest pests and disease. The team utilized NASA’s Landsat series alongside United States Forest Service Aerial Detection Survey data to determine forest disturbance and recovery trends. Forest disturbance data outputs from LandTrendr, LiDAR-derived aboveground total biomass maps, and forest inventory data were used in a Random Forest Classification model to estimate dead biomass. These results allowed the team to map dead biomass by year and cause, which will be used by partners at the Bioenergy Alliance Network of the Rockies as a primary input in future efforts to determine the economic and environmental feasibility of utilizing dead aboveground biomass for biofuel production.

**Keywords:**

Aerial Detection Survey, carbon cycle, Forest Inventory and Analysis, Landsat, random forest, bark beetle

**Community Concerns:**

* Pest and disease outbreaks, alongside other disturbance events, have increased tree mortality in Idaho forests.
* As the global climate continues to change, bark beetle outbreaks are expected to increase. This presents a unique opportunity to explore the use of beetle-kill wood as a bioenergy feedstock.
* Beetle-killed biomass is often located in areas that present considerable accessibility challenges.
* Environmental and economic concerns must be considered in determining feasibility of using dead biomass as a bioenergy feedstock.

**Current Management Practices & Policies**:

Colorado State University and the Bioenergy Alliance Network of the Rockies Feedstock Supply Team work through the Coordinated Agricultural Projects program to locate and quantify live and dead forest biomass to help guide forest harvest operations relative to bark beetle outbreaks. Most recently, this has been accomplished using United States Forest Service Forest Inventory and Analysis data to estimate aboveground live biomass availability in Colorado and Montana.

**Decision Support Tools & Benefits:**

|  |  |  |  |
| --- | --- | --- | --- |
| **End–Product** | **Earth Observations Used** | **Benefit & Impact** | **Software Release** |
| Aboveground Dead Biomass (ADB) Map | SRTM, Landsat 4 TM, Landsat 5 TM, Landsat 7 ETM+, and Landsat 8 OLI | Provide the distribution of dead aboveground biomass located in central Idaho between 2004 and 2016, and how disturbance impacts carbon storage in these forests on a larger spatial and temporal scale than previous work | I |
| Analysis of Timing and Cause of Dead Biomass (2004-2016) | SRTM, Landsat 4 TM, Landsat 5 TM, Landsat 7 ETM+, and Landsat 8 OLI | Integration of ADB maps to analyze trends in disturbance and dead biomass through time to better understand change and indicate cross-scale drivers | N/A |
| Dead Biomass Estimation Tutorial | SRTM, Landsat 4 TM, Landsat 5 TM, Landsat 7 ETM+, and Landsat 8 OLI | Description of methods and results for continued interpretation and modeling in future analyses of ADB | I |