**NASA DEVELOP National Program**

****NASA Ames Research Center

**Summer 2015**

**Short Title: Sierra Nevada Water Resources**

**Subtitle:** A quantitative assessment of wildfire severity and its effects on snow water equivalent throughout the Sierra Nevada, USA

**VPS Title:** A Song Of Fire and Snow: Understanding the Relationship Between Wildfire and Snowpack in the Sierra Nevada

**Project Team & Partners**

**Project Team:**

Sean Cunningham (Project Lead), sean.m.cummingham@nasa.gov

Justin Anzelc

Vishal Arya

Nolan Cate

Clayton Sodergren

**Advisors & Mentors:**

Andrew Nguyen (DEVELOP National Program)

Dr. Juan Torres Perez (Bay Area Environmental Research Institute, DEVELOP National Program)

**Partner Organizations**

USDA Forest Service (USFS), End-User, POC: Dr. Marc Meyer, Southern Sierra Nevada Province Ecologist

National Park Service (NPS), End-User, POC: Jim Roche, Yosemite National Park Hydrologist

**Project Details**

**Applied Sciences National Applications Addressed:**

Water Resources

**Study Area:** Twelve localized study regions within the Sierra Nevada were selected based on elevation, wilderness status, and fire severity to reflect characteristics representative of the range. Low, medium, and high severity burn areas were chosen as study sites in both the north and south sections of the region.

**Study Period:** April 24, 1984- April 29, 2015

**Earth Observations & Parameters**

Landsat 4-5 Thematic Mapper (TM), Landsat 7 Enhanced Thematic Mapper+ (ETM+), and Landsat 8 Operational Land Imager (OLI) - Snow cover measurements, NDSI, NDVI

**Ancillary Datasets Utilized**

* USDA Forest Service CALVEG - vegetation data
* NASA Shuttle Radar Topography Mission (SRTM)- Elevation data
* USDA Forest Service - Region 5 Vegetation Burn Severity data
* Bureau of Land Management (BLM) National Landscape Conservation System- California Wilderness Area boundaries
* USDA Natural Resources Conservation Service HUC-10 California watersheds

**Models Utilized**

* USGS, California Basin Characterization Model (BCM)

**Software Utilized**

ESRI ArcGIS Desktop - clipping & reprojecting ancillary data

Fmask - generating cloud mask and snow cover for Landsat images

R Statistical Package - creating various scripts to convert file formats

Clark Labs TerrSet - projecting elevation data and creating a mosaic, preprocessing Landsat data

**Project Overview**

Trends of diminishing snowpack throughout the Sierra Nevada, amplified by an increase in wildfire frequency and severity, has the capacity to threaten California’s water resources. To examine this interaction, Landsat data were analyzed to determine snow cover extent within the Sierra Nevada and support the California BCM snow water equivalent (SWE) estimates in order to quantify potential SWE changes in areas experiencing low, moderate, and high severity wildfires. These results will aid our end users in decision-making by describing impacts different levels of wildfire severity have on SWE throughout the region.

**Abstract**

Snowpack in the Sierra Nevada affects regional climate and ecosystem integrity, acting as a crucial component of the water supply in California. The effects of climatic variation on local forest ecosystems, including increasingly frequent and severe wildfires, possess the potential to impact SWE. Additionally, federal fire suppression policies dating back to the 1930s have led to augmented fuel loading, allowing the amount of understory brush and canopy cover to accumulate in the region. These combined factors have resulted in a greater quantity of large, high-severity fires. The effects of wildfires on snowpack have not been thoroughly investigated or quantified. This information could improve management of forest ecosystems and water resources. To achieve this, our team at DEVELOP partnered with the USDA Forest Service (USFS) and National Park Service (NPS) using NASA EOS Landsat data to quantify the effects of low, moderate, and high severity wildfires on snowpack and snow water equivalent in northern and southern Sierra Nevada ecosystems. These results will aid the USFS and NPS in decision-making by describing impacts that different levels of wildfire severity have on SWE throughout the region and how wildlife managers can use this information to assess effects of different fire regimes on SWE potential.

**Community Concerns**

* Snowpack in the Sierra Nevada is a major source of drinking water for California.
* Wildfire size, severity, and frequency are increasing in the Sierra Nevada.
* Current forest management practices and policies cause deviations from natural fire regimes.

**Current Management Practices & Policies**

Since the 1930s, federal fire suppression policies have been mandated within all states for all wildfires, natural or human-caused. This policy has been extremely effective in achieving its goal. However, many of forest ecosystems in California are adapted to frequent, low-to-moderate intensity wildfire regimes, which maintained forest structure, health, and resilience. Deviation from the natural fire regime has led to an increase in the fuel load and density of understory brush. Rising temperatures, lower precipitation levels, and the expanding human presence in forested lands have increased the frequency of high severity wildfires, costing the state upwards of $1 billion in 2008. As a result, the USDA Forest Service and National Park Service implemented mechanical thinning operations, and more recently, prescribed burning as treatments to reduce fuels.

**Decision Support Tools & Benefits**

|  |  |  |
| --- | --- | --- |
| **End-Product** | **Earth Observations Used** | **Benefit & Impact** |
| End-Product 1:  Snow cover change detection from 1984-2015 | Landsat 4-5 (TM)  Landsat 7 (ETM+)  Landsat 8 (OLI) | Will provide qualitative and quantitative data on variation in snowpack from 1984-2015 |
| End-Product 2:  Correlation coefficient between wildfire severity and snowpack | Landsat 4-5 (TM)  Landsat 7 (ETM+)  Landsat 8 (OLI) | Will provide quantitative data on how wildfire severity effects snowpack and SWE |

**Project Imagery**

**[Insert image here]**

**Caption:** [Insert Caption Here. Max of 25 words.] Image Credit: [Insert project short title] Team.

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