**NASA DEVELOP National Program**

****NASA Langley Research Center

**Fall 2016**

**Short Title: Glacier National Park Climate**

**Subtitle:** Utilizing NASA Earth Observations to Quantify Landscape Disturbances Related to a Changing Climate in Glacier National Park

**VPS Title:** Disturbing the Peaks: Mapping Landscape Disturbances in Glacier National Park

**Project Team & Partners**

**Project Team:**

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**Advisors & Mentors:**

Dr. Kenton Ross (NASA Langley Research Center)

**Partner Organizations:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| National Park Service, Glacier National Park | Richard Menicke, Geographer | End-User | No |
| NASA Ames Research Center, Biospheric Branch | Dr. Christopher Potter, Senior Research Scientist | Collaborator | No |

**Project Details**

**Applied Sciences National Applications Addressed:** Climate

**Study Area:** Glacier National Park, MT

**Study Period:** 1999 – 2016 (June – September)

**Earth Observations & Parameters:**

Landsat 4, Thematic Mapper (TM) – land cover

Landsat 5, Thematic Mapper (TM) – land cover

Landsat 7, Enhanced Thematic Mapper Plus, (ETM+) – land cover

Landsat 8, Operational Land Imager (OLI) – land cover

Shuttle Radar Topography Mission (SRTM) – Digital Elevation Model (DEM)

**Ancillary Datasets Utilized:**

* USDA Natural Resources Conservation Service (NRCS) Snow Telemetry Dataset (SNOTEL) – climatologyy/precipitation data
* USDA Forest Service Aerial Detection Surveys (ADS) – fire and pathogen mapping
* NPS shapefiles – vegetation indices

**Software Utilized:**

* ERDAS IMAGINE – land classification of Landsat imagery
* Esri ArcGIS – raster manipulation/analysis, image enhancement & map creation of Landsat ETM+/TM/OLI
* R – image composite generation

**Project Overview**

**80-100 Word Objectives Overview:**

The goal of this project was to identify, map, and quantify landscape disturbances (i.e., fires, forest pathogens, avalanches, landslides, floods, and invasive plant species) related to a changing climate in Glacier National Park. Data gathered focused on identifying subtle landscape disturbances by quantifying changes in the normalized difference moisture index of vegetation (NDMI). This will complement existing resource management programs, as well as guide Glacier National Park in future research and educational outreach.

**Abstract:**

National parks face an increasing number of threats from climate and biotic stressors, which lead to both major and minor landscape disturbances. The effects of disturbance are wide-ranging (e.g., changing species composition, altering nutrient flow and biodiversity, and landscape alterations) and impact numerous ecosystems within the park. While disturbance is part of the ecological history of a region, the major drivers and magnitude of disturbance change over time. In this project, the team quantified and mapped landscape disturbances in Glacier National Park from 1999 to 2016 (for the months of June – September). Landsat data were used to detect and map biotic stress from pathogens (such as the mountain pine beetle), fires, avalanche tracks, and landslides by using a threshold-based decision tree classification scheme similar to the work of Goodwin and others. Based on this methodology, and cross referencing results with insect Aerial Detection Surveys from the US Forest Service, it was observed that pathogen presence is represented by a negative change in NDMI of 600-4,000, with potential “green attack” phases of pathogen attack being represented by negative changes in NDMI of 250-600. Abrupt disturbances such as landslides, floods, and avalanches are represented by changes in NDMI of greater than 4,000. These results will aid the National Park Service in natural resource management by predicting a multitude of landscape disturbances in response to climate change.

**Keywords:**

Remote sensing, Landsat, disturbance, pathogens, fire, avalanche, landslide, time series, climate change, threshold

**Community Concerns:**

* Glacier National Park, a part of the larger Crown of the Continent ecosystem, has been affected by numerous landscape disturbances in recent history. These disturbances include, but are not limited to, fire, forest pathogens, and floods.
* Park managers note existing climate extremes since June of 1999, but the resulting ramifications are currently unknown.
* Examining abrupt a and subtle landscape disturbances will enable the staff at Glacier National Park to focus management resources and respond accordingly to disturbances within the park.

**Current Management Practices & Policies**:

Glacier National Park currently uses the Landsat series to observe landscape-level disturbances within the park. Landsat data are also used in assessing burn intensity and understanding burn severity patterns from large fires within park boundaries. Aerial photography from the National Agricultural Imagery Program (NAIP) is used for vegetation classification and management of park resources. However, detecting more subtle disturbances, such as pathogen damage on vegetation, is a time consuming and arduous task completed via handmade sketches during aircraft flyover. The remote and rugged terrain of Glacier National Park also poses difficulties for park staff, in that mapping disturbances on the ground is also time consuming and an inefficient use of park resources.

**Decision Support Tools & Benefits:**

|  |  |  |  |
| --- | --- | --- | --- |
| **End-Product** | **Earth Observations Used** | **Benefit & Impact** | **Software**  **Release** |
| Park Disturbance Maps | Landsat 5 TM, Landsat 7 ETM+, Landsat 8 OLI | Will aid in decision making for future park research, management, and educational outreach | III |
| Tutorial Brochure | N/A | This will allow the park to easily continue research on this subject past the completion of the term | III |

**Project VPS/Booklet Imagery**



**Caption:** ∆NDMI image generated from Landsat 8 OLI scenes for the time period of 2014-2016. Image Credit: Glacier National Park Climate Team.

**Image:** 2016Fall\_LaRC\_GlacierNationalParkClimate\_FinalImagery.pptx