NASA DEVELOP National Program
2017 Spring Project Proposal

NASA Langley Research Center
Glacier National Park Climate II
Utilizing NASA Earth Observations to Correlate Landscape Disturbances to Effects of a Changing Climate across Glacier National Park

Project Overview

Project Synopsis: This project utilizes Landsat, SRTM, and *in situ* data to create a database of disturbance history in Glacier National Park, as well as tutorials addressing how to continue this research into the future. The outcomes of this project will help officials working in the Park to map and quantify landscape disturbances, including fire, forest pathogens, avalanches, landslides, floods, and invasive species that are related to a changing climate. These outputs will benefit existing resource management programs at the Park and guide future research and educational outreach programs.

Community Concern: Glacier National Park is interested in developing a spatial database that relates landscape-level disturbances to climate-related effects across the Park as these environmental changes are currently assessed – and often managed – independently. Many disturbances have affected park lands within the larger *Crown of the Continent* ecosystem including fires, forest pathogens, and avalanches; however, park managers have identified the period from January 1999 to the present as experiencing several large disturbances. Further, the most recent vegetation mapping effort occurred in 1999, and requires updating based on these recent disturbances.

Source of Project Idea: The project idea was originally proposed by Richard Menicke, Geographer at Glacier National Park to the DEVELOP National Program in spring of 2016 through DEVELOP's call for NPS proposals. Richard identified the Park's need to develop map products that quantify landscape disturbances connected to a changing climate.

National Application Area Addressed: Climate
Study Location: Glacier National Park, MT and Waterton Lakes National Park, Alberta, Canada
Study Period: 1999 to 2016 (June-September)

Advisor: Dr. Kenton Ross (NASA Langley Research Center)

Partner Overview

Partner Organizations:

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

End-User Overview
End-User's Current Decision-Making Process: The National Park Service currently uses some NASA Earth observations from Landsat to study landscape-level disturbances within the park, in

addition to *in situ* monitoring. The Earth observations are especially important for assessment and understanding of burn severity patterns and diversity resulting from large fires within the Park's boundaries. Additionally, Park staff use aerial photography to monitor vegetation diversity and distribution.

End-User's Capacity to Use NASA Earth Observations:

National Park Service, Glacier National Park – Richard Menicke is familiar with NASA Earth observations and their applications, and is working to expand usage in Glacier National Park through his work with Dr. Potter at NASA Ames Research Center. This project would enhance the Park's usage of NASA Earth observations by furthering development of Dr. Potter's methodologies relating to landscape-level disturbances in Glacier National Park.

Collaborator & Boundary Organization Overview

Collaborator Support:

NASA Biospheric Branch, Ames Research Center – Dr. Christopher Potter is currently developing a methodology to use Landsat to monitor disturbances within national parks. The project team will be adapting this methodology, and will be utilizing Dr. Potter's expertise and experience to further expand the present methodology.

Project Communication & Transition Overview

***In-Term Communication Plan*:** The team will communicate with the project partners weekly via email to provide updates on project progress. Additionally, phone calls will be conducted once or twice each month to discuss methodology and progress in-depth. The main POC for this communication will be the team lead.

***Transition Plan*:** End products will be provided to the partners through an electronic handoff at the end of the term, and will include both maps and tutorials detailing how to expand on this research. The software release process began at the end of the Fall 2016 term.

Earth Observations Overview

Earth Observations:

Platform & Sensor	Parameters	Use
Landsat 5 TM, Landsat 7 ETM+, and Landsat 8 OLI	NDVI & NDMI	Vegetation indices which will be classified to predict various types of disturbance
Spectral Radar Topography Mission Version 3 Void-Filled	Elevation, Slope, Aspect	Additional variables to refine decision tree classification of disturbance

Ancillary Datasets:

Montana High School Science Classes – ground truth datasets – model result validation
GAP Analysis Program – ecosystem land cover – vegetation indices
NED - DEM data – vegetation indices
PRISM or DayMet – climatology data – vegetation indices
NPS disturbance data – fire and pathogen mapping – vegetation indices

Modeling:

Clark Labs, TerrSet Geospatial Monitoring and Modeling System Land Change Modeler (POC: Dr. Kenton Ross, NASA Langley Research Center)

Software & Scripting:

ERDAS IMAGINE – land classification of Landsat imagery
ESRI ArcGIS – raster manipulation/analysis, image enhancement & map creation of Landsat ETM+/TM/OLI
Excelis ENVI – vegetation indices, image processing
R – image composite generation

Decision Support Tool & End Product Overview

End Products:

End Products	Partner Use	Datasets & Analyses	Software Release Category
Time Series of Park Disturbance Maps	Will aid in decision making for future park research, management, and educational outreach	Landsat 5 TM; Landsat 7 ETM+; Landsat 8 OLI; development of threshold methodology, comparison to NAIP imagery	I
Vegetation Change Map	Will provide a more accurate measure of how disturbances are changing vegetation cover within the park	Landsat 5 TM; Landsat 7 ETM+; Landsat 8 OLI; classification of Landsat imagery	I
Current Vegetation Map	Will provide a more accurate measure of current vegetation distribution within the park	Landsat 8 OLI; classification of Landsat imagery	I
Tutorial Brochure	This will allow the park to easily continue research on this subject past the completion of the term	N/A	I
Decision Tree Threshold Classification Methodology	Classify disturbance thresholds to determine areas more or less impacted by specific disturbances	Landsat 5 TM; Landsat7 ETM+; Landsat 8 OLI; SRTM	IV

***End-User Benefit*:** The end-user will be provided updated distribution maps of current forest health, as well as a map of vegetative changes from 1999 to 2016. These products will enhance the decision-making process by providing land managers with a more holistic understanding of the change in vegetation distribution within the Park over time. Analyses will allow for more efficient distribution of management resources and future planning.

Project Timeline & Previous Related Work

Project Timeline: 2 Terms: 2016 Fall (Start) to 2017 Spring (Completion)

Multi-Term Objectives:

- **Term 1:** Fall 2016 (LaRC) – Glacier National Park Climate
    - Determine methodology for threshold-based classification to create vegetation maps.
- **Term 2 (Proposed Term):** Spring 2017 (LaRC) – Glacier National Park Climate II
    - Focus on automation of methodology for future use
    - Refine and finalize products and tools for handoff with partners
    - Include Waterton Lakes National Park partners
    - Correlation between pathogen disturbance and intensity in delta NBR
    - Look more broadly at forests/mask out non-forested areas (e.g., NE agriculture lands in Alberta or urbanized areas west of park)

Previous Terms:

2016 Fall (LaRC) – Glacier National Park Climate: Utilizing NASA Earth Observations to Quantify Landscape Disturbances Related to a Changing Climate in Glacier National Park

Related DEVELOP Work:

2007 Spring and Summer (ARC) – California Ecological Forecasting I and II: Utilizing MODIS LAI to Identify Vegetative Anomalies in Yosemite National Park

2016 Summer (WC) – Northern Great Plain Water Resources: Discovering Archaeological Sites by Utilizing NASA Earth Observations to Detect Changes in Snowpack Coverage in Intermountain National Parks

2016 Fall (WC) – Northern Great Plains Water Resources II: Utilizing NASA Earth Observations to Detect Changes in Snowpack Coverage in Intermountain National Parks

Notes & References:

References:

Potter, C. 2016. Vegetation cover change in Glacier National Park detected using 25 years of Landsat satellite image analysis. Journal of Biodiversity Management & Forestry, 5(1), *doi: http://dx.doi.org/10.4172/2327-4417.1000156*.