**NASA DEVELOP National Program**

**2018 Summer Project Proposal**

**Virginia – Langley**

**Glen Canyon Ecological Forecasting**

*Using NASA Earth Observations to Prioritize Locations for Enhanced Monitoring and Management of Cultural Resources in Glen Canyon National Recreation Area*

**Project Overview**

***Project Synopsis*:** This project will conduct spatio-temporal land cover analyses for Glen Canyon National Recreation Area (Glen Canyon) in Arizona and Utah using Aqua and Terra MODIS, Landsat, and Sentinel-2 data. These analyses will help prioritize locations in the park at risk for vegetation cover loss, which can contribute to increased erosion from wind and water, which ultimately endangers cultural resources. By assessing vegetation cover spatially and temporally, park managers will be able to better prioritize their monitoring and management efforts, and focus on areas in the park more at-risk for loss or damage of archaeological resources.

***Community Concern:*** There are many archaeological resources preserved in protected lands by the National Park Service. However, many of the areas containing these resources are difficult to access, and by extension they are also difficult to monitor and preserve. This is especially true in large parks with few individuals responsible for monitoring the entire area. Areas containing archaeological resources in the western United States are often impacted by wind and water erosion, but are protected by vegetation and naturally forming cryptobiotic crust, which hardens the topsoil and prevents mixing and breakdown of geologic layers. Vegetation density is strongly correlated with sediment stability; as vegetation is lost, erosion increases. Cryptobiotic crust hardens the topsoil and increases sediment stability. Loss of the vegetation and crust is indicative of the degradation of sediment deposits with potential for containing cultural resources. Identifying areas where crust is receding will help prioritize areas in Glen Canyon where archaeologists should focus their preservation efforts.

***Source of Project Idea:*** This project idea developed through discussions between the National Park Service and DEVELOP after previous DEVELOP work was shared internally within the National Park Service.

***National Application Area Addressed:*** Ecological Forecasting, Water Resources

***Study Location:*** Glen Canyon National Recreation Area (AZ, UT)

***Study Period:*** 1980 – 2017 (February, May, June)

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

**Partner Overview**

***Partner Organization:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| **National Park Service, Glen Canyon National Recreation Area** | Brian Harmon, Archaeologist | End User | No |

***End User Overview***

***End User’s Current Decision-Making Process:***Currently, Glen Canyon archaeologists’ ad hoc prioritization of non-inventoried areas for archaeological investigation is based on requirements of specific park projects (e.g., installation of a new trail), intensity of visitor use, and resource damage and threats reported by park staff and visitors. Within the past year, cultural resource managers have started assessing the entire park in order to systematically prioritize resources and locations for management efforts.

***End User’s Capacity to Use NASA Earth Observations:***

*National Park Service, Glen Canyon National Recreation Area* – The end user is familiar with Earth observations and currently utilizes aerial imagery to assess remote locations within the park. However, they are not currently using any remote sensing datasets in their workflow.

***Project Communication & Transition Overview***

***In-Term Communication Plan*:** The Center Lead and the Project Lead will be the main POC’s for the project. Weekly emails and biweekly telephone calls will be used to discuss project progress and receive feedback from the partner.

***Transition Plan*:** A virtual handoff will be conducted with the partner at the end of the term. All end products and project deliverables will be emailed to the partner after this handoff meeting, allowing time for feedback.

**Earth Observations Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter** | **Use** |
| **Terra MODIS** | Surface reflectance | Terra MODIS will be used to assess land cover types over short temporal scales. |
| **Aqua MODIS** | Surface reflectance | Aqua MODIS will be used to assess land cover types over short temporal scales. |
| **Landsat 5 TM** | Surface reflectance | Surface reflectance will be used to assess land cover types on a finer spatial scale than MODIS. |
| **Landsat 7 ETM+** | Surface reflectance | Surface reflectance will be used to assess land cover types on a finer spatial scale than MODIS. |
| **Landsat 8 OLI** | Surface reflectance | Surface reflectance will be used to assess land cover types on a finer spatial scale than MODIS. |
| **Sentinel-2 MSI** | Surface reflectance | Surface reflectance will be used to assess land cover types on a finer spatial scale than MODIS and Landsat. |

***Ancillary Datasets:***

National Park Service, Glen Canyon National Recreation Area *in situ* vegetation data – validate land cover types from satellite imagery

USDA Forest Service ForWarn phenology dataset – compare to land cover analyses with Landsat and MODIS

***Modeling:***

TerrSet Land Change Modeler (POC: Dr. Kenton Ross, NASA Langley Research Center)

***Software & Scripting:***

Esri ArcGIS – raster manipulation, map creation

R – geospatial processing

**Decision Support Tool & End Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Products** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| **Vegetation Cover Trend Maps** | Trend maps from 1980 to 2017 of vegetation cover will be used to indicate areas with persistent or ephemeral vegetation during the study period and where the partners should focus on restoration and monitoring efforts. | Terra MODIS and Landsat datasets will be used to classify land cover types and then assess long-term trends in vegetation cover. | N/A |
| **Vegetation Loss Analysis** | Maps identifying areas of vegetation loss over the course of the study period, especially in the last five years. This will enable partners to understand what areas of the park are more at-risk for vegetation loss and better allocate resources to those areas. | Terra MODIS and Landsat datasets will be used to identify vegetation loss over time. | N/A |
| **Forecasted Vegetation Cover** | Map of forecasted vegetation cover in 2022 will help the partner assess future trends in vegetation loss and land cover change. | Terra and Aqua MODIS, Landsat, and Sentinel-2 data will be used to identify potential locations of vegetation loss through 2022. | N/A |
| **Vegetation Cover Analysis Tutorial** | The methodology for vegetation cover analysis will be compiled into a tutorial to allow the partners to continue using this methodology in the future. | N/A | N/A |

***End-User Benefit*:**

Less than 15 percent of Glen Canyon’s 1.25 million acres has been systematically and intensively inventoried for archaeological resources. By remotely identifying areas of severe vegetation and cryptobiotic crust loss, archaeologists can target locations with a high potential to contain degrading archeological resources without having to conduct costly and time-consuming field reconnaissance. Specifically, areas with high-risk for resource loss will be defined by combining project results with recently developed models of park-wide archeological site density. Information about the location and spatial extent of high-risk areas may significantly improve Glen Canyon’s cultural resource funding and prioritization decisions.

**Project Timeline & Previous Related Work**

***Project Timeline:*** 1 Term: 2018 Summer

***Related DEVELOP Work:***

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

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