**NASA DEVELOP National Program**

**Fall 2016 Project Proposal**

**Mobile County Health Department**

**Southeastern Arizona Water Resources**

Using NASA Earth Observations to Assist the National Park Service in Assessing Snow Cover Distribution and Persistence Changes in the Sky Islands

**Project Overview**

***Objective:*** To assess historical, current, and future snow distribution and persistence changes in order to better understand the impact of climate change on the sky island region of southeastern Arizona.

***Community Concern:*** Southeastern Arizona is home to a diverse range of mountain ecosystems that are hotspots of biodiversity, known as the sky islands, including those located in Saguaro National Park. Within these sky islands, the presence of snow and its extent are important factors in replenishing streams and rock fractures that help wildlife and plants make it through the dry season. National Park Service (NPS) managers have been monitoring water presence in these streams and rock fractures since the mid-1990s, however, a major gap in information is the impact that snow has on these streams. Through a historical assessment of patterns and changes in snow cover, the NPS will be better equipped to understand and anticipate the future impacts of climate change on the vegetation and wildlife in Saguaro National Park.

***National Application Areas Addressed:***  Water Resources, Ecological Forecasting, Climate

***Study Location:*** Southeastern Arizona, AZ

***Study Period:*** Retrospective period 2000-2016; Forecast period 2016- 2020

***Advisors:*** Joseph Spruce (SSAI @ NASA LARC); Dr. Kenton Ross (NASA LARC)

***Source of Project Idea:*** This project was requested by Colleen Filippone of the NPS after hearing a DEVELOP presentation in the spring of 2016. In doing so, Ms. Filippone drafted a project idea that would help to enhance the NPS’s decision making in Saguaro National Park, which led to this project proposal being created.

**Partner Overview**

***Partner Organization:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| National Park Service | Colleen Filippone, Intermountain Region Hydrologist | End-User | No |

***End-User Overview***

***End-User’s Current Decision Making Process:***

The NPS is currently working to develop a model to predict and assess water resource impacts in Saguaro National Park related to climate change. Knowledge about future water resources conditions and change in this region is important for understanding the impact it may have on vegetation and wildlife distribution. The NPS currently monitors water through a network of stream gauges and field monitoring stations located throughout this Arizona sky island region. However, the NPS is currently unable to regularly monitor snow presence synoptically across the study area due to high elevation and remoteness of many locations. Understanding the timing, amount, extent, and impact of snow occurrence are important factors in understanding the overall hydrology of the park.

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

National Park Service – Park managers at Saguaro National Park are familiar with NASA Earth observations but have not used them in order to assess snow cover in this region. This project will help to build capacity through enhanced understanding of the capabilities of NASA Earth observations as well as enhanced decision making.

***Project Communication & Transition Overview***

***In-Term Communication Plan:***

The team will communicate weekly with the partner through emails, telecons, and video conferences. Through these communications the team will actively engage with the partner and leverage park data throughout the course of the project. The main POC for the project is Colleen Filippone of the NPS.

***Transition Approach:***

A video hand-off of the end-products is anticipated for this project. Implementation of the tools by the NPS is anticipated to occur as early as spring 2017. At this point in time, no software release is anticipated.

**Letters of Support:** National Park Service, Colleen Filippone, Intermountain Region Hydrologist

**Earth Observations Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameters** | **Use** |
| **Aqua/Terra MODIS** | Standard Snow Cover Products (e.g., MOD10A1) | Standard Aqua/Terra MODIS data will be used to detect the presence of snow cover in the sky island region during the MODIS era. Analysis of this data will help to identify trends and changes that varying snow cover may have on the region’s water resources, enhancing park management decision-making. |
| **Aqua/Terra MODIS** | Value-added Snow Cover Products | Value added snow map data available from Snow Data System at NASA JPL will also be considered. |
| **Landsat 5 TM** | Snow Cover | Landsat 5 TM data will be used for providing a higher spatial alternative to MODIS if/when cloud-free data exists during times with snow cover. |
| **Landsat 7 ETM+** | Snow Cover | Landsat 7 ETM+ data will be used for providing a higher spatial alternative to MODIS if/when cloud-free data exists during times with snow cover. |
| **Landsat 8 OLI** | Snow Cover | Landsat 8 OLI data will be used for providing a higher spatial alternative to MODIS if/when cloud-free data exists during times with snow cover. |
| **Sentinel-2** | Snow Cover | Sentinel-2 data will be used for providing a higher spatial alternative to MODIS if/when cloud-free data exists during times with snow cover. |

***Ancillary Datasets:***

NPS – historical water presence data – for understanding how snow cover and snow depth impact water presence in the park

USDA – SNOTEL snow telemetry data if/when available at the park or at other high elevation locations in Arizona – for understanding of snow presence on stream flow in certain regions of the park

USGS – Stream gauge data – for understanding of snow presence on stream flow in certain regions of the park

***Modeling:***

TerrSet Geospatial Monitoring and Modeling System Earth Trends Modeler (ETM) and Land Change Modeler (POC: Dr. James Toledano, Clark labs)

***Software & Scripting:***

ArcGIS – Raster manipulation and production of maps

TerrSet – Snow cover prediction maps

ERDAS Imagine – Image data analysis, assuming availability of such software

Google Earth Engine – Processing of MODIS and Landsat time series data

FMask – Automated snow masking for Landsat and Sentinel-2 images

**Decision Support Tool & End-Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Products** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| Historical Snow Cover Maps | The NPS does not currently have data for snow presence or extent in the study region. These maps will be used by the partner to enhance their understanding of the region’s water resources and fill a data gap in their decision-making tools. | Aqua/Terra MODIS daily snow cover data products will be the input for these maps. A trend analysis will be conducted to assess patterns and changes that may be occurring in the region. | N/A |
| Snow Cover/Depth Prediction Maps | These maps will inform the NPS of areas that may see increased or decreased absence of snow cover based on historical snow cover/depth in the region. This will allow the park to better manage those areas. | The input for these maps will be the historical snow cover maps created by the team during the term. Additionally, precipitation and temperature data will also be used as inputs for the prediction maps. | N/A |

***End-User Benefit:***

The NPS does not currently have a complete record of snow cover in the sky island region. Many of the areas with snow cover are inaccessible, leaving park managers with no way to accurately assess snow presence or extent. Historical maps of snow cover will allow the park to analyze historical impact of snow cover on water resources. The changes and trends derived from the historical maps will be used to predict future snow cover for the region.

**Project Timeline & Previous Related Work**

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

***Multi-Term Objectives:***

* **Term 1(Proposed Term):** 2016 Fall (MCHD) – Southeastern Arizona Water Resources
	+ The goal for the first term of the project is to create an overall assessment of snow cover for the study region, using MODIS and Landsat data products. This assessment will be used to create preliminary analyses of the park’s hydrology in addition to prediction maps of future snow cover. A methodology for analyzing snow cover impact on individual watersheds will also begin during this term. Partner interaction will evolve through telecons and video conferences throughout the term.
* **Term 2:** 2017 Spring (MCHD) – Southeastern Arizona Water Resources II
	+ The second term will continue to refine the methodology for analyzing individual watersheds within the region and generate comparable products using VIIRS data. The team will also analyze the impact of wildfires on snow cover and water resources using historical wildfire data provided by the partner. Research will also be conducted in use of MODIS/Landsat data fusion products. In addition, the team will look into the possibility of creating a real-time monitoring tool using NASA LANCE data. This term’s activities will allow the partner to better understand how wildfires may alter the water levels in the park. Partner involvement will increase as the team develops a methodology to incorporate snow cover data into the watershed modeling tools, drawing on the partner’s hydrology expertise. A video conference is expected in order to handoff end results to the partner.

***Related DEVELOP Work:***

Fall 2013 (LaRC) – Chile Water Resources: Assessing Potential Water Availability from Andean Snowpack for Agricultural Uses in the Coquimbo Region of Chile

Spring 2014 (LaRC) – Chile Water Resources: Using NASA Earth Observations Data to Understand Snowmelt and Address Ongoing Drought in Central Northern Chile

Summer 2013 (ARC) – Sierra Nevada Water Resources: Sierra Nevada Climate Change and Its Impact on Snow Water Equivalent In Relation To Wildfire

Summer 2015 (ARC) – Sierra Nevada Water Resources: Sierra Nevada Climate Change and Its Impact on Snow Water Equivalent in Relation To Wildfire

**Notes & References:**

***Notes:*** In addition to or replacement of the TerrSet model, the team and partner may explore the possibility of using the Automated Geospatial Watershed Assessment (AGWA) tool to model the hydrological impact of snow presence or absence on individual watersheds.

***References:***

Link to AGWA tool: <http://www.tucson.ars.ag.gov/agwa/>