**NASA DEVELOP National Program**

**Fall 2015 Project Proposal**

NASA Ames Research Center

**Lake Tahoe Water Resources**

Lake Level monitoring in Lake Tahoe using Earth Observing imagery and Google Earth Engine

**Objective:**

To use Landsat series imagery and Google Earth Engine to provide near real-time lake levels monitoring in Lake Tahoe, California, as well as altimetry from the Ocean Surface Topography Mission, MODIS Land Cover, and GMP Precipitation, to provide an economical assessment of water availability without the use of in-situ lake level monitoring techniques, equipment, or field campaigns.

**Community Concern:**

California water availability is a growing concern for residential, agricultural, and recreational water use. In recent years, drought has brought California reservoirs and natural lakes to unprecedented low levels where current methods and instruments for water level monitoring may no longer be useful. This presents large data gaps when accounting for the state’s terrestrial water supply. The concerns of drought also have affected water levels in Lake Tahoe which may negatively impact the overall health of the terrestrial and aquatic ecosystems of the lake. These ecological impacts will largely affect the significant tourism economy and its natural recreational attractions within and around Lake Tahoe communities.

**Partner Organizations:**

Lake Tahoe Basin Management Unit (End-User, POC: Dr. Joey Keely, Ecosystem Conservation Staff Officer)

NASA Ames Research Center (Collaborator, POC: Dr. Brian Coltin, Technical Intelligence Specialist)

Solano County Water Agency (SCWA) staff are interested in the applying the algorithm to future monitoring of Lake Berryessa and potentially other lakes under SCWA jurisdiction. They will provide publicly available water level data to assist in algorithm calibration. Emails has been the main avenue of communication. NASA Ames Research Center scientist, Brain Coltin, will provide technical assistance to the DEVELOP team regarding the Lake Level monitoring algorithm. He has created this algorithm using Google Earth Engine and would like to further calibrate it to, ultimately, apply it to global lake level monitoring purposes

**Letters of Support:** 1) LTBMU research permit by Dr. Joey Keely, and 2) Dr. Brian Coltin

**Decision Making Process:**

Lake Tahoe Basin Management Unit (LTBMU) staff are interested in applying the algorithm to future water level monitoring of Lake Tahoe and other lakes under LTBMU jurisdiction. According to the USDA Forest Service Region 5 Ecological Restoration Implementation Plan, “Ecological Restoration is the central driver of wildland and forest stewardship in the Lake Tahoe Basin Management Unit”. In order to accomplish restoration and preservation efforts, LTBMU considers long-term changes that may occur in climate to better understand how natural and anthropogenic drivers may affect ecosystem services. The Environmental Improvement Program (EIP) was formed to focus on restoring the clarity of Lake Tahoe, which attracts over 5 million tourists a year. The Tahoe Regional Planning Agency (TRPA) was formed through a bi- state compact between California and Nevada to impose protective land use ordinances, allowing restoration and preservation efforts to take place. The efforts from these two agencies allow LTBMU to better manage and coordinate USDA Forest Service resources with the ultimate goal of formulating sustainable solutions to address economic, social, and environmental needs. LTBMU currently uses USGS gage stations to monitor Lake Tahoe water levels, however, these stations are rapidly undergoing decommission. Additionally, smaller lakes within the region do not have gage stations and are only visually assessed, thus are not quantified for concrete scientific reporting. The agency also launches field campaigns to measure lakes in more remote regions within LTBMU, however these can be time consuming, costly, and do not provide the fine temporal coverages to monitor constant lake level changes.

**Earth Observations:**

|  |  |  |
| --- | --- | --- |
| **Platform** | **Sensor** | **Geophysical Parameter** |
| **Landsat 1-5, 7-8** | RVB, MSS, TM, ETM, OLI | Land Cover |
| **Aqua/Terra** | MODIS | Land Cover |
| **OSTM** | Posiden-03 | Altimetry  |
| **GPM** | GMI, DPR | Precipitation |

**NASA Earth Observations Highlighted:**

Landsat – will be able to provide continued water level monitoring with high temporal and spatial resolutions. It is also useful for measuring historical water levels.

Posiden-03 – will enable cross checking of Landsat data which will help support results to strengthen algorithm calibration.

MODIS – will enable cross checking of Landsat data which will help support results to strengthen algorithm calibration.

GPM – will enable cross checking of results to strengthen algorithm calibration.

**Ancillary Datasets:**

USGS In-situ Lake Tahoe Water Surface Level Data

**Models:**

NASA Google Earth Engine Lake Level Algorithm (POC: Dr. Brian Coltin, NASA Ames Research Center)

**Decision Support Tools & Analyses:**

|  |  |  |
| --- | --- | --- |
| **Proposed End Products** | **Decision to be Impacted** | **Current Partner Tool/Method** |
| Lake Level monitoring for Lake Tahoe and surrounding lakes | Enable end-users to monitor lake levels in near real-time without the use of costly equipment and time consuming field work  | Various in-situ water monitoring equipment |

*Lake Level Algorithm for Lake Tahoe* – This algorithm will enable end-users to monitor historical and current lake levels in near real-time. They will be able to do this without the use of costly equipment and time consuming field work. Additionally, they are able to apply this to all other lakes within the agency’s jurisdiction, such Fallen Leaf Lake and smaller sub-alpine lakes within the nearby Desolation Wilderness.

**Project Details:**

**National Application Area Addressed:** Water Resources

**Source of Project Idea:** Ames Earth Science Division, Bio-spheric Branch Chief, James Brass, suggested the useful applications of this global lake monitoring product. The idea was also elevated due to the involvement of Google products and the potential of building stronger relations between NASA Earth Science and Google.

**Study Location:** Lake Tahoe, California and Nevada

**Period being Studied:** 1984-2015

**Advisor:** Dr. Juan Torres-Perez (Bay Area Environmental Research Institute)

**Participants Requested:** 3

**Project Timeline:** 1 Term: Fall 2015 (Start/Completion)

**Software & Scripting Requested:**

* Google Earth Engine – Water surface and elevation of Landsat imagery
* Arc GIS Desktop 10.3.0- Raster and Vector manipulation of MODIS, GMP, and Posiden-03 products

**Notes:**

This project has the potential to create a sustainable and cost effective method of monitoring all lake levels on a global scale. The algorithm has been applied to Mono Lake, California as a proof of concept and requires very little additional calibration. The reasoning behind choosing Lake Tahoe, is because it is a popular tourist destination responsible for 5 million visitors a year, which contributes to the local and state economy. It also enables the DEVELOP team to create a lake level monitoring algorithm specific to Lake Tahoe and its surrounding lakes for historical, current, and future water availability using well established tools, software, and data. Considering the large concern regarding global water availability, this algorithm has the potential to be useful in many parts of the world where there are no methods of monitoring water levels.

The participants will refine this algorithm to hand off to the LTBMU for continued management and support of forest and aquatic parcels within their jurisdiction. If successful, the algorithm is also planned to be published and made available to the public as a global lake level monitoring tool.

The algorithm will not need to undergo the NASA software release process. It is Python script created within the Google Earth Engine Software package to call Landsat imagery and calculate bathometry values. Additional NASA EOS data will be used to cross check and calibrate these results. This helps strengthen the validity of all involved EOS instruments. There is also the possibility of using Posiden-03 data within this algorithm to produce similar results.

The additional highlight of this project involves building relations between Google and the NASA Earth Science Division at the ASP and NPO level. Google Earth Engine and Landsat have never been used to this capacity to monitor lake levels. Google Earth Engine is an inexpensive alternative for a remote sensing software package and Landsat imagery are publicly available data using a NASA EOS Platform. This algorithm can be used by foreign agencies that are unable to afford expensive software or data and is also a NASA Product. Additionally, at the center level, Ames Research Center has strong business partnerships with Google. It has been mentioned by the Ames Technology Partner Business Development Director, Larry Barone, that this DEVELOP project could start a new type of research and project partnership.

***References:***

TBMU’s contribution to the Region 5’ “Leadership Intent on Ecological Restoration”

<http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5411435.pdf>