**NASA DEVELOP National Program**

**2018 Fall Project Proposal**

**Idaho – Pocatello**

**Idaho Water Resources II**

*Approximating Evapotranspiration in Semi-Arid Sagebrush Steppe to Improve Water Balance Calculations in Southeast Idaho*

**Project Overview**

***Project Synopsis*:** Understanding water availability and transport in semi-arid landscapes is of vital importance to land management agencies—affecting fire risk assessments, rangeland management, and ecosystem health monitoring. Building on previous research that investigated soil moisture (Idaho Water Resources I), this project shifts focus to provide a more holistic view of the water budget and energy balance in these specialized systems by estimating land surface evapotranspiration (ET). Using data collected from NASA Earth observing satellites Aqua and Terra, this project will compare methods of estimating seasonal ET in Idaho’s natural landscapes using MODIS-derived model products. End products will be assessed against SMAP products from the previous term, field based soil measurements, and other methods of estimating soil moisture to determine which methodologies correlate best with limited available ground-based measurements.

***Community Concern:*** While satellite-based models exist for estimating ET in managed landscapes (e.g. METRIC), these models tend to overestimate ET in water-limited natural systems which leads to unsustainable land management practices. Moving towards more precisely quantifying seasonal water cycling in semi-arid sagebrush steppe has far-reaching benefits for a variety of land and resource management applications. This information can be used to improve land management decision-making, such as determining fire susceptibility and vegetation health via Live Fuel Moisture (LFM) estimates, calculating water balances to maintain sustainable withdrawal rates, setting cattle grazing allotment to protect rangeland resources, and overall ecosystem health monitoring.

***Source of Project Idea:*** After a discussion with several potential partners at the Idaho National Lab, Keith Weber, Lead Science Advisor for Idaho – Pocatello, started developing this project in fall 2017, with this term serving as a continuation of the summer 2018 Idaho Water Resources project.

***National Application Area Addressed:*** Water Resources

***Study Location:*** ID

***Study Period:*** January 2015 – August 2018

***Advisor:*** Keith Weber (Idaho State University, GIS TReC)

**Partner Overview**

***Partner Organizations:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| **US Fish and Wildlife Service, Eastern Idaho Field Office** | Evan Ohr, Biologist;  Lisa Dlugolecki, Biologist;  Matt Bringhurst, Soil Conservation Tech | End User | Yes |
| **Idaho Department of Fish and Game, Southeast Regional Office** | Dr. Scott Bergen, Sr. Wildlife Research Biologist | End User | No |
| **USDA, Natural Resources Conservation Service, Pocatello Field Office** | Nate Matlack, Soil Conservationist;  Trudy Pink, Resource Soil Scientist | Collaborator | No |
| **Idaho National Laboratory** | Tammie Borders, Research Scientist;  Trent Armstrong, Research Scientist | Collaborator | No |
| **USDA, Agricultural Research Service, Northwest Watershed Research Center** | Dr. Patrick E. Clark, Range Scientist | Collaborator | No |
| **National Scientific and Technical Research Council (Argentina)** | Dr. Pablo G. Aceñolaza, Researcher | Collaborator | No |

***End-User Overview***

***End User’s Current Decision-Making Process:***The US Fish and Wildlife Service is an integral part of the Department of the Interior, facilitating communication and consulting with other land management agencies to protect ecosystem health. Currently, specified areas of concern for threatened species are noted as priority conservation areas. These areas are currently defined via field work and shared information between a variety of state and federal agencies; however, remote sensing has yet to be fully leveraged for these applications.

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

*US Fish and Wildlife Service, Eastern Idaho Field Office* – Currently, the Eastern Idaho Field Office uses limited remote sensing for map creation and decision support. This project will familiarize the USFWS with additional remote sensing resources and the opportunity to expand their usage of NASA Earth observations.

*Idaho Department of Fish and Game, Southeast Regional Office* – The Idaho Department of Fish and Games (IDFG) has research and management groups that currently use satellite-derived imagery (e.g. MODIS, Landsat) for natural resource management throughout the state of Idaho. Satellite data are used to meet some specific informational needs, such as annual vegetation production, invasive species detection, and fire recovery estimation.

***Collaborator & Boundary Organization Overview***

***Collaborator Support:***

*USDA, National Resources Conservation Service, Pocatello Field Office* – Currently, the USDA Natural Resources Conservation Service (NRCS) uses airborne imagery and limited vegetation/change detection via remote sensing for landscape monitoring. They will provide project guidance and secondary scientific advising for the project.

*Idaho National Laboratory* – The Idaho National Laboratory (INL), along with the Department of Energy, is broadly interested in expanding their use of GIS and remote sensing for water security applications, enabling more effective management of water resources by determining landscape-level quantities and movement through a water system. The INL will provide scientific guidance as well as ancillary datasets.

*USDA Agriculture Research Service, Northwest Watershed Research Center* – Our partner at the USDA Agriculture Research Service (ARS) Northwest Watershed Research Center is tasked with monitoring and researching soils in the Reynolds Creek Critical Zone. This collaboration will allow for comparative analysis of satellite-derived data based on available field measurements collected *in situ* by their research team.

*National Scientific and Technical Research Council, (Argentina)* – Dr. Aceñolaza currently has an agronomy Ph.D. student (Gavilan Sebastian Anibal) who is developing a model for site-specific ET indices in Argentinian rangelands. Both parties would benefit from applying these methods to Idaho as another test case, and as a comparison to data obtained through NASA sensors.

***Dissemination by Boundary Organizations*:**

*US Fish and Wildlife Service, Eastern Idaho Field Office* – The USFWS is charged with maintaining partnerships and consulting with other agencies under the Department of the Interior as well as state and private partners. The Eastern Idaho Field Office will be the focal point for providing data and collaborating with various other partners. In addition, they will provide input for water resource management in relationship to endangered and threatened species in the intermountain west.

***Project Communication & Transition Overview***

***In-Term Communication Plan*:** Communication between the DEVELOP team and project partners will occur every two weeks via teleconference or in-person meetings. Weekly updates will be sent summarizing the current state of the project and any pertinent questions. Lines of communication will remain open if issues arise, but these meetings will primarily involve project updates and high-level results. The Center Lead will coordinate an initial project meeting within the first two weeks of the term and will transition this responsibility to the Project Lead. Initial communications will be collaborative, involving all partners to determine key project goals. As the term progresses, the Project Lead will keep partners updated on project progress and relay partner feedback to the team.

***Transition Plan*:** End users will be granted access to the data, technical paper, and project video directly through NASA Large File Transfer or via physical electronic transfer devices. Final imagery will be disseminated electronically following closeout, with a software release occurring, if necessary, via the proper channels.

**Earth Observations Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter** | **Use** |
| **Aqua MODIS** | Evapotranspiration (ET), Normalized Difference Vegetation Index (NDVI) | MOD16 ET products will be used to approximate land surface ET and assist in estimates of water/energy fluxes in the study area. MODIS NDVI will be used for correlation analysis. |
| **Terra MODIS** | ET, NDVI | MOD16 ET products will be used to approximate land surface ET and assist in estimates of water/energy fluxes in the study area. MODIS NDVI will be used for correlation analysis. |

***Ancillary Datasets:***

NASA Modern-Era Retrospective Analysis for Research and Applications Reanalysis Model (MERRA-2) Precipitation inputs – Modeled soil moisture and ET data

USDA ARS CZO/BLM *in situ* soil moisture - Live fuel moisture data and to compared to satellite-derived values

***Modeling:***

Penman-Monteith MOD16 (PM-MOD16) algorithm (POC: Dr. Kenton Ross, LaRC)

NLDAS-2 Mosaic Land Surface Model (POC: Dr. Kenton Ross, DEVELOP National Program Office)

***Software & Scripting:***

TerrSet – Raster manipulation and image processing

Esri ArcGIS – Raster manipulation and analysis, map creation

Google Earth Engine API – Time series data sampling and automation

Python – Scripting and raster analysis

Excel – Statistical analysis

R – Statistical analysis

FORTRAN 90 – Data access and interface support for MOD16

Adobe Creative Suite – Graphic creation and map manipulation

**Decision Support Tool & End Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Products** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| **ET Maps & Correlations –Vegetation/ET** | These will provide partners with information about the timing of peak NDVI with ET data. The maps will provide historical data, showcasing areas and seasonality of yearly concern as a comparison to previously developed soil moisture focused analysis. | NDVI measurements derived from the previous term will be compared with ET (Aqua & Terra MODIS, MERRA-2). | N/A |
| **ET Maps & Correlations – Soil Moisture/ET** | These maps will provide end users with information about soil moisture values and fluxes, and their relationship to ET. | Soil moisture measurements derived from previous term will be compared with ET (Aqua & Terra MODIS, MERRA-2). | N/A |

***End-User Benefit*:** End products created by the team will provide project partners and collaborators with a more holistic view of regional water budgets and transport. These products can impact a variety of land management applications, from targeting wildfire-susceptible areas to tracking vegetation stress and managing water resources. Combined soil moisture and ET data will also allow fire-focused land managers to assess conditions over large spatial scales.

**Project Timeline & Previous Related Work**

***Previous Term:***

2018 Summer (Idaho – Pocatello) – Idaho Water Resources I

***Multi-Term Objectives:***

* **Term 1:** 2018 Summer (Idaho – Pocatello) – Idaho Water Resources I
  + The summer term project focused on satellite-derived soil moisture and precipitation correlated with modeled data. These data were compared with partner-provided *in situ* soil moisture and land cover datasets for the study area, setting the stage for a more comprehensive look at water budgets in the study region during the fall term by incorporating ET.
* **Term 2 (Proposed Term):** 2018 Fall (Idaho – Pocatello) – Idaho Water Resources II
  + This proposed second term project builds off SMAP-derived and modelled data utilized in the previous term to include a more holistic exploration of water balance measurements in the system. This will incorporate MODIS ET products (MOD16) and other ET-focused datasets. Results from both projects will be compared to determine what products and/or tools will provide the most utility to partnering agencies in order to replicate ET analysis as an input for LFM approximations and other applications.

***Related DEVELOP Work:***

2016 Summer (Virginia – LaRC) – Western US Water Resources: Utilizing NASA Earth Observations to Analyze Vegetation Productivity Shifts Relative to Climate Change and Drought in Capitol Reef National Park

2015 Summer (Georgia – Athens) – Costa Rica Water Resources: Utilizing NASA Earth Observations to Develop a Comprehensive Water Budget for the Arenal-Tempisque Irrigation District of Costa Rica

**Notes:**

There is additional interest in investigating the Patagonia steppe in Argentina, a biophysically similar region to southeast Idaho with related land management concerns, for a proposed project in spring 2019. Keith Weber frequently collaborates with Dr. Pablo G. Aceñolaza Preliminary communication with Dr. Aceñolaza began during project planning for spring 2018.