**NASA DEVELOP National Program**

**Fall 2016 Project Proposal**

**BLM at ISU GIS Training and Research Center**

**Southeastern Idaho Water Resources**

Leveraging NASA Earth Observations to Identify Existing Surface Water Features and Improve Water Management and Resource Allocation in East Idaho

**Project Overview**

***Objective:*** Identify surface water sources in east Idaho using satellite earth observations to aid land and water managers with resource allocation challenges.

***Community Concern:*** Idaho has over 95,000 miles of rivers and streams and more than 100 lakes and reservoirs that supply water necessary for anthropic, economic, and ecological sustenance. These riparian areas also support numerous biota that can become candidates for sensitive species monitoring, such as the Idaho sedge (*Carex idahoa*), and wildfire protection. As a result, it is important to know the spatial extents of water sources and to understand their flow dynamics in order to improve management decisions.

***National Application Areas Addressed:*** Water Resources

***Study Location:*** Southeastern Idaho

***Study Period:*** September 2015 to May 2016

***Advisors:*** Keith Weber (GIS Training and Research Center at Idaho State University), Charles Peterson (Idaho State University), Mark Carroll (NASA GSFC)

***Source of Project Idea:*** During a meeting with Karen Kraus and Mike Kuyper, at the Bureau of Land Management, these managers identified a need to identify surface water in a more efficient way to increase monitoring and management capacities.

**Partner Overview**

***Partner Organizations:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| Bureau of Land Management (BLM) | Karen Kraus, Natural Resource Specialist  Michele Mavor, Fire Ecologist | End-User | No |
| Idaho Department of Water Resources (IDWR) | Linda Davis, Senior GIS Analyst  Danielle Bruno-Favreau, GIS Analyst | End-User | No |
| Idaho Department of Fish and Game | Scott Bergen, Principal Wildlife Research Biologist | Collaborator | No |
| NASA RECOVER Science Team | Keith Weber, GIS Director  John Schnase, Senior Computer Scientist  Mark Carroll, SR. Support Scientist | Collaborator | Yes |

***End-User Overview***

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

Currently our end-users agencies (USDI BLM or IDWR) are responsible for the management of surface waterbodies to meet both urban and rural water needs, and to manage resources for flora and fauna habitat. Neither of our end-users use satellite data to identify surface water features, instead they rely on the National Hydrological Database (NHD) to determine areas which require special management practices. For instance, the BLM is required to place a buffer around each river or stream in the NHD before they can spray for weeds even if water no longer exists in these waterways, this increases cost of control products and can allow for continued inhabitation of invasive species. They are also required to claim the water bodies they manage which entails documenting the waterbody location with georeferenced photographic evidence. However, the NHD includes ephemeral water bodies, areas which may hold waters at some time during the year, but which do not support actual riverine habitat, therefore these areas do not require management. The process of confirming perennial or intermediate water bodies is time consumptive and resource intensive. The NHD is outdated and does not accurately represent the needs for project management, instead it draws resources away from project needs and therefore representative data is still needed. In addition to the BLM, the Idaho Department of Water Resources (IDWR) uses the NHD combined with local knowledge and maps to identify water sources. Surface water bodies are important to IDWR because these water sources are often tied to many regulations. IDWR uses this information to decide annual allowances of water usage and diversions. The NHD, although considered a standard resource, includes ephemeral water bodies, features identified as far back as the 1950’s, and originally included any feature that has the potential to store water. The standard use of NDH increases BLM’s resource cost’s and could lead to IDWR making decisions with misrepresented data.

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

Bureau of Land Management - The Pocatello field office has been using GIS software for approximately 10 years. However, their use of satellite remote sensing data is limited and essentially constrained to viewing products produced for their use e.g., fire severity maps for the BLM are typically produced by USGS. Several people from the BLM attended the NASA ARSET “Remote Sensing for Wildfire Applications” workshop on October 6-8, 2015 hosted at ISU’s GIS TReC. This training improved their understanding of satellite remote sensing and their ability to make use of these data in their land management workflows. This, in addition to the close working relationship with DEVELOP will help build their capacity to utilize NASA Earth observations particularly for water identification.

Idaho Department of Water Resources – The IDWR uses METRIC, a satellite-based surface energy balance model derived from Landsat imagery to administer Idaho’s water resources. METRIC estimates evapotranspiration as well as land use/land cover using Landsat imagery. These seasonal maps are then used to resolve water resource conflicts and agricultural water issues. The proposed DEVELOP project will build capacity for IDWR in regards to leveraging Earth observations and provide the most current information specifically regarding surface water sources.

***Collaborator & Boundary Organization Overview***

***Collaborator Support:***

Idaho Department of Fish and Game – This organization will be supporting the project by providing expert knowledge and data on water that will be used for recreation as well as support of riparian plant and animal life.

RECOVER Science Team – Will be used in an advisory role and will provide expert knowledge on techniques to leverage Earth observations to identify surface water features.

***Boundary Organization Dissemination:***

RECOVER Science Team – This is a fire-specific decision support system that automatically brings together, in a single analysis environment, all the information necessary for post-fire rehabilitation decision-making. In response to a fire event, RECOVER uses its rapid resource allocation capabilities to automatically prepare Earth observation data, derived decision products, and historic biophysical data so that, when the fire is contained, Emergency Stabilization and Rehabilitation (ES&R) and Burned Area Emergency Response (BAER) teams will have a complete and ready-to-use browser-based RECOVER dataset and GIS analysis environment that is customized for the target wildfire. RECOVER currently uses national hydrologic data (NHD), wetlands data from USFWS, and watershed boundary polygons from USGC (Watershed Boundaries dataset (WBD)). None of these datasets adequately identify smaller surface water resources that are frequently the location of rare and endangered plants and animals. Once completed, these data layers can be made available to RECOVER end-users and partners through the RECOVER DSS to aid in post-fire planning.

***Project Communication & Transition Overview***

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

Communication between DEVELOPers and project partners will occur roughly every three weeks via teleconference or in-person meetings. Lines of communication will remain open if questions arise but these meetings will primarily involve project updates and high level results. The center lead will be responsible for setting up the first project/participant in-person meeting within the first two weeks of the term, and then the project lead will take over. There will also be bi-weekly project meetings between DEVELOPers and science advisors.

***Transition Approach:***

Our end-users will have access to the data via the ISU GIS TReC Spatial Data Library. A link will be provided to them along with the final draft of the technical paper and VPS. Final images and maps will be handed off during closeout and an e-mail containing the same data will be sent so the end products and data can be used for planning purposes as soon as possible. Currently, software development in not planned nor is there a need for a software release.

**Earth Observations Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter(s)** | **Use** |
| **TRMM/GPM** | HUC 12 level rainfall | TRMM/GPM rainfall climatology to inform the estimation of intermediate and ephemeral streams in the current study period |
| **MERRA** | Precipitation | Inform the estimation of seasonal variation on intermediate and ephemeral streams |
| **Landsat 8 OLI** | Spectral classification | Examine spatial resolution and its capability to classify surface water bodies and land cover |
| **Sentinel-2A** | Spectral indices | SWIR/NIR bands used to identify water |
| **SRTM Version 2** | Identify water bodies | Spectral classification of larger water bodies |

***Ancillary Datasets:***

USGS – National Hydrography Dataset – Identify currently defined surface water. A current copy of these data already exists at the GIS TReC and is in active use as part of the NASA RECOVER DSS.

USGS – Essential Climate Variable (ECV) – Use the ESPA/LSRD algorithm on individual Landsat scenes to derive information about the climate

USGS – National Elevation Dataset (NED) – 10 meter DEM. A current copy of these data already exists at the GIS TReC and is in active use as part of the NASA RECOVER DSS.

USGS – National GAP Analysis Program (GAP)– Land cover classification

Sandia National Laboratory – Energy and Water Data – Provide data on availability, cost, and use of water

USDA National Agriculture Imagery Program (NAIP) - NAIP Digital CIR 2015 – Source for point classification of observable water sources.

SRTM - Water Body Dataset- Use as secondary information for identifying streams

***Software & Scripting:***

Esri ArcGIS– Image analysis and classification

IDRISI TerrSet – Imagery processing, Image analysis

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

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Product** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| Surface Water Map | This product will be used to update the current NHD for the study area. The initial results will help our project partners focus resources in areas known to hold water and thereby eliminating outdated data provided by NHD. The second term will further the analysis by discerning intermediate versus perennial water bodies, and excluding ephemeral water bodies. | The datasets will be compiled and analyzed to provide a comprehensive map of surface water in the study area using Landsat 8. These maps will be analyzed and compared with the most current NHD and BLM’s current knowledge of water body locations | N/A |
| Surface Water Body Identification Comparison Map | This product will allow end-users to determine when Landsat resolutions are appropriate. | This will include an indices for detection of water bodies utilizing Landsat 8 OLI versus Sentinel-2A. | N/A |
| Tutorial | The partner will apply project methodologies to other study areas. | Landsat in conjunction with Sentinel-2A products when methods differ. | N/A |

***End-User Benefit:***

Developing a method that will use Earth observations to identify surface water features will benefit our project partners in a number of ways. The frequency of Earth observations in combination with the results from this project will provide end-users the most up to date information on surface water spatial extents. Having this information will aid end-users in project planning, field assignments, and allocation of resources.

**Project Timeline & Previous Related Work**

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

***Multi-Term Objectives:***

* **Term 1:** Fall 2016 (ID) – Southeastern Idaho Water Resources
  + This term will be used to develop methods to accurately identify current surface water sources while initiating the creation of an end-user tool. However, the identification of surface water bodies is not enough to meet partner needs, since a simple identification method could include ephemeral water bodies while excluding intermediate water bodies. Therefore, this project will continue in the spring 2017 term. Project close out will occur to present first term findings and discuss the second term of this project.
* **Term 2 (Spring 2017):** Spring 2017 (ID) – Southeastern Idaho Water Resources II
  + The second term will use the methods developed in the first term to discern between intermediate and perennial surface water areas, while excluding ephemeral bodies, and enhancing tool development to handle the particular variables needed for discernment. Partner interaction will continue to develop through this term with in-person meetings scheduled as needed to determine the best way to implement and deliver project techniques and methods. The project handoff will take place in person after a closeout event at ISU GIS TReC.

***Related DEVELOP Work:***

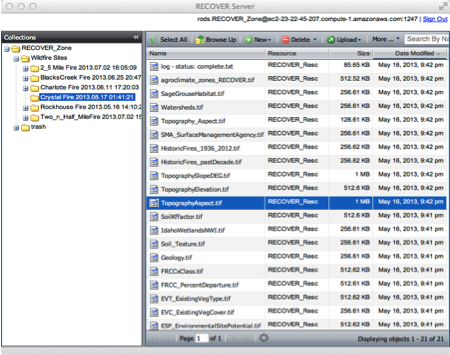
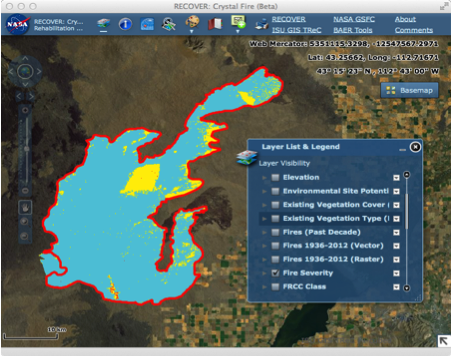
**Notes & References:**

***Notes:*** RECOVER is a site-specific decision support system that automatically brings together in a single analysis environment all the information necessary for post-fire rehabilitation decision-making. In response to a fire detection event, RECOVER uses the rapid resource allocation capabilities of cloud computing to automatically collect Earth observational data, derived decision products, and historic biophysical data so that when the fire is contained, Burned Area Emergency Response (BAER) teams will have a complete and ready-to-use RECOVER dataset and GIS analysis environment that is customized for the target wildfire.

The RECOVER system was originally developed for use in savannah ecosystems and focused on the post-wildfire decision processes of the BAER teams. During RECOVER's evaluation phase, our agency partners recommended that the capabilities of the recovery system be extended to (1) enable RECOVER's use in forested ecosystems and (2) enable RECOVER's use in pre- and active-fire decision processes.

The RECOVER DSS is made up of a RECOVER Server and a RECOVER Client (Fig. 1). The RECOVER Server is a specialized server deployed at ISU’s GIS TReC and in the Amazon Elastic Compute Cloud. The RECOVER Client is a full-featured Adobe Flex Web Map GIS analysis environment. When provided a wildfire name and geospatial extent, the RECOVER Server aggregates site-specific data from pre-designated, geographically distributed data archives. It then does the necessary transformations and re-projections required for the data to be used by the RECOVER Client. It exposes the tailored collection of site-specific data to the RECOVER Client through web services residing on the Server.

Figure 1. RECOVER Server and Client interfaces. For YouTube demonstrations, please see:  
 <http://www.youtube.com/watch?v=LQKi3Ac7yNU> RECOVER Server  
 <http://www.youtube.com/watch?v=SGhPpiSYpVE> RECOVER Client



In a typical scenario-of-use, RECOVER uses the rapid resource allocation capabilities to automatically gather various Earth observation and ancillary data products. Additional data can be added manually if needed, and the entire data collection is refreshed throughout the burn so that when the fire is contained, BAER teams have at hand a complete and ready-to-use RECOVER dataset that is customized for the target wildfire. The RECOVER server continues to gather data after the fire to support long-term monitoring of ecosystem recovery.

Our extensive use of web services allows RECOVER’s site-specific data to be consumed by state-of-the-art web-based GIS applications, such as the RECOVER’s Adobe Flex Client. This makes it possible for our agency partners to avail themselves of RECOVER’s analytic capabilities on any computer running a web browser, without having to acquire and maintain standalone GIS software. In addition, RECOVER’s web services architecture facilitates the future development of client applications that run on mobile devices. Most modern smart phones, tablets, etc. actually consist of just the display and user interface components of sophisticated applications that run in cloud data centers. This is the mode of work that RECOVER is intended to eventually accommodate.