Utah Water Resources
Utilizing Landsat to Detect Ephemeral Water Sources in Support of a USGS Feasibility Assessment and Management Strategy of Equids

VPS Title: Desert Riches
Mapping Ephemeral Surface Water: the Desert's most Precious Resource

Project Team

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Project Overview

Project Synopsis: This project utilized NASA and ESA Earth observations to locate perennial and ephemeral surface water within the Sinbad Herd Management Area (HMA) in central Utah. This region provides rangeland for wild burros, so understanding habitat selection in the area will aid burro conservation efforts. Working with United States Geological Survey (USGS), the team combined pre-existing data of water occurrence with Earth observations to map ecologically-relevant water sources across seasons. These maps and methodologies will aid researchers in developing habitat selection models for burros (*Equus asinus*) within the Sinbad HMA as well as for wild horses (SSP) across other HMA.

Abstract: Since 1971, federal agencies have been tasked with managing burros in federally-designated herd management areas (HMAs). Because these areas are often large and remote, obtaining sufficient data on horse and burro populations and habitat preference can be difficult and expensive. In recent years, the United States Geological Survey (USGS) has partnered with the Bureau of Land Management (BLM) to study the population dynamics and habitat preferences of wild horse and burro populations on the Sinbad HMA in central Utah. Researchers at the USGS and BLM hypothesize that surface water is potentially an important factor in wild horse and burro habitat selection, thus these agencies are interested in determining how water availability affects species' movement in both time and space. NASA DEVELOP leveraged NASA Earth observations and pre-existing water availability data to determine the spatial and temporal distribution of water on the landscape. Maps were developed to help researchers create habitat selection models for wild horses and burros on the Sinbad HMA and elsewhere.

Keywords: Google Earth Engine, surface water, random forest classification model, burro, Landsat, SRTM, Sentinel-1 C-SAR

National Application Area Addressed: Water Resources
Study Location: UT
Study Period: March 2013 – November 2017

Community Concern:

- The BLM and USGS support healthy populations of free-roaming burros on the rangelands across the west as a part of a multiple-use mission.
- The Sinbad HMA is home to over 100 burros.
- Water in semi-arid regions is a critically limiting factor for burro distribution, and information regarding water resources for equids in these ecosystems is limited.
- Information regarding the locations of ephemeral water sources is needed for the BLM and USGS to enact informed and effective management decisions.

Project Objectives:

- Test the feasibility of using NASA Earth observations to detect surface water at small scales
- Determine the seasonality of available surface water
- Up-scale the methods by creating a toolset and tutorial for use in other regions and by other organizations

Partner Overview

Partner Organizations:

Organization	POC (Name, Position/Title)	Partner Type	Boundary Org?
USGS, Fort Collins Science Center, Ecosystem Dynamics Branch	Dr. Kate Schoenecker, Ecologist	End User	Yes
Bureau of Land Management, Utah State Office	Gus Warr, Program Manager	Collaborator	Yes

Decision Making Practices & Policies:

In accordance with the Wild Free-Roaming Horse and Burro Act of 1971, the BLM is responsible for managing populations of free-roaming burros on public lands. The agency has partnered with the USGS to study habitat selection of burros on the Sinbad HMA. Currently, the USGS utilizes both radio telemetry and field observation data to monitor the movement and habitat use of focal species as a means to more accurately assess herd counts in designated HMAs. Water availability is assessed through sporadic field surveys. These surveys are limited in scope and are insufficient to develop reliable habitat selection models. Remote sensing techniques and NASA Earth observations are currently not utilized.

Project Benefit to End User:

This project will save the USGS and BLM time and money by further refining monitoring and field survey efforts. Specifically, accurate assessments of available surface water will enable the USGS to create better models of burro habitat selection. The project also enabled analysis across larger scales and new study sites that would not be possible without full utilization of NASA Earth observations. End products will be integrated in the USGS and BLM decision-making and management processes to more effectively manage herd populations in semiarid ecosystems.

Earth Observations & End Products Overview

Earth Observations:

Platform & Sensor	Parameters	Use
Landsat 8 OLI	Surface reflectance, normalized difference vegetation index,	This dataset provides the temporal (16 days) and spatial (30 m) resolution needed for mapping water available to equids.

	normalized difference moisture index, tasseled cap brightness, greenness, and wetness	
Sentinel-1 C-SAR	4 C-band radar polarization levels, water surface, and topography roughness	This dataset provides medium to high temporal (6 days) and spatial resolution (5 m) imagery in all weather conditions.
SRTM	Elevation, slope, aspect, and compound topographic index	This dataset was used to derive topographic indices used as predictors representing important characteristics of hydrologic networks and water collection depressions.

Ancillary Datasets:
USGS and BLM Equid Field Measurements – Species habitat usage
USDA National Agriculture Imagery Program (NAIP) – High-resolution aerial imagery for identification of surface water features

Modeling:
Random Forests (POC: Dr. Catherine Jarnevich, USGS Fort Collins Science Center) – Classification algorithm used to select variables to be used as model inputs

Software & Scripting:
Google Earth Engine API – Large scale image analysis
Esri ArcGIS – Image processing, end product generation
R – Statistical analyses, raster processing

End Products:

End Product	Earth Observations Used	Partner Benefit & Use	Software Release Category
Water Detection Map	Landsat 8 OLI, SRTM, Sentinel-1 C-SAR	This product utilizes Google Earth Engine and random forest modeling techniques to integrate NASA Earth observations, remote sensing data, and partner collected herd field data. These data will be employed to detect water in Utah herd management areas.	N/A
Modeling Tutorial	Landsat 8 OLI, SRTM, Sentinel-1 C-SAR	The tutorial covers data processing, fitting statistical models to the data, and interpretation as well as mapping of model output. The tutorial will enable end users to replicate this study in future years and for additional study locations.	N/A

Project Handoff Package

Transition Plan:
Project materials and final products will be handed off to the USGS and BLM during the final week of the term. The team will host a seminar at the National Resource and Ecology Lab to disseminate project results to the Geospatial centroid at CSU. A short training workshop on the use of the data and tutorial will follow the seminar.

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Handoff Package:
- Final project deliverables
- Water Detection Map
- Modeling Tutorial
- Seminar to communicate project results
- Training workshop on use of data and tutorial
- Shapefiles and raw data associated with the end products

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