**NASA DEVELOP National Program**

**2018 Spring Project Proposal**

**California – JPL**

**Black Rock Playa Urban Development**

*A Multi-Sensor Approach to Determine the Impacts of Human Activity and Natural Surface Deformation on the Black Rock Playa*

**Project Overview**

***Project Synopsis*:** The Black Rock Playa has seen the formation of unnatural dune formations in the past decade. This project aims to utilize both Earth observations, such as Landsat 8 OLI, and several Synthetic Aperture Radar (SAR) platforms to observe whether the dune formations are caused by human activity, natural processes, or drought. There is concern that the dunes may be caused by the Burning Man events and project partners at the Bureau of Land Management (BLM) need to submit an Environmental Impact Statement (EIS) to assess the event’s impact. The resulting surface deformation maps from SAR and optical imagery will be used by the partners by referencing the results in their National Environmental Policy documents to decide whether recreational events, such as Burning Man, should be permitted in the area. The end products will also provide inputs into whether the Burning Man events meet their “leave no trace” policy.

***Community Concern:*** The Black Rock Playa is one of the main natural features in the Black Rock-High Emigrant Trails National Conservation Area. The playa, which is a salt flat when not flooded by rain/melting snows, has seen the formation of dunes and pits over the last decade. This limits activities such as high speed racing and land surfing. Debate exists amongst the public as to the cause; it is uncertain whether the changes are due to people driving across it, the annual Burning Man event that is held on the playa, drought and other natural processes, or all the above. Associated with the formation of dunes is fine dust in the 2.5 and 10 micron range which results in air quality concerns. Burning Man is requesting permission to raise the population at the festival to 100,000 people, but there is a concern that a larger population will cause more landscape changes and reduce air quality.

***Source of Project Idea:*** This project was requested by the Black Rock Field Office, Winnemucca District, Bureau of Land Management. Dr. Mark Hall from BLM met with Natasha Stavros from NASA Jet Propulsion Laboratory at a conference and exchanged ideas about using SAR to determine dune formations and playa disturbance.

***National Application Area Addressed:*** Urban Development

***Study Location:*** Black Rock Desert – High Rock Canyon Emigrant Trails National Conservation Area, NV

***Study Period:*** January 1997 – December 2017

***Advisors:*** Bruce Chapman (NASA Jet Propulsion Laboratory, California Institute of Technology), Tom Farr (NASA Jet Propulsion Laboratory, California Institute of Technology)

**Partner Overview**

***Partner Organization:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| **Bureau of Land Management, Winnemucca District, Black Rock Field Office** | Dr. Mark E. Hall, Field Manager; Zwaantje Rorex, GIS Specialist; Duane Bayes, Geologist | End User | No |

***End-User Overview***

***End User’s Current Decision-Making Process:***All decisions concerning land use on BLM lands require compliance with the National Environmental Policy Act (NEPA). In many cases a Categorical Exclusion (CX), Environmental Assessment (EA), or Environmental Impact Statement (EIS) is written to inform the public of the impacts to the human environment and to aid the authorized officer in the decision-making process. Remote sensing may be used as part of a baseline study for the document. Many EAs and EISs utilize Landsat or Google Earth imagery. The Burning Man organization is requesting permission to increase the population at the event, so an EIS is needed to assess its impact and decide whether an event should be permitted on the playa.

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

*Department of Interior, Bureau of Land Management, Winnemucca District, Black Rock Field Office –* The BLM’s National Operations Center has a remote sensing division, but most of the work is focused on using conventional optical satellite platforms to help map sage grouse habitat. The end user, Dr. Mark Hall, is familiar with remote sensing and recently had talks and poster presentations at the AGU meeting on using new generation satellite imagery for land management decisions. Dr. Mark Hall has also done preliminary work with SAR imagery from ESA and JAXA. This project will create a replicable methodology that will build BLM’s capacity to assess landscape changes using SAR and NASA Earth observations.

***Project Communication & Transition Overview***

***In-Term Communication Plan*:** The team will talk to the partners throughout the term on a weekly or biweekly basis based on the time-availability of the partners and the progress of project. Results will be shared via email or telecon. The main POCs will be Dr. Mark Hall and the project lead.

***Transition Plan*:** The team will provide Dr. Mark Hall with a technical report and land change maps of the study area. Optional deliverables, such as a tutorial or a brochure, are planned as a hand-off document, so the end user can replicate the SAR and optical analysis for future use. The technical report will be used as a baseline study for future proposals by the BLM and software release is not planned at this time.

**Earth Observations Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameters** | **Use** |
| **ALOS-PALSAR** | Surface roughness | ALOS-PALSAR provides surface roughness and will be used to document changes in the land surface from 2006-2011. |
| **ERS-2** | Surface roughness | ERS-2 will be used to document changes in the land surface from 1995-2011. |
| **RADARSAT-1** | Surface roughness | RADARSAT-1 will be used to document changes in the land surface from 1997-2008. |
| **JERS-1** | Surface roughness | JERS-1 will be used to document changes in the land surface for 1997-1998. |
| **Sentinel-1 C-SAR** | Surface roughness | Sentinel-1 images provide texture and surface roughness and will be used to document changes from 2011-present. |
| **Sentinel-2 MSI** | Surface reflectance | Sentinel-2 will complement the Landsat sensors and will be used for feature detection. Image enhancement techniques will be developed and fine-tuned to delineate sand dunes. |
| **Landsat 5 TM** | Surface reflectance | Landsat 5 TM is a 30m dataset that will be used to delineate dune features from 1997-2011. |
| **Landsat 8 OLI** | Surface reflectance, panchromatic sharpening | Landsat 8 OLI is a 30 m dataset that will be used to delineate dune features from 2013-present. Image enhancement techniques will be developed and fine-tuned to delineate sand dunes. |
| **Terra ASTER** | Surface reflectance | ASTER will complement the Landsat sensors and fill in the gap between 2011-2013 for dune mapping. |

***Ancillary Datasets:***

Bureau of Land Management Geology and Soils Dataset – This dataset will be used to look at the soil types and the geology of the study area.

Bureau of Land Management Soil Moisture Dataset – This dataset will be used to look at the soil moisture conditions in the study area.

***Software & Scripting:***

Esri ArcGIS – create quality maps for presentations and reports

ESA PolSARpro – preprocess SAR data, run classifications, and analyze polarimetric signatures

Python – batch process multispectral imagery

Exelis ENVI - raster manipulation and analysis, image enhancement, image classifications

ESA Sentinel Application Platform (SNAP) – preprocess Sentinel-1 and Sentinel-2 raster imagery

**Decision Support Tool & End Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Products** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| **Historic Map of Playa Land Change and Use** | The time series of the Black Rock Playa will provide the BLM with information about the changes in the Black Rock Desert, particularly in the Burning Man closure area. The maps would be used to supplement their EIS report. | ALOS-PALSAR, RADARSAT-1, ERS-2, JERS-1, Sentinel-1, Landsat 5, Landsat 8, ASTER, and Sentinel-2 will be used to map dune formations and other disturbances and will be used to analyze trends in its recurrence to see if it is caused by recreational activities. | N/A |
| **Flooding Events Time Series and Analysis** | Maps of flood occurrence will provide partners with information about surface feature morphology. Results will determine whether flooding plays a role in erasing Burning Man’s footprint or if prolonged drought causes the dunes. Results will be mentioned in the EIS. | SAR and optical data will be used to determine the correlation between flood and drought conditions on surface deformation. The footprints from Burning Man will be analyzed if it still remains after a flooding event. | I |

***End-User Benefit*:** The end products will provide additional insight to partners at the BLM in determining the source of the dunes. The BLM needs data to assess whether the Burning Man event and its growing population are the cause of the unnatural dunes and dust creation. The end products will be an additional resource that BLM will use to determine if a population increase in the area can be permitted. Given the spatial area and temporal scale, remote sensing is the only way to address deformation of the playa from human use.

**Project Timeline & Previous Related Work**

***Project Timeline:*** 1 Term: 2018 Spring

***Related DEVELOP Work:***

2013 Summer (JPL) – California-Mississippi Disasters: Utilizing Airborne SAR Sensors to Assess Aqueduct, Levee and Road Conditions After Earthquake and Flood Events

2015 Spring (JPL) – Global Disasters: Utilizing the Power of Remote Sensing and Crowdsourcing for Natural Disaster Damage Assessment and Response

**Notes & References:**

***References:***

Bodart, C., Gassani, J., Salmon, M., & Ozer, A. (2009). Contribution of SAR interferometry (from ERS1/2) in the study of aeolian transport processes: The cases of Niger, Mauritania and Morocco. In A. Marini & M. Talbi (Eds.), *Desertification and Risk Analysis Using High and Medium Resolution Satellite Data* (129-136). Dordrecht: Springer.

Bodart, C., Dominique, D., & Andre O. (2007). Detection and monitoring of sand dune mobility in southeast Niger using multi-temporal coherence images. *Poster presentation at Fringe 200.* Retrieved from http://earth.esa.int/fringe07/participants/610/pres\_610.pdf

Dakir, D., Rhinane, H., Saddiqi, O., El Arabi, E., & Baidder, L. (2016). Automatic extraction of dunes from Google Earth images: New approach to study the dunes migration in the Laayoune City of Morocco. *International Archives of the Photogrammetry, Remote Sensing & Spatial Information Sciences*, *42*.

Marticorena, B., Kardous, M., Bergametti, G., Callot, Y., Chazette, P., Khatteli, H., ... & Zribi, M. (2006). Surface and aerodynamic roughness in arid and semiarid areas and their relation to radar backscatter coefficient. *Journal of Geophysical Research: Earth Surface*, *111*(F3).

Paisley, E. C., Lancaster, N., Gaddis, L. R., & Greeley, R. (1991). Discrimination of active and inactive sand from remote sensing: Kelso Dunes, Mojave Desert, California. *Remote Sensing of Environment*, *37*(3), 153-166.

Tollerud, H. J., & Fantle, M. S. (2014). The temporal variability of centimeter-scale surface roughness in a playa dust source: Synthetic aperture radar investigation of playa surface dynamics. *Remote Sensing of Environment*, *154*, 285-297.