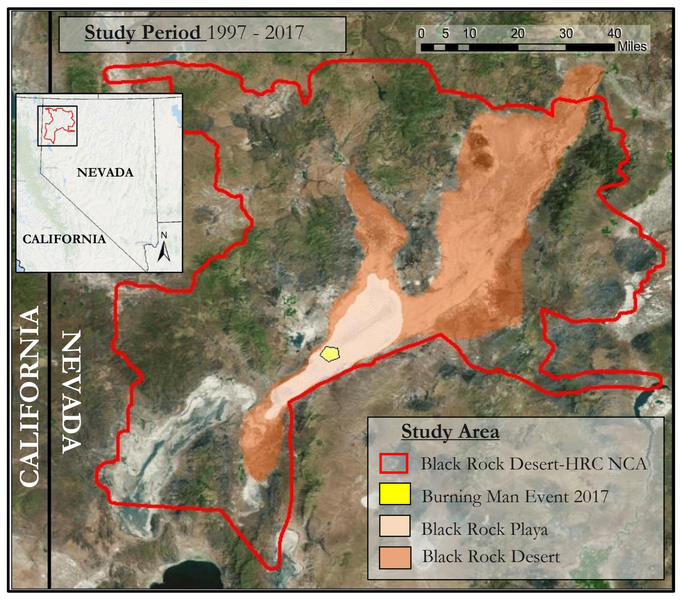
A Multi-Sensor Approach to Determine the Impacts of Human Activity and Natural Surface Deformation on the Black Rock Playa, Nevada

Study Area

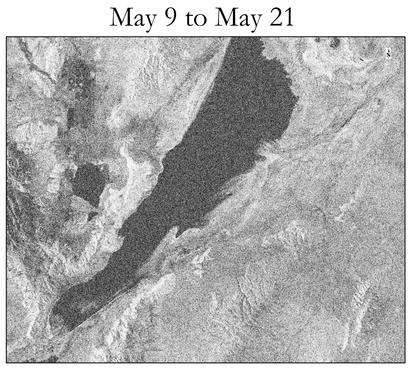


Objectives

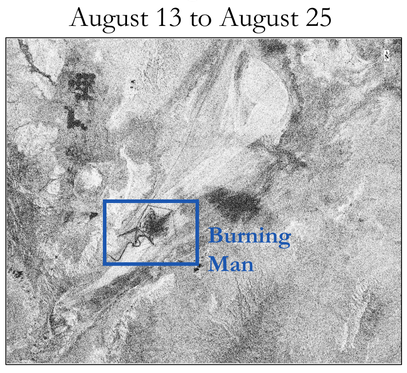
- **Generate** surface deformation maps of Black Rock Playa from optical SAR imagery
- **Analyze** the relationship between temporal changes in mound formation and recreational activities, drought conditions, flooding events, and other weather patterns
- **Assess** the respective influence of anthropogenic activity, drought, and natural processes on playa surface deformation

Results

Change from May 9 to May 21

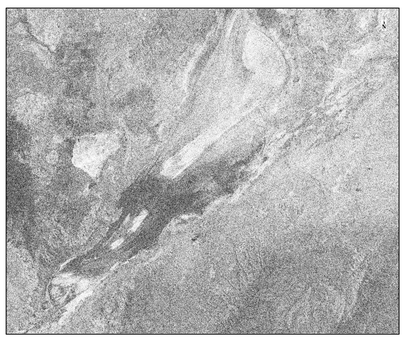


Change from August 13 to August 25



Change from September 6 to September 18

Change from November 17 to November 29



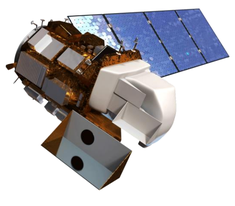
Coregistered and processed Sentinel-1 C-SAR image pairs showing surface deformation throughout 2017. Darker areas reflect pixels with high decorrelation (low correlation) and indicate regions experiencing significant surface disturbance between the associated image acquisition dates.

Abstract

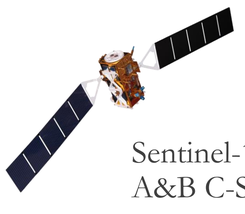
Since the early 2000s, wind-deposited sediment mounds have been growing and encroaching onto the Black Rock Playa of the Black Rock Desert-High Rock Canyon Emigrant Trails National Conservation Area. These sedimentary structures along the edge of the playa alter the natural landscape, limit recreational activities such as land sailing and high-speed racing, and potentially indicate increased dust emission. Possible sources of increased sediment input for the mounds are drought, natural processes, or anthropogenic activity. Some members of the community believe that Burning Man, a festival hosted annually on the playa, may be the primary culprit. With Burning Man's recent request to increase its population capacity, the Bureau of Land Management (BLM) must evaluate the event's environmental impact through submission of an Environmental Impact Statement. To better understand contributing factors to mound growth and migration, the DEVELOP team assessed landscape changes from 1997 to 2017. Surface deformation maps were generated from Synthetic Aperture Radar (SAR) Earth observations from Sentinel-1, in conjunction with optical Earth observations from Landsat 5 Thematic Mapper (TM), Landsat 8 Operational Land Manager (OLI), and the National Agriculture Imagery Program. Historic weather data from Black Rock Playa and nearby weather stations were used to place surface geomorphology observations in the context of typical drought years, flooding events, and wind patterns. Results will help constrain the mechanism behind mound growth and migration and will assist BLM's Winnemucca District, Black Rock Field Office in determining if recreational activities should continue to be permitted on the playa.

Earth Observations

Landsat 5 TM

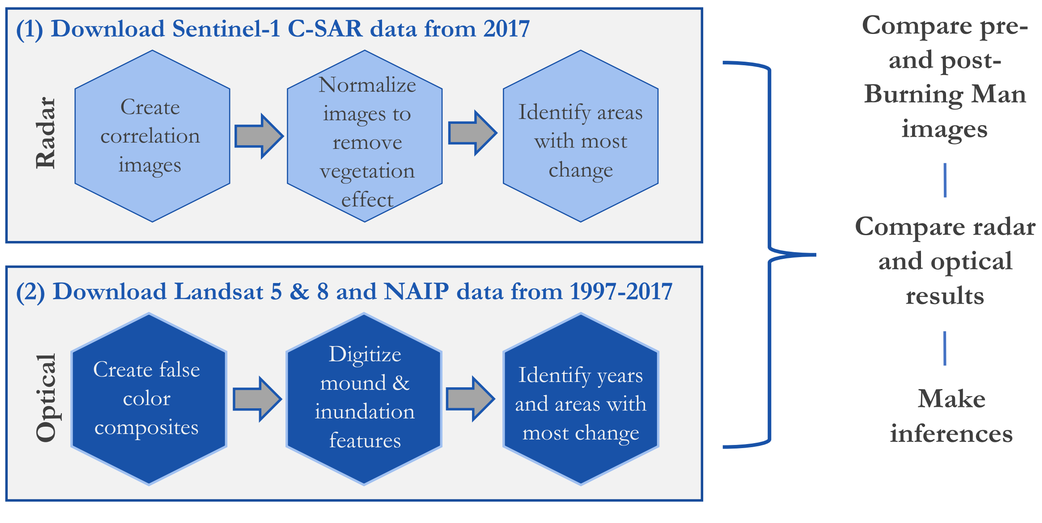


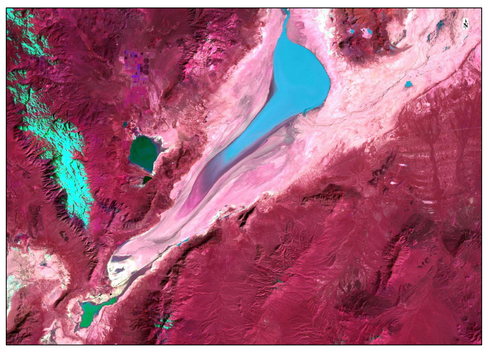
Landsat 8 OLI



Sentinel-1 A&B C-SAR

Methodology





Landsat 5 false color composite highlighting flooded areas in the Black Rock Playa.

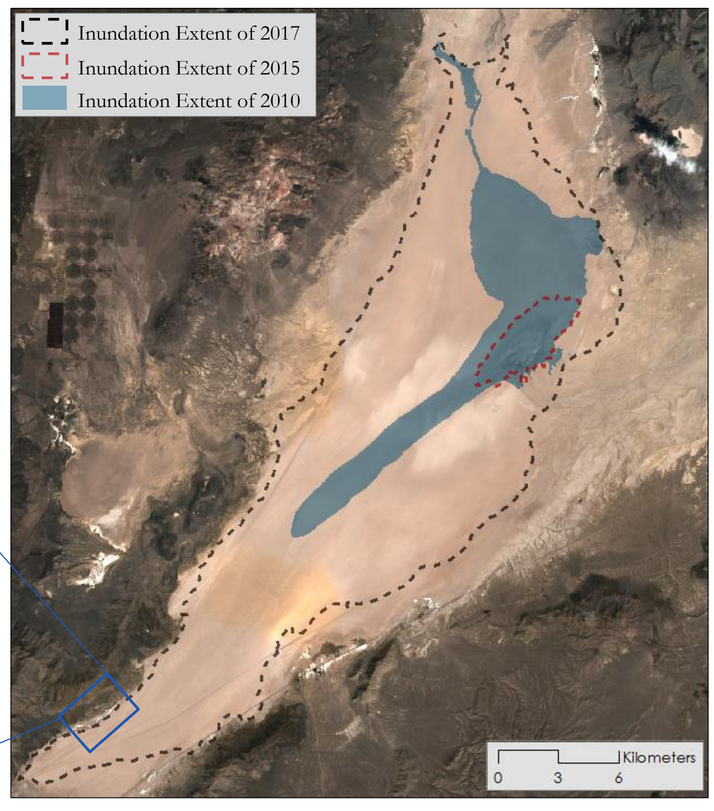


Image showing maximum inundation extent for years 2010, 2015, and 2017. These inundation polygons represent the region of the playa whose surface soil experienced wetting and drying in a given year, resulting in a smooth, durable, protective crust. Rectangular cutout highlights a dense region of mounds along the edge of the playa. The brown line indicates the unchanging extent of mound encroachment that persisted from 2006 to 2017 in NAIP imagery.

Conclusions

- Morphology and presence of vegetation suggests that the unnatural "dunes" are actually vegetation mounds.
- The extent of annual inundation could potentially be responsible for mitigating mound encroachment.
- SAR data visualizes and confirms surface deformation resulting from Burning Man, other recreational activities, and natural processes such as dust storms, flooding, and precipitation.
- Direct correlation between mound growth and a possible cause could not be found.
- No observable mound boundary encroachment in the NAIP imagery between 2006 and 2017.
- SAR and optical processing used in this study provides the BLM with a sound methodology for assessing surface deformation on the playa from various activities and natural events.

Project Partner

Black Rock Field Office, Winnemucca District

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Team Members

Neda Kasraee
Project Lead

Dara Laczniak

Marcella Rose

Nick Rousseau

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