**NASA DEVELOP National Program**

**2024 Spring Project Proposal**

**Maryland – Goddard**

**Coronado Disasters**

*Monitoring Geohazards and Slope Failure Along Newly Constructed Border Fence Roads in Coronado National Memorial*

**Project Overview**

***Project Synopsis*:** The Coronado National Memorial (CORO) in Hereford, AZ is located on the United States southern border and contains newly constructed and currently unfinished border fencing and roads. CORO is concerned with prioritizing mitigation of damage to border fencing and roads due to geohazards such as rock falls as well as restoration of those already damaged. This project will use Landsat 8 OLI and Landsat 9 OLI-2 to perform change detection analysis focusing on before and after border fence and road construction. The team will determine if these methods are feasible or if higher resolution remote sensing data such as Maxar imagery will be necessary. Using the Landsat imagery along with ancillary data provided by NPS, the team will use the Random Forest method to model the susceptibility of slope failure near the newly constructed fences and roads. This analysis will provide funding justification and assist NPS with prioritization of susceptible areas on which to focus mitigation efforts.

***Study Location:*** Coronado National Memorial, Hereford AZ

***Study Period:*** January2019 – December 2023

***Advisors:*** Sean McCartney, (NASA Goddard Space Flight Center, SSAI), sean.mccartney@nasa.gov, Thomas Stanley, (NASA Goddard Space Flight Center, University of Maryland, Baltimore), thomas.a.stanley@nasa.gov

**Partner Overview**

***Partner Organization:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **Contact (Name, Position/Title)** | **Partner Type** | **Sector** |
| **National Park Service, Coronado National Memorial** | Jessica Garcia, Physical Scientist | End User | Federal Government |

***End User Overview***

***End User’s Current Decision-Making Process & Capacity to use Earth Observations:***The Coronado National Memorial is governed by the Southeast Arizona Group of the NPS and was established to commemorate the first organized expedition to the Southwestern region, along the Mexico-United States border. Due to the location of the monument, border fencing and roads have been in ongoing construction since 2019 but geohazards are impacting this new construction. The NPS is not currently taking action against this damage, but should the responsibility of these efforts fall on the NPS, this project would assist in decision-making and prioritization as well as justifying federal funding. The end users currently use remotely sensed data such as LiDAR but are not utilizing NASA Earth observations to make decisions regarding border fencing and roads.

**Earth Observations Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter(s)** | **Use** |
| **Landsat 8 OLI** | Surface reflectance | Surface reflectance will be used to generate true color images of the landscape and create change detection maps showing the location of newly constructed border roads and fencing. |
| **Landsat 9 OLI-2** | Surface reflectance | Surface reflectance will be used to generate true color images of the landscape and create change detection maps showing the location of newly constructed border roads and fencing. |
| **SRTM** | Elevation, slope, and aspect | Characteristics of the landscape will be visualized using elevation, slope, and aspect.  |
| **Maxar** | Land surface reflectance | High resolution land surface reflectance products will be used for identifying newly constructed border roads and fencing within the study region.  |

***Ancillary Datasets:***

* National Agriculture Imagery Program (NAIP) –Identify newly constructed border fencing and roads within the study region.
* Global Precipitation Measurement (GPM) Integrated Multi-satellitE Retrievals for GPM (IMERG) – Assess areas more prone to slope failure
* Soil Moisture Active Passive (SMAP) – Assess areas with varying degrees of soil moisture
* Sentinel -1 SAR backscatter products – Determine surface roughness and the projected local incidence angle (PLIA) to be used to get information about the imaged surface

**Decision Support Tool & End Product Overview**

***End Products:***

|  |  |  |
| --- | --- | --- |
| **End Product** | **Partner Use** | **Datasets & Analyses** |
| **Change Detection Maps** | Change Detection Maps will show the NPS areas of newly constructed border fencing and roads and will be used to determine where to focus damage mitigation efforts starting in 2013 before construction of the border fencing to present.  | Landsat 8 OLI, Landsat 9 OLI-2, NAIP, and Maxar data will be used to do change detection analysis. Esri ArcGIS Pro will be used for completing the Change Detection Maps. |
| **Slope Failure Susceptibility Maps** | Maps of Slope Failure Susceptibility will allow the NPS to prioritize mitigation efforts based on areas that are most susceptible to slope failure. | Landsat 8 OLI, Landsat 9 OLI-2, NAIP, Maxar, LiDAR, SRTM, and 1-meter DEMs will be used to create relevant datasets (road and fence locations, elevation, slope, and previous slope failure points) for the Random Forest Model that will determine the Slope Failure Susceptibility. ArcGIS Pro will be used for creating susceptibility maps. |
| **Slope Failure Prioritization Model** | A model of Slope Failure Prioritization will allow the NPS to prioritize mitigation efforts based on areas that are most susceptible to damage from slope failure. | Landsat 8 OLI, Landsat 9 OLI-2, NAIP, Maxar, LiDAR, SRTM, and 1-meter DEMs will be used to create relevant datasets (road and fence locations, elevation, slope, and previous slope failure points) for the Random Forest Model that will determine the Slope Failure Susceptibility. ArcGIS Pro will be used for creating prioritization maps based on the susceptibility analysis. |

**Project Timeline & Previous Related Work**

***Project Timeline:*** 1 Term: Spring 2024

***Similar Past DEVELOP Projects***:

* 2019 Summer (LaRC) – Dominican Republic Disasters:

<https://develop.larc.nasa.gov/2019/summer/DominicanRepublicDisasters.html>

* 2023 Spring (GA) - Coronado Ecological Conservation:

<https://ntrs.nasa.gov/api/citations/20230003685/downloads/2023Spring_GA_CoronadoEco_Presentation_FD-finalv3.pptx.pdf>

* 2021 Summer (MA) – Cincinnati & Covington II:

https://develop.larc.nasa.gov/2015/summer/EastAfricaDisasters.html<https://develop.larc.nasa.gov/2021/summer/CincinnatiCovingtonUrbanDevII.html>

* 2015 Summer (MSFC) – East Africa Disasters: https://develop.larc.nasa.gov/2015/summer/EastAfricaDisasters.html

<https://ui.adsabs.harvard.edu/abs/2015AGUFMNH43D..07S/abstract>

* 2015 Spring (GSFC) – Himalaya Disasters:

**Notes & References:**

***Notes:***The NASA Landslide Hazard Assessment for Situational Awareness (LHASA) Model may serve as point of reference for this project – especially the Landslide Susceptibility Map section as this is related to the Slope Failure Susceptibility Map end product. Also, work done by researchers at Goddard concerning global landslide susceptibility may serve as a point of reference during the analysis, especially since Dr. Thomas Stanley will be serving as a science advisor on this project.

* [gpm.nasa.gov/landslides/projects.html](https://gpm.nasa.gov/landslides/projects.html)
* <https://earthobservatory.nasa.gov/images/89937/a-global-view-of-landslide-susceptibility>

***References:***

Emberson, R., Kirschbaum, D. & Stanley, T. (2020). New global characterisation of landslide exposure. *Natural Hazards and Earth System Sciences, 20* (12), 3413-3424. doi:10.5194/nhess-20-3413-2020

Li, W., Zhan, W., Lu, H., Xu, Q., Pei, X., Wang, D., Huang, R., & Ge, D. (2022). Precursors to large rockslides visible on optical remote-sensing images and their implications for landslide early detection. *Landslides, 20*(1), 1–12. <https://doi.org/10.1007/s10346-022-01960-1>

Stanley, T., & Kirschbaum, D. B. (2017). A heuristic approach to global landslide susceptibility mapping. *Natural Hazards, 87*(1), 145-164. doi:10.1007/s11069-017-2757-y