**NASA DEVELOP National Program**

**2024 Spring Project Proposal**

**Pop-up Project – University of Virginia**

**California Disasters**

*Incorporating Satellite-Derived Precipitation and Soil Moisture Products into Flood Preparedness and Emergency Management in California*

**Project Overview**

***Project Synopsis*:** California saw major storms and rainfall caused by multiple atmospheric rivers in late 2022 through early 2023. These storms caused major flooding with 22 lives lost and 4.6 billion in property damage. This project will partner with the CA Department of Water Resources to assess the utility of satellite data for monitoring precipitation and soil moisture to fill in data gaps for improved risk assessments in Northern California, using the 2022-2023 winter storms and flooding events in Merced and Monterey counties as a use case for the potential utility of these data to inform flooding preparedness and emergency management efforts.

***Study Location:*** Merced and Monterey counties, CA

***Study Period:*** January 2019 – January 2024

***Advisor:*** Dr. Venkat Lakshmi (University of Virginia) [vlakshmi@virginia.edu](mailto:vlakshmi@virginia.edu)

**Partner Overview**

***Partner Organization(s):***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **Contact (Name, Position/Title)** | **Partner Type** | **Sector** |
| **California Department of Water Resources** | Dr. Mike Anderson, California State Climatologist; Dr. MD Haque, Senior Engineer & Supervising Engineer/Manager Risk Assessment and Mapping Program | End User | State |

***End User Overview***

***End User’s Current Decision-Making Process & Capacity to use Earth Observations:***The CA DWR is interested in improving their risk assessments for water on the ground. They utilize US Army Corps of Engineers models for basin-scale in some areas with some areas having no data. They have explored the use of some Sentinel data but due to temporal limitations have not implemented that widely. Satellite precipitation and soil moisture measurements are of interest as not all areas have in situ data or specialized models. The CA DWR team is interested in tutorials that help them to assess the utility of satellite data for their risk assessments and incorporation in future modeling.

**Earth Observations Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter(s)** | **Use** |
| **GPM IMERG** | Precipitation | GPM data will be used to measure rainfall and explore as a possible data gap filler in areas with no rain gauges. |
| **SMAP** | Soil moisture | In combination with Landsat moisture indices and GPM IMERG precipitation data, and SMAP and ECOSTRESS surface soil moisture will characterize conditions associated with flooding. |
| **ECOSTRESS** | Soil moisture | In combination with SMAP, Landsat moisture indices and GPM IMERG precipitation data, SMAP surface soil moisture will characterize conditions associated with flooding |
| **Landsat 8 OLI** | Spectral vegetation and moisture | Landsat imagery will be used to calculate vegetation and moisture index anomalies to characterize flood risk. |
| **Landsat 9 OLI-2** | Spectral vegetation and moisture | Landsat imagery will be used to calculate vegetation and moisture index anomalies to characterize flood risk. |
| **Sentinel-2 MSI** | Spectral vegetation and moisture | Sentinel optical imagery will be used to calculate vegetation and moisture index anomalies to characterize flood risk. |
| **Sentinel-1 C-SAR** | Synthetic aperture radar | SAR data will be used to identify and map flooding extent. |

***Ancillary Datasets:***

* OpenET – Evapotranspiration data from 2016-2022 will be used to quantify evapotranspiration, compute climatologies, and input into the hydroperiod trend analysis.
* USGS Watershed Boundary Dataset (WBD) – regional watershed boundary data for watershed creation and calculating regional rainfall
* US Census Bureau 2020 Census Demographic Data – population and demographic data by census tract from the most recent US Census

**Decision Support Tool & End Product Overview**

***End Products:***

|  |  |  |
| --- | --- | --- |
| **End Product** | **Partner Use** | **Datasets & Analyses** |
| **2022-2023 Flood Case Study** | Provides insights into the 2022-2023 flood events based on satellite-derived measurements. | GPM IMERG, SMAP, ECOSTRESS, Landsats, and Sentinel data will be collected as available before, during, and after the flood events to provide precipitation and soil moisture values. |
| **Climatology Maps** | This product will analyze precipitation and evapotranspiration normals over the past five years to provide partners with a spatiotemporal assessment of climate variables to identify areas susceptible to flood. | GPM IMERG, SMAP, ECOSTRESS OpenET to measure precipitation and evapotranspiration and calculate averages of each climate variable and generate climatology maps. |
| **Soil Moisture Tutorial** | Explore incorporation of satellite-derived soil moisture products in future flood risk mapping. | SMAP, ECOSTRES, Landsats, Sentinel-2 MSI to calculate soil moisture in a specific geography and time period. |
| **Precipitation Tutorial** | Explore incorporation of satellite-derived precip products in future flood risk mapping. | GPM IMERG to calculate rainfall measurements in a specific geography and time period. |

**Project Timeline & Previous Related Work**

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

***Similar Past DEVELOP Projects***:

* 2023 Summer (PUP) – Chile Wildland Fires: website URL
* 2023 Spring (PUP) – InVEST Urban Development: <https://appliedsciences.nasa.gov/what-we-do/projects/incorporating-earth-observation-data-integrated-valuation-ecosystem-services>
* 2022 Summer (MA) – Kansas City Disasters: website <https://appliedsciences.nasa.gov/what-we-do/projects/assessing-environmental-and-socioeconomic-factors-urban-flood-vulnerability>

**Notes & References:**

***Notes*:** DEVELOP NPO met with Dr. Haque at the AGU Fall Meeting and discussed project ideas.

***References:***

* California Department of Water Resources website - <https://water.ca.gov/>