**NASA DEVELOP National Program**

**2018 Summer Project Proposal**

**California – JPL**

**Southern California Coast Disasters**

*Improving Flood Extent Mapping Using the Coastal Storm Modeling System (CoSMoS) Tool with NASA Earth Observations and UAVSAR within Southern California*

**Project Overview**

***Project Synopsis*:** The objective of this project is to assist the US Geological Survey (USGS) Pacific Coastal and Marine Science Center in fine tuning their Coastal Storm Modeling System (CoSMoS). The USGS is concerned that the homes and roadways built close to the shore in Southern California are subject to flooding from king tide events due to many environmental factors. The project partner uses models, such as CoSMoS, to forecast flood hazard regions, but is currently facing an issue in outlining the landward extent of coastal flooding since they need to create these points to validate their storm flood models and assess regions most at risk to coastal flooding. This project aims to create a flood extent shapefile or raster of the Southern California coast identified from UAVSAR, Sentinel-1 C-SAR, Landsat 8 OLI, Sentinel-2 MSI, and WorldView-2 imagery via categorization of polarimetric data. The results will support USGS in validating their model and increase their capacity to use remotely sensed data in their model.

***Community Concern:*** Storm surge and wind, a changing climate, and sea-level rise effect flooding events. Within Southern California, homes and roadways are often close to the shore. Sections of beach cities, such as Newport Beach, Seal Beach, and Del Mar have been flooded during king tides. As sea level rises, many tidal flooding events will shift from being minor to extensive with increases in damage and disruptions to daily life. Obtaining a better spatial understanding of coastal flood extents will help pinpoint regions at high risk during flooding events. Beach communities will become more aware of flood hazards as USGS continues to refine their flood hazard modeling processes.

***Source of Project Idea:*** The project resulted from communication between JPL DEVELOP mentor Ben Holt and USGS scientist Andrea O’Neill. The project was requested by USGS to validate their models since they are interested in building their capacity in using Synthetic Aperture Radar (SAR) data.

***National Application Area Addressed:*** Disasters

***Study Location:*** Mexico/California border north to Point Conception along Southern California’s coast, CA

***Study Period:*** October2014 – December 2017

***Advisors:*** Bruce Chapman (NASA Jet Propulsion Laboratory, California Institute of Technology), Cathleen Jones (NASA Jet Propulsion Laboratory, California Institute of Technology), Ben Holt (NASA Jet Propulsion Laboratory, California Institute of Technology)

**Partner Overview**

***Partner Organization:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| **USGS, Pacific Coastal and Marine Science Center** | Andrea O’Neill, Oceanographer and Meteorologist | End User | Yes |

***End-User Overview***

***End User’s Current Decision-Making Process:***USGS has models, including CoSMoS, which project flood hazards using geographic points of the landward extent of coastal flooding events. The partner currently uses tide gauges and offshore buoy data to validate their modeled projections at localized points in the study area.. In an effort to include remote sensing, the partners requested their UAVSAR flights to get data over the study area to derive geographic points for use in validating their models in Southern California.

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

*USGS, Pacific Coastal and Marine Science Center* – The USGS modeling team has not used NASA Earth observations extensively, and this will be the first time using this sensing platform and methodology within the California region. This will significantly build their observational and analytical capacity for model validation.

***Collaborator & Boundary Organization Overview***

***Dissemination by Boundary Organizations*:**

*USGS, Pacific Coastal and Marine Science Center* – The USGS modeling team is expecting to be involved in data preparation and analysis, as they will be incorporating results and analyses into their ongoing work. USGS expects to disseminate project results as part of existing risk projections and ancillary data sets to California State Coastal Conservancy and the State of California. Data will also be made publically available on their site.

***Project Communication & Transition Overview***

***In-Term Communication Plan*:** Full participation by partners is expected via routine email communication and conference calls addressing progress and products. Andrea O’Neill will be the POC for communication with the Project Lead. Weekly or biweekly telecons and email exchanges will be conducted over the ten-week term. Additional information concerning comparisons with draft modeled projections and any *in situ* photographs taken will be discussed and investigated.

***Transition Plan*:** Final products will be handed off to the partners via email, video conference, or in-person during the term close-out at JPL depending on the time availability of the partner. A tutorial will be provided, so the partners can follow the processes that the team worked on. The technical report will be used as a baseline study for future work by the USGS. It is expected the partner will use the end results within two months after the end of the term. Software release is not planned at this time.

***Letters of Support*:** Patrick Barnard, Research Director, USGS Pacific Coastal and Marine Science Center

**Earth Observations Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter(s)** | **Use** |
| **NASA Gulfstream III UAVSAR** | HH, HV, and VV radar | Decibel values will be used to delineate land and water edges to outline the landward extent of coastal floods. A method will be developed to get the flood line points from SAR imagery. |
| **Sentinel-1 C-SAR** | VH and VV radar | Decibel values will be used to delineate land and water edges to outline the landward extent of coastal floods. A method will be developed to get the flood line points from SAR imagery. |
| **Landsat 8 OLI** | Surface reflectance  | Spectral signatures will be used to classify the water edges at a 30 m resolution. |
| **Sentinel-2 MSI** | Surface reflectance | Spectral signatures will be used to classify the water edges at a 10 m resolution. |
| **WorldView-2** | Surface reflectance | Spectral signatures will be used to classify the water edges at 0.46 m resolution. |

***Ancillary Datasets:***

Seafloor Mapping Lab (SFML) bathymetry data – Bathymetry data will be used to gather information about the depth and shapes of the underwater terrain (http://seafloor.csumb.edu/SFMLwebDATA\_SURVEYMAP.htm)

USGS Pacific Coastal and Marine Science Center Coastal Storm Modeling System (CoSMoS) – Modeled flood line extent shapefile will be derived for comparison

USGS Pacific Coastal and Marine Science Center high-resolution seamless topobathy DEM – 2 m spatial resolution topo-bathy DEM will be used for coastal flood zone mapping

USGS Pacific Coastal and Marine Science Center flood extent calibration points – Calibration points derived from coincident photography from the Urban Tides citizen-science initiative organized by USC Sea Grant will be used with CoSMoS and test the accuracy of the flood extent maps

***Software & Scripting:***

Esri ArcGIS – create quality maps for presentations and reports and for classification of flood areas and generating associated geographic extents

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

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

R – data extraction and statistical analysis

ESA Sentinel Application Platform (SNAP) – processing of Sentinel-2 data

**Decision Support Tool & End Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Products** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| **Flood Line Extent of the Southern California Coast** | The end product derived from SAR imagery will provide a spatially expansive and high-resolution dataset for validation of flood lines along the coast, allowing further refinements of their modeling procedures. The end product will highlight regions more at risk by storm surges or king tides. | The Coastal Storm Modeling System (CoSMoS) will be provided from the partner to project flood hazards, while flood extent points from UAVSAR, Sentinel-1, Landsat 8, Sentnel-2, and WorldView-2 imagery will be used with *in situ* geotagged photos to further calibrate the model.  | I |

***End-User Benefit*:** The end products provide an invaluable and spatially-expansive data set for model validation and identifying key areas of flood risk within Southern California. Traditional data sources (tide gauges, offshore buoys) for flood model verification do not offer insight into regional coastal flood variability. Previous collections of *in situ* photographs and local testimony during flood events to provide similar model validation data are isolated (one modern Southern California dataset limited to one township) and are commonly unfeasible to implement at a project-level given the time and resources required. The end product will build capacity for the partners to include remote sensing based flood extent points in their models.

**Project Timeline & Previous Related Work**

***Project Timeline:*** 1 Term: 2018 Summer

***Related DEVELOP Work:***

2016 Fall (MSFC) – Mississippi River Basin Disasters: Utilizing NASA Earth Observations to Enhance Flood Monitoring Throughout the Mississippi River Basin

2015 Summer (VA) – Peru Disasters: Identifying and Mapping Flood Prone Regions in the La Liberated Region of Peru Using NASA’s Earth Observations

2014 Spring (JPL) – Global Disasters: Utilizing the Power of Remote Sensing and Crowdsourcing for Natural Disaster Damage Assessment and Response

**Notes & References:**

***Notes*:** UAVSAR imagery was obtained via ROSES proposal (13-ESI13-0029).

***References:***

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