**NASA DEVELOP National Program**

**2018 Fall Project Proposal**

**Alabama – Marshall**

**Ohio River Valley Transportation & Infrastructure**

*The Application of SAR Data to Identify Optimal Access Routes for Emergency Services after Flood Events in the Ohio River Valley*

**Project Overview**

***Project Synopsis*:** This project aims to develop a risk map that identifies areas in the western Ohio River Valley that are most likely to be impacted by flood events, along with an optimal road map that identifies routes that disaster response organizations can take to provide relief to impacted communities. Using Sentinel-1 C-SAR and Landsat 8 OLI and the Normalized Difference Flood Index (NDFI) for flood mapping, we will be able to identify transport infrastructure that will be most accessible after a flood event based on the analysis of past flood events. Our project partners, the National Weather Service (NWS) Ohio River Forecast Center, Federal Emergency Management Agency (FEMA), and NASA Short-term Prediction Research and Transition Center (SPoRT), will use the information gathered from this project to enhance their understanding of flooding as it relates to transportation, and it will increase the Ohio River Valley’s resilience to frequent flooding.

***Community Concern:*** The Ohio River is a significant contributor to the economic and environmental prosperity of the 13 state-region of the Ohio River Valley. The approximately 27 million people who live in this area utilize the river for a number of purposes, including industrial manufacturing, power generation and drinking water. While the Ohio River is a critical resource to the region, it is also the source of numerous flood events that cause both social and economic damages to impacted communities. This frequent flooding can severely disrupt surface transportation, limiting disaster response and relief organizations ability to get to those in need. In response, there is a push to develop more resilient management plans that will help the valley prepare for future flood events.

***Source of Project Idea:*** This project idea came from a discussion with the Alabama – Marshall science advisors and Dr. Franz Meyer, chief scientist at the Alaska Satellite Facility and associate professor at the University of Alaska Fairbanks. Through Dr. Meyer’s interest in DEVELOP and utilizing SAR, the MSFC leadership created a project that aligned with the National Program Office application area targets.

***National Application Areas Addressed:*** Transportation & Infrastructure, Disasters

***Study Location:*** Western portion of the Ohio River Valley; IL, IN, KY

***Study Period:*** October 2017– March 2018

***Advisors:*** Dr. Jeffrey Luvall (NASA Marshall Space Flight Center), Dr. Robert Griffin (University of Alabama in Huntsville), Dr. Franz Meyer (University of Alaska in Fairbanks)

**Partner Overview**

***Partner Organizations:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| **NOAA National Weather Service, Ohio River Forecast Center** | James Noel, Service Coordination Hydrologist | End User | No |
| **Federal Emergency Management Agency** | Christopher Vaughn, Geospatial Information Officer | End User | No |
| **NASA Short-term Prediction Research and Transition Center (SPoRT)** | Jordan Bell, Research Associate II | Collaborator | No |

***End-User Overview***

***End User’s Current Decision-Making Process:***The Ohio River Forecast Center makes flooding predictions and issues advisories and warnings to the surrounding areas – including the discussion of passable or impassable roadways. The Ohio River Forecast Center does not currently use remote sensing for their decision-making processes.

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

*NOAA National Weather Service, Ohio River Forecast Center* – Hydrologists and meteorologists at the Ohio River Forecast Center are familiar with NASA Earth observations, although these products are not directly incorporated in current NWS activities related to flood forecasting. By using Earth observations for flood analysis, the DEVELOP team will provide a higher-resolution perspective on flooding predictability than what is currently available from operational weather forecast tools.

*Federal Emergency Management Agency* – FEMA uses Earth observations to provide first response and damage assessments after natural disasters. The tools created by this project will enhance their capabilities to discern what areas need the greatest assistance after flooding events.

***Collaborator & Boundary Organization Overview***

***Collaborator Support:***

*NASA Short-term Prediction Research and Transition Center (SPoRT)* – SPoRT currently utilizes Earth observations from NASA, NOAA, and commercial land remote sensing imagers. This project will build their capacity by developing new products to map flood extent that will assist their partners with using imagery for flood applications. Effective flood mapping can also support the validation and improvement of stream flow and flood forecasting models such as the National Water Model, developed by the National Water Center in Tuscaloosa, Alabama.

***Project Communication & Transition Overview***

***In-Term Communication Plan*:**  The Project Lead will initiate contact with the project partners the first week of the term for team introductions and to determine if there have been any changes to the desired end-products. Meetings will take place with the Ohio River Forecast Center and FEMA via teleconference every one or two weeks throughout the rest of the term. The team will meet with NASA SPoRT team members (Jordan Bell, and contractor(s) supporting training development) in person and/or through email communications on a weekly basis to discuss progress of the project.

***Transition Plan*:** All end products and deliverables will be provided to the project partners via a web conference either through Google Hangouts or Skype. During this meeting, the team will present the results to the partners and field any questions they may have.

**Earth Observations Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter** | **Use** |
| **Sentinel-1 C-SAR** | Surface reflectance | These data will be used to identify flood water immediately after a flood event. |
| **Landsat 8 OLI** | Surface reflectance | These data will be used to identify existing land cover, specifically current bodies of water. |

***Ancillary Datasets:***

USGS National Land Cover Database (NLCD) – Land cover data will be used to mask out existing bodies of water.

Oak Ridge National Laboratory LandScan – Population data will be used in flood impact analysis.

Homeland Infrastructure Foundation-Level Data (HIFLD) – Infrastructure data will be used in flood impact analysis.

USDA National Resources Conservation Service (NRCS) U.S. General Soil Map (STATSGO2) – This dataset will be used to identify different soil types within the Ohio River Valley.

USDA NRCS Disaster Response Imagery – This imagery will be used for damage analysis.

US Census Bureau TIGER dataset – Primary and secondary roads will be identified and incorporated in our flood risk analysis.

USGS 3D Elevation Program (3DEP) – 3.4 m resolution elevation data will be used to derive aspect and slope for analysis.

***Software & Scripting:***

Esri ArcGIS – Raster manipulation and analysis, imagery processing, and map production

**Decision Support Tool & End Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Products** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| **Ohio River Valley Flood Risk Map** | The Flood Risk Map will aid the  end users’ decision-making process by identifying an area’s flooding probability at various flood stages within the Ohio River Valley. Project partners will also use this map to pinpoint areas that have previously experienced severe flooding. | Sentinel-1 C-SAR and other ancillary datasets will be incorporated with NDFI created with imagery from Landsat 8 OLI to identify areas that frequently flood within the study area. | N/A |
| **Disaster Response Optimal Road Map** | Project partners will use the Optimal Road Map to determine the best roads to take when responding to disasters. This map will increase the area’s resilience to flooding by reducing emergency response time. | Based on the Flood Risk Map results, this analysis will consider the areas and roads that are frequently flooded and will determine the best routes for disaster response organizations to take when responding to a natural disaster. | N/A |
| **ArcGIS Online Story Map** | The interactive map will be used by project partners to display results. | Sentinel-1 C-SAR, Landsat 8 OLI, and ancillary datasets will be integrated into an online map showing the areas that frequently flood and the importance of considering these areas when responding to flood events. | N/A |

***End-User Benefit*:** The Ohio River Valley Flood Risk Map and Disaster Response Optimal Road Map will be used for flooding resilience in the Ohio River Valley, specifically by the Ohio River Forecast Center and FEMA. These products will enable end users the ability to determine the most effective and efficient transportation systems to take when responding to a disaster, potentially reducing response times across the region, and will allow more targeted flood warning messages. Results will also help the Ohio River Forecast Center identify flood reaches within the area.

**Project Timeline & Previous Related Work**

***Project Timeline:*** 1 Term: 2018 Fall

***Related DEVELOP Work:***

2018 Summer (MCHD) – New Orleans Urban Development: Utilizing Earth Observations to Assist Groundwork New Orleans in Reducing Flood Vulnerability in New Orleans, Louisiana, Metropolitan Area

2017 Spring (MSFC) – Mississippi River Basin Disasters II: Utilizing NASA Earth Observations to Create an Automated Flood Probability Map in the Mississippi River Basin

2016 Spring (VA) – Wise Disasters: Utilizing NASA Earth Observations to Identify and Predict the Extent of Flooding and to Mitigate its Risks in Wise County, Virginia

2014 Spring 2014 (GSFC) – Mekong Disasters: Utilizing NASA Earth Observations to Enhance Flood Impact Products and Mitigation in the Lower Mekong Water Basin