**NASA DEVELOP National Program**

**2019 Summer Project Proposal**

**Maryland – Goddard**

**Ellicott City Disasters**

*Applying NASA Resources to a Statistical Flood Risk Model to Improve Early Warning Systems and Public Safety*

**Project Overview**

***Project Synopsis*:** This DEVELOP project will incorporate NASA EO and other publicly available resources (such as SPoRT Land Information System, NWS Radar, USGS 3DEP) into a statistical flood risk model to improve early warning system capabilities in Howard County, Maryland. Pre-installed stream gauge monitors from the Department of Homeland Security and Howard County Office of Emergency Management (OEM) will provide *in situ* measurements for validation and accuracy assessments of the flood risk model. Information maps correlated with flooding events will be derived from the model and presented to the Howard County OEM. The statistical flood risk model and informative maps incorporating NASA climate and hydrologic model outputs will provide additional situational awareness and enhance the existing flood monitoring capabilities of the Howard County OEM, increasing their abilities to mitigate flooding damages in Ellicott City, MD.

***Community Concern:*** Over the past ten years, Ellicott City, MD, has been the victim of multiple detrimental flooding events which have claimed human lives and caused millions of dollars in property damage. While the town has grappled with these flooding issues for over 100 years, the local flooding dynamics are changing. Both the frequency and intensity of flooding events have increased in recent years and are projected to get worse with changing environmental conditions, thus escalating the need for better flood monitoring and prediction. Accurate, timely, and detailed data reports are necessary to mitigate the effects of severe flooding in the region.

***Source of Project Idea:*** Maryland – Goddard’s Lead Science Advisor, Dr. John Bolten, approached relevant partners with the idea to improve flood monitoring in Ellicott City after the community was devastated by flooding events in 2018.

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

***Study Location:*** Ellicott City, MD

***Study Period:*** January 2011 – May 2019

***Advisors:*** Dr. John Bolten (NASA Goddard Space Flight Center), Brian Cleary (Howard County Storm Water Management Division), Dr. Sujay Kumar (NASA Goddard Space Flight Center)

**Partner Overview**

***Partner Organizations:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| **Howard County Government, Office of Emergency Management** | Mike Hinson, Acting Emergency Management Director | End User | No |
| **Howard County Government, Storm Water Management Division** | Brian Cleary, Project Manager  | Collaborator | No |
| **NOAA, National Weather Service, Baltimore-Washington Weather Forecast Office** | Christopher Strong, Warning Coordination Meteorologist | Collaborator | No |

***End-User Overview***

***End User’s Current Decision-Making Process:***The Howard County OEM develops and maintains emergency management plans that encompass emergency response, as well as disaster recovery, mitigation, and protection. OEM also provides guidance to governmental and emergency response agencies on the development of disaster management plans. OEM staff conduct countywide planning as well as training and exercise programs to help the County prepare for natural, technological, and man-made emergencies. In addition, OEM staff manage and coordinate the County's Emergency Operations Center (EOC) during times of emergency management activation. The current decision support system capabilities include WebEOC emergency management technology, cameras, and a direct link to the National Weather Service and the Maryland Department of Transportation.

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

*Howard County Government, Office of Emergency Management* – Howard County OEM currently does not use NASA Earth observation data in its operations. OEM leadership has expressed interest in learning more about what other data sources exist and how they can use them to improve their situational awareness and decision making.

***Collaborator & Boundary Organization Overview***

***Collaborator Support:***

*Howard County Government, Storm Water Management Division* – The Storm Water Management Division will provide ancillary flood risk model inputs, project advising, and feedback on flood risk model design. This office is responsible for managing the quality and quantity of storm water that originates in, falls onto, or passes through Howard County.

*NOAA, National Weather Service, Baltimore-Washington Weather Forecast Office* – NOAA NWS will provide ancillary flood risk model inputs and feedback on flood risk model design. This office is responsible for issuing warnings for Ellicott City, MD, and can provide additional model input data as necessary.

***Project Communication & Transition Overview***

***In-Term Communication Plan*:** The Project Lead will serve as the primary point of contact for communication with the project partners and advisors. The team will communicate with project partners through triweekly teleconferences, in-person meetings, and weekly email updates.

***Transition Plan*:** Digital visualization end products will be provided during an in-person handoff in Week 10, where the team will discuss results and answer any questions regarding the products. Software release will likely be required for the flood model, delaying partner application of the model until software release is complete.

**Earth Observations Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter** | **Use** |
| **GPM IMERG** | Precipitation | Precipitation data will be used to approximate near real-time precipitation intensity. |
| **SMAP L-band Radar & L-band Radiometer** | Soil moisture | Soil moisture data will be used to supplement flood risk analyses. |
| **Sentinel-1 C-SAR** | Soil moisture | Soil moisture data will be used to supplement flood risk analyses. |

***Ancillary Datasets:***

NOAA NWS Radar Data Related to the Floods of 2011, 2016 and 2018 in Ellicott City – These data will be used to reconstruct the previous three major floods to show users how the system is anticipated to work

NOAA NWS Stream Gauge Data Related to the Floods of 2011, 2016 and 2018 in Ellicott City – These data will be used to reconstruct the previous three major floods to show users how the system is anticipated to work

NOAA NWS Hydrologic Modeling Data Related to the Floods of 2011, 2016 and 2018 in Ellicott City –These data will be used to reconstruct the previous three major floods to show users how the system is anticipated to work

Department of Homeland Security Preinstalled Stream Gauge Monitor Data – *In situ* measurements will be used for validation and flood model inputs

Ron Peters’ Preinstalled Ground HDTV Flood Monitoring Camera Imagery – Ground imagery will be used to supplement emergency management

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

NASA SPoRT Land Information System (LIS) – Flood model inputs will bolster modeling capabilities

NASA North American Land Data Assimilation System (NLDAS-2) – Near real-time precipitation model comparisons will bolster modeling capabilities

NASA SPoRT Multi-Radar Multi-Sensor (MRMS) – Flood model inputs will bolster modeling capabilities

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

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

USGS Daily Streamflow Conditions Data – *In situ* measurements will be used for validation and flood model inputs

***Modeling:***

Machine learning Environment for NASA Scientific data Applications (MENSA) (Sujay Kumar, NASA Goddard Space Flight Center)

***Software & Scripting:***

Python 3.7 – Statistical flood risk modeling

Esri ArcGIS Pro 2.3 – Raster manipulation and analysis, imagery processing, and map production

Google Earth Engine API – Data acquisition and image processing

**Decision Support Tool & End Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Product** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| **Ellicott City Statistical Flood Risk Model** | The flood risk model will be used by the Howard County Office of Emergency Management to improve its early emergency warning system capabilities and enhance its decision-making processes. | Stream gauge data, GPM precipitation measurements, SMAP, and Sentinel-1 soil moisture data, and existing precipitation and climate models from NASA SPoRT LIS will be input into the MENSA model to establish statistical correlations between flood risk parameters. | IV |
| **Ellicott City Statistical Flood Information Maps** | Flood information maps derived from the flood risk model will help display how various factors have influenced Ellicott City flood events, enhancing future emergency management preparedness. | Stream gauge data, GPM precipitation measurements, SMAP, and Sentinel-1 soil moisture data, and existing precipitation and climate models from NASA SPoRT LIS will be analyzed and compared to determine factors’ influence on flood events. | N/A |
| **Ellicott City Statistical Flood Risk Model Tutorial** | The flood risk model tutorial will graphically demonstrate how to apply and analyze the flood risk model. | N/A | N/A |

***End-User Benefit*:** The statistical flood risk model and derived information maps will supplement the emergency management actions of the Howard County OEM by displaying the correlation of various parameters that have historically caused flooding in the region. The model can influence early warning decisions when potential flooding conditions are either present or predicted, allowing the OEM to better direct its resources where necessary.

**Project Timeline & Previous Related Work**

***Project Timeline:*** 1 Term: 2019 Summer

***Related DEVELOP Work:***

2018 Fall (MSFC) – Ohio River Valley Transportation & Infrastructure: Utilizing Synthetic Aperture Radar and NASA Earth Observations to Identify Optimal Transportation Routes to Assist Emergency Responders after Flood Events in the Ohio River Valley

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

2018 Spring (ID) – Navajo National Monument Water Resources: Monitoring and Forecasting Precipitation Patterns and Erosion Potential to Enhance Archaeological Preservation and Decision Making

2017 Spring (MSFC) – Mississippi River Basin Disasters II: Automated Mapping of Flood Events in the Mississippi River Basin Utilizing NASA Earth Observations