**NASA DEVELOP National Program**

**2019 Fall Project Proposal**

**Massachusetts – Boston**

**Central Java Disasters**

*Evaluating Coastal Flooding and Related Marine Turbidity Variations caused by Extreme Tidal Inundation Events in Central Java, Indonesia*

**Project Overview**

***Project Synopsis*:** Extreme tidal inundation events frequently impact the densely populated northern coast of Central Java, Indonesia. The project will assess this tidal inundation and marine turbidity variations related to erosion and land subsidence. Partners of the project include the Water Resources and Spatial Planning Office of Central Java Province and the Center for Coastal Rehabilitation and Disaster Mitigation Studies at Diponegoro University. The project will utilize imagery from Landsat 8 OLI, Aqua & Terra MODIS, and Sentinel-1 C-SAR to complete analyses. A tool will be created to map tidal inundation events, vegetation, and the region’s changing northern coastline. The team will also map turbidity in the neighboring Java Sea to assess variations in sediment availability. These tools will allow end users to monitor environmental conditions that threaten human safety, city infrastructure, and marine ecosystems.

***Community Concern:*** Coastal damage caused by tidal inundation is of great concern to managers in Central Java. For example, the Marine and Fisheries Department of Central Java reported that more than 1,000 ha in Semarang City and 2,116 ha in Demak were inundated in 2015. Since these widely publicized events, tidal inundation and coastal flooding have continued to be persistent issues that the highly populated region must manage and mitigate. Inundated land has caused a loss of housing, infrastructure damage, health problems, and transportation issues. Fluxes in coastal turbidity associated with tidal inundation and land loss also threaten marine ecosystems and affect projects that rely on sedimentation to restore flooded lands.

***Source of Project Idea:*** Dr. Magaly Koch, Research Associate Professor at the BU Center for Remote Sensing, reached out to Dr. Cedric Fichot to see if DEVELOP would be interested in working on a tidal flooding project with her colleague from the Center for Coastal Rehabilitation and Disaster Mitigation Studies, Dr. Anindya Wirasatriya. Dr. Koch, Dr. Fichot, Dr. Wirasatriya, and Boston University graduate students will be involved with the project, and they have coordinated *in situ* data collection and site visits to take place over the summer.

***National Application Areas Addressed:*** Disasters, Water Resources

***Study Location:*** Northern coast of Central Java, Indonesia

***Study Period:*** January2014 – August 2019

***Advisors and Mentors:*** Dr. Cedric Fichot (Boston University), Dr. Valerie Pasquarella (Boston University), Dr. Magaly Koch (Boston University), Juliette Bateman (Boston University)

**Partner Overview**

***Partner Organizations:***

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| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| **Water Resources and Spatial Planning Office of Central Java Province** | Sakti Kania Army, Coordinator; Vera Hari Dhamayanti, Senior Staff; Aswar Annas Kunaefi, Senior Staff | End User | Yes |
| **Diponegoro University, Center for Coastal Rehabilitation and Disaster Mitigation Studies** | Dr. Anindya Wirasatriya, Oceanographic Laboratory Coordinator; Dr. Rudhi Pribadi, Senior Lecturer; Dr. Muhammad Helmi, Senior Lecturer and Head of the Center | End User | Yes |

***End-User Overview***

***End User’s Current Decision-Making Process:***The Center for Coastal Rehabilitation and Disaster Mitigation Studies (CoREM) at Diponegoro University researches the effects of coastal degradation and solutions to land loss in human settlements. The organization is responsible for communicating its research to government and non-profit agencies. It actively participates in coastal restoration efforts, most notably mangrove forest regeneration, and makes decisions based off research completed by university members and collaborators. The Water Resources and Spatial Planning Office of Central Java Province (WRSPO) is responsible for water resource management, including the interface between land and water in coastal ecosystems. Its decision-making processes are typically governed by *in situ* environmental monitoring and research conducted externally by academic institutions and NGOs. In addition to management responsibilities related to inundation and flooding, the WRSPO is also concerned with coastal water quality that is affected by changes in turbidity associated with land loss.

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

*Diponegoro University, Center for Coastal Rehabilitation and Disaster Mitigation Studies* – CoREM is familiar with the

use of satellite imagery to assess flood risk (predominantly based on topography) and land loss due to subsidence. However, the use of NASA Earth observations related to marine turbidity and land cover is limited within the organization. This project will build CoREM’s capacity in aquatic optics and more complex land classification.

*Water Resources and Spatial Planning Office of Central Java Province* – The WRSPO is familiar with limited satellite remote sensing methods through collaborations with external organizations. This end user will also build capacity in aquatic optics and land classification but will begin this project with significantly less in-house knowledge of satellite remote sensing analysis.

***Boundary Organization Overview***

***Dissemination by Boundary Organizations*:**

*Diponegoro University, Center for Coastal Rehabilitation and Disaster Mitigation Studies*– CoREM partners with various restoration and city-level organizations to contribute to coastal rehabilitation efforts. It will disseminate project information to these partners, most notably government partners in Semarang City, who are interested in results relevant to urban management and mangrove restoration projects.

*Water Resources and Spatial Planning Office of Central Java Province* – The WRSPO is tasked with disseminating information to the various regency and city governments within Central Java. It will serve as an effective starting point to convey project information to coastal communities in the region. This office also collaborates with marine conservation organizations that are interested in the project’s turbidity assessments.

***Project Communication & Transition Overview***

***In-Term Communication Plan*:** Due to the 11 hour time difference, much of the in-term communication with the partners will likely take place via email on a weekly basis. However, the partners are available in the early morning and evening to join video calls. These calls will likely take place 3 to 4 times during the term. The main POC for communication will be the Project Lead, with communications support provided by the Fellow.

***Transition Plan*:** The team will complete a project handoff via Google Meet during the last week of the term. After giving their project presentation, the team will answer partner questions and walk partners through their land cover tool and turbidity maps. Maps will be put through export control and then sent to partners via Google Drive along with deliverables. Land cover analysis Google Earth Engine code will be shared via GitHub once the Software Release Process is complete.

**Earth Observations Overview**

***Earth Observations:***

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| --- | --- | --- |
| **Platform & Sensor** | **Parameter** | **Use** |
| **Landsat 8 OLI** | Surface reflectance | Surface reflectance will be used to examine land cover and turbidity. |
| **Aqua MODIS** | Surface reflectance | Surface reflectance will be used to examine turbidity. |
| **Terra MODIS** | Surface reflectance | Surface reflectance will be used to examine turbidity. |
| **Sentinel-1 C-SAR** | Ground range detection | Ground range detection will be used to identify flooded areas. |

***Ancillary Datasets:***

* Boston University Fichot Aquatic Optics Laboratory Central Java Turbidity Dataset – create a local algorithm to estimate turbidity in the Java Sea

***Software & Scripting:***

* Google Earth Engine API – land classification of Landsat and Sentinel-1 imagery
* SeaDAS – atmospheric correction of Landsat imagery
* MATLAB – algorithm development and application of the algorithm to Landsat and MODIS imagery

**Decision Support Tool & End Product Overview**

***End Products:***

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| --- | --- | --- | --- |
| **End Product** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| **Tidal Inundation Land Cover Analysis Tool and Maps** | This tool will allow the end users to obtain more frequent and widescale assessments of tidal inundation along the coast of Central Java. More frequent assessment will enable end users to target areas of consistent inundation for mitigation and evaluate mangrove restoration efforts. | Data from Sentinel-1 C-SAR and Landsat 8 OLI will be used in Google Earth Engine to develop land classifications that will display tidal inundation and vegetation along the northern coast of Central Java. | III |
| **Marine Turbidity Estimation Maps** | Maps will allow end users to view variations in marine turbidity due to land subsidence and flooding. Estimation of sediment availability will inform coastal restoration and conservation of ecosystems sensitive to turbidity. | Data from Landsat 8 OLI, Aqua MODIS, and Terra MODIS will be processed using an algorithm generated from *in situ* turbidity data to create maps that will display turbidity for selected dates within the study period. | I |

***End-User Benefit*:** The team’s products will assist end users with ongoing efforts to assess tidal inundation and its effects on populated areas and neighboring marine ecosystems. Methods and maps created throughout the term will serve as the basis of a greater effort to use satellite remote sensing to save time and resources typically associated with field environmental monitoring. Turbidity maps will also provide insight into sedimentation potential, which is vital for land restoration. Overall, using Earth observations to scale up environmental monitoring to the regional level will help end users unify management and research practices across Central Java’s northern coast.

**Project Timeline & Previous Related Work**

***Project Timeline:*** 1 Term: 2019 Fall

***Related DEVELOP Work:***

2019 Spring (AZ) – Lake Ontario Disasters: Employing NASA Earth Observations in the Greater Toronto Area to Improve Flood Preparedness for Coastal Communities

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 Summer (MA) – Plum Island Estuary Water Resources II: Employing Remote Sensing Techniques to Quantify Sediment Supply and Evaluate Marsh Vulnerability in the Plum Island Estuary

**Notes & References:**

***Notes*:** The project has additional support from professors and graduate students within the Boston University Center for Remote Sensing. This support will provide the team with additional advising (if necessary) and access to relevant BU datasets.

***References:***

Damastuti, E., & de Groot, R. (2017). Effectiveness of community-based mangrove management for sustainable resource use and livelihood support: A case study of four villages in Central Java, Indonesia. *Journal of Environmental Management,* *203*(1), 510-521. <https://doi.org/10.1016/j.jenvman.2017.07.025>

Marfai, M. A., King, L., Singh, L. P., Mardiatno, L. D., Sartohadi, J., Hadmoko, D. S., & Dewi, A. (2008). Natural hazards in Central Java Province, Indonesia: An overview. *Environmental Geology,* *56*(2), 335-351. <https://doi.org/10.1007/s00254-007-1169-9>

Susiatiningsih, H., Farabi, N., & Paramasatya, S. (2018). Semarang City's flood risk: A threat

to human security. *E3S Web of Conferences,* *73*, 08027. https://doi.org/10.1051/e3sconf/20187308027