**NASA DEVELOP National Program**

**2018 Summer Project Proposal**

**Alabama – Marshall**

**Chao Phraya Water Resources**

*Assessing Water Quality in Chao Phraya Basin, Thailand through Sedimentation Modeling and Urban Footprint Expansion*

**Project Overview**

***Project Synopsis*:** In collaboration with the Royal Thai Embassy Office of Science and Technology (OST), Asian Disaster Preparedness Center (ADPC), and NASA SERVIR Science Coordination Office, this project aims to provide the Bangkok Metropolitan Administration (BMA) and the Asian Institute of Technology (AIT) with products that assess water quality in the Chao Phraya Basin and illustrate the change in water quality and urban footprint over time. The project will utilize TRMM, GPM, Aqua MODIS, Terra MODIS, SRTM, Landsat 8 OLI, and Suomi NPP VIIRS to identify key runoff areas in the watershed, create a model of sediment in the watershed, and generate a water quality and urban footprint time series. As the policy maker for the Bangkok Metropolitan area in regards to urban planning waste management, environmental protection and more, BMA is an important stakeholder in the information products created by this project. AIT will use these products to support their promotion of sustainable development and act as another conduit to the BMA.

***Community Concern:*** The Chao Phraya Basin underwent intense development of reservoirs and canals throughout the 19th and 20th centuries, resulting in a highly developed area home to a variety of economic activities and the dense urban center in Bangkok. Currently, rice farmers, orchardists, shrimp farmers, urban residents and other groups compete over the Chao Phraya water. With available water in the dry season being just over half of anticipated demands, access to water and its quality becomes increasingly important for the continuation of these economic activities and livelihoods. In 2015, the upper Chao Phraya river was determined to have fair water quality, however, the central and lower Chao Phraya were determined to have poor water quality, according to the Pollution Control Department. In addition, the Pollution Control Department found that water quality had deteriorated from 2006 to 2015, even though overall water quality in Thailand remained stable.

***Source of Project Idea:*** This project arose from a brainstorming session between OST, ADPC, SERVIR, and Alabama – Marshall leadership. These collaborators suggested that a project dealing with water quality and urbanization would benefit the Asian Institute of Technology and the Bangkok Metropolitan Administration.

***National Application Area Addressed:*** Water Resources

***Study Location:*** Chao Phraya Basin, Thailand

***Study Period:*** January 2000 – May 2018

***Advisors:*** Dr. Jeffrey Luvall (NASA Marshall Space Flight Center), Dr. Robert Griffin (University of

Alabama in Huntsville), Leigh Sinclair (University of Alabama in Huntsville/Information Technology and

Systems Center), Maggi Klug (University of Alabama in Huntsville)

**Partner Overview**

***Partner Organizations:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| **Asian Institute of Technology** | Dr. Sarawut Ninsawat, Assistant Professor | End User | No |
| **Bangkok Metropolitan Administration** | Rattanawadee Charoensook, Sanitary Technical Officer | End User | No |
| **Royal Thai Embassy, Office of Science & Technology** | Gam Bunyakiat Petri, Project Consultant and Policy Analyst | Collaborator | Yes |
| **Asian Disaster Preparedness Center** | Peeranan Towashiraporn, Chief of Party, Department Head for the Disaster Risk Assessment and Monitoring Unit | Collaborator | Yes |
| **NASA SERVIR Science Coordination Office** | Eric Anderson, SERVIR-Mekong Regional Science Coordination Co-Lead and Water Related Disaster Thematic Service Area Lead | Collaborator | No |

***End-User Overview***

***End User’s Current Decision-Making Process:***The BMA oversees the city of Bangkok and creates city-wide environmental policy, including services such as transportation. The BMA values the use of GIS for mapping schools, roads, and other applications; however its use is not ubiquitous. AIT is involved with GIS intensive projects, such as through their SERVIR-Mekong small grant project.

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

*Asian Institute of Technology* – The AIT is familiar with Earth observations and encourages their application through lectures, seminars, workshops, and conferences. This project’s urbanization and sedimentation modeling approach in this project complements the Spatio-Temporal Analysis on Urban Development & Scenario-Based Flood Risk Assessment in Bangkok Metropolitan Region, SERVIR-Mekong grant project. Their involvement is also a conduit to the BMA, as the BMA is a stakeholder in the SERVIR-Mekong grant project.

*Bangkok Metropolitan Administration* – The BMA does not currently incorporate NASA Earth observations into their decision-making processes, but aims to enhance departmental cooperation through increased use of GIS.

***Collaborator & Boundary Organization Overview***

***Collaborator Support:***

*Royal Thai Embassy, Office of Science & Technology* – Through teleconferences, the OST will provide feedback on the project, focusing on aspects of urbanization and water quality that are of most importance to Thailand. Additionally, the OST will provide assistance identifying and collecting ancillary datasets. Finally, the OST will facilitate communication between the DEVELOP team and the end users.

*Asian Disaster Preparedness Center* – Through teleconferences, ADPC will enhance the quality of this project with their technical feedback and knowledge of the Mekong region as well as facilitate communication with the end users.

*NASA SERVIR Science Coordination Office* – Through in-person meetings with the team, NASA SERVIR will increase the strength of this project by providing their technical expertise (i.e. remote sensing, SWAT modeling). In addition, NASA SERVIR will assist with the identification and collection of ancillary datasets.

***Dissemination by Boundary Organizations*:**

*Royal Thai Embassy, Office of Science & Technology* – Officials at the Royal Thai Embassy will serve as the liaison to local organizations and decision makers throughout the Chao Phraya region. The Royal Thai Embassy will provide these local parties with the derived end-products and results that will improve water quality management practices. Specifically, the OST has identified the BMA as an important stakeholder in water quality and urbanization information within the Chao Phraya basin. The OST will assist with communication of throughout the project with this end user.

*Asian Disaster Preparedness Center* – With a diverse range of established partnerships from various UN agencies to government agencies, community-based organizations, and universities, ADPC will serve as a liaison to interested organizations throughout the Chao Phraya basin. Specifically, ADPC has identified the SERVIR-Mekong grantee AIT as an end user that would benefit from the land cover and urban footprint change-aspect of the project. They will assist with the DEVELOP team’s communication with this end user throughout the term.

***Project Communication & Transition Overview***

***In-Term Communication Plan*:** The Center Lead will set up partner calls for the first week of the term for participants and partners to introduce themselves and discuss any possible updates or desired changes to the project. Communication with the Royal Thai Embassy will include a DEVELOP NPO and NASA Headquarters OIIR representatives. Further communication with the AIT throughout the term will occur on a weekly or biweekly basis via teleconference. The Project Lead will update the BMA throughout the term via email. The BMA will discuss their feedback with the Royal Thai Embassy, who will relay it to the team via teleconference.

***Transition Plan*:** For local partners, handoff will consist of an in-person presentation. For non-local partners, the handoff will be conducted remotely, via webinar, during the last week of the term. During this webinar, the team will explain their methods and field the partners’ questions about the results and products. The products will be delivered digitally via google drive at the end of the term for immediate implementation by the end users.

**Earth Observations Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter** | **Use** |
| **TRMM TMI** | Precipitation | Precipitation will be used as an input for the SWAT model. |
| **GPM GMI** | Precipitation | Precipitation will be used as an input for the SWAT model. |
| **Aqua MODIS** | Land surface temperature | Land surface temperature will be used as an input for the SWAT model. |
| **Terra MODIS** | Land surface temperature | Land surface temperature will be used as an input for the SWAT model. |
| **SRTM** | Elevation | Elevation with be used as an input for the SWAT model. |
| **Landsat 8 OLI** | Land cover | Land cover will be used to examine urban footprint expansion. |
| **Suomi NPP VIIRS** | Land surface temperature | Land surface temperature will be used as an input for the SWAT model. |

***Ancillary Datasets:***

SEDAC Global Human Footprint, v2 – contribute to urban footprint time series based on population density, intensity of infrastructure, and human land use

SEDAC Global Man-made Impervious Surface – contribute to urban footprint time series based on percent of impervious cover

NASA SERVIR Regional Land Cover Monitoring System – compare with land cover classes calculated by team

DIVA-Geographic Information System (GIS) Thailand Roads – use shapefile detailing the road and railroad systems in Thailand based on the 1992 Digital Chart of the World and Humanitarian Data Exchange (HDX) 2005

FAO Harmonized World Soil Database v 1.2 – use soil type as an input for SWAT model

***Modeling:***

Soil and Water Assessment Tool (POC: Thailynn Munroe, NASA SERVIR)

***Software & Scripting:***

Esri ArcGIS – processing of satellite imagery and creation of maps and time series

**Decision Support Tool & End Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Product** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| **Map of Key Runoff Areas** | This map will provide the BMA with key runoff areas within their management area to assist with decision-making regarding water quality. Additionally, the context of the Bangkok Metropolitan area within the basin will provide a complete picture of potential water quality impact of runoff areas outside of the metropolitan area. | Based on TRMM TMI, GPM GMI, MODIS, VIIRS, SRTM and ancillary datasets, the SWAT model will identify and map key runoff areas. | N/A |
| **Water Quality Time Series** | This time series will provide partners with a historical understanding of water quality within the Chao Phraya basin. The BMA will use this to focus health and environmental measures regarding water quality. | Based on TRMM TMI, GPM GMI, MODIS, VIIRS, SRTM and ancillary datasets, water quality, specifically sedimentation, will be mapped and a time series created for the study period. | N/A |
| **Urban Footprint Time Series** | This time series will provide the AIT with a depiction of urban development throughout the Chao Phraya basin, complementing their spatio-temporal urbanization study of the Bangkok Metropolitan area. Additionally, it will enable both partners to make connections between water quality and urbanization. | Based on SEDAC and other ancillary datasets, the urban footprint within the basin will be mapped and a time series created for the study period. | N/A |

***End-User Benefit*:** Through the SERVIR-Mekong small grant, AIT is investigating climate change scenarios and potential impacts on flooding. The upstream land cover changes on runoff and sedimentation will be complementary to their research. This project will allow them to investigate the impact of related processes without committing limited resources. BMA will benefit from additional water quality assessments that are specific to their basin, but are not limited solely to the metropolitan area.

**Project Timeline & Previous Related Work**

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

***Related DEVELOP Work:***

2016 Fall (UGA) Atlanta Water Resources III: Identifying Key Areas to Reduce Stormwater Runoff and Maximize Conservation Efforts in Metropolitan Atlanta

2016 Summer (ARC) Elkhorn Slough Ecological Forecasting: Detecting Eutrophication Sources, Hotspots, and Nutrient Levels in a Central California Estuary to Support Watershed Management Decisions

**References:**

Bidorn, Bitsawan, Kish, S., Donoghe, J., Bidorn, K., and Mama, R. (2016). Sediment transport characteristic of the Ping River basin, Thailand. *Procedia Engineering,* *154*, 557-564.

Molle, F. (2006). [Development and management of river basins: Scales, power, discourses](http://www.iwmi.cgiar.org/assessment/files_new/publications/Workshop%20Papers/RGS_2006_FMolle.pdf). RGS-IBG Annual International Conference, 30th August - 1st September, 2006. *Royal Geographical Society and Institute of British Geographers*, *London*, August 2006.

NASA SERVIR. SERVIR-Mekong grantees kick off innovative research (2017). Retrieved from https://www.servirglobal.net/Global/Articles/Article/2562/servir-mekong-grantees-kick-off-innovative-research.

Pollution Control Department, Ministry of Natural Resources and Environment. [*Thailand State of Pollution Report 2015*](http://infofile.pcd.go.th/mgt/PollutionReport2015_en.pdf?CFID=2140989&CFTOKEN=61488210). Bangkok: Pollution Control Department. Retrieved from http://infofile.pcd.go.th/mgt/PollutionReport2015\_en.pdf?CFID=2140989&CFTOKEN=61488210.

Sirikasem, Peerapong. A case of Bangkok Administration. ISO/TC211 Geographic information/Geomatics in Bangkok: Plenary Meeting.

Suif, Z., Fleifle, A., Yoshimura, C., & Saavedra, O. (2016). Spatio-temporal patterns of soil erosion and suspended sediment dynamics in the Mekong River Basin. *Science of the Total Environment,* *568,* .933-945.

U.S. Department of Agriculture, Blackland Research & Extension Center, Texas A&M AgriLife Research. (2012). Soil and water assessment tool (SWAT) fact sheet. Retrieved from http://agrilife.org/brc/files/2012/09/SWAT.2012.pdf

Vigiak, O., Malago, A., Bouraoui, F. Vanmaercke, M., Obreha, F., Peosen, J., Habe, H., Fehrer, J., & Groselj, S. (2017). Modelling sediment fluxes in the Danube River Basin with SWAT. *Science of the Total Environment, 599-600*, 992-1012.