**NASA DEVELOP National Program**

**Alabama – Marshall**

*Project Summary – Summer 2018*

**Chao Phraya Water Resources**

*Assessing Water Quality in Thailand’s Chao Phraya Watershed through Modeling Sediment Concentration and Urban Footprint*

**VPS Title:** Full Stream Ahead: Modeling Water Quality in Thailand’s Chao Phraya River and Surrounding Watershed

**Project Team**

***Project Team*:**

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**Project Overview**

***Project Synopsis*:** Throughout the last century, the Chao Phraya watershed has experienced a substantial increase in urban development, which has coincided with a decrease in water quality in the lowest reaches of the river, affecting the river’s outlet in the Bangkok Metropolitan Area. Through the utilization of NASA Earth observations and the Soil and Water Assessment Tool (SWAT model), this project identified sub-basins contributing to high sediment concentrations and analyzed the relationship between these areas and the expanding urban footprint. By better understanding the relationship between urbanization and water quality, regional stakeholders will be able to make more informed decisions as they implement measures for remediation.

***Abstract*:**

The Chao Phraya River and surrounding watershed has seen an extensive increase in urban development in the last century, while simultaneously experiencing significant degradation in water quality. Covering 30% of Thailand, the Chao Phraya watershed encompasses rural areas and major metropolitan centers, including Bangkok. The poorest water quality is found in the southernmost reaches of the river, which directly flows through the administrative capital. Due to rising concerns from the Bangkok Metropolitan Administration (BMA) and the Asian Institute of Technology (AIT), this study identifies locations to prioritize watershed remediation efforts. Using the Tropical Rainfall Measuring Mission (TRMM) Multi-Satellite Precipitation Analysis (TMPA), and Shuttle Radar Topography Mission (SRTM) datasets as inputs, this study applied the Soil and Water Assessment Tool (SWAT) to model the change in water quality over four time steps from 2003 – 2017. The change in water quality, defined as sediment concentration, was analyzed in comparison with the historical changes in the urban footprint. Additionally, a regression analysis was completed to determine the potential relationship between urbanization and sediment concentrations. The team found that the greatest increases in sediment contributions occurred in the upper and middle sub-basins of the watershed. No correlation was found between percent change in urbanization and percent change in sediment contribution from 2003-2017, suggesting that urban land cover change does not directly impact sediment loads. The results from this analysis will be used by project end users for future mitigation efforts and, more generally, to expand their use of GIS and NASA Earth observations.

**Keywords:**

SWAT model, remote sensing, NASA ACCESS, SERVIR-Mekong Regional Land Cover Monitoring System, TRMM TMPA, SRTM

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

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

***Study Period:*** January 2003 – December 2017

***Community Concern:***

* Over the last century, intense development has taken place along the Chao Phraya River, leading to an increased interest in the river’s flow and quality from academic institutions and administrative organizations.
* Changes in water quality and quantity, associated with urban expansion, affect the decision-making of lower riparian stakeholders, especially during the dry season when the available water meets just over half of the demonstrated demand.
* It is difficult for stakeholders to identify where it would be most effective to concentrate remediation efforts to improve water quality.

***Project Objectives:***

* Locate areas contributing to high sediment concentrations
* Understand the historical changes in water quality within the watershed
* Analyze the relationship between urbanization and sediment concentration

**Partner Overview**

***Partner Organizations:***

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

***Decision Making Practices & Policies***:

Bangkok is governed, in part, by the Bangkok Metropolitan Administration (BMA). The BMA is responsible for the overall well-being of the city as it oversees environmental policy, urban planning, and public health. Currently, the BMA uses GIS mapping to assist in their local infrastructure development and assessment, but the use of GIS technologies is not ubiquitous and the use of remotely-sensed data is nearly nonexistent. The Asian Institute of Technology (AIT), a postgraduate institution, uses GIS tools and processes to promote sustainable development throughout the region.

***Project Benefit to End User***:

Currently, the BMA does not have an approach to assess basin-wide land-use changes that may affect their water quality. Project results will widen the BMA’s scope of analysis by incorporating NASA Earth observations and basin-wide modeling into their decision-making processes. This project will also help increase BMA’s knowledge of the historical changes in water quality and urbanization throughout the watershed that may have contributed to the poor water quality in their area. This analysis will address the need for holistic management of the watershed and may influence the BMA’s future policy and collaborative efforts throughout the river system. On a more fundamental level, this project will provide the BMA and AIT with a replicable model for understanding the relationship between changing water quality and urban footprint expansion, which will prove useful as they expand their GIS capabilities. For AIT in particular, this project will identify opportunities for further research and provide the modeling tools to complete similar analyses in the future.

**Earth Observations & End Products Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter** | **Use** |
| **TRMM TMPA** | Precipitation | Daily precipitation data from 2000 – 2017 with a spatial resolution of 0.25° were used as a meteorological input for the SWAT model. |
| **SRTM** | Elevation | Elevation data from 2000 with a spatial resolution of 90 m were used as an input for the SWAT model. |

***Ancillary Datasets:***

NASA SERVIR Regional Land Cover Monitoring System (RLCMS) – Land use files from 2004-2016 were used as inputs into the SWAT model and for the urban footprint analysis

Food and Agriculture Organization (FAO UN) Harmonized World Soil Database v 1.2 – Soil classification map from 2003 was used as an input for the SWAT model

National Center for Environmental Prediction Climate Forecast System Reanalysis (NCEP CFSR) – Relative humidity, wind, solar radiation, and air temperature data were used for SWAT weather inputs

***Modeling:***

ArcSWAT (POC: Thailynn Munroe, World Resources Institute) – Continuous and distributed watershed model used to simulate flow and sedimentation throughout the study area.

SWAT-CUP (POC: Thailynn Munroe, World Resources Institute) – Calibrate the SWAT model

***Software & Scripting:***

Esri ArcGIS – data processing, data visualization

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Products** | **Earth Observations Used** | **Partner Benefit & Use** | **Software Release Category** |
| **Recent Average Water Quality Map** | SRTM and TRMM TMPA | This map will provide partners with a general understanding of which sub-basins are contributing the most to sediment concentrations, and thus are in most need of water quality improvement based on a recent average from 2015 – 2017. | N/A |
| **Water Quality Time Series** | SRTM and TRMM TMPA | This three-step time series will provide partners with an understanding of how water quality has changed within the Chao Phraya watershed over a 12-year time period from 2003-2014. | N/A |
| **Water Quality and Urban Footprint Percent Change Map** | SRTM and TRMM TMPA | The partners will be able to identify which sub-basins have experienced the largest percentage changes in both water quality and urban footprint within the 15 years from 2003-2017. This will be important for identifying a potential explanatory relationship between urbanization and poor water quality. | N/A |
| **Seasonal Variation Graphs** | SRTM and TRMM TMPA | These two graphs will help partners visualize the impact of land cover change on monthly variation in sediment concentration and streamflow for four time steps from 2003-2017. | N/A |

**Project Handoff Package**

**Transition Plan:**

The team sent handoff package materials to each of the project partners during the second to last week of the term. A teleconference meeting was held the following week where the team gave a brief presentation of the hand-off materials and allotted time for the project partners to ask questions about the handoff package.

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**Handoff Package:**

* Average Water Quality Map
* Water Quality Time Series
* Water Quality and Urban Footprint Percent Change Map
* Seasonal Variation Graph
* PowerPoint Tutorial – Accessing NASA EO’s and RLCMS for use in the SWAT
* Watershed and Sub-basin Shapefiles
* Precipitation text files
* Technical Paper
* Project Video
* Poster
* Presentation

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