**NASA DEVELOP National Program**

**2018 Fall Project Proposal**

**Georgia – Athens**

**Osa Peninsula Water Resources III**

*Utilizing NASA Earth Observations to Assess Threats to Mangrove Forests and Coral Reef Health to Prioritize Areas for Restoration in the Osa Peninsula, Costa Rica*

**Project Overview**

***Project Synopsis*:** The abounding rivers of the extremely biodiverse Osa Peninsula of Costa Rica are threatened by contamination due to monoculture, animal agriculture, and human settlement. NASA DEVELOP and Osa Conservation are collaborating to assess threats to the health of river, mangrove and coral reef ecosystems based on watershed land use in the Osa region. During the third term, the team will integrate several environmental and social factors to determine priority watersheds for monitoring, restoration and environmental education. They will create a series of risk assessment maps related to the health of watersheds, mangroves and coral reefs using Landsat series, Terra ASTER and MODIS, Sentinel-2 MSI, and *in situ* water quality data. These maps will allow the end users to examine the relationship between watershed land use, river water quality, mangrove forest health, and coral reefs.

***Community Concern:*** Although Costa Rica is considered a pioneer for conservation, the country relies on extensive use of agricultural pesticides and fertilizers. Pesticide pollution is the result of anthropogenic watershed degradation from an overall lack of knowledge, monitoring, and enforcement of healthy riparian land use practices. The Osa Peninsula is especially vulnerable to ecosystem loss due to its unparalleled biodiversity and endemism. This project will identify whether Forestry Law 7575, which made riparian corridors protected land in 1996, has affected rates of riparian deforestation or reforestation in the past 22 years. Additionally, mangroves are considered to be one of the most productive ecosystems in the tropics and are integral for terrestrial and marine stability in the Area of Conservation Osa (ACOSA) region. It is important to understand the effects of upstream watershed land use, river water quality, and seasonality on mangrove health to better protect them and the marine coastal ecosystem.

***Source of Project Idea:*** The project idea was originally generated by Osa Conservation’s team, including Hilary Brumberg, Noelia Hernandez and Monica Espinoza, and adapted after discussions with the DEVELOP National Program office and Georgia – Athens node leadership.

***National Application Area Addressed:*** Water Resources, Ecological Forecasting

***Study Location:*** ACOSA (Area of Conservation Osa) Costa Rica: Osa Peninsula & Golfito with an emphasis on Esquinas, Yellow-Billed Cotinga Sanctuary in Rincon, Puerto Jimenez, Sierpe Humedal & Drake Bay

***Study Period:*** January1985 – December 2017

***Advisor:*** Dr. Marguerite Madden (University of Georgia, Department of Geography)

**Partner Overview**

***Partner Organization:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| **Osa Conservation** | Dr. Andrew Whitworth, Science Director | End User | Yes |

***End-User Overview***

***End User’s Current Decision-Making Process:***Osa Conservation’s Watershed Health (Ríos Saludables) program monitors the river water quality across the Osa Peninsula through biological and chemical testing. These data are compared with the riverbank land use type through visual observations and Iniciativa Osa y Golfito (INOGO) land use land cover maps to assess the effects human activity has on river health. These results are currently used to inform targeted long-term water quality monitoring, community outreach and education efforts. Osa Conservation is currently responsible for the conservation and restoration of multiple sites across the Osa Peninsula, and is interested in focusing its future restoration efforts on riparian corridors and coral reefs. Project partners hope to collaborate with local land owners and other stakeholders to enhance sustainable restoration in assistance with the Osa Conservation’s Mangrove Restoration Project and Marine Program.

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

*Osa Conservation* – Osa Conservation has used Landsat imagery for a variety of small projects but no analysis was completed. This project combines Earth observations with other spatial data to perform analyses and generate models, which Osa Conservation does not currently have the capacity to do.

***Collaborator & Boundary Organization Overview***

***Dissemination by Boundary Organizations*:**

*Osa Conservation* – Osa Conservation will share results with their numerous and varied partners across Costa Rica, including local NGOs, the Ministry of Environment and Energy (MINAE), the National System of Conservation Areas (SINAC), and Administrative Associations of Aqueducts and Sewage Systems (ASADAS).

***Project Communication & Transition Overview***

***In-Term Communication Plan*:** The Osa Conservation team is available for weekly phone conferences and monthly Skype video conferences to offer input and guidance to the team. Additionally, the team will provide relevant maps, datasets, and documents to the DEVELOP team throughout the term.

***Transition Plan*:** The end products will be handed off to Dr. Andrew Whitworth and shared with the rest of Osa Conservation staff and community members. The combined results from both terms will be used in conservation reports, educational materials, and scientific publications.

***Letter of Support*:** Dr. Andrew Whitworth, Science Director,Osa Conservation

**Earth Observations Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameters** | **Use** |
| **Landsat 5 TM** | Land cover, turbidity  | Landsat 5 TM data will be used to examine historic changes in vegetation health, water quality, and deforestation. |
| **Landsat 8 OLI** | Land cover, turbidity  | Landsat 8 OLI data will be used to examine current vegetation health, water quality, and deforestation conditions. |
| **Terra ASTER** | Elevation | Terra ASTER data will provide topographic information and watershed delineation. |
| **Terra MODIS**  | Sea surface temperature  | Terra MODIS data will be used to determine sea surface temperature. |
| **Aqua MODIS** | Sea surface temperature | Aqua MODIS data will be used to determine sea surface temperature. |
| **Sentinel-2 MSI** | Land cover, turbidity  | Sentinel-2 MSI data will supplement the Landsat data and help in examining current vegetation health, water quality, and deforestation conditions. |

***Ancillary Datasets:***

Osa Conservation *in situ* water quality data – Validate satellite-based water quality data and assess whether river water quality affects mangrove health

Atlas Digital de Costa Rica 2008: Aqueducts, aquifers, protected areas, watersheds, geology, geomorphology, habitats affected by climate change, wetlands, lagoons, precipitation, population, provinces, rivers – Provide potential layers in Land Use Conflict Identification Model (LUCIS) to examine important physical and human factors in the area

Stanford Iniciativa Osa y Golfito (INOGO) Mapas 2012 – Compare with Landsat imagery and potentially use in LUCIS model

***Modeling:***

Land Use Conflict Identification Model (LUCIS Plus model) (POC: Dr. Rosanna Rivero, University of Georgia, College of Environment and Design)

Soil and Water Assessment Tool (SWAT) Model (POC: Dr. Adam Milewski, University of Georgia, Department of Geology)

***Software & Scripting:***

Esri ArcGIS 10.5 – raster manipulation, analysis, image enhancement, and map creation

Exelis ENVI 5.0 – image processing and classification

Sentinel Application Platform (SNAP) software – image processing

**Decision Support Tool & End Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Products** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| **Watershed Health & Water Quality Risk Maps** | Integrate many environmental and societal factors to determine priority watersheds for water quality monitoring and community outreach; pair maps with *in situ* water quality data to identify high risk parcels of riparian land to convert to productive silvicultural systems with local land owners as case studies for a national approach of sustainable riparian restoration | Landsat series, Sentinel-2, and Terra ASTER data will be used to identify the effects of changing land cover conditions on watershed health in the Osa Peninsula. | N/A |
| **Riparian Strip Deforestation & Erosion Time Series**  | Determine ecosystem longevity to calculate rates of riparian land use change; assess effectiveness of 1996 Forestry Law 7575 to show whether government enforcement is a strong approach to prevent deforestation; observe seasonal and annual changes in river morphology and erosion rates | Landsat series data will be used to identify locations where land cover conditions in the Osa Peninsula have led to deforestation.  | N/A |
| **Mangrove Health Maps** | Assess whether watershed land use and river water quality affect mangrove health by combining maps with local water quality data; observe distributional and seasonal patterns of negra forra (mangrove fern); this end product could also be used by Osa Conservation’s Mangrove Restoration Project and Marine Program | Landsat series data will be used to derive biophysical parameters used to map the health of mangrove forests in the Osa Peninsula. | N/A |
| **Turbidity & SST Time Series for Coral Resilience**  | Determine how mangrove health affects their temporal and spatial influence on the turbidity, in order to identify suitable areas for the coral viability; as well the sea surface temperature to recognize key sites for the coral restoration project | Aqua & Terra MODIS will be used to identify sea surface temperature, while Landsat 5 TM, Landsat 8 OLI, and Sentinel-2 MSI will be employed to detect turbidity levels and validate sea surface temperature. | N/A |

***End-User Benefit*:** Osa Conservation is a grassroots non-profit in Costa Rica that has been dedicated to protect this area since 2003. Their Watershed Health Program’s goal is to monitor water quality by working with communities at high risk of water contamination from human and agricultural waste. The end user will benefit from products derived from remotely sensed data to inform land management decisions along rivers and mangroves in the region. Additionally, by determining the watersheds and communities of the Osa Peninsula that are at risk, the end user can determine where to focus education and awareness efforts.

**Project Timeline & Previous Related Work**

***Project Timeline:*** 3 Terms: 2018 Spring to 2018 Fall

***Multi-Term Objectives:***

* **Term 1:** 2018 Spring (GA) – Osa Peninsula Water Resources
	+ The team examined the changes in land cover conditions for watersheds across the Osa Peninsula of Costa Rica and determined the rates of riparian land use and vegetation change. The results of this term were handed-off to partners at Osa Conservation for review.
* **Term 2:** 2018 Summer (GA) – Osa Peninsula Water Resources II
	+ The team integrated the environmental factors derived in term 1 along with SWAT model results to determine priority watersheds for water quality monitoring and to inform communities. The team examined land use and vegetation changes at a high resolution and key areas for restoration. They employed Earth observations to monitor seasonal and annual changes in river morphology and erosion rates. Final end products will be shared with partners at Osa Conservation via videoconference and in person at Annual Earth Science Applications Showcase in Washington, D.C.
* **Term 3 (Proposed Term)**: 2018 Fall (GA) – Osa Peninsula Water Resources III
	+ The team will incorporate social data provided from the project partners to the priority watershed results from the second term to help improve water quality monitoring as well as inform local communities. The team will integrate physical variables such as turbidity and sea surface temperature to determine suitable areas for a coral restoration project in Osa Peninsula. This will be linked to the health of mangrove forest since it is affected by sedimentation from land-use, where buffering mangroves will influence the sediment load reaching the marine coastal ecosystem. Additionally, the team will assess whether watershed land use and river water quality affect mangrove health by combining maps with local water quality data. Through a videoconference, the team will conduct a training webinar to explain the project methodologies and share the final products via Google Drive.

***Previous Terms:***

2018 Summer (GA) – Osa Peninsula Water Resources II

2018 Spring (GA) – Osa Peninsula Water Resources

***Related DEVELOP Work:***

2017 Summer (GA & AL) – Costa Rica Oceans: Assessing Changes in Vegetation and Marine Environments at the Isla del Coco Marine Reserve with Satellite Imagery

2016 Fall (LaRC) – Everglades Ecological Forecasting II: Utilizing NASA Earth Observations to Enhance the Capabilities of the Everglades National Park to Monitor and Predict Mangrove Extent to Aid Current Restoration Efforts

2016 Summer (GA) – Costa Rica Water Resources: Monitoring Drought and Water Balance in the Guanacaste Province to Enhance Decision Making and Response Planning in Costa Rica

2015 Summer (GA) – Costa Rica Water Resources II: Utilizing NASA Earth Observations to Develop a Comprehensive Water Budget for the Arenal-Tempisque Watershed of Costa Rica

2013 Fall (GA) – Costa Rica Ecological Forecasting: Utilizing NASA Earth Observations to Prioritize Reforestation Efforts in the Pájaro Campana Biological Corridor in Costa Rica

**Notes & References:**

***Notes*:** Social data from our project partners at Osa Conservation will be added to ancillary data when it becomes available to us. The team will also explore the MODIS chlorophyll-a products from NASA Ocean Color to aid in their water quality analysis.