**NASA DEVELOP National Program**

**2018 Summer Project Proposal**

**Georgia – Athens**

**Osa Peninsula Water Resources II**

*Assessing Threats to River Water Quality and Mangrove Health Based on Watershed Land Use on the Osa Peninsula, Costa Rica*

**Project Overview**

***Project Synopsis*:** The abounding rivers of the extremely biodiverse Osa Peninsula of Costa Rica are threatened with contamination due to monoculture, animal agriculture, and human settlement. NASA DEVELOP and Osa Conservation are collaborating to assess threats to river water quality and mangrove health based on watershed and riparian land use in the Osa region. During the second term, the team will integrate several environmental and social factors to determine priority watersheds for water quality monitoring and education. They will create watershed health and water quality risk maps and mangrove health maps using Landsat 5 TM, Landsat 7 ETM+, Landsat 8 OLI, Terra ASTER, Sentinel-2 MSI, and *in situ* water quality data. These maps will allow the team to examine the relationship between watershed land use, river water quality, and mangrove health.

***Community Concern:*** Although Costa Rica is considered a pioneer for conservation, the country relies on extensive use of pesticides and fertilizers. Pesticide pollution results from anthropogenic watershed degradation due to an overall lack of knowledge, monitoring, and enforcement of healthy riparian land use. The Osa Peninsula is especially vulnerable 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. Additionally, mangroves are considered one of the most productive ecosystems in the tropics and are integral for the biodiversity, stability, and communities of 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.

***Source of Project Idea:*** The project idea was originally generated by Hilary Brumberg and adapted after discussions with the DEVELOP National Program office and Georgia node leadership.

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

***Study Location:*** ACOSA region Costa Rica: Osa Peninsula & Golfito with an emphasis on Esquinas, 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** | Hilary Brumberg, Research Fellow, Watershed Health Program Coordinator | End User | Yes |

***End-User Overview***

***End User’s Current Decision-Making Process:***Osa Conservation’s Watershed Health (Ríos Saludables) program monitors the water quality in rivers 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 (LULC) maps to assess the effects of human activity on river health. These basic results are currently used to inform targeted long-term water quality monitoring and 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. Project partners hope to develop productive silvicultural systems with local land owners to enhance sustainable riparian restoration and to assist 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 images for a variety of small projects. The imagery were used, but no analysis was completed. This project combines NASA Earth observations with other spatial data to perform analysis and 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*:** Hilary Brumberg is available for weekly phone conferences and monthly Skype video conferences to offer input and guidance to the team. Additionally, she will provide relevant maps, datasets, and documents to the DEVELOP team throughout the term.

***Transition Plan*:** The end-products will be handed off to Hilary Brumberg 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.

***Letters of Support*:** Dr. Andrew Whitworth, Director of Restoration Ecology & Biodiversity Conservation**,** Osa Conservation.

**Earth Observations Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter(s)** | **Use** |
| **Landsat 5 TM** | Land cover, water quality | Landsat 5 data will be used to examine historic changes in vegetation health, water quality, and deforestation. |
| **Landsat 7 ETM+** | Land cover, water quality | Landsat 7 data will be used to examine historic changes in vegetation health, water quality, and deforestation. |
| **Landsat 8 OLI** | Land cover, water quality | Landsat 8 data will be used to examine current vegetation health, water quality, and deforestation conditions. |
| **Terra ASTER** | Elevation | Terra data will provide topographic information and watershed delineation. |
| **Sentinel-2 MSI** | Land cover, water quality | Sentinel 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 – Potential layers in Land Use Conflict Identification Model to examine important physical and human factors in 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 and analysis, image enhancement & 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 Product** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| **Watershed Health & Water Quality Risk Maps** | Integrate many environmental and social factors to determine priority watersheds for water quality monitoring and education; 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 example 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; if correlations are observed, would further encourage government, local, and scientific communities to maintain healthy rivers through improved knowledge, monitoring, and enforcement; observe distributional and seasonal patterns of negra forra (mangrove fern); 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 |

***End-User Benefit*:** Osa Conservation is a NGO in Costa Rica that works with communities at high risk of water contamination from human and agricultural waste, with the goal of monitoring water quality. The end user is in need of research that will inform land management decisions along rivers in this extremely biodiverse study area. Additionally, the program has an environmental education component, and by determining the watersheds and communities of the Osa Peninsula that are at risk, the end user can determine where to focus education efforts.

**Project Timeline & Previous Related Work**

***Project Timeline:*** 2 Terms: 2018 Spring to 2018 Summer

***Multi-Term Objectives:***

* **Term 1:** 2018 Spring (GA) – Osa Peninsula Water Resources
  + In the first term of the project, the team examined the changes in land cover conditions for watersheds across the Osa Peninsula of Costa Rica. The team determined the rates of riparian land use change and used Earth observations to monitor seasonal and annual changes in river morphology and erosion rates. The results of this term were handed-off to partners at Osa Conservation for review.
* **Term 2 (Proposed Term):** 2018 Summer (GA) – Osa Peninsula Water Resources II
  + In the second term of this project, the team will integrate the environmental factors derived in the previous term along with social data provided by our partners to determine priority watersheds for water quality monitoring and education. Additionally, the team will assess whether watershed land use and river water quality affect mangrove health by combining maps with local water quality data. Final end-products will be shared with partners at Osa Conservation via videoconference.

***Previous Terms:***

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 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. Details regarding *in situ* water quality data will be provided at the beginning of the first term for this project. The team will also explore the MODIS chlorophyll-a products from NASA Ocean Color to aid in their water quality analysis.