**NASA DEVELOP National Program**

**Georgia – Athens**

*Project Summary – Spring 2018*

**Osa Peninsula Water Resources**

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

**VPS Title:** Water You Waiting For? Protecting Water Resources in the Osa Peninsula, Costa Rica

**Project Team**

***Project Team*:**

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**Project Overview**

***Project Synopsis*:** NASA DEVELOP and Osa Conservation collaborated to assess the impacts of forestry laws and protected areas on changes in land use and other human activities affecting biodiversity, watershed health, and water quality in the Osa Peninsula of Costa Rica. A time series analysis of satellite imagery revealed risk factors and patterns between public policy, land use change, deforestation, and erosion. Results and outreach materials from this project will further assist Osa Conservation in their efforts to educate the public, inform environmental policy decisions, and support the restoration of biodiversity in the Osa Region.

***Abstract*:**

The Osa Peninsula, located in the southern region of Costa Rica’s Pacific Coast, is one of the most biologically-diverse places on Earth and is a popular ecotourism destination. However, the area faces watershed degradation and loss of biodiversity due to deforestation, pollution from agriculture, and human settlement. NASA DEVELOP worked with Osa Conservation to analyze land use and land cover change in the Osa Peninsula to better understand threats to river water quality and mangrove health. This project used Landsat 5 Thematic Mapper (TM), Landsat 8 Operational Land Imager (OLI), and Terra Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) to create a land cover time series map from 1987 to 2017. These time series data were used to compare land use over time, as well as patterns in water quality, mangrove health, erosion, and deforestation. The time series also helped to identify the impact of the creation of protected areas and the 1996 Forest Law 7575, which aimed to support reforestation and riparian health. Osa Conservation will use and distribute results to the National System of Conservation Areas (SINAC), Ministry of Environment and Energy (MINAE), and local communities to inform land management decisions, policy enforcement, education and outreach initiatives, and watershed restoration and monitoring.

**Keywords:**

Biodiversity, watershed health, river health, water quality, land use change, mangrove health, Landsat, ASTER

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

***Study Location:*** Area of Conservation Osa (ACOSA), Costa Rica: Osa Peninsula and Golifo with an emphasis on Esquinas, Rincon, Puerto Jimenez, Sierpe Humedal and Drake Bay

***Study Period:*** January 1987 – December 2017

***Community Concern:***

* Costa Rica had one of the highest deforestation rates in the world during the 1980s, with forest cover decreasing from over 50% during the 1940s to 29% by 1986. In response to this, the Costa Rican government introduced Forest Law 7575 in 1996, which aims to support reforestation by protecting riparian zones and compensating landowners for conservation efforts. Understanding land use change patterns before and after the implementation of these policies will help Osa Conservation identify their effectiveness and how lands in area watersheds have been used. This knowledge will help provide information important for the development of environmental policy and public education.
* Agriculture is the principle reason for deforestation across Costa Rica. Important monocultures that have replaced forests have been non-native palm oil, teak, and cattle pastures. Understanding the change in area used for each type of agriculture will help determine the impact on water quality of rivers in the Osa Peninsula.
* The combination of land use change and agricultural practices have led to a decrease in biodiversity in the Osa Peninsula. This leads to a decrease in native species and less productive ecosystems. In addition, the local ecotourism economy of the Osa Peninsula will be negatively impacted if the current rate of biodiversity loss continues.
* Byproducts of agriculture and deforestation have decreased the water quality of rivers in the Osa Peninsula. This ultimately has a negative impact on the many endemic and endangered species in the region. There is a growing need to discern which watersheds are at the highest risk of being affected by human activities. This will allow conservationists to better target educational programs, policy enforcement, and monitoring initiatives.
* Mangroves are integral to the biodiversity and stability of the region’s ecosystem and economy. In order to better protect them, it is vital to understand how land use in watersheds within the Osa Peninsula impacts their health. If links are found between mangrove health and water quality, this places further emphasis on the importance of watershed conservation efforts.

***Project Objectives:***

* Produce high resolution time series maps of land use and land cover change in the Osa Peninsula between 1987-2017
* Determine rates of land use change in riparian zones
* Quantify the effectiveness of the 1996 Forest Law 7575 in curbing deforestation and erosion in riparian zones
* Create accessible public outreach materials to inform the local community on how to implement sustainable practices

**Partner Overview**

***Partner Organization:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| **Osa Conservation** | Hilary Brumberg, Watershed Conservation (Ríos Saludables) Program Coordinator | End User | Yes |

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

The Osa Conservation Watershed Conservation Program (Ríos Saludables) currently uses biological and chemical testing to monitor the river water quality across the Osa Peninsula. The data collected from these tests are compared with land use type through visual observations and maps created by the Iniciativa Osa y Golfito (INOGO) land use land cover (LULC) maps. These basic results assess the effects of human activity on river health and are 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, including developing a case study of community-based riparian corridor restoration.

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

Osa Conservation has used Landsat imagery for a variety of small projects, but no analyses have been conducted. This project combines NASA Earth observations with other spatial data to perform analyses that will provide greater insight into the relationship between land use change and water quality on a greater temporal spectrum. One application of this analysis will be to gauge the effect that the 1996 Forest Law, which designated riparian corridors as protected land in Costa Rica, has had on riparian deforestation and reforestation. This will allow Osa Conservation and their collaborators to better understand how historical land cover changes have driven water quality degradation in the region. These insights will help improve land management decisions and more efficiently protect and restore watershed areas.

**Earth Observations & End Products Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter** | **Use** |
| **Landsat 5 TM** | Land cover | Landsat 5 TM data were used to examine historical changes in land use and deforestation. |
| **Landsat 8 OLI** | Land cover | Landsat 8 OLI data were used to examine current land use and deforestation. |
| **Terra ASTER** | Elevation | Terra ASTER data were used to create a DEM of the study area. |
| **PlanetScope** | Land cover  | Data from PlanetScope were used to examine recent land cover and to validate the results of the Landsat 8 OLI.  |

***Ancillary Datasets:***

Atlas Digital de Costa Rica 2008 and 2014 – Aqueducts, aquifers, protected areas, watersheds, geology, geomorphology, habitats affected by climate change, wetlands, lagoons, precipitation, population, provinces, rivers – Inform land use classification

Stanford Iniciativa Osa y Golfito (INOGO) Mapas 2012 – Compare land use classifications from 2012 with Landsat imagery

***Software & Scripting:***

ESRI ArcGIS 10.5 – Classification of Landsat and PlanetScope imagery and map creation

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Product** | **Earth Observations Used**  | **Partner Benefit & Use** | **Software Release Category** |
| **Land Cover Time Series** | Landsat 5 TM Landsat 8 OLI PlanetScope  | Landsat and PlanetScope data were used to identify locations that have undergone major deforestation, reforestation, and land use change. Elevation data were also used for visualization of land use and deforestation. This will help Osa Conservation better understand historic land cover change. | N/A |
| **NDVI Analysis Map** | Landsat 5 TM Landsat 8 OLI  | NDVI maps from different study periods (1987, 1999 and 2017) were used to identify vegetation over time. | N/A |

**Project Handoff Package**

**Transition Plan:**

The Osa Peninsula Water Resources team hosted a virtual hand-off event with the project partners to present findings and share end products. The team also provided the partners with a package that included all the deliverables from this term and discussed any questions about the project or planning for future terms.

*Project Continuation Plan*: Based on partner consultation and feedback, the next term will pursue the following objectives:

* Define and integrate environmental and social factors to produce watershed health and water quality risk maps
* Identify areas of mangrove deforestation and mangrove species at risk, produce mangrove health maps, and combine local water quality data to assess whether watershed land use and river water quality affect mangrove health

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**Handoff Package:**

* Land Cover Time Series Map
* NDVI Analysis Map
* Final Deliverables
* Project Video

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