**NASA DEVELOP National Program**

**2017 Summer Project Proposal**

**University of Georgia & Mobile County Health Department**

**Costa Rica Oceans**

*Utilizing NASA Earth Observations to Assess Changes in Shoreline and Marine Communities at the Isla del Coco Marine Resources*

**Project Overview**

***Project Synopsis*:** The Isla del Coco Marine Reserve located off the coast of Costa Rica is currently threatened by a number of environmental concerns including coral bleaching, shoreline erosion, and changes in ocean temperatures. The DEVELOP team will assist the Sistema Nacional de Áreas de Conservación de Costa Rica, Embassy of Costa Rica to the United States, and the Ministry of Environment and Energy - Water Directorate through the assessment of historical and current conditions. The team will work to create time series analysis products using Landsat 5, 7, and 8, Sentinel-2, Aqua and Terra MODIS, ASTER, and SUOMI NPP VIIRS data. These products will assist reserve management in evaluating historical and current conditions of the reserve and provide them with additional information to create informed decisions.

***Community Concern:*** Isla del Coco is a small island (about 24 km2) located 532 km off the Costa Rica Pacific coast. The island was declared a National Park by the Costa Rican government in 1978 and a World Heritage site by UNESCO in 1997 due to its natural richness in biodiversity. Over the last decade local researchers and the resident staff have detected a steady increase in coral reef bleaching likely likely influenced by increasing sea surface temperatures, deeper water temperatures, and changes in exposure to solar radiation at the Isla del Coco and the Marina of Manejo Montes Submarinos in the deeper zones. This threatens not only the primary framework of the local reefs but also their ecological services (i.e., coastal protection, recruitment and nursery grounds for ecologically and economically important fish and invertebrate species, recreation, etc.). Further, the isle’s shoreline has experienced increased coastal erosion that threatens the national parks’ infrastructure.

***Source of Project Idea:*** Ing. Marco Vinicio Araya Barrantes (Conservation Director of the Marine Conservation Area Cocos) presented the idea to the Costa Rican Embassy representative Ms. Alejandra Solano Cabalceta who contacted DEVELOP NPO for the potential of conducting such project. Based on the previous collaborations between the UGA node and the Costa Rican government and the advisor expertise on ocean-related matters, particularly on shallow-water tropical ecosystems and the recently conducted marine/water health projects, the present project represents an excellent opportunity for conducting joint research between these two nodes.

***National Application Area Addressed:*** Oceans

***Study Location:*** Costa Rica, Isla del Coco Marine Reserve

***Study Period:*** March 1984 – July 2017

***Advisors:*** Dr. Marguerite Madden (University of Georgia), Dr. Deepak Mishra (University of Georgia), Dr. Cedric Fichot (Boston University), Joe Spruce (SSAI)

**Partner Overview**

***Partner Organizations:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| Sistema Nacional de Áreas de Conservación de Costa Rica, Área de Conservación Marina Isla del Coco (Costa Rica) | Ing. Marco Vinicio Araya Barrantes, Conservation Director of the Isla del Coco Marine Reserve | End-User | No |
| Embassy of Costa Rica to the United States | Ms. Alejandra Solano Cabalceta, External Affairs Officer | Collaborator | Yes |
| Ministry of Environment and Energy, Water Directorate (DA-MINAE) (Costa Rica) | Vivian Gonzalez Jimenez, Project Engineer | Collaborator | Yes |

***End-User Overview***

***End-User’s Current Decision-Making Process:***

The Marine Conservation Area Cocos is managed by the Sistema Nacional de Áreas de Conservación de Costa Rica (SINAC) which is part of the Ministry of Environment and Energy of Costa Rica. SINAC has instrumental legal authority which allows them to dictate policy, plan, and implement processes aimed at achieving sustainability in the management of natural resources in Costa Rica.

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

*Sistema Nacional de Áreas de Conservación de Costa Rica, Área de Conservación Marina Isla del Coco (Costa Rica)* – The Isla del Coco Conservation Area has a permanent staff in charge of the daily operations (park rangers, biologists, researchers and marine operators). Research is conducted on the biodiversity of the island and there is limited access to NASA Earth observations due to the remoteness of the island. Their aim is “to have a set of data spanning over a set of years of the changes in the superficial temperature of the ocean, bleaching coral reefs, the behavior of the isle’s shoreline, the cloud cover over the national parks, among other variables that will allow us to understand new trends causes by climate change.”

***Collaborator & Boundary Organization Overview***

***Collaborator Support:***

*Embassy of Costa Rica to the United States* – The Embassy of Costa Rica to the United States is familiar with DEVELOP projects and has partnered with DEVELOP in the past. While they are aware of and have used NASA Earth observations before, the proposed project will continue to enhance their capacity and familiarity with NASA Earth observations.

*Ministry of Environment and Energy, Water Directorate (DA-MINAE) (Costa Rica)* – DA-MINAE is responsible for the management, conservation, and sustainable development of the environmental and natural resources of the country, and the Water Directorate is responsible for the management of water resources. In support of this mission and in response to the ongoing drought in Guanacaste, DA-MINAE is managing the PIAAGwhich aims to coordinate all institutions focused on the water sector (e.g., research, infrastructure, water management) towards monitoring and mitigating the impacts of the drought on the country’s natural resources and peoples.

***Dissemination by Boundary Organizations*:**

*Embassy of Costa Rica to the United States* – The Embassy will disseminate project results to officials in the Costa Rican government to inform them of our findings. This will help promote local action strategies for further conservation of Isla del Coco terrestrial and marine resources.

*Ministry of Environment and Energy, Water Directorate (DA-MINAE) (Costa Rica)* – MINAE will disseminate project results to decision makers in the water sector to inform them of our findings. This will also help promote local action strategies for further conservation of Isla del Coco terrestrial and marine resources.

***Project Communication & Transition Overview***

***In-Term Communication Plan*:** Ing. Marco Vinicio Araya Barrantes and the ACMIC personnel will communicate with the team about three times throughout the summer term via Skype. Teams at UGA and MCHD will communicate regularly through meetings at the beginning and end of each week in order to establish weekly goals and targets. Additional communication during the week will be conducted via email and Google Hangout to share ideas and methods between nodes.

***Transition Plan*:** Results from the shoreline and environmental variables assessment will be provided to the end-users through a cloud environment (such as Google Drive) and all reports, tutorials, and documents will be shared via email. The project results will be presented to the interested parties through a webinar at the end of the summer term. Software release will not be necessary as the team will be providing model outputs, as opposed to Python scripts.

**Earth Observations Overview**

***Earth Observations:***

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| --- | --- | --- |
| **Platform & Sensor** | **Parameters** | **Use** |
| **Landsat 5 TM** | Normalized Difference Vegetation Index (NDVI), Near-Infrared / Red Band Ratio (Near-IR/R) | Will be used to evaluate historical changes in vegetation health over time |
| **Landsat 7 ETM+** | Normalized Difference Vegetation Index (NDVI), Near-Infrared / Red Band Ratio (Near-IR/R) | Will be used to evaluate historical and current changes in vegetation health over time |
| **Landsat 8 OLI** | Normalized Difference Vegetation Index (NDVI), Near-Infrared / Red Band Ratio (Near-IR/R), Coastal band (B1), Panchromatic sharpening | Will be used to evaluate historical and current changes in vegetation health over time in addition to water quality parameters |
| **Aqua MODIS** | Sea Surface Temperature (SST), Remote Sensing Reflectance (Rrs), Chlorophyll A (Chl-a), Photosynthetically Available Radiation (PAR), Colored Dissolved Organic Matter (CDOM) | Will be used to assess water quality parameters and create a time series of changes in water quality over time |
| **Terra ASTER** | Elevation | Will be used to incorporate elevation data into analysis |
| **Terra MODIS** | Sea Surface Temperature (SST), Remote Sensing Reflectance (Rrs), Chlorophyll A (Chl-a), Photosynthetically Available Radiation (PAR), Colored Dissolved Organic Matter (CDOM) | Will be used to assess water quality parameters and create a time series of changes in water quality over time |
| **Suomi NPP VIIRS** | Sea surface temperature (SST), Remote Sensing Reflectance (Rrs), Chlorophyll A (Chl-a) | Will be used to assess water quality parameters and create a time series of changes in water quality over time |
| **Sentinel-2 MSI** | Land cover (shoreline detection), Chlorophyll A (Chl-a) | Will be used to create high resolution maps of land cover and shoreline change |

***Ancillary Datasets:***

USGS - Water-Quality Data for the Nation - Provides chemical, physical, and biological properties of water throughout the U.S. (including American Samoa). Also provides water statistics on a daily basis along with historical data.

NOAA - Coral Reef Information System (CoRIS) - Extensive list of data sets such as bathymetry, fish stock characteristics, shorelines, ocean geochemistry, water quality, critical habitats, socioeconomic information, and coral imagery.

WorldFish - ReefBase - Public data and research database for all large-scale coral reef studies. This includes a Reef Manager Toolbox, a collection of manuals and guidelines from various projects and organizations.

The Nature Conservancy - Reef Resilience Toolkit - Provides the latest information, guidance, and resources to help managers address climate change impacts on local coral reef ecosystems.

***Software & Scripting:***

Exelis ENVI – image processing

Esri ArcGIS – map creation

Python – SeaDAS processing

MatLab – statistical analysis of oceanic variables

**Decision Support Tool & End Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Products** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| **Isla del Coco Vegetation Time Series Analysis** | This analysis will help the end-users identifying potential patterns of vegetation loss or changes in forest structure. | This dataset will consist of a NDVI time series for the study area based on Landsat data from 1984 to present day. | I |
| **Coastline Change Time Series Analysis** | This aims to aid decision-making officials on assessing potential climate change related factors that may be affecting the islands coastline. | This end-product will be based on the environmental context and use TerrSet Earth Trends Modeler to assess the most significant environmental contributions to shoreline changes. | I |
| **Time Series Analysis of Environmental Variables (SST, CDOM, Chl-a, Kd) Affecting the Health of the Island’s Coral Reefs** | This aims to aid decision-making officials on assessing potential climate change related factors that may be affecting the island’s shallow-water marine ecosystems. | This end-product will consist of a time-series of environmental variables (SST, CDOM, Chl-a, Kd) from 1999 to present day. | N/A |

***End-User Benefit*:** The project methodologies will provide a replicable process for Isla del Coco Marine Reserve managers to enhance remote monitoring capabilities, providing a new means for measuring change. Improved understanding of the island’s vegetation health, coastal erosion, and water quality variables will support the Isla del Coco Marine Reserve in environmental decision making.

**Project Timeline & Previous Related Work**

***Project Timeline:*** 1 Term: 2017 Summer

***Related DEVELOP Work:***

2017 Spring (LaRC-JPL) - Mississippi Sounds Water Resources: Synthesizing Trends in Water Quality Parameters Affecting Reef Health in the Mississippi Sound Using NASA Earth Observations

2014 Summer (ARC) - America Samoa Oceans: Evaluating a Watershed Modeling Approach for Water Quality on Near-Shore Coral Reef Ecosystems in America Samoa Using NASA Earth Observations

**Notes & References:**

***Notes*:** As this will be a joint project, the MCHD and UGA have decided to distribute the workload between the two nodes. UGA will focus efforts on creating the Time Series Analysis of Environmental Variables Affecting the Health of the Island’s Coral Reefs and the Coastline Change Time Series Analysis. MCHD will focus their efforts on the creation of an Isla del Coco Vegetation Time Series Analysis.

***References:***

NOAA Coral Reef Information System (2017 April 11). *Coral Reef Information System.* Retrieved from <http://www.coris.noaa.gov/>

NOAA Coral Reef Watch (updated daily). *Coral Reef Watch Satellite Monitoring.* Retrieved from <http://coralreefwatch.noaa.gov/satellite/index.php>

Área de Conservación Marina Isla del Coco (2017). *Área de Conservación Marina Isla del Coco.* Retrieved from <http://www.isladelcoco.go.cr/>

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