**NASA DEVELOP National Program**

**2020 Spring Project Proposal**

**Georgia – Athens**

**Costa Rica & Panama Ecological Forecasting II**

*Identifying Current and Future Areas of Environmental Concern in La Amistad International Park for Resource Management*

**Project Overview**

***Project Synopsis*:** The Mesoamerican Biological Corridor integrates protected areas into a single conservation area, encompassing over 600 protected areas across Central America. This project will analyze land use change in protected areas initially implemented in the corridor’s plan in southern Costa Rica and northern Panama. This project will use the Land Use Conflict Identification Strategy (LUCIS) model by applying weight to classes established in a 2019 land use map created using Landsat 5 TM and Landsat 8 OLI, and a 2029 land cover forecast. The resulting map will help to identify and forecast potential conflict areas in land conservation. The project will also address the partners’ need for a short-term forest change tool that will allow partners to monitor major forest changes in the corridor. These products will assist in renewing conversations between land managers and agencies involved in the coordination of the corridor.

***Community Concern:*** The 202,230 square miles of Central America is home to 7% of all scientifically known life forms. Due to a lack of biodiversity conservation in the area, Belize, Guatemala, El Salvador, Honduras, Nicaragua, Costa Rica, Panama, and southern portions of Mexico banded together to create the Mesoamerican Biological Corridor with the idea of preserving biodiversity and supporting sustainable economic development. Since the establishment of the Mesoamerican Biological Corridor in 1997, deforestation has continued to plague the area and the sustainability of the corridor continues to be a challenge, with indigenous land rights impacted, agriculture and development expansion, and the strain of financial and natural resource management. Countries within the corridor region have spent money on transboundary and conservation initiatives and trained officials but communication and conservation strategies have not been concrete. Although the focus of this project will be La Amistad International Park, other portions of the corridor may also be considered.

***Source of Project Idea:*** This project was introduced to the Georgia – Athens NASA DEVELOP node as part of NASA’s call for projects in the SICA region. Conversations on the current ecological needs for the region between Fellow, Shelby Ingram, Dr. Kenton Ross, DEVELOP National Science Advisor, and Amanda Clayton, DEVELOP Projects Manager, led to the development of this project. The first term of the project provided the partners with historical and future land use map for the La Amistad region. The second term was established to provide partners with modeled information related to the risk of each land use change and improve access to imagery and data within the forest change tool.

***National Application Area Addressed:*** Ecological Forecasting

***Study Location:*** La Amistad International Park, Costa Rica, and Panama

***Study Period:*** January1999 – July 2019; Forecasting to 2029

***Advisors:*** Dr. Marguerite Madden (University of Georgia, Department of Geography), Dr. Rosanna Rivero (University of Georgia), Dr. Sergio Bernardes (University of Georgia, Department of Geography)

**Partner Overview**

***Partner Organizations:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| **Ministerio de Ambiente y Energía, Centro Nacional de Información Geoambiental (Costa Rica)** | Rafael Monge, Director  | End User | Yes |
| **Autoridad Nacional del Ambiente (Panama)** | Roney Samaniego, Environmental Information Systems Analyst | End User | Yes |

***End User Overview***

***End User’s Current Decision-Making Process:***The Costa Rican Ministerio de Ambiente y Energía promotes and contributes to management, conservation, and sustainable development by enacting laws and engaging in international agreements. The Centro Nacional de Información Geoambiental(CENIGA) provides the scientific and environmental knowledge for the larger organization. The energy, environment, seas, and land management projects completed by CENIGA directly result in legal amendments. They currently coordinate with organizations that use remote sensing and *in situ* observations. The National Environmental Authority of Panama also determines policies for the conservation, protection, and restoration of the environment. Most sustainability and biodiversity conservation policy and activities follow the Sustainable Production and Biodiversity Conservation Systems Project. Some remote sensing data and products are used.

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

*Ministerio de Ambiente y Energía, Centro Nacional de Información Geoambiental (Costa Rica)*– The end users are familiar with NASA Earth observations and some possibilities of their use. From conversations, it seems that most of the integration of Earth observation data is out-sourced to another sector of the organization. This project will increase their knowledge of the use of Earth observations and provide them with a tool that they can operate in-house.

*Autoridad Nacional del Ambiente (Panama)*– The end users are familiar with NASA Earth observations and some possibilities of their use. From conversations, it seems that most of the integration of Earth observation data is out-sourced to another sector of the organization. This project will increase their knowledge of the use of Earth observations and provide them with a tool that they can operate in-house.

***Collaborator & Boundary Organization Overview***

***Dissemination by Boundary Organizations*:**

*Ministerio de Ambiente y Energía, Centro Nacional de Información Geoambiental (Costa Rica)*– CENIGA is in charge of sharing scientific and environmental knowledge across the country. Additionally, one of their guiding principles is communication. Through this principle, they disseminate information within the National Environmental Information System and guarantee transparency in the management of institutional resources and international cooperation.

*Autoridad Nacional del Ambiente (Panama)*– The Autoridad Nacional del Ambiente provides communities with ways to sustainably use natural resources and guides the development of conservation projects. Since they have established relationships with communities, they have the capability to integrate the results of this project into current and future projects. They also offer training, which serves as a way to disseminate information to other officials and the public.

***Project Communication & Transition Overview***

***In-Term Communication Plan*:** Node leadership and DEVELOP’s NPO will organize a Webex with the team and partners during week one of the term. Following the initial meeting, the Project Lead will serve as the point of contact and will schedule bi-weekly Webex meetings with the partners to provide updates, ask and answer questions.

***Transition Plan*:** The team will present their final results to the partners during week 10 of the term. All end products with the exception of the tool will be emailed following the presentation of them and NASA export control. Software release IV will be required for the tool and partners are aware of the NASA software release process. While awaiting release, partners will be provided an operator manual so they will have the capacity to use the tool once it is released.

**Earth Observations Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameters** | **Use** |
| **Terra MODIS** | Surface reflectance  | Terra MODIS will be used to map land cover for forest cover change analysis. The 8-day temporal resolution will provide more imagery  |
| **Landsat 7 ETM+** | Surface reflectance | Landsat 7 ETM+ will be used to map land cover for forest cover change analysis. |
| **Landsat 8 OLI** | Surface reflectance | Landsat 8 OLI will be used to map land cover for forest cover change analysis.  |
| **Sentinel-2 MSI** | Surface reflectance | Sentinel-2 MSI will be used to supplement Landsat data when cloud-free imagery is not available. |

***Ancillary Datasets:***

* Japan Aerospace Exploration Agency (JAXA) Advanced Land Observing Satellite Digital Surface Model (ALOS DSM) – Topographic information used for accurately assigning classification cutoffs for land cover
* Open Geospatial Consortium Services of the National Territorial Information System –Information on political administrative divisions, river basins, and roads to use in determining land features and areas within the park
* National Museum of Costa Rica National Biodiversity Portal – Shapefiles of protected/threatened species used to locate critical areas for biodiversity

***Modeling:***

* Land Use Conflict Identification Strategy (LUCIS) (POC: Dr. Rosanna Rivero, University of Georgia) – Modeling connectivity between protected lands for strategic land use planning

***Software & Scripting:***

* Esri ArcMap 10.7 – Map creation
* Google Earth Engine API – Image processing, modeling

**Decision Support Tool & End Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Product** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| **Current Land Use Conflict Potential Map** | Results of current land conflicts to biodiversity assist the partners in short term decision making for targeted conservation.  | This map will use the classes distinguished in the 2019 land use map created with sensors from the Landsat series in the first term. Assigning weights to the classes and supplemental environmental data in the LUCIS model will provide this map of information on areas of immediate biodiversity concern. | N/A |
| **Forecasted Land Use Conflict Potential** | Partners will be able to recognize the types of agriculture and development that will impose the greatest threat to forest cover and biodiversity in La Amistad so they can focus conservation efforts for the future. | This map will use the classes distinguished in the forecasted 2029 land use map created with sensors from the Landsat series and QGIS in the first term. Assigning weights to the classes and supplemental environmental data in the LUCIS model will provide this map of information on areas of immediate biodiversity concern. | N/A |
| **Short-term Forest Change Tool** | This tool will enable partners to process monthly maps of forest change in protected lands in Costa Rica and Panama. This will increase conservation conversations and assist in the future of corridor links. | This decision-support tool will assess forest disturbances in La Amistad using Terra MODIS, Landsat 5 TM, Landsat 8 OLI and Sentinel-2 MSI. The base of the code will come from Hansen Global Forest Change. | IV |
| **Short-term Forest Change Tool Operating Procedures Manual** | This procedural document will serve as a manual for partners to use while using the Short-term Forest Change Tool. | N/A | N/A |

***End User Benefit*:** This project will benefit conservation goals throughout the Mesoamerican Biological Corridor. Areas in La Amistad International Park that are at risk of forest cover and soil type changes that could impact biodiversity will be evident and officials will be able to decide on the future course of action in those areas. The short-term forest change tool and potential conflict maps will assist partners in communicating the impact of local agriculture and development in La Amistad on biodiversity.

**Project Timeline & Previous Related Work**

***Project Timeline:*** 2 Terms: 2019 Fall to 2020 Spring

***Multi-Term Objectives:***

* **Term 1:** 2019 Fall (GA) – Costa Rica & Panama Ecological Forecasting
	+ The first term of the project used Landsat data to classify land use and land cover in La Amistad International Park. In addition to creating maps for three decadal dates, the project team also forecasted land use to the year 2029. The forecast identified potential land cover types for term II to utilize in the LUCIS model. Additionally, the team modified and updated a previous NASA DEVELOP tool in Google Earth Engine to produce the Forest Change Detection Tool 2.0. The products from this term enabled partners to understand the general land cover existing on both the Costa Rica and Panama sides of the park and identify areas that have seen the greatest change over time.
* **Term 2 (Proposed Term):** 2020 Spring (GA) – Costa Rica & Panama Ecological Forecasting II
	+ The decadal and forecasted land use and land cover maps from term I will be used in the LUCIS model. The team will identify areas facing the greatest land use pressure from forecasted agriculture and development. Following the in term I handoff, partners expressed the need for a more user-friendly tool. Term II will create a tool to assist with identifying short-term forest gain and loss. This tool will better address the end user’s day-to-day needs. The final project handoff will consist of demonstrations of how the model was applied and how to run the tool.

***Previous Terms:***

2019 Fall (GA) – Costa Rica & Panama Ecological Forecasting: Detecting Land Change Along the Mesoamerican Biological Corridor in Costa Rica and Panama for Targeted Resource Management

***Related DEVELOP Work:***

2016 Spring (LaRc) – El Salvador Ecological Forecasting: Utilizing NASA Earth Observations to Develop a Historical Baseline Trajectory of Changes in Forest Cover and Degradation Indicators in El Salvador

2016 Fall (GSFC) – Kenya Ecological Forecasting: Estimating Carbon Sequestration within Global Environment Facility Funded Protected Areas in Kenya to Aid Future Policy

2018 Summer (GA) – Honduras Ecological Forecasting: Utilizing NASA Earth Observations to Develop a Forest Change Detection Tool for Land Conservation in Honduras

2019 Summer (GA) – Talamanca-Osa Ecological Forecasting II: Assessing Habitat Suitability and Human-Jaguar Conflict Areas to Identify Potential Jaguar Corridors Connecting La Amistad and Corcovado National Parks in Costa Rica

**Notes & References:**

***Notes*:** This project continues DEVELOP’s role in the NASA and SICA joint statement signed in March of 2019.

***References:***

Anderson, E. R., Cherrington, E. A., Tremblay-Boyer, L., Flores, A. I., & Sempris, E. (2008). Identifying critical areas for conservation: Biodiversity and climate change in Central America, Mexico, and the Dominican Republic. *Biodiversity, 9*(3-4), 89-99. <https://doi.org/10.1080/14888386.2008.9712912>

Dettman, S. (2006). The Mesoamerican Biological Corridor in Panama and Costa Rica: Integrating bioregional planning and local initiatives. *Journal of Sustainable Forestry, 22*(1/2), 15-34. doi:10.1300/J091v22n01\_02

Ministerio De Ambiente. (n.d.). Sistemas de producción sostenible y conservación de la biodiversidad. Retrieved from <http://produccionsostenibleybiodiversidad.org/>

Ministerio De Ambiente. (n.d.). Welcome to MiAMBIENTE. Retrieved from <https://miambiente.gob.pa/>

Ministerio de Ambiente y Energía. (2019). Centro Nacional de Información Geoambiental. Retrieved from <http://ceniga.go.cr/?page_id=134>

Ministerio de Ambiente y Energía. (2018). Misión y vision. Retrieved from <https://minae.go.cr/acerca-de/acerca-del-minae/mision-y-vision>

Rivera, V. S., Cordero, P. M., Cruz, I. A, & Borrás, M. F. (2002). The Mesoamerican Biological Corridor and local participation. *Parks, 12*(2), 42-54. Retrieved from <https://www.researchgate.net/profile/Christo_Fabricius2/publication/229076648_Do_rural_people_really_benefit_from_protected_areas_-_Rhetoric_or_reality/links/58a060f8a6fdccf5e96e5c16/Do-rural-people-really-benefit-from-protected-areas-Rhetoric-or-reality.pdf#page=44>