**NASA DEVELOP National Program**

Langley Research Center

**Fall 2015**

**Short Title:** **El Salvador Ecological Forecasting**

**Subtitle:** Utilizing NASA Earth Observations to Develop a Historically Based Trajectory of Deforestation and Degradation in El Salvador

**VPS Title:** The Time to Act is Now! Using Historical Landsat Data to Forecast Change in El Salvador’s Pine-Oak Forests.

**Project Team & Partners**

**Project Team:**

Jordan Ped (Project Lead), jordan.w.ped@nasa.gov

Taylor Dougherty (USAF)

Courtney Duquette

Clarence Kimbrell (USAF)

Susannah Miller

Stephen Zimmerman

**Advisors & Mentors:**

Dr. Kenton Ross (NASA DEVELOP National Program)

**Partner Organizations:**

The Earth Institute, Columbia University (ABES Project) (Collaborator)

POC: Dr. Sean Smukler, Assistant

Professor & Sean Kearney, PhD student, University of British Columbia

La Mancomunidad La Montañona, Chalatenango, El Salvador (End-User)

 POC: Arnulfo Alberto, Director

Ministerio de Medio Ambiente y Recursos Naturales (MARN), El Salvador (End-User)

POC: Giovanni Molina, Geo-environmental Information Systems Manager

**Project Details**

**Applied Sciences National Applications Addressed:** Ecological Forecasting, Agriculture

**Study Area:** El Salvador (area of focus: La Mancomunidad La Montañona, Chalatenango)

**Study Period:** 1982 - 2015

**Earth Observations & Parameters:**

Landsat 4, 5, 7 & 8, TM , MSS, ETM+, OLI/TIRS - Land Use/Cover; Vegetation

RapidEye Constellation, Jena-Optronik - Land Use/Cover; Vegetation

QuickBird, BGIS 2000 - Land Use/Cover; Vegetation

LIDAR, unknown - Vegetation metrics

Aerial Imagery, unknown - Land Use/Cover (validation)

**Ancillary Datasets Utilized:**

* ABES Field surveys (2012 ground observations of forest patches .01 hectares to 1 hectare)
* ABES/MARN RapidEye (La Mancomunidad: 2012, 2014, 2015; El Salvador: 2010/11)
* ABES/MARN QuickBird (December 2012)
* MARN LiDAR (2014, possibly available)
* MARN Airborne imagery (<1 m, 2014, possibly available)

**Models Utilized:**

* Clark Labs TerrSet Land Change Modeler (POC: Dr. James Toledano, Clark Labs)
* Oregon State and USDA LandTrendr

**Software Utilized:**

ERDAS IMAGINE - Land classifications

ArcGIS - Raster Manipulation/Analysis, Image Enhancement & Map Creation

ENVI – Land cover classifications

R - Programming language, land classifications

**Project Overview** The overall objective of the project is to develop a methodology for monitoring and forecasting ecological change in La Mancomunidad La Montañona region in El Salavdor. Ministerio de Medio Ambiente y Recursos Naturales (MARN) and other El Salvadorian end-users will use this methodology to determine at risk areas and implement effective policy. The long-term changes in the extent of the region's pine-oak forests and agricultural land use were identified in order to determine indicators of deforestation and degradation. This information will develop baseline trajectories against which future monitoring and modeling of forest change can be compared.

**Abstract:**

Tropical rainforests have been recognized as a significant contributor to maintaining the global carbon budget and contain a significant portion of the world's biodiversity. However, these ecosystems are threatened by deforestation and forest degradation and require careful management to retain their environmental services. La Mancomunidad La Montañona in Chalatenango, El Salvador is home of the critical Rio Lempa watershed where small scale farmers and pastoralists commonly practice slash and burn agriculture. Using NASA Earth Observations in collaboration with Ministerio de Medio Ambiente y Recursos Naturales (MARN) and the Earth Institute of Columbia University (ABES Project) a methodology was developed for stakeholders and policy makers to monitor long-term changes in forest cover and identify indicators of forest degradation. A baseline time series showing forest cover and land use land cover from 1982-2015 was used to forecast forest cover change. These predictions and tools will help assess priority areas for conservation and/or development of sustainable agricultural practices.

**Community Concerns:**

* Forests have been recognized as a significant contributor to maintaining the global carbon budget and are home to 80% of the world’s terrestrial biodiversity.
* El Salvador has the least forest cover (121,000 hectares) and the highest population density (300 people/km2) of the seven countries in Central America leaving this area extremely vulnerable to forest degradation and deforestation.
* The forests of La Montañona are critical to maintaining springs and rivers from which many communities rely on as their only source of water.
* The forests in the mountainous region support soil stability preventing mudslides and excessive loss of soil fertility, which subsistence farmers rely on.

**Current Management Practices & Policies**:

 In El Salvador, management policies and practices are not strictly enforced. The governing bodies in this region are working with the Earth Institute at Columbia University’s ABES project to determine the best ways to regulate effective payment for ecological services (PES) programs and implement Reducing Emission from Deforestation and Degradation (REDD+) guidelines set forth by the United Nations at the United Nations Framework Convention on Climate Change (UNFCCC). These include obtaining a national forest inventory and working with all levels of government to institute different policies that will prioritize areas for conservation.

**Decision Support Tools & Benefits:**

|  |  |  |
| --- | --- | --- |
| **End-Product** | **Earth Observations Used** | **Benefit & Impact** |
| Regional Forest Inventory (1982-2015) | Landsat 8 OLI, QuickBird, RapidEye | Determine forest extent and composition for current and future monitoring |
| Land Use/Land Cover (1982-2015) | Landsat 8 OLI, QuickBird, RapidEye | Analyze land cover change patterns and current land use practices for comparison and risk assessment |
| Forecasting Model of Forest Cover Change | Landsat 8 OLI, Quickbird, RapidEye | Prioritize conservation zones and identity high risk deforestation and degradation areas |

**Project Imagery\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**[Insert image here]**

**Caption:** [Insert Caption Here. Max of 25 words.] Image Credit: [Insert project short title] Team.

**Image:** File Name (Please submit your image as a separate .jpeg as well as inserting it in this document)

**Software Release Requirements\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

 **This project could benefit from software release, but additional information is still needed from partner organizations before any details can be determined.**

What category do the tools your project is creating fall within? [Category I to V]

If your decision support tools fall within Category IV, fill out this section:

**Software Title:** Insert here (ex. DEVELOP National Program Python Package)

**Software Abbreviation:** Insert here (ex. dnppy)

**Technical Point of Contact:** Insert full name, permanent email, and node here. Also include whether employed through SSAI or Wise County. (Team member who knows the most about the software.)

**Brief Description of the Software:** Insert here (ex. The dnppy package will be used to functionalize common programming tasks in the geospatial community, specifically for working with NASA data products. It will include functions for processing satellite data and assist in structuring analysis to reduce the startup time for DEVELOP teams to learn programming and create tools for end users.)

**Type of Code:** *Executable Code* and/or *Source Code* (Select one or both)

**Will the software include any embedded computer databases?** *Yes* or *No* (Select one)

**Does the software use or call any open software or libraries?** *Open Source* and/or *Proprietary/Commercial* (Select one or both)

**List the software or libraries used, under what license they were obtained, and the URL for the license in the table below:**

|  |  |  |
| --- | --- | --- |
| **Name** | **License** | **License URL** |
| Ex. Arcpy module | Ex. group license through ArcGIS | http://www.esri.com/software/arcgis |
| Ex. Python | Ex. Open source license | http://opensource.org/licenses/Python-2.0 |
|  |  |  |

**Full Software Description and Plan**

**Introduction/Objective:**

What motivated the creation of this software, what problem does it address?

**Applications and Scope:**

Where and how will this software be used to influence decisions?

**Capabilities:**

What can it do better than what was previously available?

**Interfaces:**

How is one expected to use the software? For example, command line, GUI, script execution, etc.

**Assumptions, limitations, & Errors:**

What areas that the software could be improved upon in the future? This is where limitations of the theory, model, science, etc should be briefly documented. If the tools only work for a specific scenario, say so.

**Testing:**

What validation techniques and testing strategy will be used to build confidence in the software?