**NASA DEVELOP National Program**

**2018 Summer Project Proposal**

**Virginia – Langley**

**Colombia Ecological Forecasting**

*Utilizing the Open Data Cube to Develop Science Application Products for Colombia*

**Project Overview**

***Project Synopsis*:** The Colombian Institute of Hydrology, Meteorology and Environmental Studies (IDEAM) is a government agency of the Ministry of Environment and Sustainable Development and is responsible for producing and managing scientific and technical information pertaining to water, vegetation, and forests for Colombia. This project will use the Open Data Cube technology to conduct studies of an active deforestation region near Caquetá, Colombia to support IDEAM and its desire to increase capacity for using satellite data to address local and national needs. These studies will address the analysis of deforestation utilizing Landsat and Sentinel satellite data and its correlation with field data and the optimization of the user interface of the Colombian Data Cube implementing a workflow module.

***Community Concern:*** Deforestation is a significant problem in Colombia, and Caquetá has been a hot spot of deforestation during the last decade. The ability to utilize satellite data for the detection and subsequent impact of deforestation is a high priority for Colombia and other developing countries. This project will test the use of the new Colombia Data Cube to assess deforestation based on Landsat and Sentinel data and analyze its correlation with field data. This project will develop a case study for validation of deforestation and land change detection algorithms. To date, the IDEAM team has been implementing their data cube but is still improving the execution of concurrent tasks to improve efficiency and effectiveness of analyses. This project also will test a new workflow module in order to reduce code duplication, enhance flexibility and reduce memory requirements. These results will be of high value to Colombia and will also provide case studies for other countries around the world that are using Data Cubes.

***Source of Project Idea:*** NASA's Committee on Earth Observation Satellites (CEOS) Systems Engineering Office (SEO) has been working with IDEAM and the University of the Andes for three years on the Colombian Data Cube. The group has a primary interest in deforestation and land change detection using new satellite-based algorithms and desires to improve the Colombian Data Cube performance by implementing a new workflow module.

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

***Study Location:*** Caquetá, Colombia

***Study Period:*** 2000 – 2017

***Advisors:*** Dr. Brian Killough (NASA Langley Research Center), Dr. Kent Ross (NASA Langley Research Center)

**Partner Overview**

***Partner Organizations:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| Instituto de Hidrología, Meteorología y Estudios Ambientales (IDEAM) (Colombia) | Pilar Lozano Rivera, Consultant; Cristhian Forero, Student | End User | No |
| University of the Andes | Dr. Harold Castro, Computing and Systems Department Associate Professor; María Paula Mancipe Diaz, Industrial Engineer | End User | No |

***End-User Overview***

***End User’s Current Decision-Making Process:***IDEAM uses remote sensing for monitoring forested areas. The products from their forest management program are used to estimate carbon stocks for reporting to the United Nations Framework Convention on Climate Change (UNFCCC) and to assessment national conservation plans. Assessing and validating land use changes in remote areas is often difficult, time-consuming, and costly.

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

*Instituto de Hidrología, Meteorología y Estudios Ambientales (IDEAM) (Colombia)* – The end user is familiar with common GIS and satellite data, including the use of NASA's Landsat satellite data. IDEAM is currently working with NASA to adopt a new Data Cube technology for their analysis of satellite data. This project will increase their capacity to use this data and develop relevant application products with validated results.

*University of the Andes -* The end user is familiar with common GIS and satellite data, including the use of NASA's Landsat satellite data. The University of Andes is currently working with IDEAM to utilize the new Data Cube technology for research purposes and to support enhanced capacity of the Colombia government to use satellite data.

***Collaborator & Boundary Organization Overview***

***Collaborator Support:***

*Instituto de Hidrología, Meteorología y Estudios Ambientales (IDEAM) (Colombia)* – The collaborator is familiar with GIS and satellite-based Earth observations, and currently uses this information for decision-making processes. The collaborator will help with ancillary data preparation (deforestation alerts and land change areas) and the analysis of radar data. The results of this project will be useful for the IDEAM team as they increase their capacity to use the Data Cube.

*University of the Andes* – The collaborator is familiar with GIS and satellite-based Earth observations, and currently offers courses and training on the use of big data and high-performance computing for decision-making processes. The collaborator will help with data analysis and evaluation of products. Additionally, the University can incorporate techniques developed in this project as part of their teaching curriculum.

***Dissemination by Boundary Organizations*:**

*University of the Andes* – The University is interested in using the Data Cube as an educational tool for teaching students how to use satellite data and develop application products. The results of this project could be used to engage other universities across Colombia as they may all have access to the Colombian Data Cube.

***Project Communication & Transition Overview***

***In-Term Communication Plan*:** The team will communicate with the project partners weekly via email to provide updates on project progress and to ask questions as needed. Weekly teleconference or video calls will also be used to have more discussion about project methodology and results. The POC for this communication will be the Project Lead.

***Transition Plan*:** An initial project hand-off will occur at the end of the term, during which analysis results will be given to the partners. Any software algorithms will be released to the partners once the software release process is completed.

**Earth Observations Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter** | **Use** |
| **Landsat 7 ETM+** | Surface Reflectance | Landsat products will be used to assess land change and deforestation and in specific testing regions in Colombia. |
| **Landsat 8 OLI** | Surface Reflectance | Landsat products will be used to assess land change and deforestation in specific testing regions in Colombia. |
| **Sentinel-1 C-SAR** | Backscatter | Sentinel-1 products assess land change and deforestation in specific testing regions in Colombia. This data is unique in its ability to have information in cloudy areas. |

***Ancillary Datasets:***

Digital Globe & Dataset – Google Earth to validate land change results

IDEAM Deforestation Alerts – Locations of known deforestation regions in central Colombia

***Software & Scripting:***

Open Data Cube User Interface – web-based data cube analysis tool (http://tinyurl.com/datacubeui)

Open Data Cube Jupyter Notebooks - Python algorithms for data cube analysis

QGIS - free/open GIS tool for analyzing GIS data

Esri ArcGIS – GIS analysis

**Decision Support Tool & End Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Product** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| **Deforestation and Land Change Detection Validation Report** | This validation report will allow the Colombian Government to use the Data Cube for deforestation and land change detection and understand the validity of various land change detection algorithms based on field data. | The analysis will use the PyCCD and NDVI trend anomaly algorithms with Landsat data and the Deutscher algorithm with Sentinel-1 data to detect land change. Further assessments of land change using visual assessment of Google Earth imagery will be used to validate deforestation. Land change analyses will be compared with known Colombia deforestation locations to assess accuracy. | N/A |
| **Workflow Module and User Interface Tool** | This implementation will allow the Colombia Data Cube users to execute algorithms with increased efficiency and effectiveness compared to traditional methods The workflow will be be divided into "steps" generating several products, using the partial results from intermediate steps. | This development will use the Random Forest algorithm and the Water Observation from Space (WOFS) algorithms along with Landsat data. In addition, several algorithms from the University of Andes will be used in the workflow. | N/A |

***End-User Benefit*:** IDEAM does not currently use the Open Data Cube for its forest management reporting. They are evaluating the use of this technology for the future and believe it could provide a significant benefit to their team. This project will demonstrate the value of relevant deforestation and land change products for IDEAM and likely impact how they use satellite data in the future.

**Project Timeline & Previous Related Work**

***Project Timeline:*** 1 Term: 2018 Summer

***Related DEVELOP Work:***

2018 Spring (GA) – Osa Peninsula Water Resources: Assessing Threats to River Water Quality and Mangrove Health Based on Watershed Land Use on the Osa Peninsula, Costa Rica

**Notes & References:**

***Notes*:** Similar Open Data Cube projects are needed for other parts of the world, so this inaugural DEVELOP project is a critical first step. This project team is being funded directly by the CEOS Systems Engineering Office at Langley and is not using ASP-provided funding to bring on five participants.

***References:***

Open Data Cube website: <https://opendatacube.org/>