**NASA DEVELOP National Program**

**2020 Spring Project Proposal**

**Colorado – Fort Collins**

**Lower Omo Food Security & Agriculture**

*Mapping Commercial Agriculture Expansion in the Lower Omo River Valley, Ethiopia*

**Project Overview**

***Project Synopsis*:** This project will use Landsat imagery to provide partners at the Ethiopian Wildlife Conservation Authority, Ethiopia with 1) maps that show and quantify the wild land that has been converted to plantations through large-scale agribusiness, 2) a timeline of this conversion and, 3) an analysis of where this conversation has occurred relative to protected areas in the region. The team will provide the partners with quantitative data on the location and extent of the commercial agriculture in the culturally and ecologically significant lower Omo River Valley.

***Community Concern:*** The lower Omo River Valley is a rich cultural and ecological region in southern Ethiopia, home to multiple indigenous peoples and a plethora of plants and wildlife species. Recently, a massive hydroelectric dam was constructed upstream from the lower Omo River Valley. This has prompted land grabs for large-scale plantations now that the river can be regulated and provide a reliable year-round water source. Much of this agricultural expansion has gone unregulated at the expense of local peoples’ livelihoods and the health of the ecosystem they depend on. Partners with the Ethiopian Wildlife Conservation Authority and the Natural Resource Ecology Laboratory need products to help quantify and communicate the rapid land conversion that is occurring in this unique landscape.

***Source of Project Idea:*** The Ethiopia Wildlife Conservation Authority and research scientists at the Natural Resource Ecology Laboratory contacted the DEVELOP node asking for assistance with this project. The Colorado – Fort Collins node science advisors met with these partners to work out the specific needs of the proposed project.

***National Application Area Addressed:*** Food Security & Agriculture

***Study Location:*** Lower Omo River Valley, Ethiopia

***Study Period:*** January 2000 – January 2020

***Advisors:*** Dr. Paul Evangelista (Colorado State University, Natural Resource Ecology Laboratory), Dr.

Catherine Jarnevich, (USGS, Fort Collins Science Center), Nicholas Young (Colorado State University,

Natural Resource Ecology Laboratory), Tony Vorster (Colorado State University, Natural Resource Ecology

Laboratory)

**Partner Overview**

***Partner Organizations:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| **Ethiopian Wildlife Conservation Authority** | Dr. Fanuel Kebede, Wildlife Research and Monitoring Directorate Director | End User | No |

***End-User Overview***

***End User’s Current Decision-Making Process:***The Ethiopian Wildlife Conservation Authority is the governing agency for all protected lands and wildlife in Ethiopia. Our partners make decisions related to protected area enforcement and regulations and provide recommendations to policy makers at the national level. They use multiple strategies to assess the status of wildlife species, to evaluate the current condition of protected areas and to make policy recommendations. They have maps of protected areas and other basic GIS-based features but rely on in-field surveys for analysis.

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

*Ethiopian Wildlife Conservation Authority –* Our POC at the Ethiopian Wildlife Conservation Authority understands remote sensing and the power of imagery to identify and quantify landscape change but does not have the knowledge or tools to conduct a more formal remote sensing analysis. This project will increase their understanding of satellite imagery, and specifically NASA Earth observations, to understand these analyses and how these data can be applied to inform protected area management.

***Project Communication & Transition Overview***

***In-Term Communication Plan*:** The team will communicate with the partner via teleconference meetings. The Fellow and Project Lead will be the primary points of contact with the partner organizations.

***Transition Plan*:** At the end of the term, the team will host a virtual seminar to disseminate project results to Dr. Kebede. A handoff package will be sent via email. As part of the handoff package the end user will receive 1) Land-Use Conversion Maps, 2) Conversion Timeline and Analysis, 3) Two Page Project Flier, and 4) Project Video. There is no software release required for this project.

**Earth Observations Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameters** | **Use** |
| **Landsat 8 OLI** | Surface reflectance,  normalized difference  vegetation index,  normalized difference  moisture index,  tasseled  cap brightness,  greenness, and wetness | This dataset will provide the temporal (16 days)  and spatial (30 m) resolution needed to derive  environmental predictive variables for modeling  land cover. |
| **Landsat 5 TM** | Surface reflectance,  normalized difference  vegetation index,  normalized difference  moisture index,  tasseled  cap brightness,  greenness, and wetness | This dataset will provide the temporal (16 days)  and spatial (30 m 2 ) resolution needed to derive  environmental predictive variables for modeling  land cover. |
| **SRTM** | Elevation, slope, aspect,  compound topographic  index | This dataset will be used to derive topographic  indices to use as predictors representing different land cover classes. |

***Ancillary Datasets:***

Ethiopian Wildlife Conservation Authority Protected Area Spatial Database – polygons of protected areas to use as a comparison of where land cover change occurs relative to protected areas in Ethiopia

The World Bank Ethiopia Land Cover – 2017 public 10 m landcover dataset to use for validation

***Modeling:***

Random Forest (RF) (POC: Dr. Catherine Jarnevich, USGS Fort Collins Science Center)

***Software & Scripting:***

Esri ArcGIS – Image processing and end product generation

R – Statistical analyses and raster processing

Google Earth Engine API – Large-scale image analysis

Landtrendr - package of algorithms to extract spectral information from time-series imagery

**Decision Support Tool & End Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Product** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| **Land-Use Conversion Maps** | Maps will help decision makers understand the dynamic changes in land-use in the lower Omo River Valley over the last 20 years. | Landsat 8 OLI, Landsat 5 TM, and SRTM imagery will be used to identify land cover changes over time using Random Forest models and Landtrendr. | N/A |
| **Conversion Timeline and Analysis** | The timeline and analysis will allow partners to identify the location and extent of agriculture growth over the last twenty years relative to protected areas. | Landsat 8 OLI, Landsat 5 TM, and SRTM imagery will be used to track land-use conversion over time and conduct analysis in relation to protected areas. | N/A |
| **Two Page Project Flier** | A semi-technical two-page flier will be generated to efficiently communicate our findings to partners. | This will be a synthesis of the two other products described above and will include summaries of background, methods, findings, and future work in a reader-friendly format. | N/A |

***End-User Benefit*:** These products will provide an analysis of change in land-use that is essential to the quantification and communication of the rapid land conversion that is occurring in this distinctive landscape. Our end user can use these products to 1) provide context to the speed at which land-use is converting to agriculture, 2) visually analyze the spatial extent of these conversions relative to other land uses, and 3) contextualize how this has affected protected areas. These products will improve the effectiveness and efficiency of their conservation work by covering a large spatial area using NASA Earth observations that would not be feasible without remote sensing.

**Project Timeline & Previous Related Work**

***Project Timeline:*** 1 Term: Spring 2020

***Related DEVELOP Work:***

2019 Summer (ARC) – Powder River Basin Transportation & Infrastructure: Monitoring Land Disturbances Caused by Coal Mining in the Powder River Basin Using Remote Sensing

2016 Summer (CO) – Rocky Mountain Agriculture: Utilizing NASA Earth Observations to Reconstruct and Identify Historical Forest Disturbances in the Southern Rocky Mountains for Enhanced Forest Management

**References:**

Kennedy, R.E., Yang, Z., Gorelick, N., Braaten, J., Cavalcante, L., Cohen, W.B.; & Healey, S. (2018). Implementation of the LandTrendr Algorithm on Google Earth Engine. *Remote Sensing*, *10*, 691.

Ogbaghebriel Berakhi, R., Oyana, TJ., & Adu-Prah, S. (2015). Land use and land cover change and its implications in Kagera river basin, East Africa, *African Geographical Review*, *3*(3), 209-231, DOI: 10.1080/19376812.2014.912140