**NASA DEVELOP National Program**

**** NASA: Goddard Space Flight Center

**Spring 2016**

**Short Title: Indonesia Agriculture**

**Subtitle:** Identifying Current Areas of Palm Oil Production and Modeling a Risk Map for Future Expansion in Central Kalimantan, Indonesia

**VPS Title:** Calamity in Kalimantan: Palm Oil Growth at the Expense of Diversity

**Project Team & Partners**

**Project Team:**

Kyle T. Peterson (Project Lead), [kyle.t.peterson@nasa.gov](mailto:kyle.t.peterson@nasa.gov)

Michael Riedman

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**Advisors & Mentors:**

Dr. Naikoa Aguilar-Amuchastegui (WWF)

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**Partner Organizations:**

World Wildlife Fund (End-User), POC: David McLaughlin; Boundary Organization

**Project Details**

**Applied Sciences National Applications Addressed:** Agriculture

**Study Area:** Central Kalimantan, Indonesia

**Study Period:** January 2000 - January 2016

**Earth Observations & Parameters:**

TRMM, TMI – precipitation measurements and totals

GPM, GMI – precipitation measurements and trends

Aqua, MODIS – land surface temperature

Terra, MODIS – land surface temperature

FIRMS, MODIS – land surface temperature and fire data

Landsat 8, OLI – land cover land use

SRTM, IFSAR – elevation and slope

**Ancillary Datasets Utilized:**

* DIVA GIS - administrative boundaries, rivers/streams, roads
* FAO world soils - soil types
* Global Forest Watch - forest conservation and degradation, primary forest, palm oil concessions
* RSPO & WRI - locations of sustainable palm oil mills
* SEDAC World Population- population
* UMD Global Forest Change - forest degradation and tree cover
* USGS National Land Cover Dataset (NLCD) - land cover
* WorldPop - spatial population distribution
* WWF- palm oil plantation locations

**Models Utilized:**

* AT&T Labs-Research, Maximum Entropy Modeling (MaxEnt)

**Software Utilized:**

ArcGIS - raster manipulation/analysis, image enhancement & map creation of Landsat 8 OLI, Aqua/Terra MODIS, & Global Forest Watch. Vector manipulation/analysis of WWF, FIRMS, DIVA GIS data

TerrSet - raster manipulation/analysis, running MaxEnt statistical model

Python - code to analyze data and automate tasks

ENVI/IDL - raster manipulation/analysis, image processing

R - statistical analysis of MaxEnt results

**Project Overview**

Palm oil is the major economic export of Indonesia and the government intends to substantially increase palm oil production in the coming years. Although this expansion in palm oil production has stimulated the local economy in has come at an environmental cost. To protect the biological and ecological diversity of the rainforest, it is essential to map potential future palm oil plantation locations at the district level and encourage expansion in regions that will not cause rainforest degradation.

**Abstract:**

Indonesia is the world’s leading producer of palm oil. To keep pace with the continued worldwide expansion of palm oil demand, the government of Indonesia formulated an agricultural policy with the express purpose of doubling palm oil production by 2020. Unfortunately, palm oil plantation expansion has come at the cost of natural rainforest and biodiversity loss in the Central Kalimantan region. Although the government imposed a moratorium on deforestation in 2011 and has extended it to present, there has been little enforcement and deforestation continues to be a pressing issue in the region. The purpose of this project was to work with the WWF to establish current natural forest areas and to identify current palm oil plantations, including those on protected lands. A second component of the project was to delineate future, suitable locations for palm oil plantations that do not cause rainforest loss by creating a risk map. The suitability analysis of palm oil plantations relied on MaxEnt to model palm oil plantation locations. This model used known plantation locations, continuous data from remote sensing systems including LANDSAT 7 and 8, TRMM, GPM, MODIS, Aqua/Terra along with ancillary data, to best predict other current and future locations of palm oil plantations. This analysis was overlaid by both a fuzzy weighted linear combination and a geographically weighted regression to compare different approaches. By mapping and predicting future locations, conservation groups can more effectively allocate their resources to prevent rainforest degradation.

**Community Concerns:**

* The production and harvesting of palm oil is widely recognized as a leading driver of deforestation in Indonesia, especially in Central Kalimantan.
* The increase in illegal palm oil plantations and the expansion of these plantations into rainforest and conserved areas without regulation.
* Developing a sustainable agricultural supply chain that includes major palm oil companies and local communities.
* Protecting the region’s rich biodiversity and conserving protected habitats.

**Current Management Practices & Policies**:

WWF has been working on deforestation and conservation issues in Indonesia for a long time, it is currently working on projects that address palm oil plantation growth and deforestation by creating district level incentives to increase local governance and oversight of deforestation practices. Currently, WWF has been limited to country- and district-level analyses based on field work and case studies. Remote sensing and prediction modeling is not a major application behind WWF’s work on sustainable agriculture and forest conservation.

**Decision Support Tools & Benefits:**

|  |  |  |
| --- | --- | --- |
| **End-Product** | **Earth Observations Used** | **Benefit & Impact** |
| Map of current locations of palm oil plantations in Central Kalimantan, Indonesia | Landsat 8 OLI,  TRMM TMI, GPM GMI,  Terra/Aqua MODIS, SRTM IFSAR | Map validates current locations (presently unvalidated) and will help WWF target resources to the areas and plantations most at risk for expansion |
| Risk map of future palm oil plantation locations  in Central Kalimantan, Indonesia | Landsat 8 OLI,  TRMM TMI, GPM GMI,  Terra/Aqua MODIS, SRTM IFSAR | Model shows conserved forest areas most at risk for deforestation for palm plantations and will help WWF target areas for conservation |

**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**

Category III

**Software Title:** Palm Oil Plantation Modeler

**Software Abbreviation:** POPM

**Technical Point of Contact:** Kyle T. Peterson, [kylepeterson777@gmail.com](mailto:kylepeterson777@gmail.com), SSAI, GSFC.

**Brief Description of the Software:** Utilizing both Python and IDL programming languages, POPM software creates a simplified process of downloading, atmospherically correcting, and processing raster data with the purpose of identifying potential locations of palm oil plantations. This software also leverages elements of the dnppy module provided by the DEVELOP National Program.

**Type of Code:** Both executable code and source code

**Will the software include any embedded computer databases?** No

**Does the software use or call any open software or libraries?** Both open source and proprietary/commercial

**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** |
| ArcGIS (arcpy) | Group license through ArcGIS | <http://www.esri.com/software/arcgis> |
| Python | Open source license | <http://opensource.org/licenses/Python-2.0> |
| TerrSet | Single use license | <https://clarklabs.org/terrset/> |
| dnppy | Open source license | <https://nasa-develop.github.io/dnppy/modules/download.html> |
| IDL | Group license through ENVI | <http://www.exelisvis.com/docs/using_idl_home.html> |
| ENVI | Group license through EXELIS | <http://www.exelisvis.com/IntelliEarthSolutions/GeospatialProducts.aspx> |
| R | Open source license | <https://www.r-project.org/> |

**Full Software Description and Plan**

**Introduction/Objective:**

Detecting palm oil plantations from a remote sensing approach can be a cumbersome and manually intensive process. By automating a number of these steps an analyst can create an output that identifies potential palm oil plantations for a given region with a set of relevant inputs. This software utilizes the arcpy and dnppy python modules in conjunction with IDL.

**Applications and Scope:**

This software will be utilized by the World Wildlife Fund (WWF), associated WWF projects, and partner organizations focused on sustainable palm oil plantation expansion, conservation, and reducing deforestation risk.

**Capabilities:**

This software helps users identify existing and potential oil palm plantations and supports decision making processes to promote a more sustainable palm oil supply chain.

**Interfaces:**

The software utilizes Python and IDL. Users will open the tool in Python (IDLE) and execute the given scripts.

**Assumptions, limitations, & Errors:**

Elements of this software are based on Landsat 8 data using a feature extraction technique. The decision tree applied to this model is based primarily on local spectral and physical properties of the Central Kalimantan region of Indonesia and may not accurately apply to palm oil plantations in other regions. This software also includes elements located within the DEVELOP National Program’s module “dnppy” and will need to be downloaded and installed in order to function properly.

**Testing:**

The software has been iteratively tested, compared, and validated to known locations of palm oil plantations to ensure accuracy.