**NASA DEVELOP National Program**

**Spring 2016 Project Proposal**

**University of Georgia**

**Perú Climate II**

Monitoring and Forecasting Shifting Climate and Land Change Impacts in Perú’s Parque de la Papa for Enhanced Agricultural Management

**Project Overview**

***Objective:*** Conduct a spatio-temporal analysis using NASA Earth observations to monitor and measure parameters, such as precipitation, temperature, land cover, elevation, and evapotranspiration, to quantify and forecast suitable potato crop extent, as well as assess disease and pest risk, in Perú’s Parque de la Papa for agricultural management and improved food security.

***Community Concern:*** Potatoes have both a temporal and spatial global history, spanning centuries and continents, yet they face new vulnerabilities due to pests, disease, and climate change. As the third most important food crop in the world—after rice and wheat—the potato is a critical crop in terms of food security. Shifting climates in the Perúvian Andes during the last 30-40 years have meant a push of the native, landrace, potato’s geographic distribution into higher elevations. Warming temperatures and changing rain patterns also put potatoes at risk of new pests and disease, as they bring with them the potential of migratory insects arriving earlier, more insects surviving winters, and an increase of insect generations within a single season. This was seen in 2003 when late blight wiped out the native potato harvest in Paucartambo and through its increased presence and devastation in the Cusco region in 2010.

***National Application Areas Addressed:*** Climate, Agriculture, Ecological Forecasting, Water Resources

***Study Location:*** Parque de la Papa, Perú

***Study Period:*** August 1984 to August 2015

***Advisors:*** Dr. Kenton Ross (NASA DEVELOP), Dr. Marguerite Madden (UGA Center for Geospatial Research)

***Source of Project Idea:*** Dan Irwin from SERVIR reached out to DEVELOP following a telecon with the International Potato Center where the group mentioned the above community concern. A subsequent telecon between DEVELOP and the International Potato Center identified project details.

**Partner Overview**

***Partner Organizations:***

International Potato Center (CIP) (End-User/Boundary Organization, POCs: Dr. Noelle Barkley, Manager of Genetic Resources Conservation & Dr. David Ellis, Director of CIP's Genebank)

Parque de la Papa & ANDES (End-User, POCs: Dr. Noelle Barkley, Manager of Genetic Resources Conservation and ANDES, Parque de la Papa)

***End-User Current Decision Making Process:***

Temperature increase in the high altitudes has meant a greater risk of pests and diseases such as weevils and late blight. To combat this risk, participatory programs are working with local communities to diversify potato varieties planted and have been successful in helping to ameliorate the challenges encountered with the change in native potato cultivation by traditional means. CIP is working with local communities to support their continued sustenance in the area, and has seen a shift in the past 30 years of ideal potato growing habitat to higher elevations due to changing temperatures and increased pest risk. CIP currently plants and evaluates multiple research plots at different elevations in Parque de la Papa, which provides point data for specific potato varieties as well as meteorological data for specific elevations.

***NASA Earth Observations Capacity:***

International Potato Center (CIP) – End-users are unfamiliar with NASA Earth observations and have never incorporated them into their decision making processes.

Parque de la Papa & ANDES – End-users are unfamiliar with NASA Earth observations and have never incorporated them into their decision making processes.

***Collaborator & Boundary Organization Support:***

CIP will serve as a boundary organization sharing the information in the region and with the Parque de la Papa Association and the NGO ANDES. Their past work with the community will enhance their ability to disseminate the project results. CIP seeks to foster new partnerships and projects that ensure access to the most advanced technologies and skills for developing nations.

***Communication Plan & Transition Approach:***

Bi-weekly telecons will be planned to encourage frequent communication between the team and project partners. Deliverables will be shared with partners through Google Drive and a videoconference will be scheduled at the end of the term. Final products will be delivered to end-users in a joint teleconference between UGA and Langley at the completion of the third term.

***End-User Benefit:***

CIP would like to improve their abilities to monitor and forecast climate change impacts, as well as assess suitable land where local communities could thrive based on parameters that are ideal for potato growth. This project would assist in the identification of characteristics for suitable potato production locations throughout the high elevation central Andean Plateau in Perú. CIP will benefit from the project results through improved understanding of shifting precipitation and temperature trends, the abilities of NASA Earth observations for monitoring change, as well as receiving a methodology that includes freely available datasets for subsequent analyses and monitoring activities in this region.

**Earth Observations Overview**

***Earth Observations:***

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| --- | --- | --- |
| **Platform** | **Sensor** | **Geophysical Parameter** |
| **Landsat 5-8** | TM, ETM+, OLI, TIRS | Land Cover, Evapotranspiration |
| **Terra** | ASTER | Land Cover, Elevation |
| **Aqua & Terra** | MODIS | Land Surface Temperature, Snow Cover |
| **Suomi NPP** | VIIRS | Land Surface Temperature |
| **TRMM** | PR | Precipitation |
| **GPM** | DPR &GMI | Precipitation |
| **SRTM** |  | Elevation |

***NASA Earth Observations Use:***

Landsat and ASTER can provide land cover data on an appropriate scale that can support decision making across the Parque de la Papa, and Landsat can be used to monitor evapotranspiration. While the resolution may not be able to identify characteristics of the small research plots, the synoptic view of the sensors will provide useful information for the study area.

Terra ASTER Digital Elevation Models (DEMs) or SRTM DEMs will be used for elevation as one of the parameters in the suitability map. ASTER data is used to create detailed maps of land surface temperature, emissivity, reflectance, and elevation.

Historical precipitation will be measured by TRMM. It uses several space-borne instruments to increase our understanding of the interactions between water vapor, clouds, and precipitation.

Current precipitation will be measured by GPM. The GPM constellation of satellites can observe precipitation over the entire globe every 2-3 hours. The Core satellite measure rain and snow using two science instruments: the GPM Microwave Imager (GMI) and the Dual-frequency Precipitation Radar (DPR).

Snow cover, another input for the suitability map, will be measured by MODIS. MODIS and VIIRS will provide land surface temperature measurements to identify changes over the past 15 years (2000-present).

***Ancillary Datasets:***

CIP Research plot data (Hobo (temp, relative humidity, light levels)/potato health/relative cultivar yield) (2013-2015); Historical data on crop cultivation from Parque de la Papa (2001-2007); CMIP5 air temperature forecasts.

***Models:***

TerrSet Land Change Modeler (POC: Dr. James Toledano, Clark Labs)

METRIC – Mapping EvapoTranspiration at high Resolution and Internalized Calibration (POC: Dr. Kenton Ross, DEVELOP)

**Decision Support Tool & End-Product Overview**

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| --- | --- | --- |
| **Proposed End Products** | **Decision to be Impacted** | **Current Partner Tool/Method** |
| Potato Crop Suitability Map | Suitable locations for local communities to successfully harvest sustaining potato yields | Research Plots and participatory native cultivar selection with indigenous communities |
| Potato Crop Suitability Forecasts |
| Land Cover Time Series |
| Growing Degree Days Maps |
| Chill Hour Maps |
| Diseases & Pest Risk Maps |

*Potato Crop Suitability Map* – This map will combine multiple parameters (precipitation, temperature, land cover, elevation, and evapotranspiration) to identify the current suitable habitat for successfully growing potatoes.

*Potato Crop Suitability Forecasts* – forecasts will identify suitable habitat for successfully growing potatoes in subsequent decades based on climate model projections.

*Land Cover Time Series (1984 – 2015)* – using Landsat and other observations for land cover, maps would identify land use in the study area delineating potato crop extent (if possible) and displaying trends and changes over time through a time series.

*Growing Degree Days Maps* – using MODIS, maps showing growing degree days from 2000 to the present will be created as an input into the suitability map and forecasts.

*Chill Hour Maps* – using MODIS, maps showing chill hours from 2000 to the present will be created as an input into the suitability map and forecasts.

*Diseases & Pest Risk Maps* – using temperature and other parameters specific to local disease and pests, maps will be created to identify areas most at risk.

**Project Timeline & Previous Related Work**

***Project Timeline:*** 3 Terms: 2015 Fall (Start) to 2016 Summer (Completion)

***Multi-Term Objectives:***

* **Term 1** – Team at DEVELOP Langley. Focused on the use of climatic variables, creation of growing degree days, chill hour maps, land cover analysis, and use of land change modeler.
* **Term 2 (Proposed Term)** –Team at DEVELOP UGA. Focus on land cover analysis, ecological forecasting, and begin the suitability mapping. Additionally, team will work to complete all end products previous team began and continue communication with partners as their needs may evolve.
* **Term 3** – Joint team at DEVELOP Langley & UGA. Focus on combining all parameters and previous products into a final suitability map and forecasts. Creation of tutorials and hand-off materials. Conduct a videoconference style hand-off.

***Previous Related DEVELOP Work:***

2015 Summer (Langley) – Northwest US Agriculture III: Assessing Current and Future Plant Hardiness Zones for Apple Production in Washington State using Climate Models and NASA Earth Observations

2015 Spring (UGA) – Colombia Eco Forecasting III: Utilizing NASA Earth Observations to Enhance the Conservation Efforts of Colombia’s Most Endangered Primate, the Cotton-top Tamarin (Saginus oedipus)

**Project Needs/Requests**

***Participants Requested:*** 5-6

***Software & Scripting:***

ArcGIS- map creation

ENVI- land classification of Landsat imagery

R- Supervised classification script

TerrSet- land change modeler

**Notes & References:**

***Notes:*** DEVELOP Langley team plans to conduct background research and begin work on end products. At the conclusion of the fall 2015 term, they will pass on their work to UGA. The UGA team will build upon this work and focus on creating land cover maps and a time series analysis. During the third term, Langley and UGA will work closely to develop a final suitability map and forecast.

***References:***

<http://dialogues.cgiar.org/blog/the-colorful-value-of-potatoes/>

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