**NASA DEVELOP National Program**

**2017 Spring Project Proposal**

**NASA Ames Research Center**

**Chile Water Resources**

*Integrating NASA Earth Observations into the Google Earth Engine Platform to Enhance Drought Monitoring in Chile*

**Project Overview**

***Project Synopsis*:** The objective of this project is to incorporate NASA Earth observation derived soil moisture, snow cover, and snow water equivalent (SWE) data into Chile’s drought monitoring and decision-making processes using the Google Earth Engine platform. Outcomes of this project aim to benefit the Ministry of Agriculture in Chile by enhancing their decision-making process to better inform farmers of agriculture practices, including irrigation recommendations. Satellites utilized will include Soil Moisture Active Passive (SMAP), Moderate Resolution Imaging Spectroradiometer (MODIS), Sentinel-1, and GCOM-W1. This project will also serve as a case study for Chile for potential future implementation of hosting their drought monitoring tool and supporting data in Google Earth Engine.

***Community Concern:***

Chile’s stark geographical differences across latitudes presents a spectrum of agricultural conditions throughout the entire country. Chile is also vulnerable to drought and, with sub-regions of Chile relying on contrasting irrigation practices, balancing the management of supply and demand of water across the country proves a difficult task. Currently, Chile’s Ministry of Agriculture reduces vulnerability to drought and other agriculture-climate events by disseminating response information serving as early warning for decision-makers and stakeholders of the agriculture industry.

***Source of Project Idea:*** The idea from this project developed from the Navajo Nation Climate I & II projects (spring and summer 2015). Jamie Favors began a conversation with the Agricultural Office of the Chilean Embassy about how the Drought Severity Assessment Tool (DSAT) could be adapted to address similar concerns in Chile. Since learning of Chile’s Climate Data Library, the project has shifted to assist implementing soil moisture, snow cover, and snow water equivalent data into the existing Chile Drought Observatory to enhance supporting hydrological and agricultural data.

***National Application Areas Addressed:*** Water Resources, Agriculture

***Study Location:*** Chile

***Study Period:*** January 2001 to February 2017

***Advisors:*** Dr. Eduardo Bendek (NASA Ames Research Center), Dr. Juan Torres-Perez (Bay Area Environmental Research Institute)

**Partner Overview**

***Partner Organizations:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| Ministerio de Agricultura | Sr. Antonio Yaksic, Jefe Sub Departamento de Información, Monitoreo y Prevención para la Gestión Integral de Riesgos (Deputy Chief Department) | End-User | Yes\* |
| Oficina Agrícola de la Embajada de Chile en los Estados Unidos de América | Sr. Javier Chaud, Especialista Agrícola (Agriculture specialist) | Collaborator | No |

***End-User Overview***

***End-User’s Current Decision-Making Process:***The Ministry of Agriculture in Chile utilizes an existing Climate Data Library (CDL) to serve as a drought observatory for the country and agricultural community. The Climate Data Library incorporates meteorological, hydrological, and agricultural data that help the department disseminate important information to farmers in the agriculture regions of Chile. With the information stated above, the Ministry informs farmers and stakeholders of best irrigation practices for their specific geographic regions. Some of the data provided are derived from remote sensing, and the Ministry seeks to enhance their dataset by incorporating soil moisture, snow cover, and snow water equivalent (SWE) collected from NASA Earth Observations (EO).

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

Ministerio de Agricultura –The Ministry of Agriculture in Chile is very familiar with NASA Earth observations and currently use a Landsat Earth Observation data through the CDL. The inclusion of soil moisture, snow cover, and snow water equivalent provided by NASA Earth Observations, will largely contribute to the monitoring of drought in Chile and better inform farmers for agricultural practices.

***Collaborator & Boundary Organization Overview***

***Collaborator Support:***

*Embajada de Chile en los Estados Unidos de América* – The Agricultural Office of the Chilean Embassy to the United States has been integral in the development of this project. Establishing contact with Sr. Javier Chaud, Agriculture Specialist, has allowed for direct communication with the Ministry of Agriculture in Chile and will remain a vital collaboration throughout the project to act as a liaison between the DEVELOP program and Ministry of Agriculture.

***Dissemination by Boundary Organizations*:**

Results from this project will enable the Ministry of Agriculture in Chile to provide decision makers, farmers, and scientists access to more extensive NASA Earth Observation derived data to complement the meteorological, hydrological, and agricultural conditions currently available in the CDL.

***Project Communication & Transition Overview***

***In-Term Communication Plan*:** During the research term, there will be bi-weekly teleconferences between the DEVELOP team and Sr. Yaksic’s team. The POC for communication will be Brittany Zajic, current Center Lead at NASA ARC.

***Transition Plan*:** The transition of the end product will take place via virtual webinar. The tool will be in the form of a Google Earth Engine script, and will be integrated into Chile’s decision-making process as a case study for how to host CDL in the future. The official transition will take place several months following the end of the term due to software release requirements.

***Letters of Support*:** Letter of support for this project signed by Mr. Antonio Yaksic, Ministry of Agriculture – Sub Department of Information, Monitoring and Prevention for Integrated Risks Management IMP-IRM.

**Earth Observations Overview**

***Earth Observations:***

|  |  |  |
| --- | --- | --- |
| **Platform & Sensor** | **Parameter(s)** | **Use** |
| **Soil Moisture Active Passive (SMAP) - Radiometer** | Soil Moisture | Soil moisture estimates for across Chile will enhance agricultural data for the CDL. |
| **Terra - MODIS** | Snow Cover | The MODIS snow algorithm output will be used to estimate snow cover and enhance hydrological data to supplement the CDL. |
| **Aqua – AMSR-E** | Snow Water Equivalent (SWE) | Available from 2001 to 2011, AMSR-E will provide SWE data to enhance hydrological data to supplement the CDL. |
| **Sentinel-1- C-Band** | Soil Moisture | SAR data will enhance the soil moisture estimates of SMAP. |
| **JAXA GCOM-W1 – AMSR2** | Snow Water Equivalent (SWE) | AMSR2 is processed and hosted by NASA Lance. This dataset serves as a continuation of AMSR-E for SWE hydrological data. |

***Ancillary Datasets:***

Ministry of Agriculture –Snow Depth, Density and Water Equivalent at CDL– To validate snow cover. Regarding soil moisture, the Ministry of Agriculture has the following parameters: Soil Moisture percentage, Maximum Available Soil Moisture Content and Soil Moisture at Permanent Wilting Point set by INIA at CDL (by pixel, media value).

Ministry of Agriculture –Soil Moisture percentage, Maximum Available Soil Moisture Content and Soil Moisture at Permanent Wilting Point set by INIA at CDL (by pixel, media value).

***Software & Scripting:***

Google Earth Engine – data hosting, display and analysis

Python – data download and Google Earth Engine link using Python API

**Decision Support Tool & End Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Product(s)** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| Google Earth Engine Decision Support Tool | Hosting NASA Earth observation data in the Google Earth Engine platform will enhance the Ministry of Agriculture’s current decision-making process by incorporating NASA Earth observation-derived soil moisture, snow cover, and snow water equivalent data. It will also serve as a case study for future implementation of drought monitoring in the GEE platform instead of the current CDL. | This tool will incorporate data from SMAP, Aqua and Terra MODIS, Sentinel 1, and GCOM-W1. All data will be hosted and processed by Google Earth Engine, and ready for analysis by the Ministry of Agriculture. | Options:  III |

***End-User Benefit*:**

Providing more remotely-sensed datasets encompassing indices of hydrological and agricultural observations increases temporal and spatial resolution capabilities regarding drought monitoring in Chile. More specifically, incorporating soil moisture, snow cover, and SWE parameters derived from NASA Earth observations into the Ministry of Agriculture’s drought monitoring in Chile will allow for more robust decision making for the agriculture industry as a result of these resolutions.

**Project Timeline & Previous Related Work**

***Project Timeline:*** 2 Terms: 2017 Spring (Start) to 2017 Summer (Completion)

***Multi-Term Objectives:***

* **Term 1 (Proposed Term):** 2017 (ARC) – Chile Climate I
  + The first term of this project will work closely with the Ministry of Agriculture to incorporate NASA Earth observation derived soil moisture, snow cover, and snow water equivalent (SWE) data into Chile’s drought monitoring and decision-making processes using the Google Earth Engine platform. The focus of the first term will be to complete the decision-making tool to enhance the Ministry of Agriculture’s access to applicable NASA Earth Observation hydrological data.
* **Term 2:** 2017 Summer (ARC) – Chile Climate II
  + The decision-making tool created in the first term will be validated in the second term using data found from the CDL and Ministry of Agriculture. The Ministry of Agriculture will support the second term’s efforts to apply the tool to a specific agriculture region of the country, the Central Valley of Chile. This agriculture region is highly dependent on the water from surrounding glaciers for irrigation, and water availability is a challenging measure to make from the ground. Remote sensing techniques using NASA Earth Observation data will be applied to this region to estimate glacier mass balances and quantifying their relationship to water availability for agriculture.

***Related DEVELOP Work:***

2013 Fall (LaRC) – Chile Water Resources: Assessing Potential Water Availability from Andean Snowpack for Agricultural Uses in the Coquimbo Region of Chile

2014 Spring (LaRC) – Chile Water Resources II: Using NASA Earth Observation Data to Understand Snowmelt and Address Ongoing Drought in Central Northern Chile

2015 Spring (ARC) – Navajo Nation Climate I: Monitoring Conditions in the Navajo Nation Using NASA Earth Observations

2015 Summer (ARC) – Navajo Nation Climate II: Assessing Climate Change Impacts on Ground Water Availability and Drought Vulnerability in the Navajo Nation Using NASA Earth Observations

**Notes & References:**

***References:***

Climate Data Library. (n.d.). Retrieved 2016, from <http://www.climatedatalibrary.cl/>

Observatorio Agroclimático. (n.d.). Retrieved 2016, from <http://www.climatedatalibrary.cl/IMP->

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