**NASA DEVELOP National Program**

**2022 Spring Project Proposal**

**California – JPL**

**Chile Disasters**

*Automating Wildfire Risk and Occurrence Mapping In Google Earth Engine to Improve Wildfire Detection and Response Time Efforts*

**Project Overview**

***Project Synopsis*:** The Corporación Nacional Forestal (CONAF) is a private, non-profit that aims to sustainably manage and protect Chile’s forest resources, which includes wildfire management. This project will use Landsat 8 OLI, Sentinel-2 MSI, Terra/Aqua MODIS, SMAP, and GPM IMERG to calculate anomalies and characterize wildfire risk over the last 6 years, map burned area of historical fires, and automate wildfire risk mapping in Google Earth Engine (GEE). The goal of this project is to build the capacity of the partners at CONAF and the Embassy of Chile to map wildfire risk and fire perimeters using NASA Earth observations (EOs) in near real-time to improve wildfire prevention and response time efforts.

***Study Location:*** Chile

***Study Period:*** January 2015 – December 2021

***Advisor:*** Virginia Iglesias (University of Colorado Boulder)

**Partner Overview**

***Partner Organizations:***

|  |  |  |  |
| --- | --- | --- | --- |
| **Organization** | **POC (Name, Position/Title)** | **Partner Type** | **Boundary Org?** |
| **Corporación Nacional Forestal** | Patricio Sanhueza, Forester; Jordi Brull, Forest Engineer; Jorge Saldias, Head of Department of Development and Research | End User | No |
| **Embassy of Chile** | Fernando Vasquez, Agricultural Specialist; Andres Rodriguez, Agricultural Attaché | Collaborator | No |

***End User Overview***

***End User’s Current Decision-Making Process & Capacity to use Earth Observations:***CONAF is funded by the Chilean Government Ministry of Agriculture to manage wildfires in the country in addition to managing the forest resources and protected areas. CONAF has programs to monitor, prevent, and respond to wildfires. To accomplish this goal, CONAF currently uses NASA EOs to calculate anomalies for parameters such as vegetation moisture content, soil moisture, and temperature within GEE. These parameters are then exported from GEE and input into an ArcGIS ModelBuilder workflow to model fire risk. To track fire occurrences, they also use optical imagery to manually outline fire perimeters and do not currently use any radar data. This current workflow can take up to 3-4 months to prepare all datasets utilized for fire risk, occurrence, and recovery monitoring. This project will enhance their monitoring ability and inform resource allocation by automating these processes for near real-time monitoring and potentially build their capacity to utilize radar data in their monitoring efforts.

**Earth Observations Overview**

***Earth Observations:***

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| --- | --- | --- |
| **Platform & Sensor** | **Parameter(s)** | **Use** |
| **Landsat 8 OLI** | Spectral vegetation and moisture indices | Landsat imagery will be used to calculate vegetation and moisture index anomalies to characterize fire risk. |
| **Sentinel-2 MSI** | Spectral vegetation and moisture indices | Sentinel imagery will be used to calculate vegetation and moisture index anomalies to characterize fire risk. |
| **Terra MODIS** | Land surface temperature, Burned area product | MODIS data will measure temperature anomalies to identify conditions at risk for wildfire and characterize historical and/or active fires. |
| **Aqua MODIS** | Land surface temperature, Burned area product | MODIS data will measure temperature anomalies to identify conditions at risk for wildfire and characterize historical and/or active fires. |
| **SMAP** | Surface soil moisture | SMAP in combination with moisture indices and precipitation data will characterize conditions at risk for wildfire. |
| **GPM IMERG** | Precipitation | In combination with SMAP and Landsat moisture indices, precipitation will characterize conditions at risk or wildfire |

***Ancillary Datasets:***

* CONAF Historical Fires – historical fire location and extent used to verify fires identified by remotely sensed data.

***Modeling:***

* CONAF Fire algorithms (POC: Jordi Brull, CONAF) – automate calculating parameter anomalies in Google Earth Engine already used by CONAF to characterize fire risk.
* CONAF Fire Risk ArcGIS ModelBuilder (POC: Jordi Brull, CONAF) – code in GEE the workflow currently used by CONAF within ArcGIS to convert anomaly outputs into modeled fire risk.

**Decision Support Tool & End Product Overview**

***End Products:***

|  |  |  |  |
| --- | --- | --- | --- |
| **End Product** | **Partner Use** | **Datasets & Analyses** | **Software Release Category** |
| **Fire Risk Anomalies** | Partners will use these anomalies and fire risk maps to see how wildfire risk has changed, monitor rural areas that are difficult to reach, and identify areas that require additional resources. | Landsat 8, Terra/Aqua MODIS, Sentinel-1 C-SAR, SMAP, and GPM IMERG will be used to show changes in wildfire risk based on parameters characterizing moisture, fuel load, temperature, and historical fire activity. | N/A |
| **Fire Severity Maps** | These maps will show results of an automated approach to map fire severity and burned area when fires have occurred. Partners can use this data to compare fire risk and fire occurrence to improve their predictive models. | Terra/Aqua MODIS, Sentinel-2 MSI and ancillary data will be compared to evaluate methods for identifying wildfires and burned area. Time permitting, the team can also explore the use of Sentinel-1 C-SAR. | N/A |
| **Wildfire Risk Google Earth Engine App** | Partners can use this app for near real-time monitoring of wildfire conditions to inform how monitoring and recovery resources should be allocated. | Landsat 8, Terra/Aqua MODIS, Sentinel-1 C-SAR, SMAP, and GPM IMERG will be used in this app to map burned area, wildfire parameter anomalies, and wildfire risk. | IV |

**Project Timeline & Previous Related Work**

***Project Timeline:*** 1 Term: 2022 Spring

**Notes & References:**

***Notes*:** CONAF’s priority for this project is automation because their current workflow relies on some manual efforts and they need these layers more quickly than they are currently producing them. We would aim to keep the entire workflow within GEE, so that they don’t have to wait to export layers and then run their models. They do not currently use any SAR data, but are aware that it can be used to map fire severity and burned area. They said that seeing how the SAR data could improve their models would be helpful, but the priority is to automate their current processes. Because it’s a lower priority, I have edited the proposal so that the focus is on automation and we can start looking at the SAR data if time permits.

***References:***

Ban, Y., Zhang, P. Nascetti, A, Bevington, A.R., & Wulder, M.A. (2020). Near Real-Time Wildfire Progression Monitoring with Sentinel-1 SAR Time Series and Deep Learning. *Scientific Reports, 10,* 1322-1337. doi: 10.1038/s41598-019-56967-x

Belenguer-Plomer, M.A., Tanase, M.A., Fernandez-Carrillo, & Chuvieco, E. (2019). Burned area detection and mapping using Sentinel-1 backscatter coefficient and thermal anomalies. *Remote Sensing of Environment, 233*, 1-18. doi: 10.1016/j.rse.2019.111345.

Czuchlewski, K.R. & Weissel, J.K. (2005). Synthetic aperture radar (SAR)-based mapping of wildfire burn severity and recovery. *Proceedings. 2005 IEEE International Geoscience and Remote Sensing Symposium.* pp.4. doi: 10.1109/IGARSS.2005.1526102.