**NASA DEVELOP National Program**

****International Research Institute for Climate and Society

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**Uruguay Agriculture II**

*Validating a Remotely Sensed Drought Severity Index Using a Soil Water Balance Model Based on In Situ Station Data*

**Project Team:**

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**Partner Organizations**

Instituto Nacional de Investigación Agropecuaria (INIA), Collaborator & End-User, POC: Guadalupe Tiscornia, Research Scientist

**Applied Sciences National Applications Addressed:**

Agriculture, Disasters

**Study Area:**

Uruguay

**Study Period:**

January 2003 - December 2014

**Earth Observations & Parameters**

TRMM, TRMM Microwave I and Precipitation Radar – Rainfall

Aqua & Terra, MODIS – Land Surface Temperature and Vegetation Indices

**80-100 Word Objectives Overview**

This project tested the ability of a Drought Severity Index (DSI) to monitor drought using soil water balance with percent available water (PAW), as PAW has been shown to be a good indicator of vegetation stress. Additionally, TRMM precipitation data was replaced with NOAA’s CPC Morphing Technique (CMORPH) global precipitation estimate product within the DSI. A comparison of the original DSI with the one utilizing CMORPH was conducted in order to assess which product is best for use in Uruguay.

**Abstract**

The importance of monitoring drought is indispensable for countries whose economic viability is strongly tied to agriculture. Droughts are a major concern for the country of Uruguay, affecting their agricultural and energy sectors. The development of a remotely sensed drought monitoring tool that can aid government agencies in disseminating drought information to local stakeholders will be helpful in sustaining these important economic sectors. This study tested the ability of an existing Drought Severity Index (DSI) to monitor drought within Uruguay using remotely sensed products. The DSI, based off of methodology from Rhee et al. (2010), uses the climatological anomalies of NASA’s Moderate Resolution Imaging Spectrometer (MODIS) land surface temperature (LST) data, precipitation data from the Tropical Rainfall Measuring Mission (TRMM), and MODIS Normalized Difference Water Index (NDWI) data. By comparing the DSI to soil water balance (SWB) data from meteorological stations provided by the Instituto Nacional de Investigación Agropecuaria (INIA), this study was able to validate a remotely sensed drought index to station data, which has been used as the standard to define droughts within Uruguay. In addition to the validation of the DSI, the SWB data was compared to a series of modified DSI’s. NOAA’s CPC Morphing Technique (CMORPH) was substituted in for TRMM data, while alternative vegetation indices (Normalized Difference Vegetation Index (NDVI) and Enhanced Vegetation Index (EVI)) were exchanged for NDWI. This modified DSI has the potential to aid INIA and the Ministry of Agriculture in informing land managers, insurance providers, and policy makers in drought preparation and mitigation practices.

**Community Concerns**

* Droughts are a major economic concern for the country of Uruguay, affecting their agricultural and energy sectors.
* A 2009 multi-month drought in Uruguay caused an estimated 400 to 450 million U.S. Dollars to be lost, according to the Uruguayan Agriculture Programming and Policy Office (OPYPA) (MercoPress, 2009).
* Much of Uruguay’s power is generated by hydroelectric sources, making them susceptible and sensitive to droughts, as evidenced by a drought in the late 1980s, which reduced the hydroelectric output so much petroleum was imported, and the country had to adopt strict energy conservation strategies in order to keep up with the country’s energy demand (MercoPress, 2009 and National Drought Mitigation Center, 2013).

**Current Management Practices & Policies**

Uruguay does have some tools to assist land managers and policy makers such as NDVI, water balance monitoring from meteorological station data, and daily rainfall records, all of which are provided by the INIA. These tools are very useful for their respective purposes, but none address the concern of drought directly. The DSI created in this study would benefit the land managers and policy makers in Uruguay by giving the tools needed to better assess drought on a regional scale.

**Decision Support Tools**

* Drought Severity Index – A drought severity index will be created for local scale drought monitoring in Uruguay that will be based on methods from Rhee et al. (2010). This approach combines Land Surface Temperature (LST), Vegetation Indices (NDVI, NDWI, or EVI), and precipitation (TRMM and CMORPH).

**Benefit to End-User:**

* The main benefit of the Drought Severity Index developed in this study will be in assisting land managers, insurance providers, and policy makers in better assessing the effects of drought on a local scale through a decision support tool.
* Validation of the DSI with in situ station data will determine the ability of the DSI to measure drought within Uruguay and provide another tool, based solely on remote sensing data to monitor drought within the country.

**Models Utilized**

* NOAA’s CPC Morphing Technique (CMORPH) Global Precipitation Estimate
* Scaled Drought Severity Index, Model C12, (Rhee et al., 2010)
* INIA Soil Water Balance Using: a) effective rainfall from 84 meteorological stations (79 from InUMet and 5 from INIA) getting a value of surface runoff estimated on antecedent rain (from 5 days earlier), b) potential evapotranspiration based on daily values from temp, air humidity, windspeed, and solar radiation using the Penman-Monteith method, and c) soil water holding capacity defined by the Charter Soil Survey of Uruguay (scale 1:1,000,000) where the soil type determines the capacity of water retention in the area of root activity.]

**Ancillary Datasets Utilized**

* NOAA CPC Morphing Technique (CMORPH) – Precipitation
* INIA Soil Water Balance – Percent Available Water

**Software Utilized**

IRI Data Library – Manipulation of TRMM, LST, VI, and CMORPH data

SAS JMP – Statistical work

ArcGIS – TRMM, LST, VI, and CMORPH Raster Manipulation/Analysis, Image Enhancement & Map Creation