**NASA DEVELOP National Program**

**** International Research Institute for Climate and Society

**Fall 2013**

**Uruguay Agriculture**

*Using Terra MODIS Land Surface Reflectance, MODIS – Vegetation products and Tropical Rainfall Measuring Mission – Precipitation to Assess Regional Scale Drought in Uruguay*

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**Applied Sciences National Applications Addressed:**

Agriculture

Climate

**Study Area:**

Uruguay

**Study Period:**

May 2000 – Jun 2013

**Community Concern:**

Drought is a major economic concern for the country of Uruguay. In 2009, the Agriculture Programming and Policy Office, OPYPA, estimated that an amount equivalent to 400 to 450 million US dollars was lost in the Uruguayan economy due to a several months long drought (MercoPress, 2009). Energy production is also a concern during periods of drought since much of Uruguay's power comes from hydroelectric sources, which are very sensitive to drought conditions (MercoPress, 2009). During the late 1980’s, drought reduced the output of hydroelectric power so much that the country had to resort to the more expensive option of importing petroleum as well as adopting strict energy conservation efforts to keep up with the country’s energy demands (National Drought Mitigation Center, 2013). Decision support tools that specifically address response strategies to drought will become increasingly useful to farmers, insurance providers, and policy makers as they deal with an even more volatile climate in the future.

**80 – 100 Word Blurb**

This study looked into the effectiveness of different Vegetation Indices (VI) for use in monitoring drought as well as for use within the previously published Drought Severity Index (DSI) from Rhee et al., 2010. After establishing the proper VI for the climate of Uruguay, the DSI was applied to the country to give a monthly visual representation of drought impact throughout the region. This tool will be useful to land managers, insurance providers, and policy makers to better assess the effects of drought on a regional scale and provide a decision support tool for drought preparedness.

**Abstract**

It’s important to monitor drought, as it’s a major economical concern for numerous countries throughout the world. The United States uses a statewide decision support tool called the U.S. Drought Monitor to track the effects of drought. This tool in turn helps ranchers, farmers, and policy makers make key decisions about how drought is affecting their area of concern on a regional scale. While the country of Uruguay does have some tools to assess drought severity (such as Normalized Difference Vegetation Index (NDVI) and water balance monitoring) it may prove useful to have a tool similar to the U.S. Drought Monitor. To accomplish such a task, this study created a Drought Severity Index (DSI) comprised of Land Surface Temperature (LST), Precipitation, and a Vegetation Index (VI) based on methodology from Rhee et al. (2010). In Rhee et al. (2010) it was shown that the Normalized Difference Drought Index (NDDI) was the superior VI for humid climates in the USA based on their comparison of four VI’s. This version of the DSI, which includes the NDDI parameter, may be more applicable to Uruguay given its humid/semi-humid climate. This study analyzed the effectiveness of the NDDI parameter for the country of Uruguay and compared its drought sensitivity to that of other VI’s such as NDVI and Normalized Difference Water Index (NDWI), as well as the anomalies to each VI. These parameters can be obtained by using NASA’s Earth Observing System (EOS) and can be transformed into a drought monitoring system using the International Research Institute for Climate and Society (IRI) data library. This study also investigated the overall usefulness of VI’s with respect to drought monitoring and drought conditions. Once the proper VI had been chosen the methodology was run in the IRI data library. The new methodology has the potential to help the Instituto Nacional de Investigación Agropecuaria (INIA) and the Ministry of Agriculture to better inform the land managers, insurance providers, and policy makers for drought mitigation and preparedness.

**Partners/Collaborators**

Instituto Nacional de Investigacion Agropecuaria (INIA), Uruguay: Guadalupe Tiscornia and Ministry of Agriculture

**Current Management Practices & Policies**

Uruguay does have some tools to assist land managers and policy makers such as NDVI, water balance monitoring, 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.

**Benefit to End-User:**

* The main benefit of this tool will be to assist land managers, insurance providers, and policy makers in better assessing the effects of drought on a regional scale and to provide a decision support tool for drought preparedness.

**Decision Support Tools**

* Product 1 – A Drought Severity Index (DSI) will be created for regional scale drought monitoring based on the method from Rhee et al. (2010) which combines Land Surface Temperature (LST), Vegetation Indices (NDDI, NDVI, or NDWI), and Precipitation (TRMM).

**Earth Observations & Parameters**

TRMM, Precipitation Radar – Rainfall

Terra, MODIS – Land Surface Temperature and reflectance

**Future Applicable NASA Missions**

Soil Moisture Active-Passive (SMAP)

**Models Utilized**

Scaled Drought Severity Index, Model C12, from Rhee et al. (2010) calculated as:

* (1/4) *scaled LST* + (1/2) *scaled TRMM* + (1/4) *scaled VI*
* Scaled Land Surface Temperature (*LST*) is calculated as:

(LSTmax - LST)/(LSTmax - LSTmin)

* Scaled Tropical Rainfall Monitoring Mission (*TRMM*)is calculated as:

(TRMM - TRMMmin)/(TRMMmax - TRMMmin)

* Scaled Vegetation Index (*VI*)is calculated as:
	+ Scaled Normalized Difference Drought Index (*NDDI*)

                       (NDDImax - NDDI)/(NDDImax - NDDImin)

                                                   or

* + Scaled Normalized Vegetation Index (*NDVI*)

            (NDVI - NDVImin)/(NDVImax - NDVImin)

                                                   or

* + Scaled Normalized Water Index (*NDWI*)

            (NDWI - NDWImin)/(NDWImax - NDWImin)

**Ancillary Datasets Utilized**

* IRI Data Library to retrieve remote sensing and climate data for Uruguay

**Software Utilized**

* SAS JMP Statistical Software – Statistical Analysis
* Expert Mode within IRI Data Library – Data collection and manipulation
* ArcGIS – Raster Manipulation/Analysis

**References**

MercoPress (March 20, 2009), retrieved on September 23, 2013 from: http://en.mercopress.com/2009/03/20/uruguays-preliminary-farm-losses-to-drought-estimated-in-450-million-usd

National Drought MItigation Center (2013), retrieved on September 23, 2013 from: http://drought.unl.edu/DroughtBasics/TypesofDrought.aspx

Rhee, J., Im, J., & Carbone, G. J. (2010). Monitoring agricultural drought for arid and humid regions using multi-sensor remote sensing data. *Remote Sensing of environment*, *114*(12), 2875-2887.

**Imagery & Captions (only to be included in the final draft, not rough draft)**

**Image A caption.** The DSI (using NDWIa for the VI) applied over the country of Uruguay for January 2009. Bolder black line represents the country boundary for Uruguay while the thinner black lines represent the different departments of the country. The color ramp and explanations are modified from Rhee et al. (2010).

**Image A.**

 