Satellite data and supervised learning to prevent impact of drought on crop production: Meteorological drought

Gideon Kruseman (CIMMYT), Joint work with Leonardo Ornella, Jose Crossa Workshop *Mathematics of the Economy and Climate*, Soesterberg July 15-17, 2019

Overview

- Trigger
- Context
- Theoretical background
- Operationalization

Trigger

https://www.intechopen.com/online-first/satellite-data-and-supervised-learning-to-prevent-impact-of-drought-on-crop-productionmeteorologica

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Satellite Data and Supervised Learning to Prevent Impact of Drought on Crop Production: Meteorological Drought

> By Leonardo Ornella, Gideon Kruseman and Jose Crossa Submitted: November 22nd 2018 Reviewed: February 26th 2019 Published: June 6th 2019 DOI: 10.5772/intechopen.85471

Chapter

Satellite Data and Supervised Learning to Prevent Impact of Drought on Crop Production: Meteorological Drought

Leonardo Ornella, Gideon Kruseman and Jose Crossa

Abstract

Reiterated and extreme weather events pose challenges for the agricultural sector. The convergence of remote sensing and supervised learning (SL) can generate solutions for the problems arising from climate change. SL methods build from a training set a function that maps a set of variables to an output. This function can be used to predict new examples. Because they are nonparametric, these methods can mine large quantities of satellite data to capture the relationship between climate variables and crops, or successfully replace autoregressive integrated moving average (ARIMA) models to forecast the weather. Agricultural indices (AIs) reflecting the soil water conditions that influence crop conditions are costly to monitor in terms of time and resources. So, under certain circumstances, meteorological indices can be used as substitutes for AIs. We discuss meteorological indexes and review SL approaches that are suitable for predicting drought based on historical satellite data. We also include some illustrative case studies. Finally, we will survey rainfall products existing at the web and some alternatives to process the data: from high-performance computing systems able to process terabyte-scale datasets to open source software enabling the use of personal computers.

Keywords: remote sensing, supervised learning, meteorological index, wavelet

CIMMYT Overview



Mission

Maize and wheat science for improved livelihoods.

Vision

A world with healthier and more prosperous people – free from global food crises – and more resilient agrifood systems.



The big impact

- Annual benefits of \$3.5-4 billion.
- 50% of maize and wheat in the developing world is based on CIMMYT varieties.
- Trained over 10,000 agricultural experts and scientists.



Wheat helps feed the world



Maize helps feed the world





Context:

Foresight, Ex-ante Impact Assessment & Targeting



Some Definitions

Research theme on foresight and targeting

- Foresight: Looking into the crystal ball at the future to understand what it means for us today
- We define **ex-ante impact assessment** as the analysis at how pipeline technologies fit into farming systems and livelihood strategies and as the analysis of potential impact of research investments
- **Targeting** looks at short term questions of where, when, what and how of technology deployment



Now near future

far future

Drivers of change

- Climate change
- Population growth
- Overall economic development
- Global systems integration
- Urbanization
- Lengthening of value chains
- Rural transformation

Selected topics



Threat of wheat blast to South Asia's food security: An ex-ante analysis Mottaleb et al. 2018 Plos One

- Climate change and production
- New and emerging pests and diseases in crops
- Changing diets and food systems
 - Near future decision support





Near future decision support

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- Support vector regression (SVR) and least squares support vector regression (LS-SVR)
- Artificial neural network (ANN)
- Deep belief networks (DBN)
- Bagging
- Random forest regression (RFR)
- Adaptive neuro-fuzzy inference system or adaptive network-based fuzzy inference system (ANFIS)

CIMMYT

- Boosting
- Hybrid models

Data sources

- Era5 data (ECMWF)
- Weather company (IBM)
- Focus on some of our key research sites for starters





context



https://reliefweb.int/map/zimbabwe/southern-africadrought-situtation-emergency-responsecoordination-centre-ercc-dg-echo





Weather in Harare, Zimbabwe





Moments

The moments describe the distribution of the rainfall



Scatterplot Matrix of the Features of the Harare Data Set: normalized moments daily rainfall



Scatterplot Matrix of the Features of the Harare Data Set: normalized moments maximimum T



Lead/lag correlation (months) between the Multivariate ENSO Index Version 2 and precipitation



cross-correlation is a <u>measure of similarity</u> of two series as a function of the displacement of one relative to the other.





Lead/lag correlation (months) between the (Tmax-Tmin) and precipitation











Decomposing monthly values of SPEI into seasonal, trend and irregular components using loess







Thank you for your interest!