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Modelling drought impacts over agricultural areas in Iberia using hydro-meteorological and satellite-based drought indices

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Presently, and as consequence of both precipitation decrease and temperature increase, crop yield is being affected by drought conditions and is expected to continue to be affected in the future. Under the scope of climate change, warming and drying climatic conditions are expected to take place, as well as an increasing frequency of droughts and water scarcity in the Iberian Peninsula (IP), which can lead to widespread impacts in agricultural productions. Therefore, a continuous monitoring of drought conditions using diverse drought indicators, at various spatial and temporal scales, is crucial in the agricultural sector.

This work aims to model the influence of drought conditions over some of the major agricultural drought-exposed areas in the IP. Two clusters of provinces dominated by rainfed agricultural practices were identified and selected for further analysis at the regional level. Two types of indices were used to evaluate drought hazard, namely the hydro-meteorological drought index SPEI (Standardized Precipitation Evapotranspiration Index) and the satellite-based indices VCI (Vegetation Condition Index), TCI (Temperature Condition Index) and VHI (Vegetation Health Index). Drought impacts were assessed concerning the response of two rainfed winter cereal yields (wheat and barley) to the regional drought conditions during 1986-2012. Generally, the years displaying higher rates of crop loss (1992, 1995 and 2005) also exhibited dry conditions according to both SPEI (negative values) and satellite-based indices (values below 40).

Strong correlations between the crop yield and the referred indices (SPEI, VCI, TCI and VHI) were found during crop intermediate growth stages (spring and summer), rather than in the initial growth stages (autumn/winter). Moreover, correlation values also suggested that yield loss is associated with moisture stress (low values of VCI) during early-spring and with heat stress (low values of TCI) during early-summer. Several statistical models based on Multiple Linear Regression (MLR) and Artificial Neural Networks (ANN) techniques were established using cross-validation to estimate the yield response to drought conditions. The results of both statistical approaches suggested the potential of modelling drought-related yield losses, and some improvements were found by the ANN in comparison with the MLR methods.

Facing the obtained results, we firmly believe that this approach constitutes a first step towards the development of an agricultural drought risk model for the IP, and may contribute to assist final users and insurance companies with some guidance on decision making process.

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