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ESA-CCI soil moisture for agricultural drought: validation by using crop data

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Drought is one of the most damaging natural hazard caused by an intense and extended deficiency of precipitation. It is a matter of importance to give a widespread definition of drought considering the increase in drought frequency, duration and severity in recent years due to climatic changes. Many studies have been focused on the definition of four different types of droughts: Meteorological, Agricultural, Hydrological, Socio-Economic. They occur at different time scales. With the aim to quantify drought levels several drought indices have been developed based on different variables as indicators. Soil moisture represents one of the best indicators to build agricultural drought indices as agricultural drought occurs when there is not enough soil moisture to support crop production. The aim of this work is to establish the relation between drought and crop yield as a validation of developed indices.

We focused our analysis over two different climatic regions namely, Italy and India, which have been affected by severe historical droughts in the recent years. In India, to integrate drought analysis with crop phenology, we used 12 years annual crop yield data (1998-2009) for Karnataka State and 13 years annual crop yield data (1998-2010) for Maharashtra State. Two types of crops (Maize and Rice) were selected for the Kharif period (May to October). The crop dataset for every district of the two states was correlated with two agricultural drought indices: Soil Water Deficit Index (SWDI, Martinez-Fernandez et al, 2016) and the Standardized Soil Moisture Index (SSI, AghaKouchak & Farahmand, 2015) considering different times of accumulation (e.g. 3, 6 months). For Italy, we collected crop production from Eurostat database for Maize and Rice following the same approach of India.

Soil moisture observations were derived from the ESA CCI Soil Moisture product from 1981 to 2016 (Dorigo et al., 2017) and aggregated monthly. Correlation Analysis (Pearson R) was carried out by using firstly the raw data crops for every district. In a second step, the datasets were de-trended to find crop yield anomalies by either linear regression if statistically significant or by removing the mean values from the series. Overall crop anomalies analysis slightly improves the correlation with drought indices. The results show that for the SSI as well as for the SWDI the highest correlations while Maize exhibits lower correlation both for the raw and the de-trended datasets. Furthermore, SSI gives higher correlation with crop yields than SWDI in the study areas.

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