Characterizing water stress (Ponding and Droughts) in irrigated agricultural systems: integrating remote sense data, field surveys, and local knowledge.

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**Abstract.** Quantifying surface water stress [Drought and surface water ponding (DSP)] in lowland agricultural regions is challenging because limited water supplies are distributed over long distances based on complex water management systems constrained by legal, economic, and social framework. Facing shortages of freshwater resources, irrigated agriculture often requires more effort and more careful practices than typical agriculture for production to continue for a long time. This work focus on an irrigated area in north-eastern Italy, a territory of about 400k ha, part of the central Veneto, where water demands is met through a mechanical and well-regulated widespread distribution of water resources. For this complex landscape, reliance on weather data alone is not sufficient to monitor areas of DSP, particularly when these data can be i) untimely, sparse, and incomplete, and ii) water inflows are mechanically controlled, with varying flow exchanges, not necessarily reflecting climatic fluctuations. Augmenting climatic data with satellite images to identify the location and severity of DSP phenomena, therefore, is a must for complete, up-to-date, and comprehensive coverage of current crop conditions.

The objective of this research is to apply and standardize open-source data to augment DSP-monitoring techniques in conjunction with local knowledge. For this, we selected four pilot study areas, characterized by different agricultural production, and farm management.

The study was conducted with 20 years (2000-2021) satellite images, together with weather data from local meteorological stations covering the timeframe 1994-2021.

From the harmonization of Landsat7 and 8, and Sentinel2 data, we retrieved a baseline information for each parcel. The Z-scores of the NDVI distribution were used to estimate the probability of occurrence of the present vegetation condition at a given location relative to the possible range of vegetative vigor, historically.

At the end of each irrigation season [March-October], DSPcrop events were identified as periods of low vigor from the NDVI Zscore. Similarly, from the climate data, DSPclimate events and characteristics were identified using the SPI [Standardized Precipitation Index]. We identified DSP events by using run theory. Specifically, a DSP event has been defined as the period in which the NDVI Zscore or SPI is continuously below (for both SPI and NDVI) or above (For the SPI) a critical threshold. For each season, we identified and analyzed the following four main DSP characteristics: duration, frequency, and severity.

Over multiple years, we compared the results of the DSP identification with local knowledge of the farmers, highlighting specific management conditions that were applied over the fields, to identify and target locations more susceptible to DSP.

Findings indicate that the framework, along with other monitoring tools, is useful for assessing the extent and severity of DSP at a spatial resolution of 10m. The framework can provide a near-real-time indicator of vegetation condition within irrigated regions, and more specifically areas of varying water management conditions.

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