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Advancing drought monitoring via feature extraction and multi-task learning algorithms

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A drought is a slowly developing natural phenomenon that can occur in all climatic zones and can be defined as a temporary but significant decrease in water availability. Over the past three decades, the cost of droughts in Europe amounted to over 100 billion euros, with the recent summer droughts being unprecedented in the last 2,000 years. Although drought monitoring and management are extensively studied in the literature, capturing the evolution of drought dynamics, and associated impacts across different temporal and spatial scales remains a critical, unsolved challenge.

In this work, we contribute with a Machine Learning procedure named FRIDA (FRamework for Index-based Drought Analysis) for the identification of impact-based drought indexes. FRIDA is a fully automated data-driven approach that relies on advanced feature extraction algorithms to identify relevant drought drivers from a pool of candidate hydro-meteorological predictors. The selected predictors are then combined into an index representing a surrogate of the drought conditions in the considered area, including either observed or simulated water deficits or remotely sensed information on crop status. Notably, FRIDA leverages multi-task learning algorithms to upscale the analysis over a large region where drought impacts might depend on diverse but potentially correlated drivers. FRIDA captures the heterogeneous features of the different sub-regions while efficiently using all available data and exploiting the commonalities across sub-regions. In this way, the accuracy of the resulting prediction benefits from a reduced uncertainty compared to training separate models for each sub-region. Several real-world examples will be used to provide a synthesis of recent applications of FRIDA in case studies featuring diverse hydroclimatic conditions and variable levels of data availability.