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A novel methodology for mapping irrigation types from very high resolution remotely sensed data

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This research aims at introducing a new methodology to create maps of irrigation types at very high resolution, with yearly updates. While different studies were already performed on simply mapping irrigated areas, there is still no research on classifying irrigation types based on remotely sensed data. This information has a critical scientific value since detailed information on irrigation greatly improves the understanding of human activities on the water cycle. In particular, precise knowledge of different irrigation types is needed in order to correctly model the anthropogenic impact in various land surface models (Ozdogan et al., 2010; Evans and Zaitchik, 2008). Additionally, these maps are also useful for administrative purposes, to estimate the percentage of different irrigation types, monitor changes in irrigation practices and consequently encourage more sustainable use of the freshwater resources. In this research, we produce maps of irrigation types combining state-of-the-art supervised AI classification algorithms for time series classification together with a selection of hydrological variables. In order to train and test the AI models, a field campaign to collect ground truth data was performed in November 2020 around the intensely cultivated region of Catalunya, Spain. From this campaign, important information about crop types and irrigation types (sprinkler, flood, drip/subsurface and non-irrigated) were retrieved for a large number of fields, ensuring to collect a representative sample of the different cultivation and irrigation types employed in the area. Three different models were tested using as inputs a large variety of hydrological variables both alone and combined in multivariate models. Two machine learning models, Time-Series Forest and Rocket, and one Deep Neural Network model, ResNET, were selected for this classification task. The classification was performed using time-series from three different years in order to train the models with a more general and robust dataset, independent from specific meteorological conditions of a single year. The main finding of the research was that Soil Moisture (*SM*) and Actual Evapotranspiration (*ETa*) at very high spatial resolution (20 m) consistently showed the highest accuracy, when combined together, with respect to the other variables considered, regardless of the AI model used. Additionally, ResNET showed

consistently better performance than the other two AI models over all the metrics used for the comparison (accuracy, precision, recall and kappa). The final classification accuracy retrieved from ResNET using *SM* and *ETa* as inputs was 86.59 +/- 2.79, obtained from 10 different runs of the model trained each time with different ground truth data subsamples. As a result of these findings, yearly maps of irrigation types can be created for large areas at field level, delivering detailed information on the status and evolution of irrigation practices.

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