Classification of Irrigation Systems at Field Level from Remotely Sensed Soil Moisture and Actual Evapotranspiration Time-Series

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This study proposes a novel methodology for classifying irrigation systems at field scale, in order to address the lack of such maps at high resolution from remotely sensed data. This information has a critical scientific value since detailed information on irrigation practices greatly improves the understanding of human activities on the water cycle. In particular, precise knowledge of different irrigation systems is needed in order to correctly model the anthropogenic impact in various land surface models. Additionally, these maps are also useful for administrative purposes, to estimate the percentage of different irrigation systems, monitor changes in irrigation practices and consequently encourage more sustainable use of the freshwater resources. The hypothesis of this study is that time-series of two main hydrological variables, Actual Evapotranspiration (ET_a) and Soil Moisture (SM) at high resolution (20 m) show variations directly related to the different irrigation systems used. Three different Artificial Intelligence (AI) models for time-series classification were employed and compared for this specific task: two classical machine learning algorithms, Time-Series Forest and Rocket, and one deep learning model, ResNET. In order to train these models, an extensive field campaign was performed in 2020 in an intensively cultivated region in Catalunya, Spain. Data for more than 300 fields were collected, from different crop types and labelled by four different classes: flood, sprinkler, drip and not irrigation. 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. Initially, we demonstrated how irrigation systems are correctly classified from ET_a and SM regardless of the crop type used: AI models were trained separately for each crop type and results were aggregated together and compared with a general AI model trained with all crop types. Secondly, tests were performed to identify the most

suitable AI model and also to identify the most suitable set of variables for the classification, among ET_a, SM, but also Leaf Area Index, Crop Stress Coefficient, Normalized Difference Vegetation Index and Land Surface Temperature. Results showed how combining ET_a and SM produced the best classification results in terms of accuracy of around 90 %, when used with ResNET. As a result, it was possible to create annual maps of irrigation systems for the considered study area, which showed a general trend towards modern irrigation systems such as drip and sprinkler.