IrriTer, a digital twin approach to assess and forecast site-specific crop water requirements at irrigation district scale

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In the Mediterranean region, agricultural water use accounts for a large share of the water demand and is key for food security and socio-economic stability in rural areas. At the same time, both farm irrigation management and distribution are not trivial tasks, since crop water requirements are site-specific and vary in time due to weather, agronomic practices and other factors. In this context, the availability of EO data opens the opportunity to develop tools for the supervision and management of irrigation, scalable from farms to districts and basins. Time series of observed biophysical parameters of the vegetation and estimates of actual crop evapotranspiration (ETa) are promising resources for these applications. Those data can be assimilated in digital twins that integrate observations from different sources with soil water balance models, enabling the assessment of irrigation performance and management decision making. In this study we describe an approach that assimilates EO data and simulates the water balance variables of the soil-crop system at each individual plot. The goal is to obtain a dynamic view of irrigation performance scaling from individual plots to the basin, quantifying at real time the progress of crop growth and seasonal water balance, including forecasts of the forthcoming water demand. This approach has been implemented in the lower Ter River basin (Catalonia, Spain), on an area of 675 km2. A separate digital twin was defined for each of the 25000 agricultural plots listed in the Land Parcel Identification System. For each plot, the agricultural scenario was set up according to open data of EU CAP's Single Farm Payment and a soil map classification of the area. This included the list of crops declared from 2015 to 2021, the irrigation method and the soil class. From these basic categoric data, more detailed parameters of the crop, soil and irrigation method were assigned according to the description of actual agricultural scenarios on the area. The development of the crop and its soil water balance is simulated in real time for each field, using a customized model based in a rationale similar to FAO's AquaCrop, with additional adaptations for permanent crops, localized irrigation and discontinuous canopies. Simulations are updated on a daily basis, using online weather data from the Meteorological Service of Catalonia. In parallel, as soon as new Sentinel-2 images are available, fAPAR is computed with the PROSAIL radiative transfer model and assimilated in the model. The output are maps and time series with the estimated ETa, irrigation and available soil water at each plot. These maps are updated

daily. Time series cover the whole year, on a week basis, including the forecasts for the remaining part of the year.