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Forecasting irrigation demand by assimilating satellite images and numerical weather predictions

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Forecasting irrigation water demand, with small predictive uncertainty in the short-medium term, is fundamental for an efficient planning of water resource allocation among multiple users and for decreasing water and energy consumptions.

In this study we present an innovative system for forecasting irrigation water demand, applicable at different spatial scales: from the farm level to the irrigation district level.

The forecast system is centred on a crop growth model assimilating data from satellite images and numerical weather forecasts, according to a stochastic ensemble-based approach. Different sources of uncertainty affecting model predictions are represented by an ensemble of model trajectories, each generated by a possible realization of the model components (model parameters, input weather data and model state variables). The crop growth model is based on a set of simplified analytical relations, with the aim to assess biomass, leaf area index (LAI) growth and evapotranspiration rate with a daily time step. Within the crop growth model, LAI dynamics is let be governed by temperature and leaf dry matter supply, according to the development stage of the crop. The model assimilates LAI data retrieved from VIS-NIR high-resolution multispectral satellite images. Numerical weather model outputs are those from the European limited area ensemble prediction system (COSMO-LEPS), which provides forecasts up to five days with a spatial resolution of seven kilometres. Weather forecasts are sequentially bias corrected based on data from ground weather stations. The forecasting system is evaluated in experimental areas of southern Italy during three irrigation seasons. The performance analysis shows very accurate irrigation water demand forecasts, which make the proposed system a valuable support for water planning and saving at farm level as well as for water management at larger spatial scales.