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Using an integrated approach between hydrological and crop models to assess surface water balance in ungauged basin

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In the last decades hydrological models have been extensively used in research fields in order to improve water balance assessment and to support integrated water resources management by quantifying the soil–plant–atmosphere interface. Due to complexity of the physical system, the mathematical models can generally represent and simulate only the basic components of the system. On the other hand, calibration and validation processes of the hydrological models in ungauged basins are still complex tasks, due to the lack of reliable methods and the uncertainty in representing the hydrological processes and the physical features of a basin. Therefore, in order to practically apply model's results, there is a continuous needing to assess their accuracy through the calibration and validation processes at gauged sites.

In this context, an integrated approach is presented that couples a semi–distributed hydrological model called Distributed model for Runoff, Evapotranspiration, and Antecedent soil Moisture simulation (DREAM) with the FAO's Crop Water Productivity Simulation Model (AQUACROP). DREAM uses rainfall, Leaf Area Index (LAI) and potential evapotranspiration as inputs and streamflow, infiltration, real evapotranspiration, subsurface flow and deep percolation as outputs. Soil moisture content is accounted for as an internal variable. The simulations were done for Lama San Giorgio, a basin located in a wadi area in the central part of Apulia region (Southern Italy) for the period 2001—2005 and the meadow is mainly covered by durum wheat. According to ACLA2 project survey (Caliandro et al., 2005), the depth of the soil upper layers is about 80 cm.

Calibration and validation of the DREAM model were carried out by assessing an accurate estimation of soil water content using AQUACROP model which is a more detailed model in terms of soil water dynamics. Instead, one of the most significant features of DREAM model is the evaluation of lateral flow exchanges by means of a redistribution function weighted by the wetness index. The calibration process was done by adjusting a specific parameter of the water balance, the subsurface flow (through a subsurface flow coefficient C), by exploiting the results of soil moisture content provided by AQUACROP model. Then, the outputs of daily soil water content obtained by DREAM model were compared with the estimations of soil behaviour provided by the AQUACROP model. The simulations were done for a certain number of cells in the study area, for different years. The chosen factors were used to obtain an average value of C in time and space, which in this study is equal to 0.5. Finally, the results of the DREAM model in terms of evapotranspiration provided a satisfactory approximation of those obtained by AQUACROP model, while the Canopy Cover, an output of AQUACROP, was compared with the LAI used as input for the DREAM model.