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Performance of evapotranspiration models for a maize agro-ecosystem: from bare soil to maximum coverage in irrigated and rainfed conditions

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To assure an efficient management and planning of irrigation water resources, an accurate computation of actual evapotranspiration (ET) from cropped surfaces is needed. ET models can be classified in two categories: "direct" methods, based on the original Penman-Monteith (P-M) equation, in which the canopy resistance rc is modelled, and "indirect" methods, based on the calculation of ET for a well-watered reference grass (ET_0) with constant r_c multiplied by a crop coefficient that represents the relative rate of ET from a specific crop and condition to that of the reference.

This last procedure, standardized by FAO-56 bulletin, is the most widely adopted for the estimation of ET. However, in literature there are evidences that direct methods (P-M models with r_c modelled) are still the most performing. In fact, for indirect methods, errors introduced by the calculation of ET_0considering a constant r_c for reference crop and by the estimation of the crop coefficient, which actually integrates several physical and biological factors, can be relevant.

This study evaluates the performance of different models for the estimation of ET for a maize agro-ecosystem in the Padana Plain (Northern Italy). The following models have been considered: 1) the "one-step" P-M model using a constant daily canopy resistance following the classical Monteith approach; 2) the "one-step" P-M model using a variable canopy resistance based on the approach of Katerji-Perrier, in which r_c is calculated as a function of climate variables, aerodynamic resistance, vegetation type and its water status; 3) the "two-step" Shuttleworth model as updated by Shuttleworth and Gurney (1990), which combines one-dimensional models of crop transpiration and of soil evaporation, where canopy and soil surface resistances regulate the heat and mass transfer at the plant and soil surfaces, and aerodynamic resistances regulate those between these surfaces and the atmospheric boundary layer; 5) the indirect "single crop coefficient" method proposed by FAO-56; 6) the indirect "double crop coefficient" method proposed by FAO-56, which allows the separation of soil evaporation and crop transpiration.

Latent heat fluxes measured in 2006, 2010 and 2011 in an experimental maize field by eddy-covariance are used to evaluate the models accuracy. Crop, soil and meteo data monitored contextually are used for different models implementation. Data from the closest standard agro-meteorological station are adopted in the ET_0 calculation for indirect methods.

Results of this work confirm what reported by other authors in the literature, demonstrating that the calculation of crop evapotranspiration by direct method is more accurate than the use of indirect methods for both irrigated (2006, 2010) and rainfed (2011) conditions.