

Modelling Water Flows in the Vadose Zone and Water Table Interactions at Field Scale in the Lower Mondego Valley, Portugal

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Abstract

The paper presents an approach to modelling water flows interaction in the vadose zone. The study was applied to surface irrigated maize in the Lower Mondego Valley, located in the centre-west of Portugal with 12,000 ha of irrigated area. The study aims at: (i) evaluating the drainage and capillary rise fluxes through the lower boundary of the root zone using the HYDRUS model, and (ii) assessing the impacts of recharge flows due to irrigation and/or originating in the surrounding drainage ditches on the water table using the MODFLOW model. Two different field soil conditions (sandy-loam and silty-loamy) were considered. The parameterization of the unsaturated vadose zone was performed using the Van Genuchten-Mualem equations characterizing the soil hydrodynamics behaviour. Aimed at modelling, field observations included: dynamics of the groundwater table level using piezometer recorders; soil moisture dynamics; meteorological, field irrigation and crop development data. The HYDRUS calibration was performed through adjusting simulated to observed soil water content. Groundwater modelling with MODFLOW was performed using data on aquifer-system geometry, hydrological parameters and the groundwater heads observed. The use of MODFLOW focused the evaluation of recharging flows to the groundwater table consisting in vertical flows from the unsaturated zone (obtained from the HYDRUS), and lateral flows from ditches and the adjacent rice paddies. Drainage flows from water table to ditches and deep percolation to the main aquifer were also evaluated. The application of these two models, adopting an iterative process, allowed to properly simulate the dynamics of water table level variations. The paper presents the comparison between models results and field observation data. In order to minimize irrigation water excess and keeping soil water storage in levels appropriate to obtain maximum yields, a modification of the irrigation schedule is suggested, which is combined with water level control and improvement of surface irrigation performance.

Keywords: water table dynamics, capillarity rise, HYDRUS model, MODFLOW model, surface irrigation, maize