Geophysical Research Abstracts,
Vol. 10, EGU2008-A-09072, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-09072
EGU General Assembly 2008

1 Simplified modelling of surface water – groundwater interactions based on coupled one-dimensional Richards and Boussinesq equations.

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Farmed ditches are known in Mediterranean catchments to be zones of groundwater recharge and thereby may contribute to groundwater pollution. For many environmental purposes, it is therefore essential to be able to model the surface-subsurface flow processes that occur within and at the vicinity of ditches. Various modelling approaches have already been used. They all imply to simulate the behaviour of groundwater under transient conditions related to the infiltration of water from the stream bed to the groundwater. Several saturated flow approaches have been proposed. They may perform satisfactorily when the flow processes in the vadose zone can be neglected. But in arid and semi-arid areas, vadose zone processes are often important which, as shown by several authors (e.g. Vauclin et al., 1979; Sorman et al., 1997), requests to operate variably saturated modelling approaches to estimate recharge volumes and watertable growths. Moreover, at the scale of intensively farmed catchments, recharge processes are heterogeneous in space and their modelling often requires a three-dimensional approach. Nevertheless, three-dimensional modelling of variably

saturated flow at such a scale are known to experience convergence difficulties and to be time consuming. Simplified solutions, that link one-dimensional variably saturated flow and two-dimensional saturated flow approaches, have therefore been proposed (e.g. Pikul et al., 1974; Abbott et al., 1986; Niswonger and Prudic, 2005).

In this study we present a simplified modelling approach of recharge of a shallow groundwater that extends the initial ideas of Pikul et al. (1974) to simulate variable thickness of unsaturated and saturated zones and ensure the closure of the water balance. The modelling approach is based on the coupling between the hydrus1d (Simunek et al., 1998) simulation code that computes unsaturated flow and a finite element 2D-Boussinesq code that computes saturated flow. At each time step, the unsaturated profile is defined from the soil surface to the water table surface. Its upper boundary condition is generally a flux condition (precipitations) but can shift to a pressure condition when runoff water layer forms. Its lower boundary condition is a constant zero pressure head due to the phreatic surface at the bottom of the soil profile. Recharge, which is defined as the flux at the bottom of the soil profile, is given as an input at the 2D-Boussinesq code to compute the new water table surface. The storage coefficient is also computed at each time step depending on recharge value and material properties of the soil profile in the watertable fluctuation zone.

The simplified approach was tested in the case of a rain event. Results were compared to a reference simulation performed with the SWMS_3D code (Simunek et al., 1995).

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