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Three-dimensional modelling of groundwater recharge pathways in a farmed Mediterranean catchment with a network of ditches.

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Intermittent streams are known in arid and semi-arid areas to be zones of preferential infiltration of water and solutes and, thereby, to contribute to groundwater recharge and pollution. For many environmental purposes, including water resources assessment and risk analysis of water contamination, it is therefore essential to be able to model the surface-subsurface flow processes that occur within and at the vicinity of channels and ditches. Various modelling approaches have already been used according to the specific hydraulic conditions of the stream-aquifer interaction. 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, Niswonger and Prudic, 2005), resquests 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, being of diffuse and concentrated type and varying according to soil surface conditions and to the spatial distribution of the hydrographic network.

In this study we present a three-dimensional modelling approach of recharge of a shallow groundwater during a flood event that was adapted to represent the spatial variation of infiltration processes in a small farmed Mediterranean catchment. The first

step of the approach was to develop a finite element mesh that reproduced the general topography and the main hydrological discontinuities that exist in the 30 ha farmed study zone, namely field and soil limits and a dense network of ditches. This was done by a series of semi-automated operations using facilities provided by ArcInfo and those of the mesh generator Gmsh (Geuzaine and Remacle, 2004). The second step was to use the SWMS_3D simulation code (Simunek et al., 1995), which computes three-dimensional saturated-unsaturated water flow, to simulate recharge induced by infiltration over the fields and by surface flow in the ditches network. The simulations were performed for several scenarios of watertable depth and were compared with observed hydrological data from the study area. The results first showed the relevance and feasibility of a three-dimensional unsaturated-saturated approach at the catchment scale They also showed the importance of concentrated recharge in the ditches network during flood events as compared to diffuse recharge through the field soils. Nevertheless for simulating the variation of recharge according to varying runoff event, the present three-dimensional unsaturated flow approach will need to be coupled to a surface model which predicts flood height and volumes.

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