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Observation and simulation of heterogeneous 2D water and solute flow processes in ditch beds for subsequent catchment modelling

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Ditches are involved in the transfer of pesticide to surface and groundwaters (e.g. Louchart et al., 2001). Soil horizons underlying ditch beds may present specific soil characteristics compared to neighbouring field soils due to erosion/deposition processes, to the specific biological activities (rooting dynamic and animal habitat) in the ditches (e.g. Vaughan et al., 2008) and to management practices (burning, dredging, mowing,...). Moreover, in contrast to percolation processes in field soils that can be assumed to be mainly 1D vertical, those occurring in the ditch beds are by essence 2D or even 3D. Nevertheless, due to a lake of knowledge, these specific aspects of transfer within ditch beds are generally omitted for hydrological simulation at the catchment scale (Mottes et al., 2014).

Accordingly, the aims of this study were i) to characterize subsurface solute transfer through ditch beds and ii) to determine equivalent hydraulic parameters of the ditch beds for use in catchment scale hydrological simulations. A complementary aim was to evaluate the error in predictions performed when percolation in ditches is assumed to be similar to that in the neighbouring field soil.

First, bromide transfer experiments were performed on undisturbed soil column (15 cm long with a 15 cm inner-diameter), horizontally and vertically sampled within each soil horizon underlying a ditch bed and within the neighboring field. Columns were sampled at the Roujan catchment (Hérault, France), which belongs to the long term Mediterranean hydrological observatory OMERE (Voltz and Albergel, 2002). Second, for each column, a set of parameters was determined by inverse optimization with mobile-immobile or dual permeability models, with CXTFIT (Toride et al., 1999) or with HYDRUS (Simunek et al., 1998). Third, infiltration and percolation in the ditch was simulated by a 2D flow domain approach considering the 2D variation in hydraulic properties of the cross section of a ditch bed. Last, equivalent 1D simulation parameters were seeked for mimicking the 2D infiltration intensities and patterns. The results obtained are presented and discussed based on the consistency of the simulated hydrograms, chemograms and seasonal solute losses during a series of intense infiltration events representing a typical Mediterranean climatic sequence in autumn.

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