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Characterization of flow and infiltration processes on agricultural plots irrigated by submersion.

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The surface irrigation (flood irrigation, trickle and furrow) is a traditional irrigation system widely used worldwide. This system is recognized as being highly water consumer: high volumes of water are injected to the plot, which generate significant loss of water (drainage and run-off). Although these unused water flows can generate positive externalities (feeding wetlands, groundwater recharge) a decrease of water volume used is sought in a context of limited water resource. In this system of irrigation, the amount of water that is actually brought to the plot surface ("irrigation dose") is insufficiently known because it depends on the interaction between the propagation of water at surface of the plot and its infiltration into the soil. These two processes are conditioned by multiple factors: input flow rate in the plot, irrigation duration, soil properties (hydraulic conductivity, water reserve and depth), geometry of the parcel, hydraulic factors (slope of flow, coefficient of friction hydraulic). A methodology is therefore needed for calculating the doses given on an agricultural plot in order to analyse current practices and to propose ways for optimization.

The aim of this study is to develop a methodology to estimate (i) the amount of infiltrated water at the scale of a flood irrigated agricultural field, and (ii) soil properties (permeability, useful water reserve). This work is based on the use of a flood irrigation model (CALHY, model Bader et al., 2010, Hydrol. Sci. J., 55, 177-191) combined with a device for tracking the infiltration and the advancing of water in several fields of hay which are irrigated through submersion.

Firstly, a sensitivity analysis was used to define an optimal experimental configuration with respect to the estimation of parameters of interest (hydraulic friction, soil water storage capacity, hydraulic conductivity, soil depth). This analysis was performed on each of the model parameters and for different output variables. The results show that the sensitivity depends on the type of output studied and on its localization in the field.

In a second step, numerical experiments were performed to determine the type of parameter that can be estimated by inversion: we show that the knowledge of the evolution of water heights in two cross sections (upstream and downstream parts of the plot) and other related outputs are enough for estimate all the necessary parameters for calculating the water balance .

Prospects are (I) to optimize the calculation of the parameters by the inversion of the model, (II) to spatialize the model at the scale of the entire landscape and (III) to compute the water balance of flood irrigated plots at the regional scale.