HYDRUS application to assess possible impacts of non-conventional water irrigation under two different vadose zone monitoring strategies

I. Valdes-Abellan1, J. Jiménez-Martínez2, L. Candela2
1Department of Civil Engineering, University of Alicante (Spain). javier.valdes@ua.es
2Geosciences Rennes, LMR CNRS, Université de Rennes I, Rennes (France). pablo-jimenez-martinez@univ-rennes1.fr

INTRODUCTION

Scarcity of water resources in arid and semi-arid areas has lead to the use of non conventional water sources, as desalinization of both brackish groundwater and seawater, both for urban and agricultural demands. The non-conventional water application on the vadose zone might produce impacts in porous media air changes in soil hydraulic properties, among others. Monitoring vadose zone water dynamics is a key aspect to study those possible impacts. According to the available literature, different monitoring systems have been carried out independently, but less attention has received comparative studies between different techniques (Jiménez-Martínez et al. 2009; Wallis et al. 2011; Wollschläger et al. 2009). In this study, a 9x5 m2 experimental plot was set with automatic and non-automatic sensors to control VWC (volumetric water content) and h (soil pressure head) up to 1.5 m depth. Simulation of water flow using automatic and non-automatic data was carried out by HYDRUS-1D.

EXPERIMENTAL SETUP

The automatic system was composed of five STE sensors (Decagon Devices®) installed at 20, 40, 60, 90 and 120 cm for VWC measurements and one MPS1 sensor (Decagon Devices®) at 60 cm depth for h. The non-automatic system consisted of ten Jet Fill tensiometers at 30, 45, 60, 90 and 120 cm (Soil Moisture®) and a polycarbonate access tube with a 7 mm (i.d) for moisture measurements with a TRIME FM TDR portable probe (IMKO®). Data gathering was carried out during 9 consecutive months. A detailed soil characterization was made out in laboratory to determine the most important soil parameters.

A conservative tracer test with a LiBr solution. Br- was considered due to the low background concentration of it in the soil profile. In June 27th 2012 a solution of LiBr (131.7 mmol/L) was sprinkled over 30 m2 of the plot. After 7, 37 and 57 days, undisturbed soil samples were collected at different depths and total bromine concentration (Br-) was determined by X-ray fluorescence following the methodology proposed by Abderrahim et al. (2011).

Movement of Br along the profile was well simulated with the HP1 software. Soil hydraulic parameters used in that model were those obtained during water flux modeling period with automatic experimental data set, which validates the flow model parameterization.

NUMERICAL MODELLING

Root water uptake was modeled following Feddes (1978) and Wesselingh (1985). Evapo-transpiration was computed with Penman-Monteith equation. A good agreement of data and modeled results from collected automatic and non-automatic can be recognised. General trend was captured by both strategies, except for outlier values, as expected. Peak events were better registered by automatic sensors. Slightly differences were found between hydraulic properties obtained from laboratory determinations and from inverse modeling from the two approaches. Differences up to 14% of flux through the lower boundary were detected between the two strategies. According to results, automatic sensors were more accurate and so more appropriated to detect subtle changes of soil hydraulic properties. Nevertheless, if the aim of the research is to control the general trend of water dynamics, no significant differences were observed between the two systems.

CONCLUSIONS

The HYDRUS simulation was able to reproduce the responses of a field-scale instrumented plot with automatic and non-automatic data. A good agreement between the predicted and measured soil water content and pressure head values was obtained. Hydraulic parameters monitoring results complex, being one of the main limitations the inability to measure the effective properties to describe the overall system. The instruments used normally explore a domain which is notoriously too small to describe the average property. Field measurements obtained with non-automatic (vertical-installed) instruments need to be carefully analyzed since the installation process can lead to preferential flow paths through the device wall, even with careful installation procedures. I. Without previous information on soil characteristics from laboratory determinations, inverse approach could lead to unrealistic soil hydraulic parameters-based simulated values using both the automatic and non-automatic data. However, the trend was better predicted than extreme episodes. Significant differences between the modeled parameters from the non-automatic and automatic experimental data were observed. On average, the statistics revealed that adjustments to the h data proved better than those to the h data. This fact could be related to the equilibrium time with soil that pressure head devices require to obtain reliable measurements. For the tracer test, a good agreement between measured and predicted total bromine (Br) concentration along the soil profile was obtained, which validate the flow model.

References: