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Spatio-temporal soil moisture distribution in a Maize field

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The spatio-temporal distribution of water content is important for predicting water flow and solute transport in the unsaturated zone. In a cropped field, this distribution is affected by the interception and redistribution of water by the plants, by surface runoff, by root water uptake, and by the distribution of soil hydraulic properties and boundary conditions of the system. This study was conducted to investigate the relationship between plant root water uptake, soil structure and flow field variability.

An experimental plot in a Maize field was installed in July 2009 and measurements were performed between the 23 of July and the 21 of September 2009. Upper boundary conditions were followed with a weather station, while drainage was estimated with deep tensiometers (1.4 m). Four TDR profiles (14 TDR probes at 10, 30, 70 and 125 cm depth) perpendicular to two maize rows were monitored every hour. In addition, a square grid of 76 surface electrodes and 8 boreholes each with 7 electrodes (5, 15, 30, 50, 75, 105 and 140 cm deep) were inserted in the maize field to evaluate the 3-D distribution of the electrical conductivity by ERT. Weekly ERT measurements were performed. Subsequently, the ERT and TDR data were used to estimate the soil moisture dynamics based on petrophysical relationships. We performed root profiles at four times during the experiment to quantify the root distribution. This allowed us to investigate the relationship between plant root water uptake and soil moisture dynamics.

After the growing season, a dye tracer experiment was conducted on a 1.4 m-side square, to assess the influence of roots and macropores in water infiltration.

The results show the importance of using depth electrodes to estimate the vertical distribution of water content accurately. A high measurement resolution allowed us to observe the 3-D soil water content variability. During the growing season, we observed an increase in the coefficient of variation of soil water content when the soil becomes drier. This is in agreement with the results obtained by Hupet and Vanclooster (2005). Water dynamics in the topsoil was higher than in the lower layer. It seems that the distribution of water content at the end of the growing season was significantly influenced by the row / inter-row of maize and therefore by root water uptake. This highlights the importance of seeding patterns on soil moisture distribution in a field.

Reference:
F. Hupet and A. Vanclooster. Micro-variability of hydrological processes at the maize row scale: implications for soil water content measurements and evapotranspiration estimates. Journal Of Hydrology, 303(1-4):247–270, March 2005.