Quantifying water fluxes within soil-plant-atmosphere continuum system using hydrometric measurements and stable isotopes techniques

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Abstract

The key to improve water use efficiency is the knowledge of the water fluxes within the soil-plant-atmosphere continuum system (SPAC) and the minimization of ineffective water fluxes. Soil evaporation (E_s), interception (E_i) and percolation (P_e) are water fluxes which are not used by plant, on the other hand, transpiration (T) is the main flux for plant growth. Soil evaporation, interception and transpiration generally are combined as one single flux named evaporation. Therefore, this study has an objective to quantify these water fluxes using hydrometric measurements and stable isotopes techniques. Moreover, the soil evaporation process in the vadose zone has been described using stable isotope measurements.

The experiment was taking place in a grassland lysimeter located in the botanical garden of Delft Technical University from mid November to the end of January. Lysimeter set-up has been equipped with five soil moisture sensors, a percolation device, meteorological recorder and Rhizon samplers (see Fig.1). Penman-Monteith, water balance and HYDRUS-1D numerical model have been used to calculate the evaporation flux. Moreover, stable isotopes (^{2}H and ^{18}O) were used as a tracer.

The combination of hydrometric measurements, stable isotopes and numerical modelling proved that this combination could describe the water fluxes in the vadose zone. Average evaporation during measurement period is 0.15 mm/d, 0.36 mm/d and 0.21 mm/d calculated using Penman-Monteith, water balance and HYDRUS-1D model respectively. Water balance calculation result is overestimate compared with the other methods due to snow accumulation on the surface during measurements period. Daily percolation is 0.1-3.4 mm/d with total percolation is 164.9 mm. HYDRUS-1D model calibration had a good result with R^2=0.91. Percolation from the model calibration using December data is 0.35 mm while drain gauge measured 19.7 mm. This indicates that the lysimeter received more water and it might be caused by preferential flow or bypass channel. Moreover, isotopes signature in the drain gauge supports this assumption (see Fig.2). Snowmelt and heavy precipitation events are suspected as the main reason triggering this phenomenon.

Keywords: *water fluxes, hydrometric measurements, stable isotopes, numerical modeling*

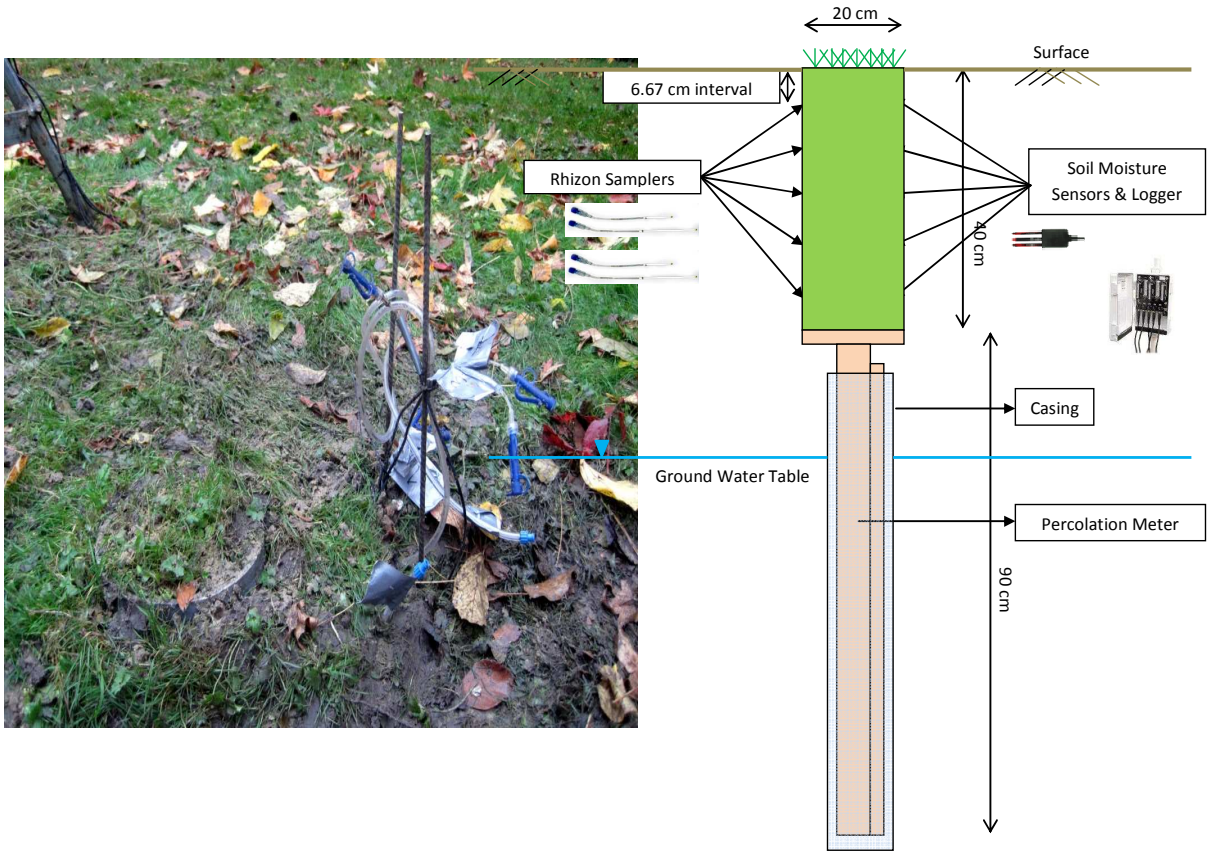

Figure 1. Lysimeter set-up at the botanical garden of Delft technical University

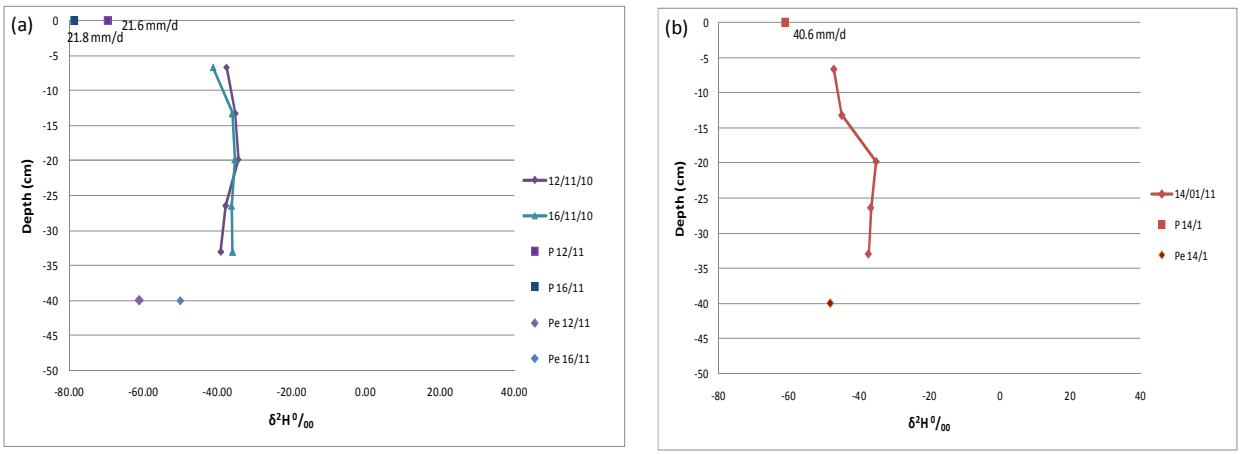

Figure 2. Isotope measurements for preferential flow at the botanical garden; a) measurements in November; b) measurement in January