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# Estimation of groundwater recharge in a stony soil based on monitoring of soil hydraulic data

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In 1997 a measuring network of the unsaturated zone was explicitly mentioned for the first time in the Austrian "Hydrography Law". Main objective of this subsurface monitoring network is to determine the major elements of the soil water balance, e.g the actual evapotransipration and deep drainage/groundwater recharge. As pilot project eight locations were equipped with sensors to measure soil temperature, soil water content (TDR probes) and soil water potential (tensiometers and granular matrix sensors). The sensors are installed in up to six depths and are recorded in 60 min increments.

Main objectives of this study were:

1. to develop a method to gain time series of soil water contents and corresponding matric potentials based from field monitoring,
2. to calculate groundwater recharge based on the established times series and
3. to apply this method to a specific location.

For demonstration of applicability one location in Styria with two sites (forest and grassland) was selected. Investigated period was the year 2004. The fluviatile formed soil profile consists of two layers. The upper layer (0 – 30 cm) is a sandy loam with 75% of fine particles ($<$ 2 mm) whereas the lower layer ($>$ 30 cm) has more than 65% rock fragments. These conditions are a big challenge for the installation of the sensors and the interpretation of the obtained data.

Important working steps of the study were visualisation, filtering of raw data for gaps and outliers and a visual plausibility check. Times series of matric potential data obtained from tensiometers and granular matrix sensors had to be merged in order to close gaps in tensiometer data and to utilise the extended data range (below –100 kPa) of granular matrix sensors. Determination of evapotranspiration was avoided by the assumption of zero flux at the soil surface during night periods without precipitation. Consequently the flux through the lower boundary must have been equal to the change in profile water content during dry nights. Hydraulic gradient was calculated with the matric potential values at the two deepest measurement levels. This yielded in $k_{unsat}(h)$ data pairs, which were imported into the program RETC together with $\theta\ (h)$ data pairs obtained from water content and matric potential measurements. Due to physical deficiencies $k_{unsat}(h)$ data had to be smoothed by sliding average. Van Genuchten-Mualem parameters were fitted with RETC by adjusting the distribution coefficient between retention and conductivity data. After fixing the hydraulic properties at the lower boundary by this way, deep drainage could be calculated for the entire year with $h$, $k_{unsat}(h)$ and the derivative of the total potential.

The developed method delivered plausible results for evapotranspiration and deep drainage. It opens promising perspectives for the determination of water balance elements for all locations of the monitoring network.