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Simplified estimation of field saturated soil hydraulic conductivity from ponded infiltration data

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Simple and reasonably rapid experiments are desirable to conduct a spatially distributed determination of field-saturated soil hydraulic conductivity, K_{fs}, that is a highly variable soil property. Bagarello et al. (2012) recently developed a simplified approach to estimate K_{fs} that is based on a ponded field infiltration experiment. A cylinder is inserted to a short depth into the soil, so to produce a minimal disturbance of the porous medium, and the infiltration time of a few small volumes of water repeatedly applied at the surface of the confined soil is measured. Calculating K_{fs} needs to determine the slope of the linearized cumulative infiltration vs. time relationship, the ring radius and an estimation of the so-called α* parameter basically from a rough knowledge of the soil texture. Bagarello et al. (2012) also showed that a site-specific prediction of α* can be obtained from the slope of the linearized cumulative infiltration curve.

Validation of the simplified approach was conducted with a relatively large data set that included approximately 200 soil sampling points from Burundi and Sicily. The K_{fs} values obtained by the simplified approach were compared with the ones determined by the well established One-Ponding-Depth approach by Reynolds and Elrick (1990). A more general α* estimating relationship was also developed.

The estimates of K_{fs} obtained with the simplified and the OPD approaches were significantly correlated (coefficient of determination, R^2 = 0.94, $R > 0$, P = 0.05) and they differed by not more than a factor of two in 98% of the cases. Moreover, the differences between the two datasets were not significant according to a two tailed paired t test (P = 0.05).

The new α* estimating relationship allowed to obtain K_{fs} values that differed from those estimated with the complete BEST procedure for soil hydraulic characterization (Lassabatère et al., 2006) by less than a factor of two in 97% of the cases. In addition, the two sets of K_{fs} data were significantly correlated (R^2 = 0.76), the means did not differ significantly according to a two-tailed paired t test, and the linear regression line between the two estimates of K_{fs} did not differ significantly from the identity line according to the calculated 95% confidence intervals for the intercept and the slope. Therefore, this investigation confirmed that the measured infiltration curve contained the necessary information to estimate α*.

The developed method is cheap, rapid and parsimonious in terms of both the devices that have to be transported and the measurements that have to be carried out in the field. Therefore, it is a good candidate method for intensively sampling an area of interest with a practically sustainable experimental effort and, hence, it could allow improved interpretation and simulation of soil hydrological processes, such as runoff generation.