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# An assessment of the BEST procedure to estimate the soil water retention curve

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The Beerkan Estimation of Soil Transfer parameters (BEST) procedure represents a very attractive method to accurately and quickly obtain a complete hydraulic characterization of the soil (Lassabatère et al., 2006). However, further investigations are needed to check the prediction reliability of soil water retention curve (Castellini et al., 2016).

Four soils with different physical properties (texture, bulk density, porosity and stoniness) were considered in this investigation. Sites of measurement were located at Palermo University (PAL site) and Villabate (VIL site) in Sicily, Arborea (ARB site) in Sardinia and in Foggia (FOG site), Apulia. For a given site, BEST procedure was applied and the water retention curve was estimated using the available BEST-algorithms (i.e., slope, intercept and steady), and the reference values of the infiltration constants ($\beta$=0.6 and $\gamma$=0.75) were considered. The water retention curves estimated by BEST were then compared with those obtained in laboratory by the evaporation method (Wind, 1968). About ten experiments were carried out with both methods. A sensitivity analysis of the constants $\beta$ and $\gamma$ within their feasible range of variability (0.1<$\beta$<1.9 and of 0.61<$\gamma$< 0.79) was also carried out for each soil in order to establish: i) the impact of infiltration constants in the three BEST-algorithms on saturated hydraulic conductivity, $K_s$, soil sorptivity, $S$ and on the retention curve scale parameter, $h_g$; ii) the effectiveness of the three BEST-algorithms in the estimate of the soil water retention curve.

Main results of sensitivity analysis showed that $S$ tended to increase for increasing $\beta$ values and decreasing values of $\gamma$ for all the BEST-algorithms and soils. On the other hand, $K_s$ tended to decrease for increasing $\beta$ and $\gamma$ values. Our results also reveal that: i) BEST-intercept and BEST-steady algorithms yield lower $S$ and higher $K_s$ values than BEST-slope; ii) these algorithms yield also more variable values. For the latter, a higher sensitiveness of these two alternative algorithms to $\beta$ than for $\gamma$ was established. The decreasing sensitiveness to $\gamma$ may lead to a possible lack in the correction of the simplified theoretical description of the parabolic two-dimensional and one-dimensional wetting front along the soil profile (Smettem et al., 1994). This likely resulted in lower $S$ and higher $K_s$ values. Nevertheless, these differences are expected to be negligible for practical applications (Di Prima et al., 2016). On the other hand, the -intercept and -steady algorithms yielded $h_g$ values independent from $\gamma$, hence, determining water retention curves by these algorithms appears questionable.

The linear regression between the soil water retention curves of BEST-slope and BEST-intercept (note that the same result is obtained with BEST-steady, due to a purely analytical reason) vs. lab method showed the following main results: i) the BEST procedure generally tends to underestimate the soil water retention (the exception was the PAL site); depending on the soil and algorithmic, the root mean square differences, RMSD obtained with BEST and lab method ranged between 0.028 cm$^3$/cm$^3$ (VIL, BEST-slope) and 0.082 cm$^3$/cm$^3$(FOG, BEST-intercept/steady); highest RMSD values (0.124-0.140 cm$^3$/cm$^3$) were obtained in the PAL site; ii) depending on the soil, BEST-slope generally determined lowest RMSD values (by a factor of 1.2-2.1); iii) when the whole variability range of $\beta$ and $\gamma$ was considered and a different couple of parameters was chosen (in general, extreme values of the parameters), lower RMSD values were detected in three out of four cases for BEST-slope; iv) the negligible observed differences of RMSD however suggest that using the reference values of infiltration constants, does not worsen significantly the soil water retention curve estimation; v) in 25% of considered soils (PAL site), the BEST procedure was not able to reproduce the retention curve of the soil in a sufficiently accurate way.

In conclusion, our results showed that the BEST-slope algorithm appeared to yield more accurate estimates of water retention data with reference to three of the four sampled soils. Conversely, determining water retention curves by the -intercept and -steady algorithms may be questionable, since these algorithms overestimated $h_g$ yielding independent values of this parameter from the proportionality coefficient $\gamma$.

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