Revision of Manuscript HESS-2016-636

Title: Physical pedotransfer functions to compute saturated hydraulic conductivity from bimodal characteristic curves for a range of New Zealand soils

The authors propose a new mathematical formulation (inspired by the paper written by Pollacco et al., 2013) to estimate saturated hydraulic conductivity (Ks) from the parameters of the bimodal soil moisture release curve described by Romano et al. (2011). The authors use a data set of 235 soil samples collected in New Zealand and estimate Ks-values from unimodal (Pollacco et al., 2013) and bimodal (current manuscript, Pollacco et al., 2016) models. The authors observe improvements given by the bimodal model for topsoils that are affected by macroporosity. The evaluation of this manuscript is based on the following questions:

1) Is it a novel work based on a reliable scientific technique?
2) Is it clearly structured and well-written?
3) Are the experimental design and analysis of data adequate and appropriate to the investigation?

MAJOR COMMENTS

This scientific investigation can be considered novel since existing publications deal with Ks-values estimated from "unimodal" water retention curves. The data set is "robust" enough to satisfy the concluding remarks. However the manuscript is fragmented in too many small parts and requires some minor improvement in its structure.

This paper is potentially publishable since some of the material is of interest to the readership of HESS Journal. I have the following concerns on the current draft:

1) Subjective choice of h_{m_mac}=3.16 cm (Eq. 15) in absence of measurements of data points near saturation. Maybe in this case, it would be recommended to optimize h_{m_mac} in order to increase objectivity and add flexibility.

2) The parameter W ("empirical" according to the authors) in the bimodal form of Romano et al. (2011) guarantees that the sum of the matrix and macropore domains gives S_e=1 (same role as in Durner, 1994). The authors replace it with a new parameter (θ_{s_mac}). Indeed they state that this new parameter is "physically sound" and can be easily optimized with the other soil moisture parameters in the matrix range delimited by H_{mac}, that is empirically fixed at 10 cm. Isn't it a contradiction? The authors should test this hypothesis on soil samples comprising measurements near saturation. This requires at least a few examples on soils taken from UNSODA or HYPRES for instance.

3) The RMSE-values obtained by this technique should be compared to the RMSE-values of existing methods (published in other articles) that estimate Ks from unimodal soil moisture parameters.

4) Experimental design needs to be clear: The authors mention that the water content values were measured at the following matric potential points: 5, 10, 20, 40, 50, 100, 1500 kPa (Lines 296-297)

please refer to the Book Methods of Soil Analysis, Part 4, Physical Methods" (J.H. Dane and G.C. Topp, eds.), pp. 692-698, SSSA Book Series N.5, Madison, WI, USA: which method was used to measure the moisture release curve? Hanging water column, suction tables, Pressure plate etc.

Overall I recommend minor revision of the manuscript with due attention to the above comments.

MINOR COMMENTS:

1) I doubt the term "pedotransfer function" is proper to identify the estimate of Ks from water retention parameters
2) Line 21 page 1: specify if you refer 100 mm to diameter or something else
3) Line 27 page 1: I agree that there are uncertainties related to the core sizes, but eventual improvements should be tested on larger cores.
4) Line 63 page 2: add references
5) Line 144 and 168, page 5: why is it [0,1)?
6) Lines 194-195, page 6: In Eqs 11b and 11c the two integral ranges are both Se=[0,1]. Shouldn't they be Se=[0 Se,mac] and [Se,mac,1]?
7) Lines 250-254, page 8: The determination of saturated water content (namely θs) is rather easy, why do the authors use the artifact of Eq.6?
8) Fig. 2 page 25: improve overall quality, enlarge fonts
9) Fig. 3 page 26: please add the 1:1 line. Fig. 3 and 4 should be the same size
10) I encourage the authors to investigate on possible relationships between tortuosity parameters and soil physical parameters (texture, porosity etc)