Manuscript ID: hess-2022-265

Reply to anonymous Reviewer #1

RC1 #1: The motivation and objectives of this work are clearly described.

We thank for the dedicated work and time to review our manuscript and appreciate the positive feedback regarding our motivation and objectives.

RC1 #2: Compared to the usual high scientific level of papers published in HESS, the paper should be improved by addressing also the saturated hydraulic conductivity.

We agree with the reviewer that considering the hydraulic conductivity (not only saturated) will substantially improve the manuscript and highlight the indented hydrological focus of our study. We are aware of the particular importance of soil hydraulic properties for numerical simulations of flow and transport processes in the soil-plant-atmosphere system. In the revised manuscript we will use the theory developed by Peters et al. (2023) (HESSD https://hess.copernicus.org/preprints/hess-2022-431/), which does not require any conductivity measurements because these data is missing for most of the used data sets.

RC1 #3: It should also provide a deeper discussion of the model parameter xcrit whose impact on the model results remains unclear to me.

We agree with the reviewer, that the model parameter x_{crit} is not discussed deeply and are thankful for that comment. It reveals the potential to improve the formulation of our adapted Clarke model by reviewing the parameter x_{crit}. The parameter x_{crit} originates from the work on porosity in binary mixtures of coarse and fine particles of Clarke (1979) and refers to a critical volumetric fraction of fine particles. According to his concept (confirmed by later studies e.g. Zhang et al. (2011) and Sakaki and Smits (2015)), x_{crit} corresponds to the porosity of the coarse fraction. Therefore, introducing the extra parameter x_{crit} is not required and we suggest simplifying the model by replacing it now with φ_c, which is the porosity of the coarse fraction. This critical content can be understood as a threshold at which the relation between the porosity and the volumetric fraction of the fine particles changes from “coarse-controlled” to “fine-controlled” (Sakaki and Smits, 2016). These two regimes are equally observable in the water retention data of binary mixtures of coarse and fine particles (Sakaki and Smits, 2016). We accordingly implemented these two regimes in our adapted Clarke model by providing two equations for each respective case.
In the revised manuscript we suggest expressing the parameter x_{crit} explicitly by replacing it with the porosity of the coarse fraction φ_c leading to:

$$\theta_{pred} = \begin{cases} (x_f + \varphi_c x_c) \cdot \theta_f, if\ x_f \geq \varphi_c \\ \left(\varphi_c - \frac{x_f(1-\varphi_f)}{\varphi_c}\right) \cdot \theta_c + \varphi_f \cdot x_f \cdot \theta_f, otherwise \end{cases}$$

RC1 #4: The evaluation of the model fitting is limited because it is restricted to the root mean square error with a complementary analysis of the absolute deviation. Absolute deviation scaled by the measured water content would have been more relevant and could have been implemented in the parameter fitting procedure.

We are thankful for the comment and conclude that the evaluation procedure was not described clearly enough. Regarding the methodology, we would like to highlight that the water retention measurements of each mixture were first represented with parametric water retention curve models (which we specified in the appendix). For the fitting procedure, the RMSE is used as diagnostics to assess the quality of fit of the hydraulic models to the retention data. In the fitting procedure, we minimize the sum of squared residuals, not the absolute deviation. This is common practice.

Of all parametric representations, the fitted curves for the pure components (and the intermediate mixture for the extended model scheme CM2) have then been used as model input for predicting the water retention characteristics of the binary mixtures. The curves fitted to the measured data of the mixtures are considered as reference curves. Finally, we compare the predicted curves with the reference curves and use both the RMSE and absolute deviation to evaluate the quality of the model predictions.

We will clarify the terminology in the revised manuscript: i) fitted functions for prediction ('fit4pred'), ii) predicted functions using the compositional models ('pred'), and iii) fitted functions to the measured data of the mixtures as reference for the predictions ('fit4ref') (see also our response to RC1#4). Furthermore, we will improve the structure of the Material & Methods section as outlined in the reply RC2 #4.

RC1 #5: More information should be provided on parameter correlation and parameter uncertainty related to the estimation. Moreover, the fitted models are biased; the match for high water contents values is different than the match for the low water contents values (fig. 8)

We believe that this comment relates to a misunderstanding (compare explanation in RC1 #4) as we present the comparison between reference curves ('fit4ref') and predicted curves ('pred') in Figure 8.

Here, our model predictions indeed perform better in the intermediate and less accurately in the wet range, which we discuss based on the absolute deviations. This result is not surprising though, since the retention characteristics close to saturation are highly influenced by soil structure, a hardly predictable quantity. We will point on soil structure in the discussion.

Parameter uncertainty and parameter correlation can only be quantified for the single curve fittings. This information is to our understanding not of high importance in this study, since only the shape of retention curves as a whole are analysed, not the values of the single parameters. We, refer, however, to Table A1-A4, where the parameter values are given. The 95% confidence intervals and the parameter correlations matrices could be added in the supplemental materials.

RC1 #6: Discussion in section 3.6 has to be improved by addressing saturated hydraulic conductivity.

See our reply to RC1#2.

RC1 #7: Typo L40, L76, L80, L200, L310, L232 ???: Is it Technsol or Technosol or both ?

Thank you for the remark. The exact terminology is, of course, Technosol. We apologize for the typos, which will be corrected accordingly.

RC1 #8: Figure 4, 5, … have to be improved. They are too small.

We thank the reviewer for addressing this issue and will increase the figure sizes and text size of the labelling accordingly.

RC1 #9: Considering that the paper could be greatly improved by addressing also saturated hydraulic conductivity, that the discussion of the model and model fitting are not enough detailed, and that the topic is not at the heart of the HESS's themes, the paper should not be published in HESS. I encourage the authors to submit the paper after improvement to a more suitable journal.

We thank the reviewer for the suggestions to improve our manuscript that we will consider, as stated in the replies above. To our opinion, especially the consideration of hydraulic conductivity (not only saturated) improved it greatly. We are convinced that the knowledge of the soil hydrology of constructed Technosols plays a key role in urban greening (green roofs, raised beds, facade greenery) and its services regarding urban water management (drought resilience, stormwater retention, grey water management).