

Interactive comment on “Macropore flow at the field scale: predictive performance of empirical models and X-ray CT analyzed macropore characteristics” by M. Naveed et al.

M. Naveed et al.

muhammad.naveed@abdn.ac.uk

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General comments

Comment 1: The manuscript describes an interesting data set, and shows that macropore effects cannot be neglected at fine scale; in other words, pedotransfer functions and phenomenological models are not yet sufficiently developed to predict the real hydraulic properties of soils, because they do not properly account for macropore characteristics. This is evident from figure 3, which renders the rest of the paper less interesting and relevant. Sorry, but my opinion is that the paper is not suited for publication on HESS. In fact, the data set is very interesting, but data processing and interpretation

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are performed with standard tools and do not have any innovative content.

Reply: The first part of the manuscript (Figs. 1 to 4) illustrates that macropore flow cannot be predicted with common pedotransfer functions and empirical models that are based on basic soil properties. So what other options are left to predict macropore flow? With our study we illustrate the utility of X-Ray CT derived macropore network characteristics for prediction of fluid and gas transport properties and the necessity to discern biopore-flow and matrix-flow dominated systems. The major reason for failure of empirical models is that macropore flow is only weakly correlated with basic soil properties, but strongly influenced by soil structure (i.e. macropore network characteristics). This has been illustrated in the current manuscript via observed strong correlations between macropore flow and macropore network characteristics. This is not entirely novel, as few previous studies (e.g., Katuwal et al., 2015; Larsbo et al., 2014; Naveed et al., 2013; Luo et al., 2010) also showed such correlations. The novel part of this study is the distinction between biopore-flow and matrix-flow dominated soil systems. As a result of this distinction, the correlations between macropore network characteristics and macropore flow were further improved. We propose to develop and add multiple linear regression models to reveal significant macropore network characteristics for predicting macropore flow for biopore- as well as matrix-flow dominated systems. In the revised manuscript, we will attempt to clearly point out the novelty and implications of findings. Based on findings of the present study, the next logical step is the application of fluid dynamics simulations (e.g., lattice Boltzmann model) to predict conductivity and diffusivity from segmented X-ray CT data. In the future, this could replace laborious standard laboratory soil characterization.

Comment 2 However, the paper is well written and organised, but for few problems that are listed in the technical comments below.

Reply: We will address and correct all suggestions provided in the technical comments when revising the manuscript.

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Specific comments

Comment 3: The term "connected macroporosity" as defined at page 12096, line 29 to page 12097, line 2 is used to describe a connected volume of macropores, which extends from one side to the opposite end of the sample. In the scientific literature, this is often referred to as percolating cluster or percolating connected volume, borrowing the definitions and notation of percolation theory. Since a lot of connectivity indicators have been defined in the scientific literature, I think that the use of percolating macropores" should be preferred.

Reply: In the revised manuscript "connected macroporosity" will be replaced with "percolating macroporosity".

Comment 4: Page 12101, lines 23 to 25. I think that the statement "The density-corrected...biopores." is not supported by the data.

Reply: Agreed. We will revise this paragraph accordingly.

Comment 5: I think that it would be great if the authors stored the measurement results in a public data repository, making them open to the whole scientific community, so that other researchers can profit from their excellent experimental work to improve phenomenological models and to perform further analyses that could permit to extract more information from this data set.

Reply: Thanks for this excellent suggestions. We will provide a web link to the data repository in the revised manuscript.

Technical comments

All of these comments will be addressed and corrected in the revised version of the manuscript.

Comment 6: Page 12092, line 21. Erase "-0.5".

Reply: Done in the revised manuscript

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Comment 7: Page 12093, line 28. Rephrase the sentence "However...yet".

Reply: Done in the revised manuscript

Comment 8: Page 12095, line 3. Replace "1.69 ha" with "1.69-hectars-wide".

Reply: Done in the revised manuscript

Comment 9: Page 12095, line 5. Geological Survey of Denmark and Greenland (1999) is not listed in the references.

Reply: Done in the revised manuscript

Comment 10: Page 12095, line 13. Replace "ID", possibly with "internal diameter".

Reply: Done in the revised manuscript

Comment 11: Page 12096, line 7. Substitute "Jassonge" with "Jassogne".

Reply: Done in the revised manuscript

Comment 12: Page 12101, line 9. Please rephrase "both models", by explicitly writing which models are used to compute data for Figure 3.

Reply: Done in the revised manuscript

Comment 13: Page 12101, line 23. Substitute "und" with "and".

Reply: Done in the revised manuscript

Comment 14: Page 12111, lines 17 to 19. The citation to this paper is missing in the text.

Reply: Done in the revised manuscript

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 12, 12089, 2015.

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