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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.

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Comment 1: Technically the work is solid. I am not sure about the novelty of the work. What is new? It was amply demonstrated that macropore flow cannot be predicted from soil basic properties. The authors are far from being first to demonstrate this. Macroporosity, macropore mean diameter, minimum connected macroporosity and macropore local connectivity are the properties derived from network analysis that correlate with conductivities and diffusivities. Such correlation is expected to exist as macropores are major conduits of water and gases in soils. What is new?

Reply: We acknowledge the reviewer's notion that macropore flow was previously re-

lated to basic soil properties. Though this is true for fluid permeabilities (saturated hydraulic conductivity and air permeability), there is not a lot of published work related to gas diffusivity. While it was previously documented that gas diffusivity is a concentration-driven gas transport parameter that can be predicted from basic soil properties (e.g. Moldrup et al., 1998 & 2000, Deepagoda et al., 2011 & 2014), we demonstrated in the current manuscript that this does not hold for -30 cm matric potential. Only for matric potentials of -100 cm and lower empirical models for prediction of gas diffusivity from soil properties performed reasonably well. The second part of the manuscript (Figs. 6 and 7) is novel. Although a few recent studies (e.g. Katuwal et al., 2015; Larsbo et al., 2014; Naveed et al., 2013; Luo et al., 2010) reported quantitative relationships between macropore flow and X-ray CT analyzed macropore network characteristics, this is to the best of our knowledge the first study that distinguishes biopore- and matrix-flow. This was also pointed out by J. K. Koestel in his short comment. We reported that different relationships exist between macropore flow and macropore network characteristics for biopore-flow and matrix-flow dominated columns for permeabilities (air and water) as well as for diffusivity at -30 cm matric potential, but not for diffusivity at -100 cm matric potential. 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 cases. In the revised manuscript, we will attempt to clearly point out the novelty and implications of findings.

Comment 2: The last sentence of the abstract is “This could pave the way for the digital soil physics laboratory in the future.” Nothing is said in the manuscript on this matter. Is this the novelty? If yes then the authors should elaborate on this and explain what they mean. Do they suggest the need to run CTs on soil samples in addition to conductivity and diffusivity measurements?

Reply: Here we expressed our vision of future soil characterization. We reported strong correlations between macropore flow and X-ray CT derived macropore network charac-

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teristics for both biopore- and matrix-flow dominated cases. The governing macropore network characteristics for each case are revealed by means of multiple linear regression analysis. 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 3: Overall, the new take-home message of the work should be distilled and expressed.

Reply: In the revised manuscript, we will better explain the novelty and clearly discuss the implications of obtained results.

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