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Hydrology and Earth System Sciences
Discussions

Interactive comment on "A soil non-aqueous phase liquid (NAPL) flushing laboratory experiment based on time domain reflectometry (TDR) and modeling" *by* Alessandro Comegna et al.

Anonymous Referee #3

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The manuscript presents a study where TDR methodology is used to measure NAPL concentration in soil during remediation treatments. The experimental setup is based TDR measurement of saturated column where the soil was initially mixed with variable amounts of NAPL (corn oil). The oil contamination ranged from 5 to 40% volumetrically, and the remediation was based on washing treatment with solutions containing water, detergent and methanol in three different ratios. Estimation of the oil content in the soil was done through standard permittivity measurement using TDR waveguides which provide the bulk dielectric permittivity of the soil. The measured results were compared

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with the permittivity expected form dielectric mixing model which accounted for the specific contribution of the various materials (solid, water, detergent, methanol and NAPL). Obviously, the motivation for the study is directly related to the urgent need to develop measurements tolls for validation of remediation efficiency. Therefore, the objectives of this study are of very high environmental importance and relevancy to HESS readers. Nevertheless, some aspects in the manuscript require revision and an improved discussion. The motivation for this study, as presented across the manuscript, is related directly soil remediation from NAPLE. Yet the soil, which is the upper part of the subsurface, is characterized by everchanging water content. Since water content has the most significant impact on the bulk dielectric properties and the entire experimental setup refers saturated sediment, the use the term soil is misleading. Therefore, the presented method should be limited to saturated porous medium/sediment (aquifer) and not to soil. It is not clear whether the manuscript focuses on using TDR to measure the NAPL content in the sediment or on the efficiency of the treatment method. If the author wishes to test the TDR efficiency to measure NAPL concentration, then the experiment provided only qualitative data showing the reduction in NAPL during the early stages of the washing phase. Yet it has been shown only in the vary high oil concentration >15% volumetric content (figure 3). Although the experiment included lower concentration range of 5 and 10 % results from these tests were not presented or discussed although from environmental point of view these are very high concentrations. The authors show that the TDR results are biased, compare to the model (figure 4) and suggested that the reason is related to the flow and transport mechanism within the sediment column, where trapped oil turns immobile and therefor unwashable. Trapped oil in porous domain is a known phenomenon. Nevertheless, it is not clear why the TDR, which measures the bulk dielectric properties of the domain, is affected from the flow and transport mechanism. It should see total weighted contribution of all component where it is trapped or mobile. The authors choose to demonstrate the washing effect of different solution on NAPL removal from the sediment using the TDR. However, using 60 pore volumes to wash the soil is totally non reasonable or

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realistic by any means. In other words, if the authors wish to establish the TDR method as a tool for measuring NAPL content in the sediment they have to separate the washing effect from the concentration measurement. As such the NAPL concentration and the model calibration will be unbiased and more efficient. For example, biodegradation method would work much faster and provide quicker results.

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