

Dear prof. Zehe

First, we would like to express our sincere gratitude for your input and expertise in refining the manuscript. Your constructive feedback has contributed to improving the quality and impact of the work.

Our choice of using one-dimensional modeling is due to the lack of evidence or observations for two and three-dimensional processes such as lateral flow. The VMS was installed diagonally in order to capture the vertical flow in undisturbed profiles. Accordingly, all monitoring points are shifted vertically and laterally a few meters apart from each other. Nevertheless, data from these multiple 1D vertical profiles cannot provide information for such multi-dimensional processes. The implementation of a more complicated model must be backed up with more 3D geological and hydrological information, which currently is lacking.

Regarding the bromide correlation, results from 2.6m didn't match the model prediction. Nevertheless, both peaks at 5.5 and 2.6m depth were completely missing from the observations. We assumed they were not measured due to the large gap in sampling during that period (3/2016). No other significant peaks were observed to provide information for preferential flow. We elaborated on those results in lines 307-316.

Both reviewers showed concern regarding the choice of modeling methods. Specifically, the issue of parameters' sensitivity and optimization, due to the large number of parameters involved. Therefore, we implemented the Morris method sensitivity analysis (Morris, 1991) using the SAFE Matlab code provided by Pianosi et al. (2015). In this method, the parameters are modified one at a time and sensitivity is estimated as the partial derivative of the change in model output for a given change in a single input parameter (Perzan et al., 2021). Subsequently, the sensitive parameters were calibrated following the method presented by Perzan et al. (2021). As part of the optimization procedure, the uncertainty and optimal values are calculated according to the behavioral simulations (by achieving evaluation goals).

In addition to the model improvements, several adjustments were added to the manuscript according to the reviewers' comments such as the elaboration of different treatment approaches around the world, the addition of soil parameters to the supporting information (oxygen and pH value in the soil), and further specific clarifications.

Ultimately, simulating the water flow and reactive transport in the unsaturated zone presents significant challenges due to the high complexity of the vadose zone and the multiple variables that are required for the calculations. However, the main purpose of the model is to forecast the duration of treatment needed, and thus slight deviations from the desired outcome may be acceptable. The available data sets that were obtained in the current field experiment do not support a 3D model. Thus, implementing such a complicated model would not be beneficial.

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Pianosi, F., Sarrazin, F., Wagener, T., 2015. A Matlab toolbox for Global Sensitivity Analysis. *Environ. Model. Softw.* 70, 80–85