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Comment on hess-2021-455

Anonymous Referee #2

Referee comment on "Continuous monitoring of a soil aquifer treatment system's physico-chemical conditions to optimize operational performance" by Tuvia Turkeltaub et al., Hydrol. Earth Syst. Sci. Discuss., <https://doi.org/10.5194/hess-2021-455-RC2>, 2021

The study by Turkeltaub et al. is investigating the optimal length of wetting and drying cycles in the operation of soil aquifer treatment systems in the Israeli Shafdan facility. The facility operates several infiltration basins that are temporarily flooded with secondary treated wastewater to infiltrate the water under ground and to remove a variety of constituents. The ability of the SAT system to remove constituents decreases over the duration of the wetting period as the oxygen content decreases in the vadose zone. The study examined several wetting and drying cycles to determine whether redox potential could be used as an indicator to decide on the length of the wetting and drying cycles to achieve optimal efficiency.

The manuscript overall is well written and addresses an interesting topic. Over the past 20 years a lot of research has been dedicated to the understanding of physical and biogeochemical processes in SATs. This study has highlighted some interesting findings. A few comments that I think could be addressed are listed below. My main questions about the study are, why was DO not measured in the vadose zone of the infiltration basin? The authors could have collected pore water samples and analyzed the pore water for DO in situ. It seems the study is trying to use redox potential as a proxy to capture the decline in DO in the SAT system, however, no DO data was collected or presented? In addition, I find the analysis and interpretation of the drying cycle data a bit short/insufficient. The authors conclude that a 36-hr drying period is optimal for both the summer and winter season, irrespective of the starting conditions in redox potential at the beginning of the drying cycle. Yet the analysis does not fully explore or explain why Eh is recovering so much faster in the summer than in winter.

Specific comments:

Line 114: Suggest rephrasing to "...was to examine the temporal variability in redox potential..."

Line 116: Seasonal changes in climate such as rainfall and temperature are likely to also influence the wetting/drying stages and not just operation of the SAT system. I would suggest mentioning climate or season in line 116.

Line 135: You state that the surface of the spreading basins is plowed on a regular basis to prevent clogging. In the past 10-15 years operators of infiltration basins have moved away from this practice because they observed that the plowing allowed fine particles to move deeper into the vadose zone (e.g. 1-3 m), where they would accumulate and form a flow impeding layer. Have you run any geophysical scans of the vadose zone underneath the infiltration basins whether percolation has been impacted by the plowing?

Line 145: were the suction cups installed at the same depth as they sensors?

Line 195: Could you please clarify if the data on the long and short cycles are averages over the stated periods (e.g. Nov-April) or what is the time frame for these? If so, please also add a column stating the number of event (N). In addition, please clarify if the duration of these stages was set by the operator of the basin or whether there was a systematic operation scheme that was tested in this study. It is not quite clear who defined the long and short cycles.

Line 217: Please clarify what you mean by "high saturation values" – field capacity, 80% pore space filled?

Line 225: Add "parameters" after K_s and β .

Line 234: How is the soil drainage process defined in the operation? Is there a minimum water content or redox value that needs to be achieved? If so, please state it?

Line 246: How do you explain the higher VWC value during the winter?

Line 247: Do you mean "explore" instead of "elaborate"?

Line 254: Please elaborate on how the winter cycles affect infiltration capabilities.

Line 294: What is the K_{sat} at the site? It is a bit surprising that E_h is recovering so quickly. It is hard to determine based on Figure 4, hence I would recommend stating

average recovery times in days or hours for Eh to return to positive values. Is this typical for these infiltration basins? What is the retention time of the wastewater in the unsaturated zone?

Figure 6 is indicating that the infiltration basin has an inverted water table below the basin bottom which is maybe 50-80 cm thick. Below this inverted water table oxygen content and Eh seem to be higher potentially indicating unsaturated conditions. Most denitrification is therefore occurring within the saturated zone (or inverted water table) below the basin bottom, which varies in thickness depending on texture. Gorski et al. 2019 (ES&T) recently summarized some of these dynamics in a nice conceptual way, which could be helpful for this study. Have you checked whether the saturated thickness is changing with the duration of the wetting and drying cycles as well as season?

Line 388: Changes in Eh are usually lagging behind changes in oxygen content as highlight in Figure 4. Unfortunately this study does not show DO data for the pore water at 25, 50 and 100 cm depth, therefore it is difficult to estimate whether Eh is indeed a useful proxy for predicting DO depletion.

Figure 8: It would have been helpful to overlay the recovery of the volumetric water content since start of the drying cycle on top of the Eh recovery. The steep increase in Eh around 18 hrs since start of the drying cycle could be supported by the higher ET during summer. I am also wondering if the timing of the operation plays a role (e.g. operator stops flooding at the end of a workday (e.g. evening), hence ET is highest the next day around noon or 18 hours later)?