6-10-2019

A review of: On the role of operational dynamics in biogeochemical efficiency of a soil aquifer treatment system, by Ben Moshe et al.

Summary and Recommendation

The manuscript describes a series of experiments in which sequences of flooding with treated wastewater (TW) and drying periods (DP) are imposed on the surface of a 6 m deep column, as a physical analog of advanced soil aquifer treatment (SAT) in a naturally- thick unsaturated zone setting (e.g. Shafdan, Israel). The impact of DP on water content (WC) dissolved Oxygen (DO) and oxidation-reduction potential (ORP) along the column and dissolved organic carbon (DOC) and nitrogen (N) species at the outlet were examined. The important and new result (to the best of my understanding) is that longer DP not only improved the aeration and reactivity in the top 1m which is well known, it can also keep deeper parts of the column (1.75-5.75 m) in aerobic condition (DO = 3 - 4 mg/l) hence more reactive. Some similarity between ORP trends with DP between the column experiment and field experiment in an operational SAT facility are shown.

As managed aquifer recharge (MAR) is growing fast worldwide, and more MAR operations are used also as SAT operational aspects of this cheap water treatments offered by mother earth are of great interest for HESS readership. The finding of possible deep aerobic conditions has significant implications on loads of organics, N and other contaminants that can be treated by SAT. Therefore the manuscript is worthy for publication. Nevertheless the current presentation is far from HESS standards and the paper is hard to read even though there in nothing sophisticated in it. Therefore I recommend major revisions following the comments herein.

Major Comments

1) Emphasize the important result: long DP -> deep aerated reactive interval, throughout the results and discussion (is it first result of its kind?).
2) The absence of reference to the flow in the column is annoying (e.g. flow rates, hydraulic properties of sediments; a simple 1D water flow model; more sophisticated flow of water and air model …). It is a controlled experiment in a column filed with porous medium, the hydrologist reader deserves a better acquaintance with this simple flowing system. The times of flooding and drying periods are meaningless without knowing the range of flow rates in the column. A calibrated model and simulations of different DP are a natural continuation of the research starting with the experiment, and can be in a following paper, but no reference of the flow condition in the column is not acceptable. Ponding and drying in a thick unsaturated-zone infiltration system is needed not only for the biochemistry, but also to sustain infiltration rates (see Ganot, Y., R. Holtzman, N. Weisbrod, I. Nitzan, Y. Katz, and D. Kurtzman. 2017. Monitoring and modeling

infiltration-recharge dynamics of managed aquifer recharge with desalinated seawater, *Hydrol. Earth Syst. Sci.*, *21*, 4479-4493).

3) Concentration units and naming chemicals entities – be consistent in naming and with units. Micro-molar than mg/l and in the N species is it as N or for the molecule?.I suggest use mg/l as C for DOC and mg/l as N for all N species thought the manuscript and say it explicitly. NO2- is an anion, “ammonium and NO3-“, spell the chemical formula for the ammonium as well.
4) Figure captions are laconic. A figure and its caption should be much more standalone entities. For example: Figure 4 has no meaning for a reader without looking for “Experiment 3” in the text, while a few words can make it meaningful. Go over all captions.
5) Supplement - Sediment characteristics should be in the main text as part of dealing with comment # 2. A table of the chemical characteristics of all the water types should also be in the main text.
6) Scientific-writing editing is needed. In many places a reference is referred to in both the beginning and the end of a sentence, synonyms with no explanation in abstract, typos, consistency (part 1 vs. – stage 1) if possible give meaningful names to the experiments – e.g. DP-240-SW or similar is better than meaningless experimant2/stage 2.

Specific comments

1) Abstract. Some numbers describing the main results in the abstract will help. For example in the deep layers DO stabilized on 1- 2 mg/l in the short DP and 3-4 mg/l for the long DP. Also % of removal of DOC TKN for the different DP.
2) L13 – major comment (MC) 6
3) L18 “pseudo” why pseudo? It’s a real reactor.
4) L24 MC 6 typo
5) L38 I would say: … local stream and the Mediterranean sea
6) L41-42 MC 6
7) L51-52 MC 6
8) L52 – explain TKN = organic + ammonium nitrogen
9) L53 MC 3
10) L81 delete “roughly”
11) “Untraditionally” not clear
12) L100 rael->real
13) L104 Table 1 - MC 5, MC 6
14) L105 “H4H8N2O3” should be I believe C4H8N2O3
15) L114-115 MC 3, MC 5
16) L123 TKN defined before
17) Figure 2 caption: 1) what panel for what depth (a, b,c..)? 2) The initial (residual) WC (~ 15%) lookss high for the sandy sediments in the column, explain.
18) L173 numbers do not fit the figure (12-18%) and not logical, larger DP-> smaller WC makes more sense.
19) Figure 3 - MC 4 (big time). After making the figure +caption a standalone entity I would consider adding. At the caption: ”note the convergence of the deep sensors

to < 2 mg/l after the short DP versus convergence too > 3 mg/l in response to the long DP." or similar – MC1

20) L203 "(~0.04….." are these the outflow concentrations? The inflow are orders of magnitude higher. Clarify.
21) L204 missing a concentration (for NH4 I believe)
22) L 220-221 MC 6.
23) L 240-241 MC 6
24) L252 Long FP means infiltration rates will decrease due to wetting front reaching some less permeable layers at depth. Draining the top sandy layers is essential also for maintaining high infiltration rates not only for the biochemistry.
25) Figure 5 – in what depth is the ORP probe at Shafdan? MC 4
26) L278 delete "quality"
27) L296 Why "pseudo"? same as comment #3.