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MANAGED AQUIFER RECHARGE USING SECONDARY TREATED WASTEWATER – INSIGHTS FROM LARGE-SCALE SAND TANK EXPERIMENTS ON WATER QUALITY

Marcel HOROVITZ[1 2], Edinsson MUÑOZ-VEGA[2], Teresa LEITÃO[1], Christoph SCHÜTH[2], Stephan SCHULZ[2]

[1] *Laboratório Nacional de Engenharia Civil (LNEC), Avenida do Brasil 101, 1700-066 Lisbon, Portugal, mhorovitz@lnec.pt, tleitao@lnec.pt*

[2] *Technical University Darmstadt, Schnittspahnstr 9, Darmstadt, Germany, edinsson.munoz@tu-darmstadt.de, schueth@geo.tu-darmstadt.de, schulz@geo.tu-darmstadt.de*

ABSTRACT

Globally water shortages are increasing, hence, alternative sources like treated wastewater (TWW) effluent are being increasingly considered as feed water for soil aquifer treatment - managed aquifer recharge systems (SAT-MAR). Yet, the risk to deteriorate the groundwater quality by compounds still present in TWW effluents should be addressed, namely nutrients (e.g., N and P) or emerging organic compounds, (e.g., pharmaceuticals, personal care products), as well as the risk of mobilizing trace metals from the aquifer materials (e.g., As, U) during infiltration. While some countries are using TWW effluent successfully in infiltration basins, other nacional legislations are more conservative. To address the concerns, assess potential risks and to be able to take measures, it is important to understand the specific SAT-MAR system prior to implementation via experiments or numerical models.

While laboratory soil-column experiments are widely used and provide detailed process understanding under controlled conditions, transferring the results to field conditions remains challenging. On the other hand, in-situ field experiments give great insights into real systems but typically study only one SAT-MAR site under distinct environmental settings which hinders to transfer knowledge to other sites. Furthermore, in some settings in-situ field experiments cannot be conducted due to restrictive legislations. One way to bridge this gap is through large tank experiments. However, there are few such large facilities in research on MAR that seek to combine the representativeness of *in situ* experiments with the controlled characteristics of laboratory soil-column studies.

Therefore, we designed a set of large-scale sand tanks to conduct experiments for analyzing SAT-MAR settings using secondary TWW effluent under controlled conditions. The tanks in shape of an “L” are approx. 3 m long, 0.5 m wide, and 1m in height except for the infiltration zone which is 2.5m in height. The tanks are equipped with suction cups and small-diameter wells for water sampling, as well as with various on-line sensors (e.g., high-resolution oxidation-reduction potential, water pressure, soil moisture content, electrical conductivity, water pressure, and temperature) to continuously record the respective conditions along the flow path. The infiltrating water in both studies is secondary TWW effluent from a Portuguese wastewater treatment plant containing nutrients as well as various organic compounds, while the groundwater flowing continuously in the lower part of the tanks consists of local groundwater (LNEC campus).

Two experiments are performed focussing on the mixing zone between infiltrated TWW and groundwater.

In the first experiment, a single tank is packed with fine-medium sand and comprises a vadose zone as well as a saturated zone. The focus of this experiment lies in on the hydrochemistry in the mixing zone.

For the second experiment, three tanks are packed with fine-medium sand. The vadose zone of two tanks each contain a different layer of reactive material as barrier (biochar/ fine-medium sand and compost/fine-medium sand, respectively), while the third tank consists solely of fine-medium sand and acts as reference. The focus of the second study is the effect of different reactive layers on water quality changes and potential quality improvements.

Preliminary results of both studies will be presented focussing on water quality changes, specifically on nutrients and trace metals.

Keywords: managed aquifer recharge (MAR); soil aquifer treatment (SAT); secondary treated wastewater; groundwater quality