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Influence of experimental set-up on the infiltration characteristics during managed aquifer recharge operation

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The main focus during operation of managed aquifer recharge (MAR) is on clogging processes, specifically on the changes of infiltration capacities and degradation of infiltrated organic substances including vadose zone oxygen dynamics. Lab scale experiments are one opportunity to understand and characterize these processes under different drying and wetting cycles and infiltration rates. However, the multitude of assumptions and scale-related limitations of downscale investigations often lead to over- or underestimations, rendering their results useless when translated to field-like conditions.
Therefore, the specific objective of this investigation is to compare the results obtained from two different experimental set-ups with different scales: a 3D, rectangular shaped, stainless steel lysimeter (1.5 x 1.0 x 1.0 m) with an infiltration basin installed in the centre of its surface and a 1D soil column (1m, [U+1D13] 0.15 m) with the infiltration over the complete column surface. The study focuses on the influence of the experimental setup conditions on the soil clogging, water flow pattern, oxygen dynamics and degradation of organic substances. The results should allow making statements about the suitability of these lab experiments for the investigation of processes taking place in the unsaturated soil zone during operation of MAR.
Both experimental units were packed with the same soil and equipped with tensiometers, TDR-probes, oxygen probes and suction cups in two depths for the estimation of spatial and temporal distribution of soil moisture, oxygen and infiltrated substances. The lysimeter and the column were placed inside of a fully automatic climate tent, which facilitates the exact control of air temperature and humidity.
The first results confirm that both infiltration units are suitable to simulate the clogging and the oxidation of easily degradable organic substances. However, the velocity of water transport is higher in the column compared with the lysimeter due to the short distance to the sidewalls in the column, resulting in an almost only vertical water flow. The water saturation degree is generally higher in the column due to the almost non-existing horizontal water flow, as observed in the lysimeter. Additionally, the consumption of oxygen for the biodegradation of organic matter is overestimated in the column compared with the lysimeter due to the fact that the whole column surface during wetting cycles is ponded. In case of the lysimeter only the infiltration basin is flooded during the wetting cycles whereas the surrounding surface area to the walls is almost dry resulting in a more continuously exchange of oxygen.