Using reactive tracer tests to characterize Soil Aquifer Treatment with reactive barriers

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Intro and objectives

Soil aquifer treatment enhanced with a reactive barrier (rbSAT), is a useful technology to recycle reclaimed wastewater for aquifer replenishment and ecosystem recovery. Understanding the involved processes is essential for its management. Reactive Barriers are composed of aquifer sediments and organic substrates of vegetal origin that provide organic matter (O.M.).
Physico-bio-geo-chemical reactions are involved in the changes in the system during the SAT operations that can lead to **clogging** (biofilm growth or particles filtration), **removal of organic compounds** (biodegradation processes), and to **changes in preferential flow patterns** due to a change of distribution of water content within the unsaturated zone. All these changes modify the transport and fate of pollutants along the system and in their residence time distribution.

Materials and Methods

Some tracer tests, combining tracers with different properties fed with the effluent of a coastal WWTP, were performed (Figure 1).
Cocktails are composed by:
i) **conservative tracer,** salinity and metal complexes, to assess travel times and know the role of the water content of the unsaturated zone in the transport (Figure 2).
ii) **dyes with different sorption behavior:** to assess the amount of OM in the barriers and their sorption capacity (Figure 3).
iii) **organic** tracer, to assess the degradation capacity, and
iv) **carboxylate microspheres** (200 nm), to reproduce the transport of colloids (pathogens and micro/nano-plastics)

Results

The results of this test yield an image of how the systems behave at a given time. After two years of continuous operation of the systems, we will repeat the trace test. The differences in the behaviour of these tracers will give us information on the degradation of the organic part of the reactive barrier, and on the biofilm growth in different parts of the systems (barrier, aquifer).

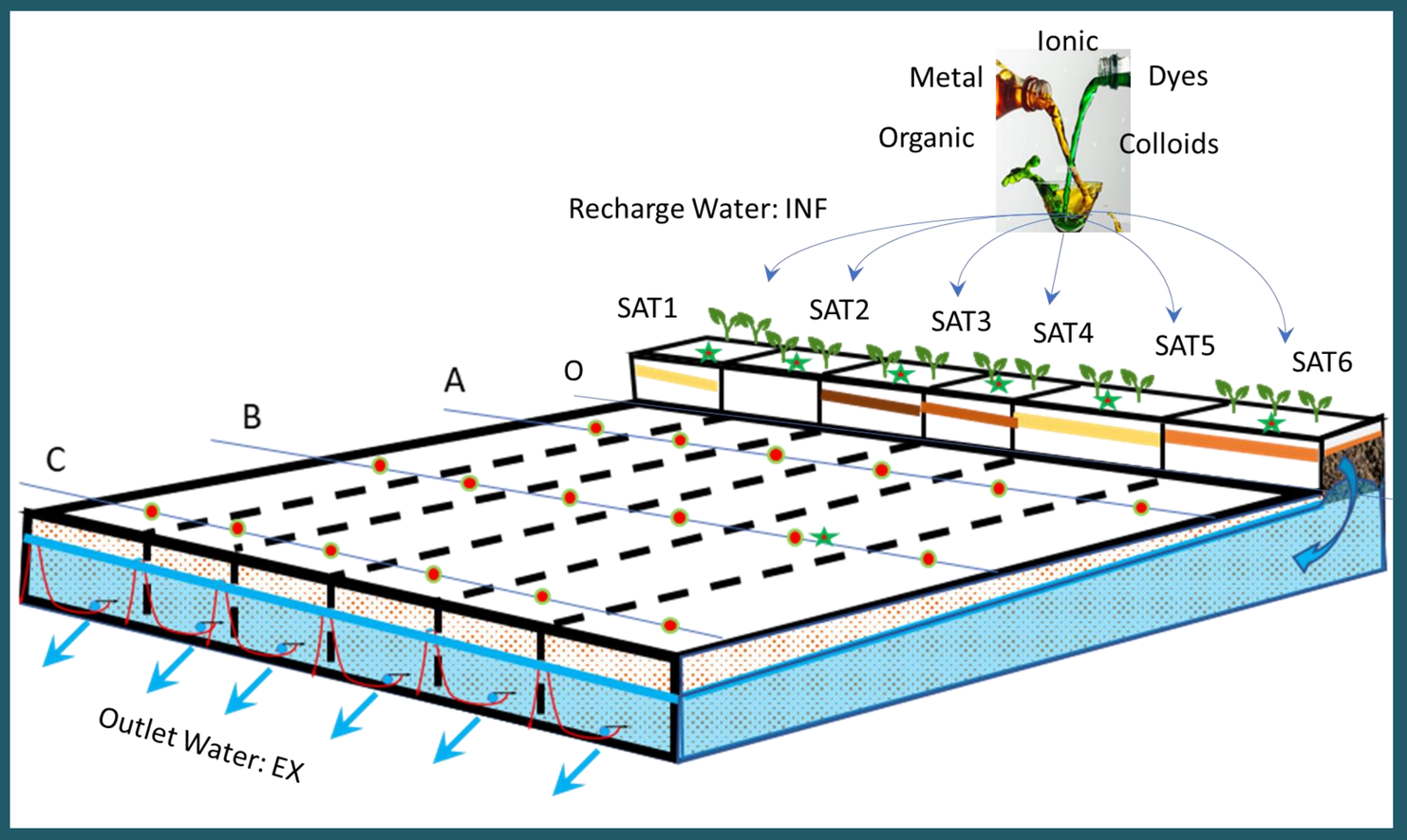

Figure 1: Six SAT replicas where the tracers test was performed. A mixture of tracers with different behavior to the recharge water (INF) was injected and its evolution throughout the system was measured at points 0 (under the barrier), A, B, and at the outlet (EX).

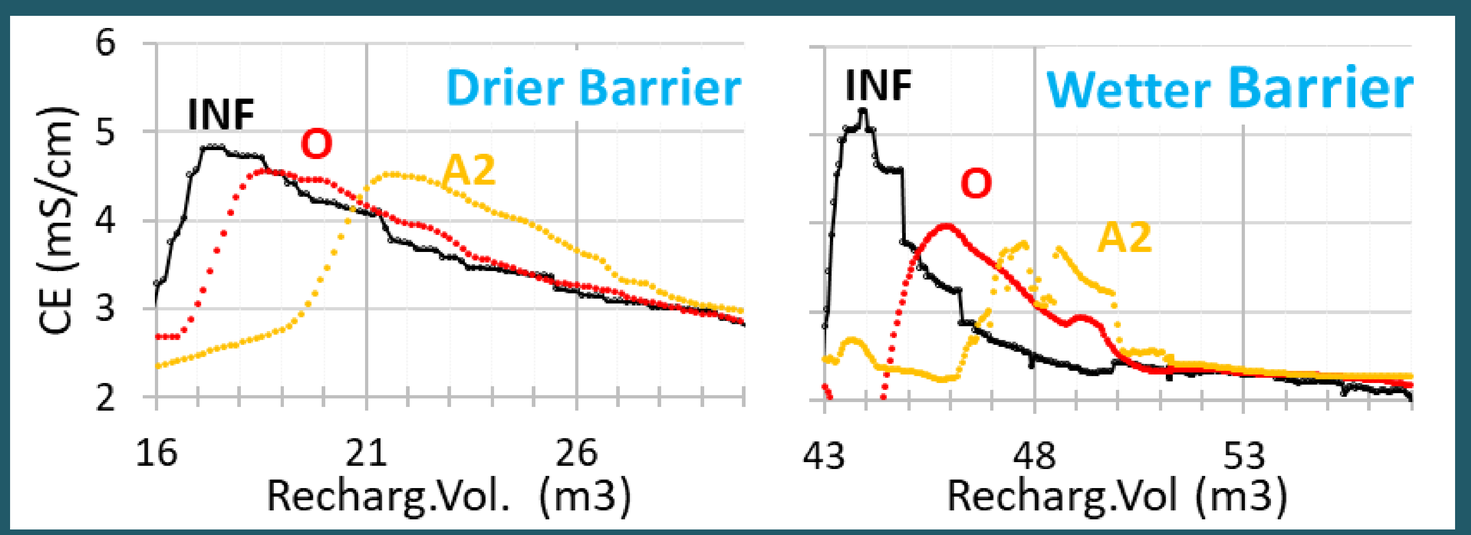

Figure:2: In the same SAT system, we compared two different water contents in the barrier (Non-Saturated Zone). When the barrier is drier, preferential paths are more evident, with less residence time, less water available, and less dilution (peaks higher and closer). A wetter barrier has a higher water content, which decreases concentrations by dilution and increases residence times (part of preferential routes are lost).

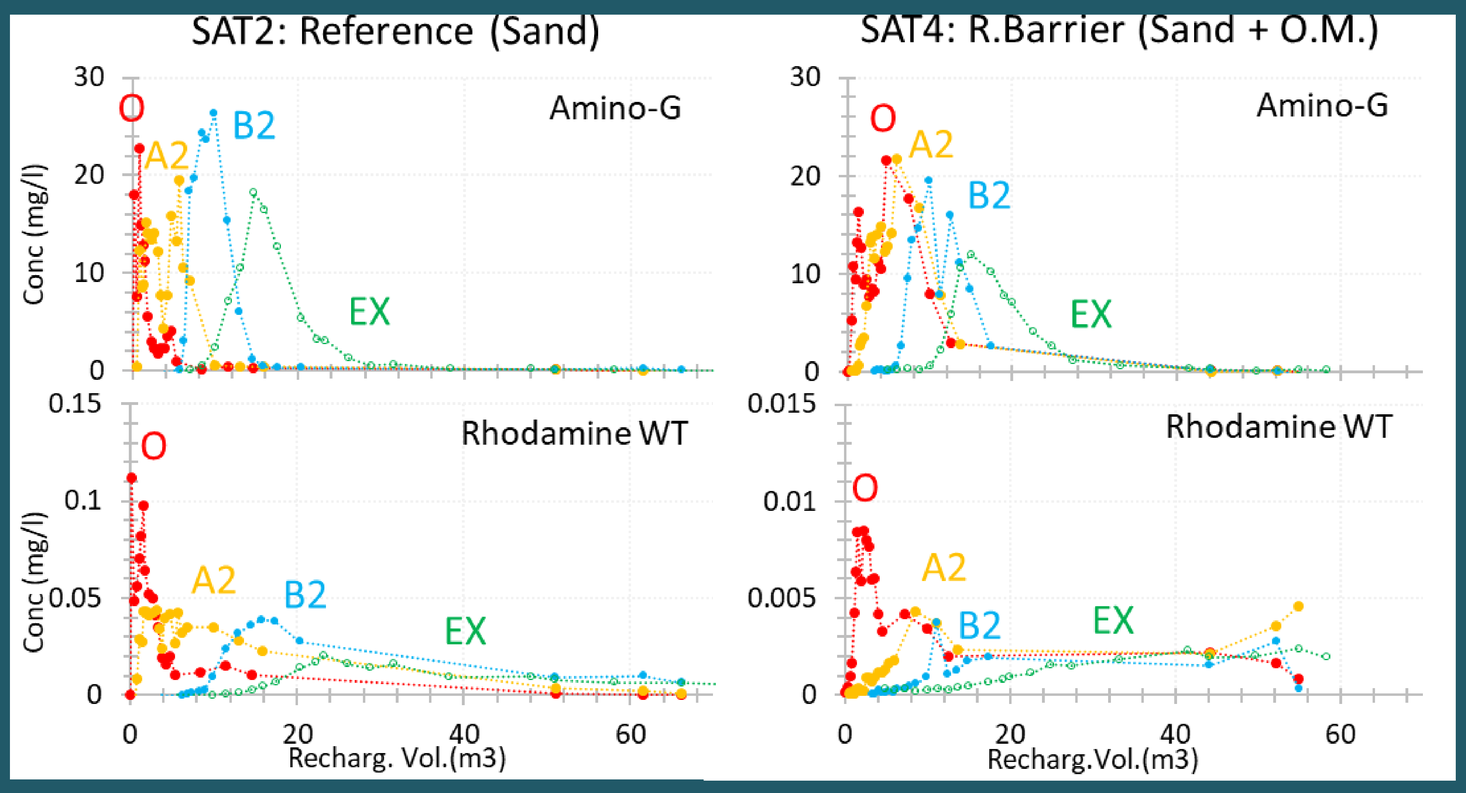

Figure 3: Dyes tracers with different behavior against Organic Matter. The Amino-G has low sorption while the Rhodamine-WT has high sorption. SAT-RB has a 10 times less Rhodamine-WT concentration, and longest tails along the system, than the Reference due to the sorption in the OM present in this Barrier.

REFERENCES:
Valhondo, C.; Carrera, J.; Martínez-Landa, L.; Wang, J.; Amalfitano, S.; Levantesi, C.; Diaz-Cruz, M.S. Reactive Barriers for Renaturalization of Reclaimed Water during Soil Aquifer Treatment. *Water* **2020**, *12*, doi:10.3390/w12041012.

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