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Aquifer recharge with reclaimed water in the Llobregat Delta. Laboratory batch experiments and field test site.

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Summary
Spain, as most other Mediterranean countries, faces near future water shortages, generalized pollution and loss of water dependent ecosystems. Aquifer recharge represents a promising option to become a source for indirect potable reuse purposes but presence of pathogens as well as organic and inorganic pollutants should be avoided. To this end, understanding the processes of biogeochemical degradation occurring within the aquifer during infiltration is capital. A set of laboratory batch experiments has been assembled in order to assess the behaviour of selected pesticides, drugs, estrogens, surfactant degradation products, biocides and phthalates under different redox conditions. Data collected during laboratory experiments and monitoring activities at the Sant Vicenç dels Horts test site will be used to build and calibrate a numerical model (i) of the physical-chemical-biochemical processes occurring in the batches and (ii) of multicomponent reactive transport in the unsaturated/saturated zone at the test site.

Keywords
Aquifer recharge, batch experiments, emerging micropollutants, infiltration, numerical model, reclaimed water, redox conditions, Soil Aquifer Treatment (SAT).

1. Introduction

In Spain, the Llobregat River and aquifers, which supply water to Barcelona, have been overexploited for years and therefore, suffer from serious damages: the river dries up on summer, riparian vegetation has disappeared and seawater has intruded the aquifer. In a global context, solutions to water stress problems are urgently needed yet must be sustainable, economical and safe. Recent developments of analytical techniques detect the presence of the so-called “emerging” organic micropollutants in water and soils. Such compounds may affect living organisms when occurring in the environment at very low concentrations (microg/l or ng/l). In wastewater and drinking water treatment plants, a remarkable removal of these chemicals from water can be obtained only using advanced and costly treatments. Nevertheless, a number of studies are demonstrating that physical, chemical and biochemical processes associated with water movement within the subsoil represent a natural alternative way to reduce the presence of these contaminants. This processes are called Soil Aquifer Treatment (SAT).

Aquifer recharge will become a source for indirect potable reuse purposes as long as the presence of pathogens and organic and inorganic pollutants is avoided. To this end, understanding the biogeochemical degradation processes occurring within the aquifer during infiltration is capital.

2. Laboratory batch experiments

A set of laboratory batch experiments has been assembled to assess the behaviour of selected pesticides, drugs, estrogens, surfactant degradation products, biocides and phthalates under different redox conditions. The setup of the experiments consists of glass bottles containing 120 g of soil and 240 ml of synthetic water spiked with the mix of micropollutants. A source of easily degradable organic carbon and, depending on the type of test, electron acceptors are added in order to yield aerobic respiration and nitrate/iron/manganese/sulphate reduction conditions. The evolution of the processes is monitored by sacrificing duplicate bottles according to a defined schedule and analysing water for major and minor components as well as for micropollutants. Results from biotic tests are compared with abiotic ones in order to discern biodegradation from other chemical processes. The soil, the synthetic water and the micropollutants selected for the experiments are representative of a test site in the

nearby of Barcelona (Spain) where artificial recharge of groundwater through ponds is going to be performed using river water or tertiary effluent from a waste water treatment plant.

The results of the experiments improve the knowledge on the behaviour of the selected micropollutants under different redox conditions and provide with useful information on the conditions to develop at the test site during artificial recharge. The data collected during the laboratory experiments and in the test site will be used to build and calibrate a numerical model of the physical-chemical-biochemical processes developing in the batches and of multicomponent reactive transport in the unsaturated/saturated zone in the test site area.

3. Field test site

The infiltration site of Sant Vicenç dels Horts has been selected to assessing the biogeochemical processes occurring during SAT. The system consists of two ponds that have been built as compensatory measure for the reduction in natural recharge caused by the construction of the High Speed Train Line. The first pond acts as a decantation pond while the second one acts as an infiltration basin (Figure 1). Recharge water comes from the tertiary treatment plant of the El Prat de Llobregat WWTP and the river (?). The CUADLL (Lower Llobregat Aquifer End-Users Community) is now managing the system operation.

Tasks that are currently being carried out at this Test Site aims at (i) improving the local experience on MAR through infiltration ponds operational aspects and (ii) monitoring the changes in water quality during the recharge processes (unsaturated and saturated zone). Special attention is being paid to the fate of emerging organic pollutants (pharmaceuticals, surfactants, pesticides, etc.). The yielding of the monitoring will be compared with the results from the laboratory batch experiments on the behaviour of selected emerging organic pollutants.

To this end, observation wells have been constructed, pressure / temperature / electrical conductivity transducers have been installed and the vadose zone under the infiltration pond has been instrumented (tensiometers, water content probes and suction cups). In addition double ring and infiltration tests have been performed in order to forecast the infiltration capacity of the basin.