Llobregat, Spain: Flexibilisation of the ASR system by injection of pre-potable water in the aquifer

Demonstration at Sant Joan Despi DWTP

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Introduction

Aquifer Storage and Recovery wells (ASR) are a combination of recharge and pumping wells. They are used for recharge when surplus water is available, and for pumping when the water is needed. The ASR system in the Llobregat aquifer is one of the oldest Managed Aquifer Recharge systems in Europe. The ASR system is composed by 12 dual injection-extraction wells, constructed in 1970 (Figure 1). The total injection capacity is 75,000 m^3/day. In the 90s the system reached its maximum activity, getting 15 Mm^3/year that were additionally injected in the aquifer. Despite the suitability of the aquifer and the good results achieved, the system has been operated fewer and fewer because the rise of the treatment costs of the potable water to be injected. Therefore in order to recover the sustainability and the economic feasibility of this ASR system, DESSIN project aims to demonstrate the injection of pre-potable water.

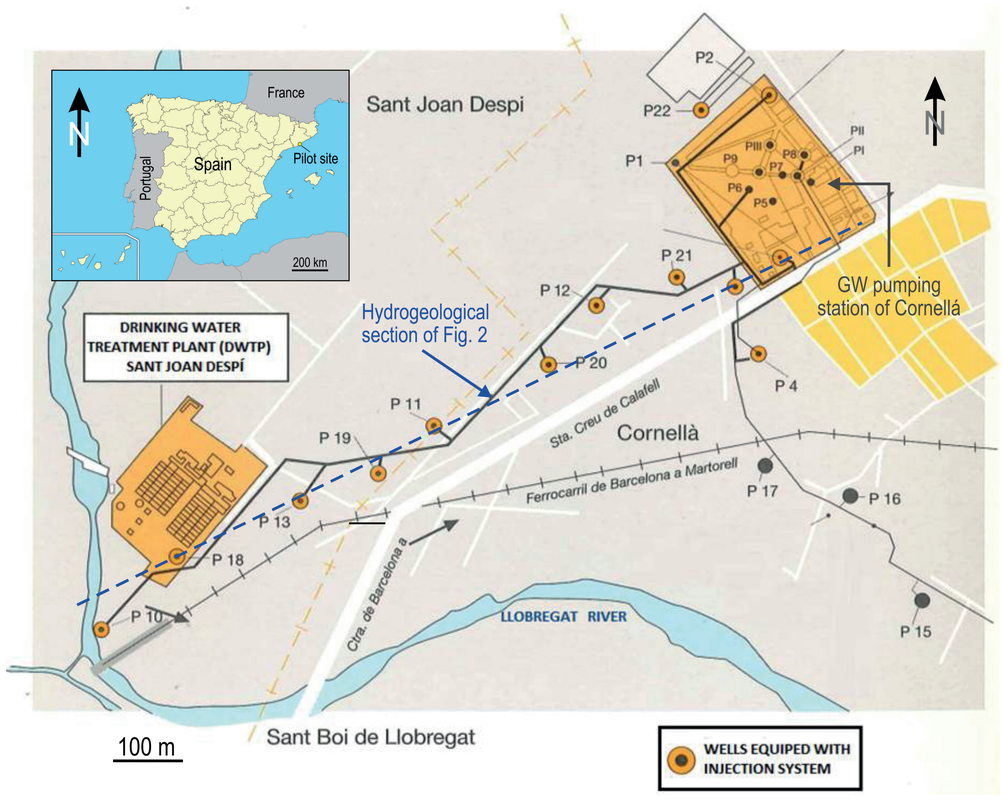

Figure 1. Location of the ASR system in the Llobregat aquifer

Site description

The total recharge area of the Llobregat Delta aquifer is 110 km^2, with a maximum storage capacity of 114 Mm^3. This aquifer is composed by Quaternary sedimentary materials coming from the erosion of the materials of the Llobregat River and its tributary rivers. These Quaternary materials are fitted in older material, from Paleozoic to Pliocene. The configuration consists in a unique free aquifer from the Low Llobregat Valley to the beginning of the Delta (ASR system). From this point to the sea, the aquifer bifurcates in an upper free aquifer and a deep confined aquifer. Both aquifers are separated by an aquitard which thickness depends on its wedge configuration and can reach 40 m. The main aquifer is therefore the most important, where extraction wells for drinking water production are located but also where seawater intrusion is taking place.

Methodology

Demonstration phase will start in autumn 2015 until the end of the project in 2017. An injection flow rate of 50L/s will be continuously injected in a selected ASR well (P18). As preparatory tasks, two main activities have been done to assess the potential impacts of the injection of non-potable water:

- Pilot experiment consisting in a column simulating water flow through the well screen and the aquifer material: evaluation of clogging (bioclogging and physical clogging).
- Numerical model using VISUAL TRANSIN code to simulate conservative transport along the aquifer: evaluation of the area of the injection plume and determination of observation network of wells and piezometers.

Results

Figure 2 shows the scheme and the picture of the assembled pilot column. Sand-filtered water is injected from the top of the column, and it is filtered passing through the aquifer material. In parallel, four disinfection methods have been tested with sand filtered water: chlorination, dioxichlorination, zonation and UV (results will be available on September 2015).

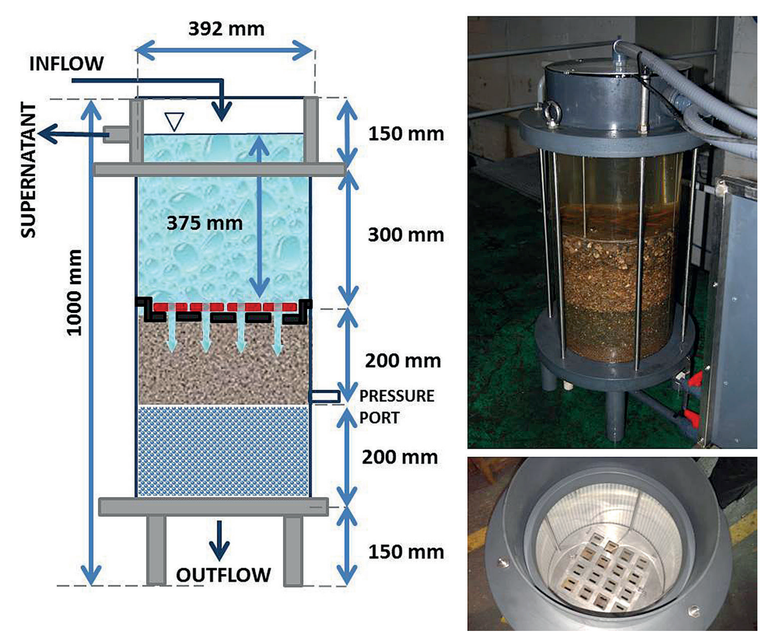

Figure 2. Column experiment. Scheme of the design (left). Picture of the assembled pilot test in Sant Joan Despí Drinking water treatment plant (right).

Simulations of numerical model carried out of Scenario 1 (Demonstration scale of the project, corresponding to an injection flow of 50 L/s in P18) and Scenario 2 (application of ASR in the entire aquifer system, corresponding to the injection of 5, 10 and 15 Mm^3/year) (see solute transport simulations in Figure 3). Results of Scenario 1 conclude that the demonstration phase of the project will have a local impact in the aquifer, as the mixing ratio (using chloride as conservative tracer) between injected water and native groundwater will be below 10% after 1.4 km of aquifer passage. Local model and regional model have been key information for the establishment of local control network (P1, P2 and P3) and the selection of external control points in the aquifer (P10, P13 and P03; in Figure 1) to verify the impact in groundwater quality during the demonstration phase.

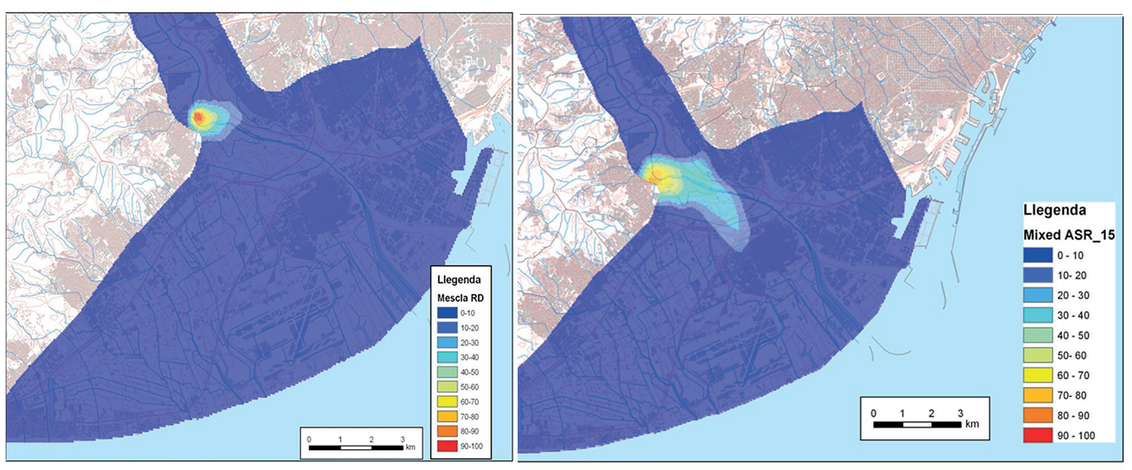

Figure 3. Results of the impact of the injected water plume at demonstration scale 1.57 Hm^3/year (left) and full-scale scenario 15 Hm^3/year (right).

Conclusions

ASR is a promising technology to provide additional water resources in the Llobregat area. Comparison with other ASR systems worldwide using non-potable water suggests that the local hydrogeology is suitable to receive sand filtered water without major problems of physical clogging. Numerical model predicts a local impact of the injected water, around 1.5 km downstream of the demonstration site. Despite column experiment will assess the bioclogging formation in the well screen; the impact will be finally tested in one existing well to evaluate the effects of non-potable water injection at real scale.

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