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Using density difference to store fresh water in saline subsurface

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The storage of fresh water in the subsurface for later recovery and use (Aquifer Storage and Recovery) is becoming more and more important in the coming decades for seasonal or emergency storage, especially in the light of climate change and increasing population.

However, fresh water storage in a saline subsurface poses a challenge: the initially vertical interface between injected fresh and native salt water is unstable and tends to rotate. The injected fresh water tends to float upward on top of native salt water, where it becomes hard or impossible to recover at a later stage. A wide body of literature exists about this buoyancy effect that is caused by the density difference between fresh and salt water. Yet, very few papers focus on solutions to this problem.

In this paper we propose a storage principle to overcome this buoyancy problem by actually using the density difference to keep the fresh water in place, by combining salt water extraction and impermeable barriers. This technique seems promising and could solve many local fresh water storage problems. It is especially applicable in shallow water table aquifers for the storage of fresh water below parks and arable land or for seasonal storage of desalinated water.

We performed laboratory-scale experiments and numerical modelling to study the dynamic behaviour of a fresh water bubble stored in saline subsurface using the technique of salt water extraction and impermeable barriers; including effects of operation dynamics, groundwater flow, and diffusion, dispersion and density differences.