Carbon Storage in Depleting Groundwater Aquifers: A Solution to Water Stress?

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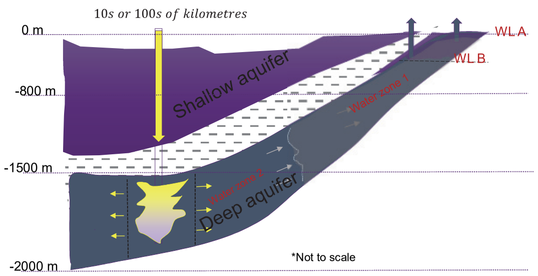
Introduction

❖ Australia has abundant deep *fresh* groundwater aquifers onshore (e.g. The Great Artesian Basin). These aquifers are experiencing water level decline due to extraction over ~100 years [a].Injecting CO_2 in depleting groundwater aquifers may:

- Boost the pressure to lift declining water levels over the broad regions;
- Displace deep water to shallower regions, making it accessible;
- Reduce CO_2 emissions.



Concept of CO_2 injection and storage combined with Enhanced Water Recovery (EWR).

Methodology

Integrated modelling (geological modelling, multiphase multicomponent flow modelling and geochemical modelling) to establish the pressure footprint, the pH footprint and the impact of carbon storage on freshwater aquifer resource availability and degradation.

Research Questions

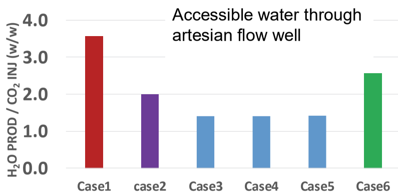
Enhanced Water Recovery (EWR) may be beneficial, but also raises concerns:

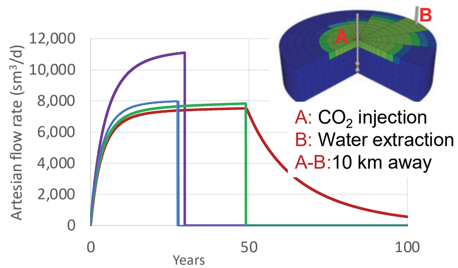
RQ 01: Can the pressure build-up increase water levels at great distance? In what time frame? For how long?

RQ 02: Does displaced water from greater depth add to shallow water supply? Does mixing water of different compositions lead to water degradation at extraction sites?

RQ 03: How much water loses quality when decreasing pH (proxy for chemical changes) as a result of CO_2 reacting with water?

Conceptual Model Example: RQ 01





case1: $K_v/K_h=10^{-5}$, extremely low vertical flow, partially open boundary
case2: $K_v/K_h=10^{-1}$, normal vertical flow, closed boundary
case3: $K_v/K_h=10^{-3}$ for localised low verti. flow in K=3, partially open boundary
case4 (base model): $K_v/K_h=10^{-1}$, normal verti. flow,partially open boundary
case5: $K_v/K_h=10^{-3}$ for low vertical flow, partially open boundary
case6: $K_v/K_h=10^{-3}$ for low vertical flow in K=3, partially open boundary

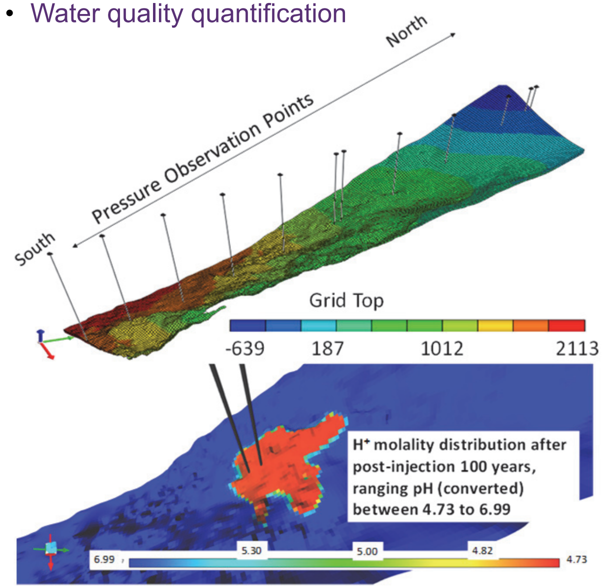
✓ Closed boundary produces higher artesian flow rate (**Case 2**);

✓ Any geological features that defer the upward flow of CO_2 are beneficial for improving water recovery (**Case 1** & **Case 6**)

✓ Less K_v/K_h contrast & opening boundary indicate less displacement of water & fast migration of CO_2 (**Case 3, 4&5**). What about a long migration path (*e.g.300 km*) & it structurally crops out (*e.g. Precipice Sst*)?

Exploratory Case Study

- Basin-scale in the Great Artesian Basin
- Pressure monitoring & water recovery volume
- Water quality quantification



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References

[a] Smerdon B, Ransley T, Radke B, Kellett J (2012) Water resource assessment for the Great Artesian Basin. A report to the Australian Government from the CSIRO Great Artesian Basin Water Resource Assessment.