

Increased fresh groundwater extraction from wells in coastal aquifers by simultaneous extraction of brackish groundwater: a numerical modeling study



Introduction

In coastal areas, the availability of freshwater is often limited to **fresh groundwater lenses** that are fed by natural recharge.

Overexploitation of freshwater lenses results in **salinization** and abandonment of freshwater wells.

Targeted **extraction of brackish groundwater** from below fresh-water lenses can improve coastal freshwater availability by:

1. protecting freshwater wells from salinization.
2. reducing lateral outflow of freshwater.
3. increasing the potential for (additional) infiltration.
4. providing a freshwater source upon desalination.

Objective

Develop **generic design and operation rules** for the coupled extraction of fresh and brackish groundwater in a recharge-fed fresh-water lens with a brackish transition zone.

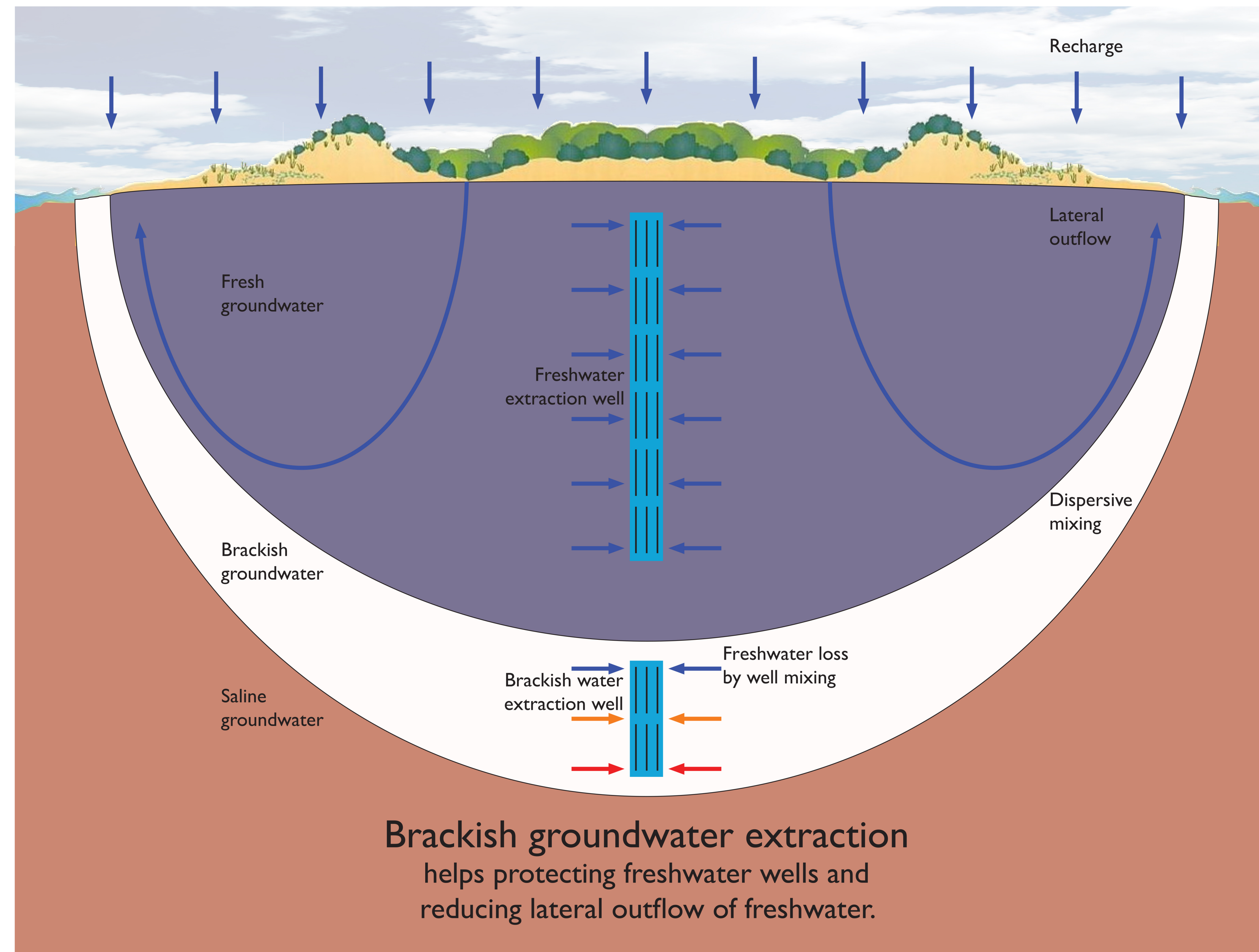
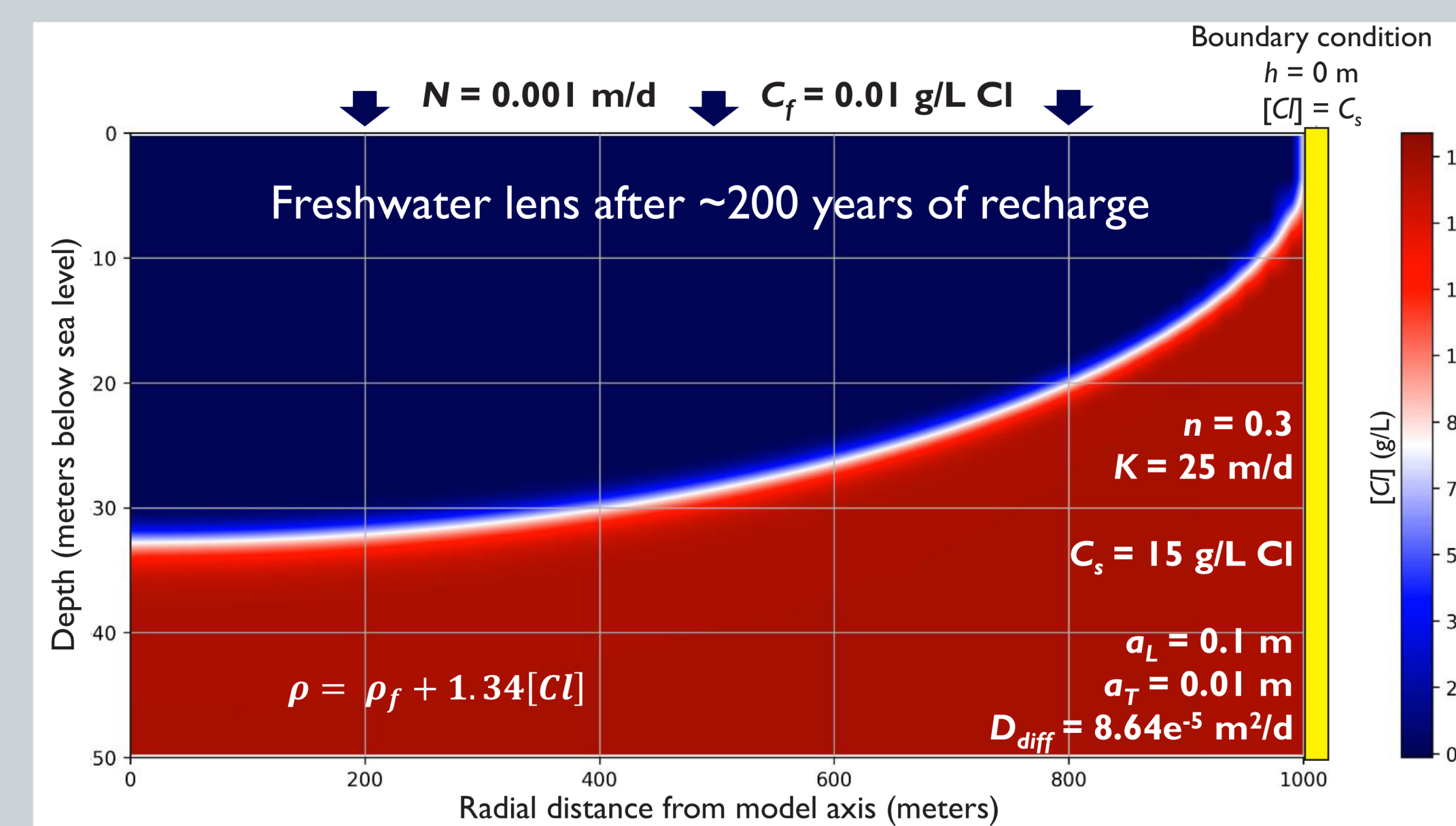
Methods

Density-dependent numerical groundwater flow and solute transport modeling with **SEAWAT v4** & **FloPy**.

Radially symmetric model (circular island) with an initial **saline confined aquifer** and **fresh recharge** from above.

- Step 1: **Development of a freshwater lens** to a steady state.
Step 2: **Extraction scenarios** with well screens in the model axis:

- **Fresh well**
 - Length = 16 m
 - Extraction rate = 4% of total recharge
- **Brackish well**
 - Length = 4 m
 - Extraction rate = 0 - 2% of total recharge



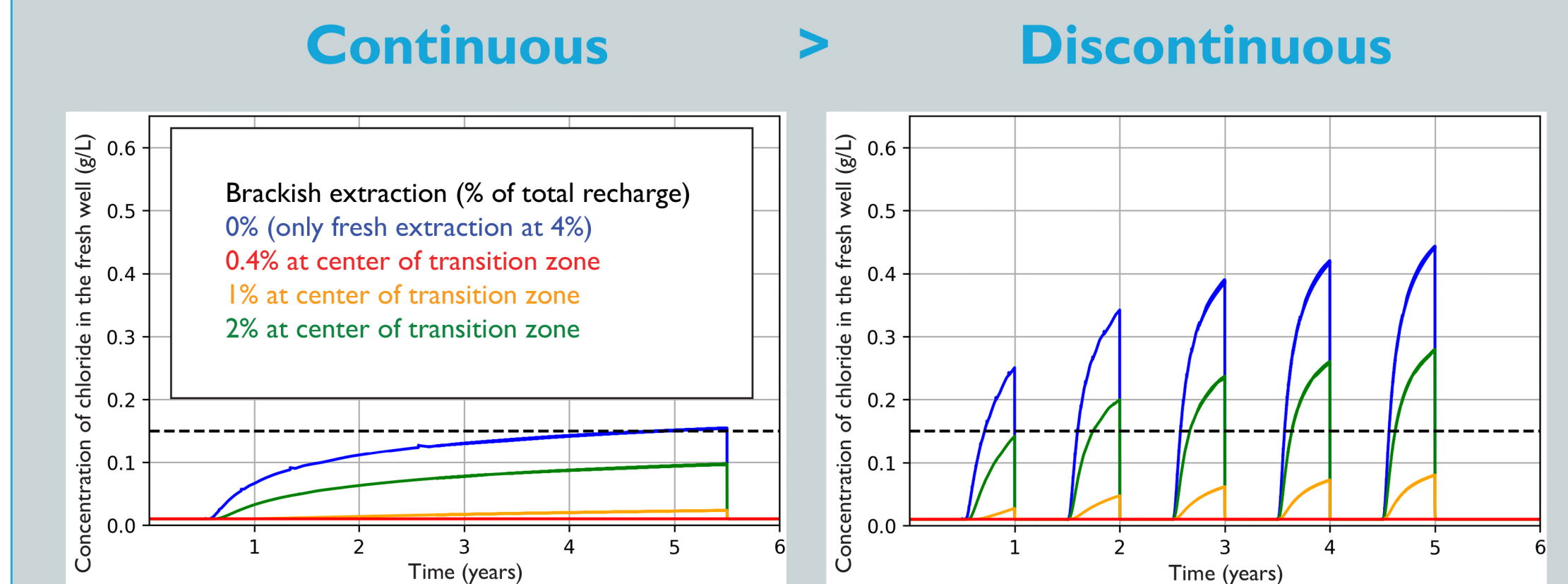
Continuous vs. discontinuous extraction

Continuous extraction rates (% of total recharge):

- Fresh well: 4%
- Brackish well: 0 - 2%

Discontinuous extraction rates (% of total recharge):

- Fresh well: alternating 0% and 8% every half year
- Brackish well: alternating 0% and 0 - 4% every half year



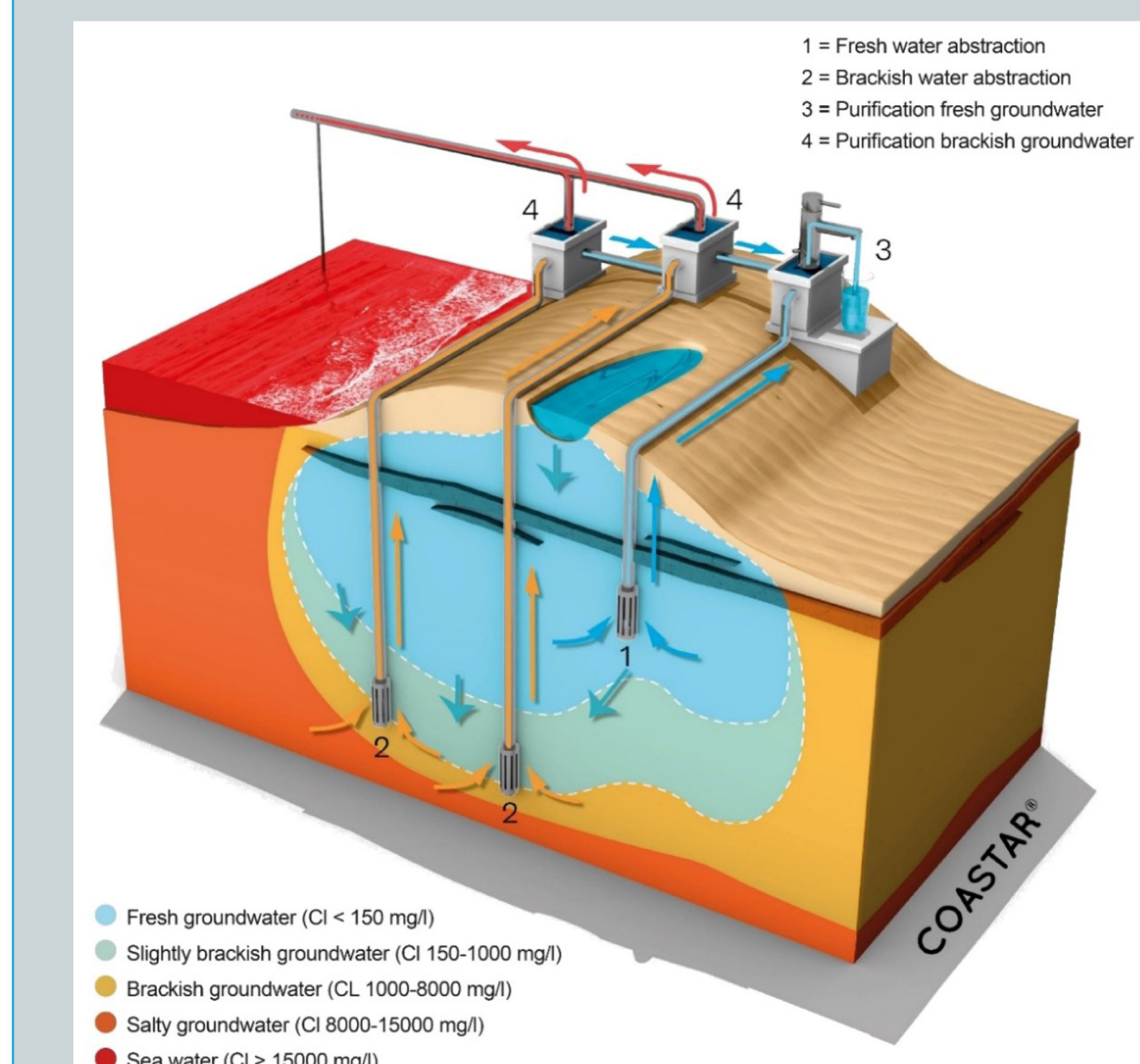
Future modeling plans

- **Sensitivity analysis** of operational & hydrogeological parameters.
- Comparison with application in infinite horizontal confined aquifers with an **unlimited lateral freshwater supply**.
- Comparison with application of **freshwater injection wells**.

Field pilot

Brackish groundwater extraction at the primary production site of drinking water company Dunea in the Dutch coastal dunes.

Freshman project



- Objectives:**
- Optimizing the existing **managed aquifer recharge** system.
 - Producing additional drinking water by **reverse osmosis**.

Curious?



The Freshman project is supported by the EU LIFE Climate Action Programme under Grant Agreement number LIFE19 CCA/NL/001222.

Effect of well depth

Placing the brackish well closer to the fresh well results in:

- better protection of the fresh well.
- less lateral outflow and dispersive mixing.
- less growth of the freshwater lens.
- more loss of freshwater by well mixing.

