Analytical analysis of timescales of seawater intrusion and retreat

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Abstract

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1. Introduction

2. Methodology

2.1. Conceptual model

The conceptual model used in this study was a confined coastal aquifer with length L and thickness B which is shown is Fig. 1. The left boundary is coast and the right boundary is the inland aquifer. $h_\mathbf{s}$ is the initial seawater level and $h_\mathbf{f}$ is the initial inland freshwater head. The initial condition is regarded to be steady state.

2.2. Theoretical method

Basic assumptions [2]:

- Darcy's flow is valid.
- The standard expression for specific storage in a confined aquifer is applicable.
- The diffusive approach to dispersive transport is based on Fick's law.

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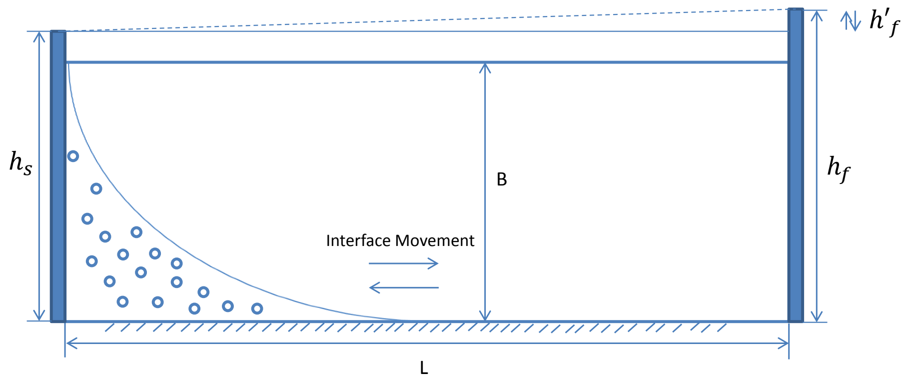

Figure 1: Conceptual model of the seawater intrusion and retreat. Following the same concept of [1]

- Isothermal conditions prevails.
- The porous medium is fully saturated with water.
- A single, fully miscible liquid phase of very small compressibility is taken in to account.

The governing equations is based on [3].

The mass balance equation:

$$\rho S\frac{\partial P}{\partial t}+\phi\frac{\partial \rho}{\partial C_{\mathbf{m}}}\frac{C_{\mathbf{m}}}{\partial t}+\nabla\cdot(\rho\mathbf{q})=\rho Q_{\mathbf{s}} \tag{1}$$

where S is the specific storativity of the porous medium, ρ is the mass density of the fluid, $\mathbf{q}$ is the Darcy velocity, $Q_{\mathbf{s}}$ is the source/sink term, ϕ is the porosity and $C_{\mathbf{m}}$ is the solute mass fraction.

The specific storativity S is defined as:

$$S=\alpha(1-\phi)+\phi\beta \tag{2}$$

where α is the coefficient of compressibility of porous medium, β is the coefficient of compressibility of the fluid:

$$\beta=\frac{1}{\rho}\frac{\partial \rho}{\partial P},\qquad \alpha=\frac{1}{1-\phi}\frac{\partial \phi}{\partial P} \tag{3}$$

The specific discharge is defined by the generalized Darcy's law:

$$\mathbf{q}=-\frac{1}{\mu}\mathbf{k}\cdot(\nabla P+\rho g\nabla z) \tag{4}$$

where μ is the dynamic viscosity of the fluid, $\mathbf{k}$ is the permeability tensor and g is the gravity acceleration.

The solute transport equation:

$$\phi\rho\frac{\partial C_{\mathbf{m}}}{\partial t}+\rho\mathbf{q}\cdot\nabla C_{\mathbf{m}}=\nabla\cdot(\phi\rho\,\mathbf{D}\cdot\nabla C_{\mathbf{m}}) \tag{5}$$

In which $\mathbf{D}$ is the dispersion tensor.

3. Result and discussion

References

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