Coupling geostatistical inversion and optimization techniques for the management of coastal aquifers

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Abstract

Water is a critical factor for economic growth in coastal areas. In this context, desalination has gained steam during the last five decades. Often, input water is absorbed directly from the sea through intake pipelines, what causes environmental side effects. However, desalting brackish groundwater is generally cheaper than desalting seawater. In that context, the design of an optimum set of pumping wells demands reliable characterizations of aquifer parameters.

In this paper, we couple geostatistical inverse modelling and optimization techniques for designing an optimum pumping network in Oman, where a desalination plant currently pumps brackish ground water at a rate of 1200 m^3/h, insufficient to satisfy the growing demand of fresh water.

In a first step, 200 transmissivity and storativity fields are conditioned to transient piezometric data (tidal fluctuations recorded in 10 observation wells and three long term pumping tests conducted in three different wells) with the pilot point technique.

Next, these hydraulic conductivity fields are used to determine an optimum pumping configuration in order to increase the current pumping rate to 9000 m^3/h. This task requires the allocation of new pumping wells and the definition of their pumping rates. The aim is to define a management solution that is robust (i.e a solution that is efficient for all our 200 simulated fields). This is obtained by a genetic algorithm that minimizes a cost function that accounts for: (1) minimum number of wells (i.e. minimum allocation costs), (2) minimum drawdown (i.e. minimum aquifer vulnerability) and (3) technical feasibility of the solution (i.e. pumps must be of prescribed flow rates). The constraints are imposed as penalty terms in the cost function.