Optimization techniques for a model problem of saltwater intrusion in coastal aquifers

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A major problem many countries are facing is saltwater intrusion in fresh water aquifers, a phenomenon that can be mainly observed in nearby sea areas. There are two main reasons for this problem. The first one includes all natural disastrous phenomena, such as earthquakes or floods, which, depending on their magnitude, can change the chemical composition of the water aquifer. The second one, where our interest mainly lies, is related to human activities, plumping and pumping policies, always in nearby sea areas. In this work we study the problem of uncontrollable fresh water pumping from coastal aquifers, using well known mathematical modeling techniques. The first step is to define the characteristics of the underground water aquifer, in order to choose the appropriate boundary values problem. Then, by using the well celebrated empirical Darcy's law (1856) and the continuity equation, we use an analytical solution, that describes, at discrete time intervals, the position of sea front (the so-called interface areas front), while it moves towards the interior of the aquifer. We also take into consideration the entire well pumping that takes place over the aquifer under study. In the last step of this study, we construct efficient cost functions to implement optimization methods in order to optimize the pumping rates. Our aim is to maximize the amount of fresh water pumping by a specific aquifer, taking care at the same time to protect the wells from saltwater intrusion. We implement the linear programming method SIMPLEX and the stochastic iterative method ALOPEX, and we compare the results.