Modeling the impact of saline groundwater pumping from coastal aquifers beneath the fresh-saline water interface for desalination purposes

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ABSTRACT

Desalination has become, in the last decades, a necessity for water supply in many locations around the world and specifically in arid and semi-arid places. The majority of the feed water that is being used for desalination is seawater which holds difficulties due to its need of extensive pretreatment. Saline groundwater (SGW) from coastal aquifers was proven to be a high quality feed water for desalination. The aim of this study was to investigate the implications of pumping SGW from a coastal aquifer on the fresh-saline groundwater interface (FSI) in terms of its location with varying pumping rates and different pumping distances from the shore. A finite element model was built with the FEFLOW software which solves the coupled flow and density dependent flow equations. A phreatic 3D model was built to simulate the behavior of the FSI due to extensive pumping regime. Furthermore, a field scale pumping test was conducted in Nitzanim natural reserve in Israel. Low pumping rate of 2.5 m^3/hour was applied and EC sensor was placed in an observation well nearby to monitor the FSI shift due to pumping. The model results show that pumping SGW in a coastal aquifer freshened the aquifer and rehabilitated parts that were salinized due to fresh groundwater pumping. In addition, the results show that the pumped water salinity decreases with increase of pumping rate up to ~30% fresh water in an extreme pumping rate of 30 million cubic meter per year from one well and the percentage of fresh water in the well decreases with lower pumping rates. Moreover, in scenarios of fresh and saline groundwater pumping simultaneously, the salinity of the saline pumping well was more stable and the FSI location experienced less variability. The field experiment results showed an agreement with the model results when salinity decrease was noticed in the observation well 13 meters from the pumping well. This study shows that pumping of SGW for desalination purposes can be a supplementary benefit of aquifer rehabilitation and fresh water extraction without detrimental effect of seawater intrusion.