Transient Investigation of the Critical Pumping Rate in Laboratory-Scale Coastal Aquifer

Abdelrahman M. Abdelgawad[1], Antoifi Abdoulhalik [2] and Ashraf A. Ahmed[3]
[1] Civil Eng. Department, Faculty of Engineering, Applied Science Private University, Amman, Jordan
[2] School of Natural and Built Environment, Queen's University Belfast, Belfast, UK
[3] Department of Civil & Environmental Engineering, Brunel University London, UK

ABSTRACT

This research investigated the transient saltwater upconing in response to pumping from a well in a laboratory-scale coastal aquifer. Laboratory experiments were completed in a 2D flow tank for a homogeneous aquifer where the time evolution of the saltwater wedge was analysed during the upconing and the receding phase following the cease of abstraction. The SEAWAT code was used for validation purposes and to thereafter examine the sensitivity of the critical pumping rate (defined here as the rate at which the 1% salt contour line of the cone apex reaches the well) and the critical time (defined as the time needed for the upconing to reach the well) to the well design and hydrogeological parameters. Results showed that the critical pumping rate and the critical time were more sensitive to the variations of the well location than the well depth. The critical time increased with increasing the location and depth ratios following a relatively simple linear equation. For all the configurations tested, the lowest critical pumping rate was found for the lowest hydraulic conductivity, which reflects the vulnerability of low permeability aquifer to salinization of pumping wells. In addition, higher saltwater densities led to smaller critical pumping rate and shorter critical time. The influence of the saltwater density on the critical time was more significant for wells located farther away from the initial position of the interface. Moreover, increasing the dispersivity induced negligible effects on the critical pumping rate, but reduced the critical time for a fixed pumping rate.

Contact Information: Department of Civil & Environmental Engineering, Brunel University London, Kingston Lane, Uxbridge UB83PH, UK, Email: ashraf.ahmed@brunel.ac.uk