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Modeling Groundwater Flow to Mitigate Seawater Intrusion in El-Tina Plain, Northwestern Sinai Peninsula, Egypt using MODFLOW

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The Sinai Peninsula is primarily relying on the groundwater storage from the shallow and deep aquifers to meet the requirements of the current and future agricultural projects. Thus, understanding of the present and future groundwater flow, especially in the northern coastal aquifers, presents a crucial step towards sustainable groundwater management plans in these regions. El-Tina Plain is located in the northwestern corner of the Sinai Peninsula covering an area of about 1600 km2 and bordered by the Mediterranean Sea to the North and the Suez Canal to the West. The rainfall is considered the main source of recharge where the average annual rainfall ranges between 80 to 90 mm. The water levels in the Pleistocene coastal aquifer range from less than one meter at the North to about 4 meters at the south. The groundwater is flowing from the south towards northern and northwestern borders, i.e. towards the Mediterranean Sea and the Suez Canal respectively. As such, the development and exploitation plans in this region are critical due to the freshwater resources are threatened by the risk of seawater intrusion and subsequent severe environmental problems. The present study aimed to determine the optimum groundwater abstraction (i.e. safe yield) to avoid the possible saltwater up-coning using MODFLOW modeling package, which is included in the framework of the Groundwater Modeling System (GMS). A two-dimensional groundwater flow model was adopted utilizing all the relevant datasets including the boundary conditions, aquifer parameters, and hydrological data. Simulation results fit well with the observed measurements and the model was calibrated using a set of conventional statistical error measures such as the bias, the mean absolute error (MAE) and the normalized root mean square error (NRMSE). Multiple scenarios of the anticipated groundwater flow under different stresses including the number of pumping wells and different discharge rates were introduced. Results show that a network of 15 water wells is recommended to be drilled in the region with an optimum abstraction rate that should not exceed 300 m3/day from each well to prevent the risk of seawater intrusion. Our findings can, therefore, contribute to better management of groundwater resources and agricultural practices in the coastal regions and elsewhere.