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Investigation of Interference of Salt water in Desert Aquifers (Case study: South Khorasan, Sarayan Aquifer)

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Introduction: Due to the increase in water consumption resulting from climate change and rapid population growth, overexploitation of groundwater resources take place particularly in arid regions. This increased consumption and reduced groundwater quality is a major problem especially in arid areas of concern among water resources managers and planners. The use of modern simulation tools to evaluate the performance of an aquifer could help the managers and planners to decide. In this research, finite difference method was used to simulate the behavior of the quality and quantity of groundwater.

Materials and Methods: Increasing the concentration of salts in the groundwater aquifers intensifies with severe water withdrawing and causes the uplift of salt water in aquifers. This is much more severe in adjacent aquifers of saline aquifers in deserts and coastal areas. Front influx of saltwater into freshwater aquifers causes interference and disturbance in water quality and complex hydro-chemical reactions occurs in the joint border area including the process of cation, groundwater flow, the reduction of sulfate, the reaction of Carbonatic and changes in the dolomitic calcite. Sarayan Aquifer has a negative balance and the annual groundwater table drawdown of 62 cm.

In this study, Total Dissolved Solids (TDS) as a groundwater quality factor was simulated to investigate the effect of the overexploitation on the saline interface of desert aquifer using MT3D module of GMS model for a period of 5 years with time steps of 6 months. One of the most important steps of the simulation of groundwater quality is to use qualitative model to predict the groundwater level which in this study were performed by quantitative models in two steady and unsteady flow states with time steps of 6 months The four basic steps of a proper modeling of the groundwater quality are sensitivity analysis of the input parameters, calibration of the sensitive parameters of the model, validation of the time step and groundwater quality forecast for the future periods. These modeling steps were carried out for steady and unsteady states by GMS software.

Aquifer hydraulic conductivity and the specific yield of aquifers were selected as two critical parameters of quantitative model in steady and unsteady states. The model was calibrated based on these two parameters and then using pest method, the value of these parameters was finalized. In order to evaluate the response of the aquifer to different periods of droughts, the verification of the model was conducted during the ten periods. The results show that observed water level has suitable correlation with simulated water level. In the same period, the simulation of water quality for TDS parameter carried out using the results of the quantitative model. After identification of sensitive parameters in the model, calibration of the model was carried out taking into account the factor of 0.5 for the ratio of horizontal to vertical distribution, vertical diffusion length of 0.2, 1 meter for effective molecular diffusion coefficient, and 20 for longitudinal diffusion.

Results and Discussion: In the total area of the aquifer, the water demand of all sectors are supplied using groundwater resources. This water withdrawal trend exacerbated the decline in groundwater levels and reduced water quality. Also in the southern strip of the aquifer, there is a desert saline groundwater aquifer, which causes the intrusion of salt water to the aquifer and negative effects on its quality. The factors influencing the salinity of groundwater in the Sarayan Aquifer are geological formations, supplying the aquifer from salty formations in the region, evaporation from the shallow part of the aquifer especially in the southern strip that leaves salt and reducing the volume of water, existence of fine soil in the media of groundwater flow. Front influx is from saltwater desert aquifer to the Sarayan Aquifer. Due to the osmotic pressure of the soil layers in the aquifer, the pollutants transferred from the higher concentration to lower concentration and an influx of salt water into the aquifer will occur from outside of the aquifer. Since the direction of groundwater flow is from the north to the south of the aquifer and salt water intrusion is from the south to the north, the velocity of saltwater intrusion dropped so quickly water. However, overexploitation of groundwater and negative aquifer balance caused uplift

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of the salt water in aquifer.

Conclusion: Review of the result of forecasted TDS concentration in Sarayan Aquifer, shows an increase in TDS concentration. This increase indicates that there is no potential for more water withdrawing in the southern parts of the aquifer by urban and agricultureal sectors. The variaty of TDS changes between 712 mg/lit in the northern strip of the aquifer to 8500 mg/lit in the southern strip shows that due to the increased concentration of TDS, the border area of water users will be changed. The forecasting of the future status of aquifer water quality showed that continuing withdrawing of water intensifies salt water interference from the desert and concentration of TDS will increase during the next 5 years. To manage aquifer quality and quantity, three scenarios of water withdraw reduction were used. The results are shown restoration of the aquifer quality and quantity using these scenarios.

Therefore the result of this research shows that the management of groundwater is necessary to improve the quality of desert aquifers and prevent salt water interference from desert considering recent droughts.

Keywords: Aquifer, Calibration, Interference saltwater, MT3D model, Quality