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Modelling of Groundwater Resources for Al-Najaf City, Iraq

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Abstract : Groundwater is a vital water resource in many areas in the world, particularly in the Middle-East region where the water resources become scarce and depleting. Sustainable management and planning of the groundwater resources become essential and urgent given the impact of the global climate change. In the recent years, numerical models have been widely used to predict the flow pattern and assess the water resources security, as well as the groundwater quality affected by the contaminants transported. In this study, MODFLOW is used to study the current status of groundwater resources and the risk of water resource security in the region centred at Al-Najaf City, which is located in the mid-west of Iraq and adjacent to the Euphrates River. In this study, a conceptual model is built using the geologic and hydrogeologic collected for the region, together with the Digital Elevation Model (DEM) data obtained from the "Global Land Cover Facility" (GLCF) and "United State Geological Survey" (USGS) for the study area. The computer model is also implemented with the distributions of 69 wells in the area with the steady pro-defined hydraulic head along its boundaries. The model is then applied with the recharge rate (from precipitation) of 7.55 mm/year, given from the analysis of the field data in the study area for the period of 1980-2014. The hydraulic conductivity from the measurements at the locations of wells is interpolated for model use. The model is calibrated with the measured hydraulic heads at the locations of 50 of 69 wells in the domain and results show a good agreement. The standard-error-of-estimate (SEE), root-mean-square errors (RMSE), Normalized RMSE and correlation coefficient are 0.297 m, 2.087 m, 6.899% and 0.971 respectively. Sensitivity analysis is also carried out, and it is found that the model is sensitive to recharge, particularly when the rate is greater than (15mm/year). Hydraulic conductivity is found to be another parameter which can affect the results significantly, therefore it requires high quality field data. The results show that there is a general flow pattern from the west to east of the study area, which agrees well with the observations and the gradient of the ground surface. It is found that with the current operational pumping rates of the wells in the area, a dry area is resulted in Al-Najaf City due to the large quantity of groundwater withdrawn. The computed water balance with the current operational pumping quantity shows that the Euphrates River supplies water into the groundwater of approximately 11759 m3/day, instead of gaining water of 11178 m3/day from the groundwater if no pumping from the wells. It is expected that the results obtained from the study can provide important information for the sustainable and effective planning and management of the regional groundwater resources for Al-Najaf City.

Keywords : Al-Najaf city, conceptual modelling, groundwater, unconfined aquifer, visual MODFLOW
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