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# Numerical modeling of groundwater flow in Ali Abad Plain of Qom to predict fluctuations of the water table and hydraulic conductivity

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**Abstract**

In the present study, numerical modeling of groundwater in Aliabad plain of Qom has been carried out using GMS software between 2006 and 2016. For this purpose, using comprehensive geological and hydrological data and information, the hydraulic level in the study area is modeled and the hydraulic conductivity is estimated in the final modeling step. To validate the model, the changes in groundwater level predicted by the model were compared with the results of piezometric measurements and the RMSE error was determined to be 1.4 m. In addition, the results indicated that in 13 out of the 26 observation wells, the average difference between the observed and predicted hydraulic level is less than 0.5 m and the maximum average difference between the above values, is equal to 2.94 m. These values reveal an insignificant modeling error of 2.5% due to the range of groundwater level changes (810 to 930 m) in the region. Comparison of the hydrograph of the observed and predicted groundwater level changes illustrates their acceptable agreement (with correlation coefficient of 0.995 and regression coefficient of 0.989). Moreover, the results of hydraulic conductivity estimation indicate high values of this parameter at the intersection of two main rivers in the region, which is attributed to occurrence of sedimentation in these areas. Accordingly, the results approve competent capability of the proposed model for simulating the hydraulic level distribution, estimating hydraulic parameters and predicting the future aquifer behavior in the study area.

***Key words**: Subsidence, Aliabad plain, Groundwater modeling, Hydraulic conductivity*

**Extended Abstract:**

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## 1. Introduction

In recent years, increase in the groundwater extraction from the aquifer of Aliabad plain of Qom city, as a result of increasing water demand for agricultural and drinking purposes, has caused a progressive decline in the groundwater level and consequently, had led to occurrence of subsidence in large areas of the plain. Despite these critical conditions, so far, no significant action has been taken in this area regarding the management of optimal groundwater utilization. In this study, modeling of groundwater level changes in the aquifer of Aliabad plain has been conducted and the hydraulic level has been simulated using groundwater modeling system (GMS) software and after ensuring the validity of the model, the hydraulic conductivity values are estimated in the final modeling step. Using the results of the present study, it is possible to estimate the hydraulic parameters of the aquifer (determining the storage coefficient and hydraulic conductivity of the aquifer), predict the future condition of the aquifer with different scenarios to help properly manage the aquifer and apply different scenarios and evaluate the aquifer behavior.

## 2. Material and Methods

Aliabad plain is located in the northwest of the Qom province. After impounding the Saveh Dam in 1994, entrance of the main river of the plain to the aquifer was completely cut off and consequently, downstream farmers used groundwater aquifers to supply their required water, which caused the aquifer to collapse in this area (Edalat et al. 2019). The Groundwater Modeling System (GMS) is a software package that provides powerful models such as MODFLOW to simulate various groundwater challenges and issues (Karimi et al. 2019).
In the present study, as the first and main strep of the modeling process, a conceptual model was developed. This conceptual model includes shape, boundary conditions, and feed and discharge sources that help to better understand the model behavior. In addition, the modeling period from 2006 as the time origin to 2016 was determined in 1-month intervals for 120 months. In this study, the hydraulic data from the initial year of the model have been used to simulate the steady state. To simulate the groundwater flow in an unstable state, changes in each parameter over time must be defined for the model. To do this, changes in the hydraulic level between 2006 and 2016 have been taken into account. Another important step is the model calibration. At this step, the hydraulic conductivity is re-estimated during the calibration process. For this purpose, hydraulic level data of 26 observation wells have been used. During this process, the model is adjusted so that the difference between the observed hydraulic level and the simulation is reduced to a reasonable value for each well.

## 3. Results and Discussion

After calculating the groundwater level for the period 2006 to 2016 by the model, to validate the model, the values obtained are compared with the actual values measured in the observation wells.

The results represent the acceptable accuracy of the model with the maximum mean difference between the observed and predicted values equal to 2.94 m and the RMSE error is 1.4.
Furthermore, the results of comparing the hydrograph of the aquifer from 2006 to 2016 using the observed and predicted data, indicate a good agreement (correlation coefficient 0.995 and regression determination coefficient 0.989) between the mean level values of groundwater level.
This means that the model has an efficient performance for simulating the hydrograph of the aquifer unit in a long-term process. In addition, the hydraulic conductivity values of the plain were estimated. The results show that except for the center and north of the study area, which have hydraulic conductivity values higher than 32m per day, in the other parts of the plain, the hydraulic conductivity ranges between 0 and 32m per day.

## 4. Conclusion

In this study, numerical modeling of the groundwater level changes in the Aliabad plain aquifer in the period of 2006 to 2016 using the GMS software based on MODFLOW architecture was conducted and the following results were drawn:

- Error values between groundwater level values simulated by the model and actual values measured in the observation wells are acceptable considering the range of hydraulic level changes between 810 and 930m in the study area.
- The values of hydraulic conductivity estimated by the model for the northern and central parts of the study area at the intersection of the two rivers of Mazlaghan and Qarachay have higher values, which can be attributed to the presence of river sediment in these areas.
- Study of soil layer characteristics in the boreholes shows that the type of layering and the presence of layers including fine-grained formations are the other factors influencing the intensity and rate of subsidence in the Aliabad plain.
- The results represent that the proposed model can be used as a basis for the analysis of subsidence caused by time-dependent groundwater extraction in the Aliabad plain.
- The proposed model could be utilized to attain the more precise data and analyses in the local regions of the Aliabad plain's aquifier.

## References

Edalat A, Khodaparast M, Rajabi AM (2019) Detecting Land Subsidence Due to Groundwater Withdrawal in Aliabad Plain, Iran, Using ESA Sentinel-1 Satellite Data Natural Resources Research:1-16.

Karimi L, Motagh M, Entezam I (2019) Modeling groundwater level fluctuations in Tehran aquifer: Results from a 3D unconfined aquifer model Groundwater for Sustainable Development 8:439-449.