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EXTENDED ABSTRACT

Estimation of Natural Recharge of Ardabil Aquifer Using CRD Method

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1. Introduction

Groundwater recharge from rainfall and the return flow of irrigation is essential for sustainable water resources management, groundwater modeling. Quantification of the rate of ground water recharge is a basic prerequisite for efficient ground water resource management. The rate of aquifer recharge is one of the most difficult components to measure when evaluating ground water resources. Numerous techniques are used to quantify recharge rate. One of these techniques is the cumulative rainfall departure (CRD) method. This method is considered to be one of the most promising and attractive due to its ease of use and low cost of application in semiarid areas. Numerous studies have been carried out to estimate groundwater recharge from rainfall. The CRD is a water balance method which depends on groundwater level fluctuations in shallow aquifers as a function of rainfall. Xu and van Tonder (2001) and Rasoulzadeh and Moosavi (2007) used the revised CRD method and Ahmadi et al. (2014) applied the CRD method to assess groundwater recharge in arid and semi-arid region.

2. Methodology

Ardabil plain is located in northwest of Iran with a cold semi-arid environment and 279.8 mm annual average precipitation. The total area of the groundwater basin is approximately 1217.17 km^2 and is located between 48° 8′ 45" to 48° 37′ 30" east longitude and 38° 2′ 15" to 38° 31′ 00" north latitude. The major source of water for irrigation purposes in the study area is groundwater. The annual average rainfall is 279.8 mm. In this study, monthly rainfall from 2001 to 2011 (10 years) was used in development of the conceptual model. The objective of the conceptual model is to capture the salient physical processes controlling the transient response of the groundwater table elevation to seasonal rainfall events and irrigation practices, and yield reliable estimates of groundwater recharge as well as specific yield. These aquifer properties can be used as input to simulate the management of the basin-wide groundwater resource. The CRD model is applied to estimate groundwater recharge. Regarding the CRD model, a few nondeterministic data such as groundwater level measurements, rainfall records, inflow and outflow, specific yield, as well as a groundwater extraction data set are essential to execute the CRD model. The study area has been divided in 26 polygons based on the observation wells using the Thiessen method with the help of ARCGIS. A conceptual model was constructed for each of the 26 polygons

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(one for eachobservation well). Then, monthly records of rainfall, the pumping rate, inflow and outflow were listed against the corresponding groundwater level record for each polygon (observation well). Calibration of the CRD model was implemented in a userfriendly Excel spreadsheet and programmed using a visual basic application (VBA), which was produced by Xu and Van Tonder (2001). The software enables one to manipulate, analyze and display data, and estimate recharge of groundwater based on measured groundwater levels and rainfall. The software minimizes the objective function using the least squares method. The calibration was performed to estimate the fraction of cumulative recharge by rainfall (r), specific yield (Sy), the fraction of withdrawal through pumping wells acts to recharge (λ), lag time and length of related rainfall events for each individual observation well model. The calibration target (objective function) was based on minimizing the difference between the estimated and observed groundwater table elevation in each individual observation well (individual polygon).

3. Results and discussion

The results showed that the water table elevation estimated by using the optimized parameters exhibits approximately a good match with the water table elevation observed for all observation wells. It can be concluded that the used model can successfully describe the groundwater fluctuation in the study area. The results depicted that the Sy ranges from 0.006 to 0.4. The estimated fraction of precipitation (r) and irrigation (λ) which infiltrate to groundwater showed that the less than of 20% of precipitation and irrigation acts to recharge groundwater in the most of area. The results showed that the average of the specific yield is estimated 0.1 and the estimated fraction of irrigation and rainfall that acts to recharge the water table are 17.46 and 16.19 percent respectively. Finally, with obtaining effective parameters in recharge, average of annual groundwater recharge is estimate 172 million cubic meters.

4. Conclusions

The advantage of the CRD model is that specific yield and recharge are estimated at the scale of interest to basin hydrologic studies and that the method requires no extensive in situ instrumentation network. Proper matching between observed and simulated water table assure that the present conceptual model has a potential for estimating groundwater recharge. The result showed that the temporal and spatial variability of recharge from rainfall and return flow of irrigation are sizeable in the study area and need to be considered for groundwater modeling and management. Groundwater recharge would have to be estimated as a temporally and spatially distributed variable.

5. References

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