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Modeling Groundwater Recharge in a System for Flash Flood Water Harvesting

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Artificial recharge (AR) is a method to balance and recover groundwater resources. Hydrologic technologies for AR and water harvesting have been implemented in various forms in Europe, the Middle East, and Northern Africa. AR may be defined as augmenting the natural infiltration of surface water into underground formations by various techniques such as by spreading of water in infiltration basins, or by artificially changing recharge conditions (Todd and Mays, 2005). Unconfined aquifers can be artificially recharged by spreading of water on the ground surface. AR by water spreading is practiced in 36 multipurpose floodwater spreading stations in Iran since 1983. The systems serve as sedimentation basins and infiltration ponds for the AR of groundwater; and also as experimental plots for investigation mitigation of several problems such as moving sand stabilization and afforestation (Kowsar, 1992). Due to water shortage in Gareh-Bygone Plain (GBP), arid south-eastern Iran, a Floodwater Spreading System (FSS) to artificially recharge the groundwater was established between 1983 and 1987 on about 2000 ha. The system is intended to improve groundwater quantity and quality.
Estimation of recharged water is a crucial subject in aquifer management. A variety of techniques are available to quantify recharge; however, choosing appropriate techniques is often difficult (Scanlon et al., 2002). The main objective of this study was to apply a numerical method to quantify the effect of AR on the groundwater resources using observed hydraulic head in the study area. Therefore, recharge rate (RCH), effect of recharged water on aquifer, resident time and also the amount of water that has been infiltrated from the river bed and FSS were investigated by utilizing a numerical groundwater model. The adopted numerical model is GMS equipped with MODFLOW-2000 and the study area was Kowsar Artifical Recharge Station located in GBP, south-east of Iran, with 6×106 m2 area.
In order to estimate the RCH as the main objective of this modeling, a 3D conceptual model was built to be representative of the study area and efficient estimation of hydraulic parameters. Groundwater flow was simulated and calibrated based on monthly observed data during both steady (Hashemi et al., 2010) and transient periods for the years between 1993 and 2007. The aquifer parameters including hydraulic conductivities (K), specific yield (Sy) and RCH were determined through calibration of model during steady state, unsteady state with no recharge, and unsteady state with recharge cases, respectively. The calibrated average hydraulic conductivity and specific yield for entire area were 0.1-md-1 and 0.05, respectively. The results show the different RCH value for different time periods depending on surface water availability and duration of flash flood. In addition, only less than 10% of total recharge allocates to the river bed infiltration while the main source of groundwater recharge in the FSS included more than 90% of recharged water. Simulation results show that the recharge of water to the aquifer causes backward movement of saline groundwater front from saline Shur River of Jahrom located in the west border toward the western and south-western part of the plain. Also the best results were obtained when the resident time was assumed to be less than one month.

Keywords. artificial recharge, groundwater, modeling, recharge rate, MODFLOW