Geophysical Research Abstracts,
Vol. 11, EGU2009-10955, 2009
EGU General Assembly 2009

Groundwater Recharge Modeling in Azraq Basin (Jordan) Considering the Unsaturated Flow Components

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Water resources in Azraq basin at the northeastern part of Jordan are at critical juncture, due to the continual and excessive abstraction of groundwater accompanied with small amounts of groundwater recharge by precipitation, and high rates of evaporation losses over the entire basin. Groundwater recharge from precipitation over the basin was estimated using soil water balance. It was found that only about 2% to 3 % of annual average rainfall infiltrates ground surface to reach the shallow aquifer. The three dimensional finite difference groundwater flow model MODFLOW (Processing Modflow Pro, version7) was utilized in order to simulate groundwater flow in the basin. Steady state was calibrated using hydraulic conductivity and flows. The calibrated hydraulic conductivity ranged between 0.1 m/day to 7.0 m/day, the system water balance for the steady state showed that spring discharge from the basin was about 15.0 MCM/yr, groundwater recharge by precipitation was about 9.5 MCM/yr, and the trans-boundaries inflow was 5.5 MCM/yr. Transient state was also calibrated using the specific yield ranged between 0.02 to 0.4. Water balance for the year 2002 showed that there are about 40 MCM/yr as water deficit and a maximum drawdown of about 22 m occur in the well field area. Groundwater recharge at five earth dams have been simulated starting from 1995, it was shown that water deficit that occur in 2002 will decreases by about 15 MCM/yr, drawdown has been slightly affected by these recharge dams. This was attributed to the high abstraction rate at the well field area; the second reason is that the locations of these earth dams are far from the well field area. The calibrated model was used to predict the aquifer future subjected to different scenarios, four scenarios were tested to verify the model ability to be a prediction tool. These scenarios showed that continuing with the current abstraction rate which is 57 MCM/yr until year 2025 will lead to an increase of the drawdown of about 14 m. Reducing abstraction rate by 50% of the current rate will reduce the drawdown by about 7 m, where assuming an abstraction rate of 85.5 MCM/yr have produced an increase of drawdown equals to 11 m in the year 2025. Soil Water Atmosphere Plant model (SWAP) was utilized to estimate groundwater recharge from precipitation in the well field area using generated data depending on the soil properties, the results showed that groundwater recharge ranged from 5 % to 8% from the annual average rainfall.