A Survey on the Impact of Groundwater Drought in Dehgolan Basin, Kurdistan Province

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Extended Abstract

Introduction
Drought is a natural disastrous phenomenon that occurs due to the continuous reduction of rainfall over a short or a long period of time. A deficit in precipitation (meteorological drought) can result in a recharge deficit, which in turn causes lowered groundwater heads and a deficit in groundwater discharge (Peters et al., 2003: 3023). Given the importance of water in human life, regulating the access to reliable and sustainable water resources and planning for proper consumption are considered essential in any region. There are two types of limitations resulting from natural phenomena or improper managements by human. An increase in population in the plain of Dehgolan, the agricultural nature of the region and urban / rural development has led to the reduction of the groundwater. This phenomenon is evident when the above mentioned factors emerge. The purpose of this study is to survey the ground water responses to drought in different periods of time according to characteristics of severity and duration.

Methodology
The applied dataset is divided into two groups:

1- Precipitation, evaporation and runoff were recorded in stations located at the Dehgolan basin or adjacent points. This dataset was obtained from the Meteorological Organization and the regional water supply company of Kurdistan province during the water year period from 1986-87 to 2002-2003.

2- Ground water level (from mean sea level) from 51 wells located within the Dehgolan plain over 1987-88 to 2003-2004 were obtained from regional water supply company of Kurdistan province.

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In order to evaluate the effect of droughts on ground water resources in the Dehgolan basin, drought occurrence was calculated using SPI index. It's easy application for different time scales, different purposes, and different climates are due to its normal properties (Hayes, 2003: 2). It can be calculated using the following equation:

1) \[ SPI = \frac{p_i - \bar{p}}{s} \]

where SPI is the Standardized Precipitation Index, \( p_i \) is the monthly rainfall value, \( \bar{p} \) is the average of rainfall for the selected 16 year, and \( s \) is the standard deviation of precipitation. The correlation coefficient between each climatic variable (including the SPI index, temperature and evaporation), runoff (as independent variables) and groundwater level (as a dependent variable) were calculated at 95% confidence interval. After identifying the drought periods and calculating the severity and duration (drought magnitude), the rate of groundwater level reduction was classified in Arc map using spatial analysis tools and Kriging interpolation method.

**Results and Discussion**

The correlation coefficient results indicate that there is no significant coefficient in SPI index, temperature and evaporation related to the ground water level while changes in groundwater levels depend on surface runoff at the basin outlet. An increase in correlation between runoff and ground water level is due to the snowmelt runoff that takes place in late winter and early spring. The groundwater level is affected significantly in this time of the year. A review on the drought severity and its duration show a direct relationship between drought and the above mentioned features. The results of ground water changes on the severity and the duration of droughts in Dehgolan basin indicate that in comparison with the less severe short-term drought, the severe long-term drought has got a higher effect upon lowering the level of ground waters.

The zoning classification of the drought and groundwater level using spatial analysis in GIS environment shows that two major factors are involved in changes in the level of groundwater plain: First, as mentioned, in the case of severe long-term droughts, the reduction amount of groundwater levels are more and second the fact that the surface drainage density is an important factor in the recharging process of ground waters.

**Conclusion**

Changes in surface runoff rate throughout the year and especially during droughts has important role in discharge of groundwater. During the short-term droughts, those zones with high elevation in Southern parts of the Dehgolan plain faced a decrease in groundwater more than other parts of the plain due to higher transmission ratio. While in continuous and prolonged droughts, middle parts of the plain faced more level drop. Drainage density as the most important determinant factor in each groundwater basins has a dominant role in determining the decreasing rate of groundwater level in parts of no drainage density. Given the potential of drought occurrence as a regular feature of this region and an increase in water demands for...
agriculture, drinking and industry versus the continues reduction of groundwater level in Dehgolan plain, critical condition in the status of water resources will be expected in this region.

*Keywords: Drought, Groundwater, Dehgolan Basin, SPI.*