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Spatial Monitoring of Groundwater Salinity in Drought and Wet Periods Case Study: Tabriz Plain

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Introduction

Groundwater, which forms part of hydrologic cycle is a reliable source for supplying the water required by human being. The occurrence of droughts and heavy precipitations are the most important climatic extremes having both short and long-term impacts on the ground- water availability. The results of climatic extremes propagate through the hydrological system, including surface water and groundwater (unsaturated zone and saturated groundwater). These impacts include changes in groundwater recharge resulting from the erratic behavior of the annual and seasonal distribution of precipitation and temperature; changes in evapotranspiration resulting from changes in vegetation. Drought is a recurring, natural phenomenon, which affects every part of the hydrological cycle. Droughts are mostly caused by periods of lower than average precipitation and propagate through the hydrological system. Fall of water table and decrease of groundwater chemical quality cause secondary soil salinity, surface water salinity and reduction of soil fertility in arid and semi-arid regions. These phenomena, which salted soil and water resources, are effective factors of desertification in the world. Thus, spatial monitoring of groundwater chemical quality at the time of climatic extremes is necessary for stable management and planning water and soil resources in the area of exposed to salinity hazard. Continued and intense droughts occurred in Iran and Tabriz plain in past years (1998-2008). The impacts of droughts make dry surface water resources and bring down water table strongly. In Tabriz plain, Farmers used surface waters of Aji-chai, Komor-chai and snikh-chai rivers. Also, they used groundwater of plain. In drought periods, that precipitation declines and groundwater level falls, high exploitation of groundwater resources change chemical quality waters. Low quality waters aren't suitable for agriculture. Also, salt waters cause secondary soil salinity in plain. Therefore, the aims of this research are determination of drought and wet periods in Tabriz plain by SPI index and spatial monitoring of chemical quality groundwater in the study years in Tabriz plain. Tabriz plain is located at the east of Urmia lake. Its west limit is salty swamps of Urmia lake margins. Moro Mountain is located in the north of Tabriz plain and Sahand Mountain is the south limit of Tabriz plain. The Onebne-ali elevations are forming the east limit of Tabriz plain. Aji-chai River is

flowing in Tabriz plain toward Urmia Lake. Other rivers such as Saeedabad-chai, Mehranrud-chai and Gomanab-chai are joining to Aji-chai River. There are two types of aquifers in Tabriz plain (Confined aquifer and unconfined aquifer). Unconfined aquifer located in east, northeast and southeast of the study plain. There are confined aquifer and unconfined aquifer in parts of west. Unconfined aquifer into plio-pleistocene tuffs has high quality waters and located in North Slope of Sahand Mountain. The plio-pleistocene tuff is composed of red and green andesitic tuff admixed with large quantities of blocks, gravel and sand of volcanic and alluvial origin. Also, unconfined aquifer into alluvial tuff is the most important aquifer in the area has been known for many years as a good aquifer.

Methodology

In this research, for defining the study region, topographical maps (1: 50000), geological maps (1:100000) and IRS satellite images were used. For calculating drought periods, monthly precipitation of selected stations in Tabriz plain in the study periods (1972-2008) were used .For studying the chemical quality of ground waters, the chemical analysis results of groundwater samples of 40 deep and semi-deep wells were used. Quality indexes include Electrical Conductivity (EC), Sodium Absorption Ratio (SAR) and Total Dissolved Solid (TDS). The electrical conductivity of water estimates the total amount of solids dissolved in water -TDS, which stands for Total Dissolved Solids. TDS is measured in ppm (parts per million) or in mg/l. Quality indexes maps (EC, SAR) draw by Arc/GIS , for studying spatial variation groundwater chemical quality. Then, drought and wet periods selected by Standard Precipitation Index (SPI). The Standardized Precipitation Index (SPI) is a way of measuring drought. The Standardized Precipitation Index (SPI) is a probability index that considers only precipitation. The SPI is an index based on the probability of recording a given amount of precipitation, and the probabilities are standardized so that an index of zero indicates the median precipitation amount (half of the historical precipitation amounts are below the median, and half are above the median). The index is negative for drought, and positive for wet conditions. As the dry or wet conditions become more severe, the index becomes more negative or positive.

Results and Discussion

The results of SPI index show that in the study period of (1972-2007), precipitation positive anomalies is high in slopes of plain margins. Gradually, negative anomalies increase toward center and northwest of plain. Based on Standardized Precipitation Index SPI in the index drought year, the northern and southern mountains plains of Tabriz plain have a normal situation. Ground water's EC show that excellent quality waters are involving % 30.38 and good quality ground waters are including %23.25 plain aquifers in drought period (2000-2001). These ground waters belong to aquifers of Sahand mountain and north elevations of Tabriz plain. Gradually waters quality decrease toward plain center and Urmia Lake. So that 17.8% of the area underground waters have a medium quality. Therefore, the ground waters are unsuitable and very unsuitble in these regions. Salt ground waters involve %13.02 plain aquifers and very salt ground waters contain %15.18. The base of EC rates and drought maps of plain, salty and very salty ground water conform to drought and strongly drought areas. SAR index of Tabriz plain ground water in drought period (2000 October) show the very alkalinity water. These

aquifers located in central and end parts of Tabriz plain. These lands conform to drought and intense drought areas. The rate of SAR ratio reduces toward elevations. Water quality increases toward elevations especially Sahand mountain. Moderate alkalinity waters contain %15.27 of the plain aquifers. Excellent and good waters are %36.9 and %22.48 plain aquifers Spatial distribution of quality indexes differ in wet period (2003 October) from drought period. Fresh ground waters rates are high in wet period. Salt water (% 9.47) and very salty water (%8.86) belong to the northwest plain aquifers. Excellent (%27.5) and good (%23.26) waters belong to Sahand mountain aquifers. Sodium Absorption Ratio (SAR) map show that there are high alkalinity ground water in small area and they located in west of Tabriz plain in wet periods. The base of (SAR) Ratio, moderate water quality includes %16.33 plain ground water.

Conclusion

The study of SPI index in periods (1972-2008) show that drought and wet periods alternately have occurred in Tabriz plain. Also, frequency of short dry periods is high as compared with long dry periods. Generally, precipitation negative anomalies increase toward plain. Chemical analysis results of 40 samples water show that excellent and good groundwater belong to Sahand mountain and north elevations aquifers, but water quality decrease in the course of center of plain and Urmia coasts. These conditions intensify drought periods.

Keywords: Spatial Monitoring, Groundwater Salinity, Drought, SPI, Tabriz Plain

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