



Investigating the Effects of Drought and Land-use Changes on Quantity and Quality of Groundwater Resources: A Case Study of Darab Plain

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Extended Abstract

Introduction: Drought is a natural hazardous phenomenon occurring in all climate types. However, it affects arid and semiarid regions more intensely than other areas. It also severely affects both the quantity and quality of water resources in arid zones. Moreover, land-use changes and urban and agricultural development also adversely influence water resources in these regions, especially groundwater resources.

The extraction of a significant portion of drinking and agricultural water from groundwater resources has led to a sharp decline in groundwater storage in Iran's arid and semiarid regions. Furthermore, as mentioned before, frequent droughts and land-use changes have affected these resources. This study, therefore, sought to investigate the effects of meteorological drought and land-use changes on groundwater quantity and quality in Darab plain, Fars Province, Iran.

Materials and Methods: Darab Plain is located in the south of Iran. The water supply in this plain is highly dependent on groundwater. The mean annual rainfall is 275 mm, and the mean annual temperature is 22 °C. In

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this study, data regarding precipitation, groundwater level, and salinity were used to estimate SPI (Standardize Precipitation Index), GRI (Groundwater Resources Index), and SECI (Standardized Electrical Conductivity Index). SPI is considered as the indicator of meteorological droughts. GRI quantifies changes in groundwater levels as a standardized index. SECI is applied to estimate any potential shifts in groundwater quality. Land-use maps of the basin for 2001, 2009, and 2017 were prepared using satellite imagery. Moreover, Landsat TM, ETM+, and OLI sensors were used. It should also be noted that land-use maps were created using the Supervised Classification method (Maximum likelihood algorithm). The produced maps included five classes: urban area, farmlands, gardens, rangelands, and bare lands.

Results: SPI results showed normal classes for most of the years throughout the study period (-0/99 to +0/99). However, the trend line indicated an apparent decreasing trend for SPI during the period. Therefore, it could be concluded that the region is experiencing more droughts. A study of groundwater level changes suggested a continuous reduction of 36 m for the entire study period. While the comparison of SPI and GRI showed a general decreasing trend for GRI, it could be seen clearly that SPI changes caused GRI shifts. Moreover, droughts accelerate GRI reduction, and SPI growth either reduces GRI decreases or increases it slightly. On the other hand, SECI results indicated the salinity growth and quality reduction in the region. During the study period, the plain experienced a 293.6 $\mu\text{mho/cm}$ increase in salinity. Furthermore, the comparison of GRI and SECI showed that any reduction in groundwater level would result in more saline. The comparison of land-use maps during the three years (2001, 2009, and 2017) also proved that agricultural uses increased by only 0.26% in 2009 compared with 2001. However, in 2017 compared with 2009, such uses decreased by 1.62%. The relationships between SPI and land-use changes with GRI and SECI were also investigated, indicating that droughts and land-use changes directly affect the quantity and quality of groundwater in Darab Plain.

Discussion and Conclusion: Climate change has affected many parts of the world, changing drought characteristics in many regions. Therefore, the subsequent changes in water resources could be considerable. Furthermore, water resources are under pressure for population growth and land-use change. In this study, the collected data was divided into three 8-years periods (1993-2001, 2002-2009, 2010-2017), and the averages of SPI, GRI, SECI, and land-use were calculated for the three periods. The results showed that the increase in the severity of drought and the rise of the agricultural lands in the second period compared to the first one caused a decrease in water quantity (GRI decrease) and quality (SECI increase). However, a decrease in the severity of drought and the fall of the agricultural land-use in the third period compared to the second one lowered the rate of groundwater level decline (compared to the rate of GRI decreasing in the second period). In the third period, SECI increased (less quality) in response to the GRI decrease. The results showed that groundwater resources in Darab Plain were strongly dependent on both drought and land-use changes. The groundwater quality in the region was also directly affected by changes in groundwater level.

Keywords: meteorological drought, Darab Plain, land use, quantity and quality, groundwater resources