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Groundwater draft in Bastam plain, Shahrood

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Abstract

In recent years, due to development in agricultural activities in Iran, a considerable groundwater draft has been occurred in almost all plains this country. The plain of Bastam is one of these plains which its groundwater resources have been markedly diminished in last few years. In order to evaluate the groundwater draft in this plain, groundwater levels for an eight-year period (2000-2007) were collected and the unit hydrograph of the plain prepared. According to the unit hydrograph of the Bastam plain, it is obvious that there is a continuous decline in groundwater level in this plain. Comparing the precipitation of this plain from 2000 to 2007 with its average in a 21-year period reveal that the main reason for groundwater decline in this region is concerned to heavy groundwater discharge.

Keywords: Bastam plain, unit hydrograph, groundwater draft

Introduction

Groundwater is an important water resource particularly in arid and semi-arid region (Karami 2009). In fact, groundwater includes almost all water supplies in most arid and semi-arid region. Groundwater is widely used for domestic, agricultural, and industrial consumptions over the world. For instance, groundwater is the main water resources in Iran (Abbasnia et al. 2019, Ghazi et al. 2021), Japan (Amano et al. 2022), Turkey (Demiroglu e al. 2019), Africa (Sayed et al. 2020), etc.

This Groundwater constitutes a primary source of freshwater for many populations around the globe, especially regions where rainfall is scanty, surface water sources are absent, and all domestic and agricultural needs are fulfilled with groundwater. However, overexploitation of groundwater, inappropriate temporal and spatial distribution of rainfall, and lack of natural nutrition compared to the amount of harvest, the cause of groundwater salinization, and gradually lead to freshwater aquifers' pollution (Bhakar and Singh, 2019; Böhlke and Denver, 1995; Jafari et al., 2018; Michael et al., 2017; Mosaffa et al., 2021; Pacheco Castro et al., 2018; Sherwood and Klein, 1963; Jafari et al., 2018).

The study area is located in the 8 km north of Shahrood, Iran. This plain is one of the most important plains in the Shahrood County from agricultural point of view. The area of this plain is about 200 square km which include almost 400 production wells. In addition, there are 54 springs and 23 qanats in this small plain. The total groundwater discharge in Bastam plain is almost 136 Mm^3 which is yielded by wells, qanats and springs. It should be

mentioned that the majority of coefficients, the value of groundwater

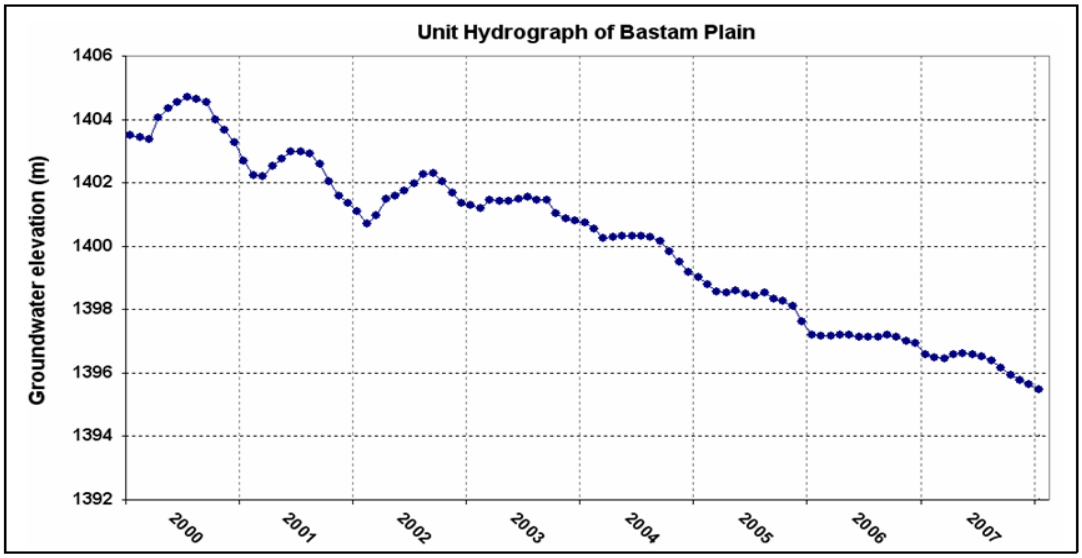

Figure 2 The unit hydrograph of eight - year period in Bastam plain

groundwater discharge is related to wells which includes about 70% of total discharge.

Figure 1 The location of study area in the map of Iran

Methods

In order to assess the groundwater draft in the Bastam plain, the available groundwater levels for an eight-year period was collected and according to Theissen's networking the unit hydrograph for this plain was prepared. Thereafter, using data from prepared unit hydrograph and average storage draft for this plain has been calculated.

The values of groundwater draft can be calculated using the following equation:

$$G_d = \Delta h \times A \times S \quad (1)$$

Where G_d = groundwater draft (Mm^3)
Δh = difference in hydraulic head (m)
A = area of plain (m^2)
S = average storage coefficient of plain (dimensionless)

Results and discussion

Decline in groundwater level in Bastam plain

The unit hydrograph of Bastam plain for an eight-year period has been drawn in Figure 2. As can be seen from the figure, there is a relatively uniform decline in groundwater level particularly after 2003. This plain, alike other plain in arid and semi-arid regions of Iran, has been faced with a heavy pumping from the aquifer.
According to the Figure 2, the groundwater decline between Oct 2000 and Oct 2007 is about 8.00 m. The continuous decline in groundwater level can be related to two parameters,

decrease in annual rainfall and heavy pumping.

Figure (3) illustrates the annual precipitation for 21-year period in Bastam station. It can be seen from the figure (3) that the values of annual precipitations in last seven years (exception for water year 2007-2008) is around the average precipitation (i.e. 160 mm). However, between 2003 and 2007 the groundwater level with a decreased. precipitation, it may be relatively uniform slope has been argued that the decline in groundwater level is not related to changes in values of precipitation. Therefore, the decline in groundwater level in the Bastam plain, alike other plains in Iran, is presumably related to heavy pumping.

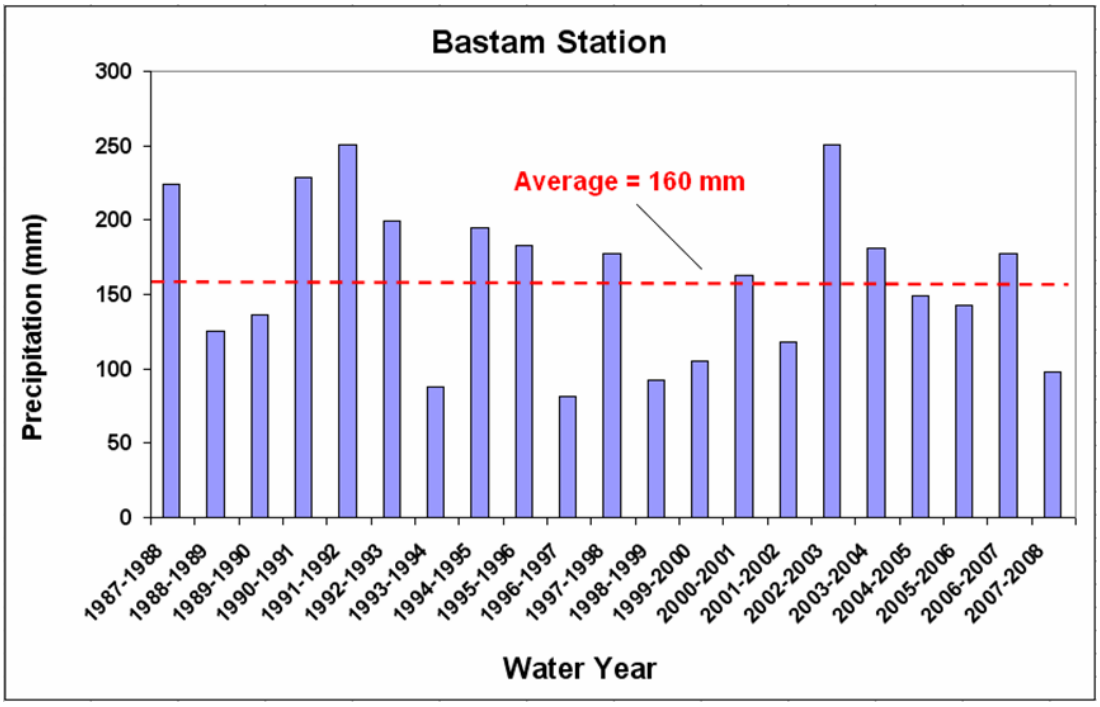

Figure 3 Annual precipitation for 21-year period in Bastam station

The hydraulic gradient in Bastam plain

Figure (4) gives the equipotential map of Bastam plain. As can be seen from this figure, the values of hydraulic gradients in Bastam plain may be divided into three groups. The highest hydraulic gradient is related to the western part of Bastam where the main recharge to the aquifer is occurred by very coarse-grained alluvial deposits of Shahrood River. In this zone the average value of hydraulic gradient is about 7%. The lowest values of hydraulic gradient in Bastam plain fall around Bastam town where the aquifer has been faced with a heavy pumping. According to comparing the groundwater level and the annual precipitation, it may be relatively uniform slope has been argued that the decline in groundwater level is not related to changes in values of precipitation. Therefore, the decline in groundwater level in the Bastam plain, alike other plains in Iran, is presumably related to heavy pumping.

In this area, the average value of hydraulic gradient ranges from 0.4% to 0.8%. In the rest part of plain, the values of aquifer hydraulic gradient range between 0.8% and 1.5%.

Assessing the groundwater draft in Bastam plain

As pointed out in earlier, the groundwater decline in plain of Bastam between Oct 2000 and Oct 2008 is about 8.00 m. It means that the groundwater level decline in this plain is about one meter per year. Having the area of the Bastam plain (i.e. 201.9

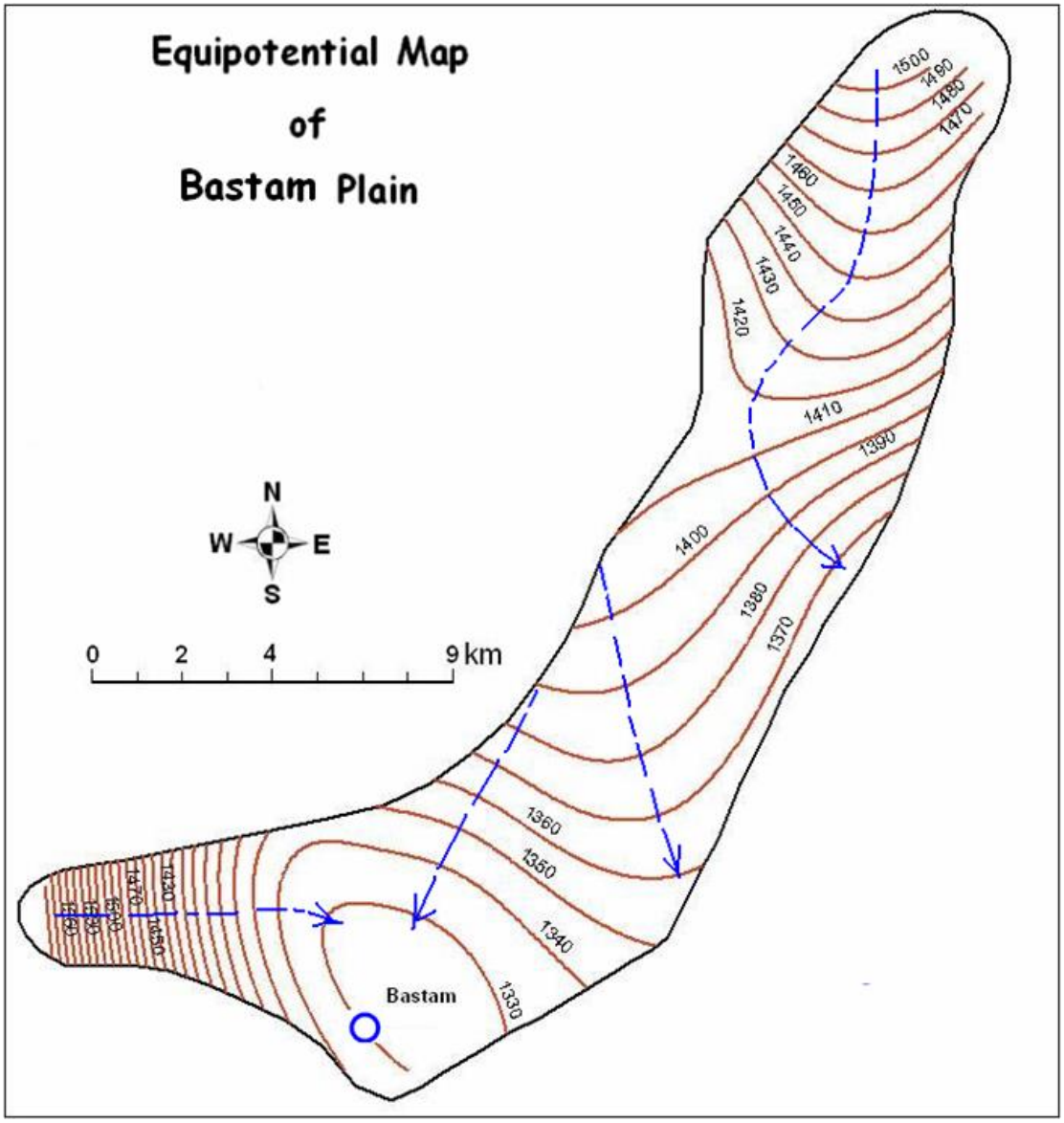

Figure 4 Equipotential map of Bastam plain

square km) and its average storage coefficient (i.e. 0.04), the value of groundwater draft in Bastam plain is calculated using equation (1) which equals to 8.075 Mm^3 per year

Conclusion

In order to evaluate the groundwater draft in plain of Bastam, the values of groundwater levels for an eight-year period were taken and the unit hydrograph prepared for this plain. According to the prepared unit hydrograph, it is evident that there is a continuous decline in groundwater level in this plain. According to the decline in groundwater levels and insignificant changes in annual precipitation in Bastam plain between 2003 and 2007, it may be concluded that the decline in groundwater level is presumably related to heavy pumping from the aquifer. Using prepared unit hydrograph, the magnitude of groundwater draft were calculated for this plain. According to the obtained results, the value of groundwater draft in plain of Bastam is about 8.075 Mm^3 per year. To prevent such a high groundwater draft, it may be suggested that the government take possession of

a large number of pumping wells and stop their pumping.

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