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Investigation of Water Balance and Map Crisis Preparation in the Recent Two Decades of Kalacho Plain, Dehdasht, Iran

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Abstract: Considering the water restrictions, it is important to check the water balance in each area. These restrictions are even more important in arid and semi-arid regions. The purpose of this study was to study the water balance in the Kalacho plain of Kohgiluyeh city. Kalacho plain is about 15 km east of Dehdasht city. In recent years, due to the excessive extraction of lowland wells, the quality of groundwater has also declined steadily. Therefore, hydrogeological assessment and aquifer management seems necessary. Groundwater management requires understanding and functioning of the aquifer under natural conditions (firstly) and then predicting the effects of harvesting or feeding. Undoubtedly, understanding the actual behaviors of a natural system requires some research for each particular area. The average annual temperature and precipitation in the meteorological stations is about 18.1 °C and 394 mm, respectively. The water crisis map of this plain has been prepared based on the data of 45 km^2 area during the 1991-1992 blue water year. Groundwater Balance Range of the Kalacho Plain is selected based on available statistics and distribution of piezometers, wells and agricultural areas. According to the long-term hydrograph, the plain faces an average loss of 0.15 m and a reservoir deficit of 2.5 million m^3. Also during the 20-year period, a total of 24 m of drop and 68 million cubic meters of reservoir deficits were created in the plain. By calculating the effective parameters in the general water balance equation (inputs and outputs), the plain was finally divided into five critical areas. Zones 1, 2 and 3 are the most critical lowland areas in the vicinity of the hydraulic connection with the Gachsaran Fm., and areas 4 and 5 are less critical because of the adjacent Asmari Formation, which feed on this karstic aquifer. Overall, this negative balance indicates an increasing drop in groundwater level and its reservoir deficit.

Key words: Water balance, crisis map, Kalacho Plain.

1. Introduction

Iran is one of the world's driest regions with average rainfall of about 252 mm per year; 65% of our country is arid and semi-arid regions with an average rainfall of less than 150 mm/year [1]. Research on stochastic analysis of subsurface flow has developed rapidly in the last decade, but applications of this approach have been very limited [2]. Although enough water is available for at least three times the Earth's population, the imbalance between population distribution and rainfall has caused water shortages in some areas [3]. Today, 26 countries are considered to be low water countries, most of which have high population growth rates. Of these 26 countries, nine are in the Middle East with water shortages. Africa has the highest number of low water countries (11 countries). In 2000, the number of Africans living in low-water countries was over 300 million [4]. Dry climates cover about one-third of the Earth's surface and 15% of the Earth's population. Three quarters of the arid regions are scattered across the continents of Asia, Africa, and Australia. Plants of semi-arid, arid and very arid regions account for 5%, 23% and 4% of the land area respectively [5]. Nowadays, the world is facing many problems in providing water. The environment and ecosystems based on freshwater resources have faced many crises and challenges with

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the occurrence of numerous droughts and the irregular harvesting of water resources [6]. At any given time, half of the world's hospital beds are occupied by patients suffering from diseases associated with lack of access to clean water [7]. Millions of women and children spend several hours each day collecting water from distant and polluted sources. The time it takes to walk the average 3.7 miles for clean water is time not spent working at an income-generating job, caring for family members, or attending school [8]. The Facts over 1 billion people outside the United States do not have access to clean, safe drinking water; 3.4 million people die each year from scarce and contaminated water sources [9]. The study of hydrology and balance of surface and groundwater constitutes one of the most important basics in water resource related plans and projects. Due to the semi-arid climatic conditions, optimum use of water resources is of great importance in Iran. The most important use of water balance results is to determine the proper amount of water harvesting, proper consumption, and to prevent damage from overcrowding or lack of nutrition [10]. Demand management includes the reduction of water consumption in irrigation, institutional change and organizational reform, and the participation of farmers in water resources management [11] in arid and low-water countries, maintaining water systems sustainability requires more rigorous principles and planning. Drought and dehydration have a significant impact on dryland agriculture [12]. The main purpose of the study is to study the water balance in the Kalacho plain, and to identify the factors affecting it, all of which are practical goals for planning the management of existing water resources in the region. Given the recent droughts and the high importance of the range of studies, perhaps the most important plain in Kohgiluyeh and Boyer Ahmad province, providing water to the region's farmers, villages and towns, and increasing demand for water, drinking and agricultural water and reports on the drop in the aquifer should be studied and optimized to optimize the use of water resources. There have been many articles and studies at home and abroad, and many articles have been submitted, but due to different climatic conditions and geological conditions, the balance of each plain should be based on regional factors, with relevant reports including evaporation, precipitation, Dubai, etc.

2. Location of the Study Area

Kalacho plain is one of the important plains of Kohgiluyeh and Boyerahmad province. The plain with an area of about 490 km^2 along the northwest-southeast between 30°50′ to 30°54′ north latitude and 50°35′ to 50°40′ east longitude southwest of Kohgiluyeh and Boyer Ahmad province. Fig. 1 shows the location of the study area. Kalacho plain from north and northwest and northeast to Cia Mountains and Tang Higun and from south and southwest to gypsum hill overlooking Dehdasht-Tang road. Pirzal and Dastani and Dastgerd village go east to Zarghamabad village and Koshak village in the sun. The surface area of the basin of this plain is estimated to be over 1,100 km^2.

In order to calculate and evaluate the hydrological parameters affecting the groundwater balance of the studied plain and the effect of hydrological factors in the model of groundwater flow simulation in this plain, Dehdasht Hydrometric Station data were used.

2.1 Geology of the Study Area

Kohgiluyeh and Boyer-Ahmad Province is geologically located in the Zagros-folded high Zagros region. The high Zagros zone is bounded on the northeast by the Sanandaj-Sirjan zone and on the southwest by the folded Zagros zone. Alpine orogenic performance has led to the formation of numerous thrust faults in the region. As a result of these faults, high altitudes and wall cliffs have been created in the area. The performance of these faults has caused the formation of the northeast part of the study area to be older than the southern part. Geological surveys in this area include 1:250,000 Dehdasht geological map and

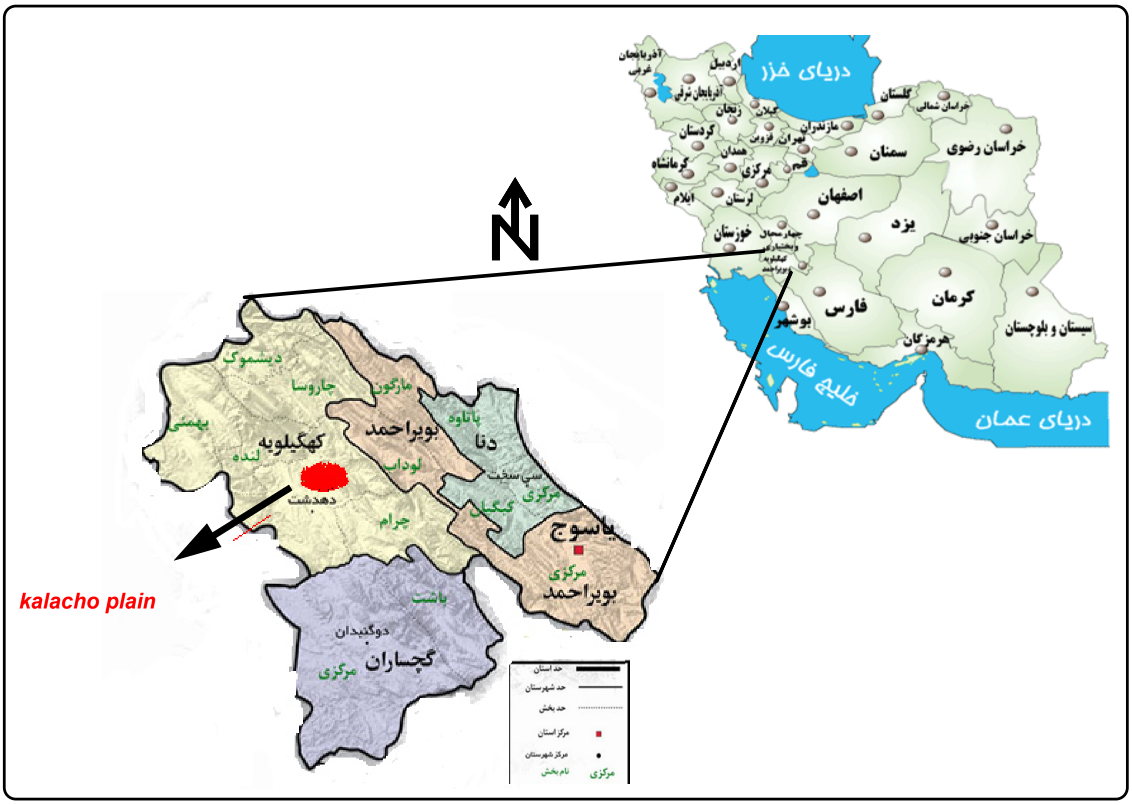

Fig. 1 Location of the study area.

1:50,000 topographic map of the study area. Fig. 2 shows the geological map of the area and the access routes to the study area.

3. Operational Wells in the Study Area

The census of the Kalacho Plain wells was done in 2013. Based on the existing reports and wells records, 264 wells in the study area have been drilled and the water pumped from these wells is used for irrigation purposes. In order to study the characteristics of the exploitation wells in the study area, the statistics and information received from the Kohgiluyeh and Boyer Ahmad Provincial Water Administration were used. Also according to records of exploitation wells in 2013 most of the wells have been drilled in the study area. Fig. 3 shows the number and distribution of wells in the Kalacho field.

In terms of depth, the wells in the area have depths of less than 10 to 90 m. In this area, well No. 160 with depth of about 90 m is the deepest well and No. 200 with depth of 8 m is considered as the lowest well in the area. Fig. 4 shows the depth points of the plain. Most of the depths are to the north and northwest of the plain and to the center and outflow to the groundwater depth. In general, it is useful to investigate the status of groundwater depth in evaporation issues. Since the lowest depth of groundwater in this plain is about 7 m, therefore, it can be concluded that there is no evaporation of groundwater in this plain.

3.1 Discharge

Based on the measurements, the instantaneous discharge of the wells varies from less than 5 to 20 L/s. The minimum discharge of the wells was measured at about 0.01 L/s for well No. 158 and the maximum discharge for well No. 139 was measured with an instantaneous discharge of 20 L/s. Based on this information, the total water abstraction from the wells in the study area is calculated to be 121 million cubic meters (Fig. 5).

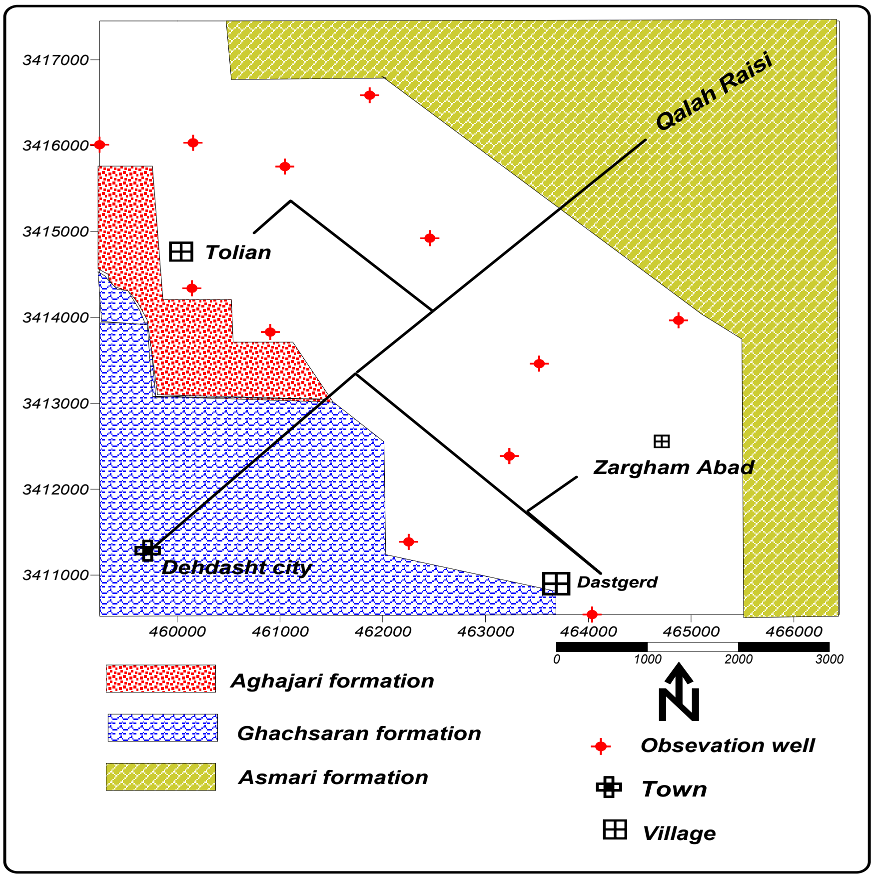

Fig. 2 Geological map of the study area and access routes to the area.

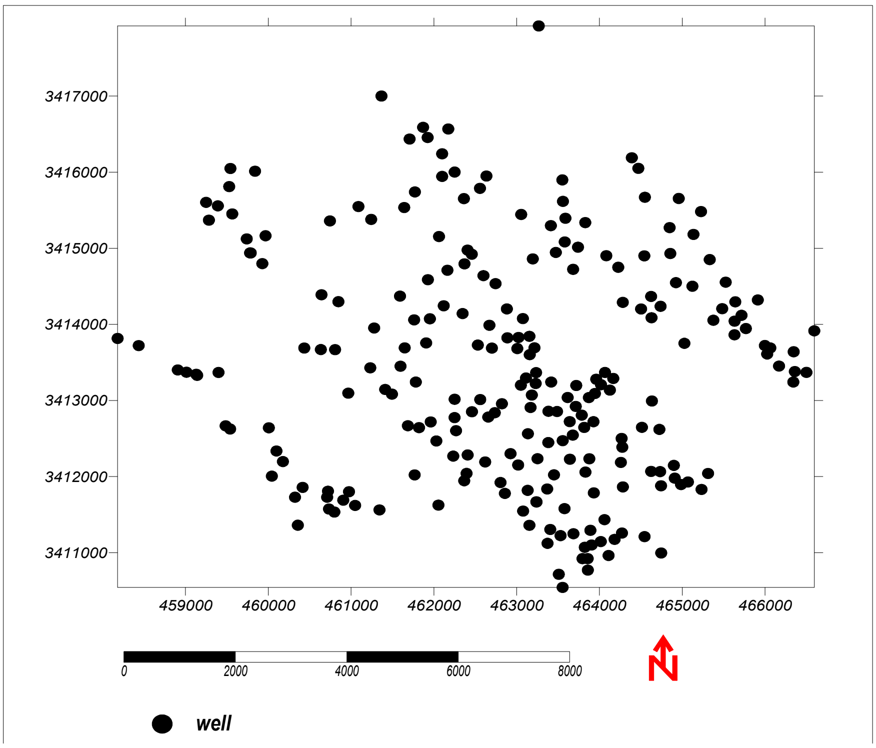

Fig. 3 Distribution and number of wells used in the Kalacho field in 2008.

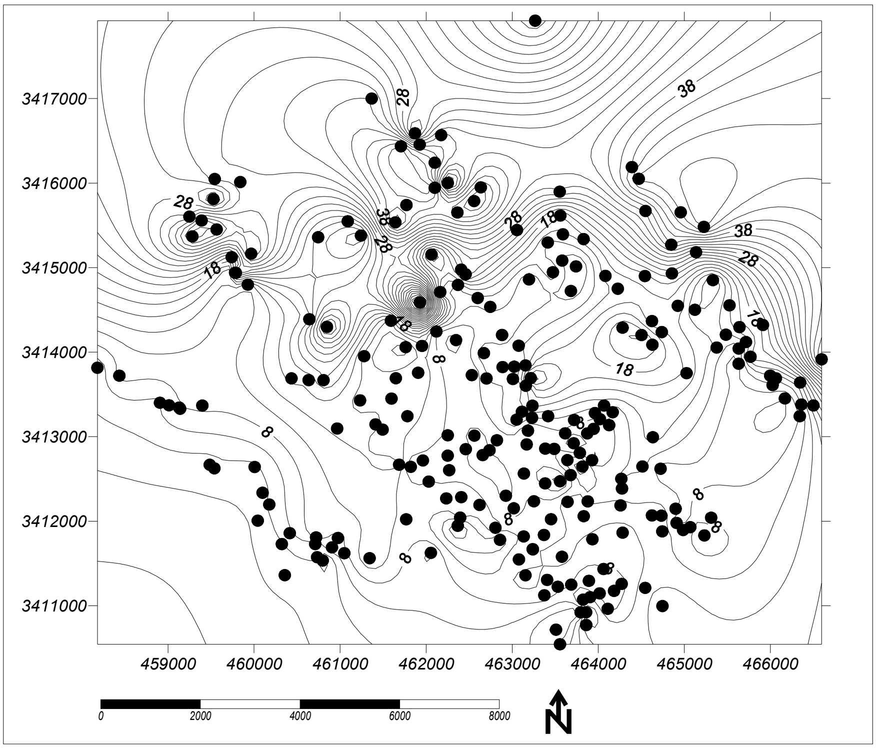

Fig. 4 Map of groundwater depths of the Kalacho plain.

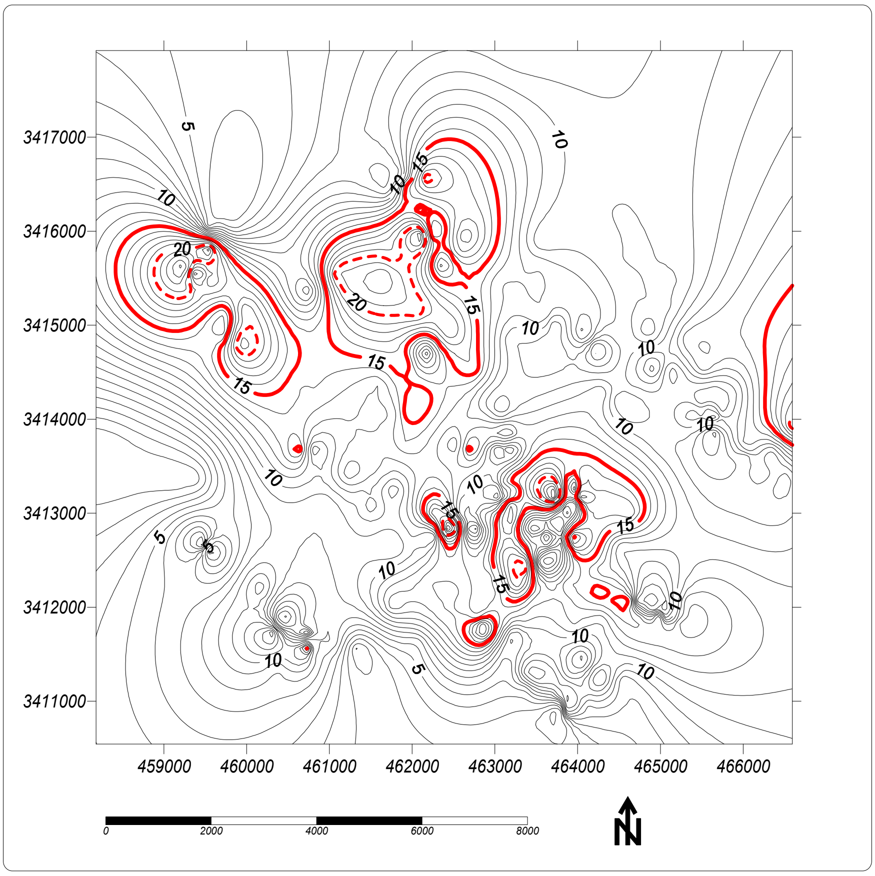

Fig. 5 Map of the discharge points of the Kalacho Plain.

3.2 Type of Use (Number)

Based on available statistics, 250 wells are used for irrigation purposes, accounting for more than 94.69% of the wells and 14 (5.31%) wells for various industrial uses, especially for small industrial units such as dairy, livestock and poultry are being used. Fig. 6 shows type of groundwater use in the plain; this figure showed that over ninety percent of the groundwater of the Klachu plain is used for agriculture.

3.3 Type of Use (Discharge)

According to the existing wells records and measuring the instantaneous discharge of some selected wells in the plain under study, approximately 97.38 million cubic meters is used for irrigation and agricultural purposes, 6.88 million cubic meters for various industrial uses and 8.02 million cubic meters used for drinking and health purposes.

4. Fountains and Marshes in the Study Area

Based on the available statistics, there are 2 aqueducts in the study area. According to previous statistics and field visits during the different months of the year, the aqueducts in the study area are subject to regional climate conditions, especially rainfall in the area and water level fluctuations. Based on available statistics it can be noted that due to the decrease in rainfall over the past few years, the discharge of the marshes has been drastically reduced and now the two aqueducts (Hossein Khan and Hassan Khan) are dry. There is no study area.

4.1 Survey of Water Level Fluctuations

Measured water level data from observation wells were used to study water level fluctuations for different periods and to investigate the effects of aquifer stresses. Basically, changes in water level depend on different conditions, including geological conditions, as well as on the proximity of the sources of feed and discharge.

5. The Direction of Groundwater Flow

Fig. 8 shows the groundwater level map of the Clachu aquifer for November 2002. The choice of November was because the first month was a simulation of the aquifer behavior (steady state) in this study and the beginning of the water year in the plain. In general,

Fig. 6 Type of groundwater use in the plain.

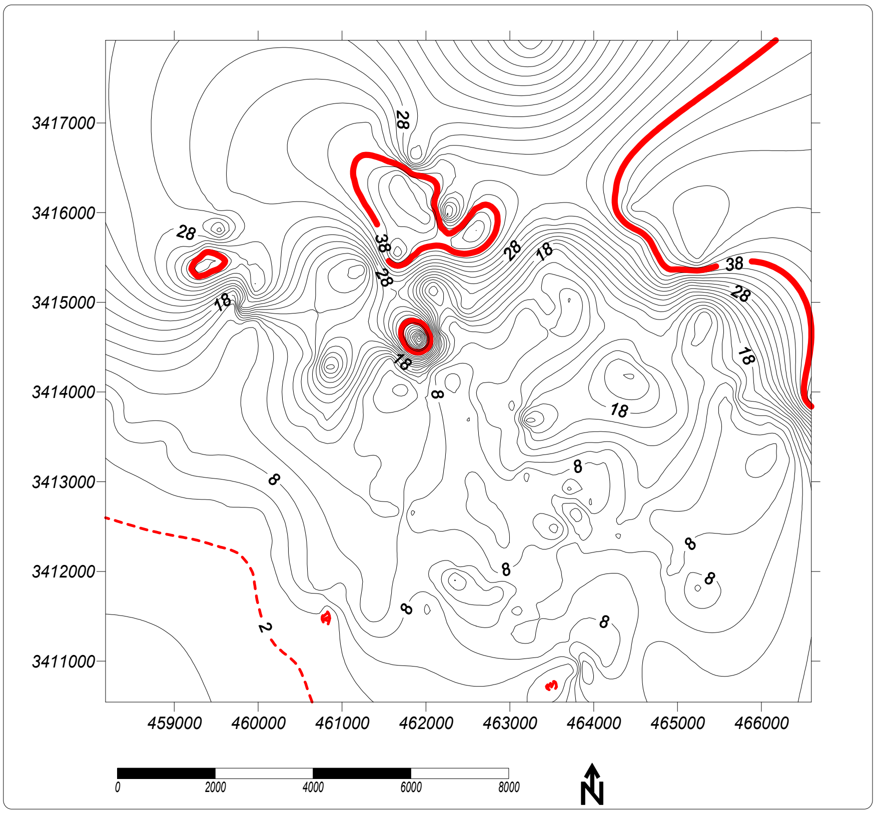

Fig. 7 Map of groundwater level fluctuations in the Kalacho plain.

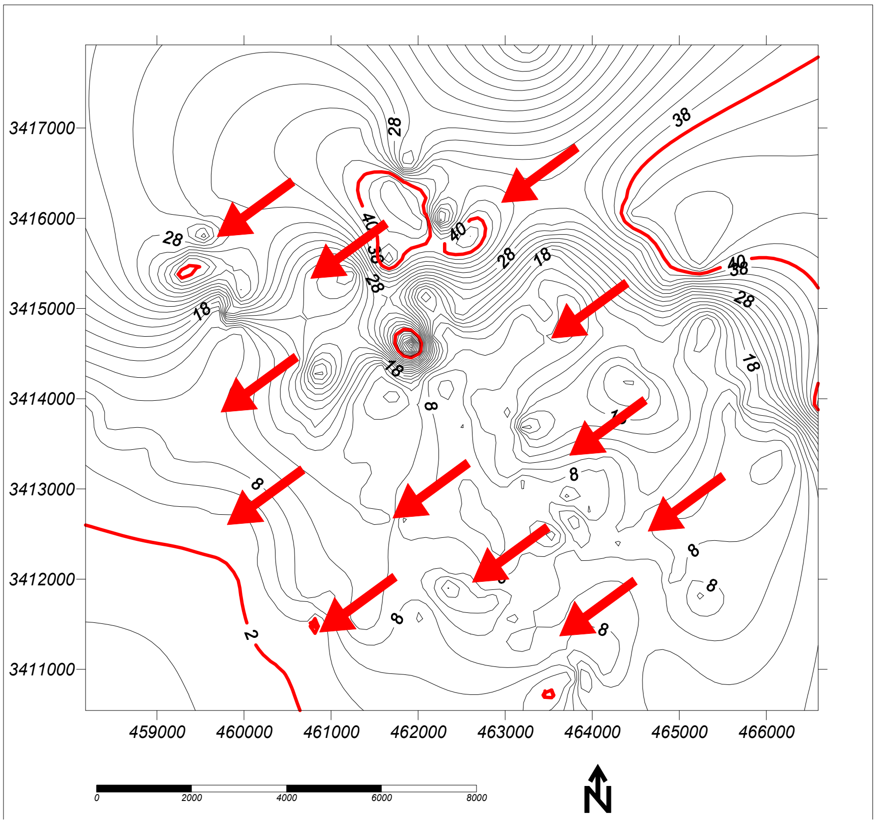

Fig. 8 Groundwater level map of the Kalacho Plain aquifer.

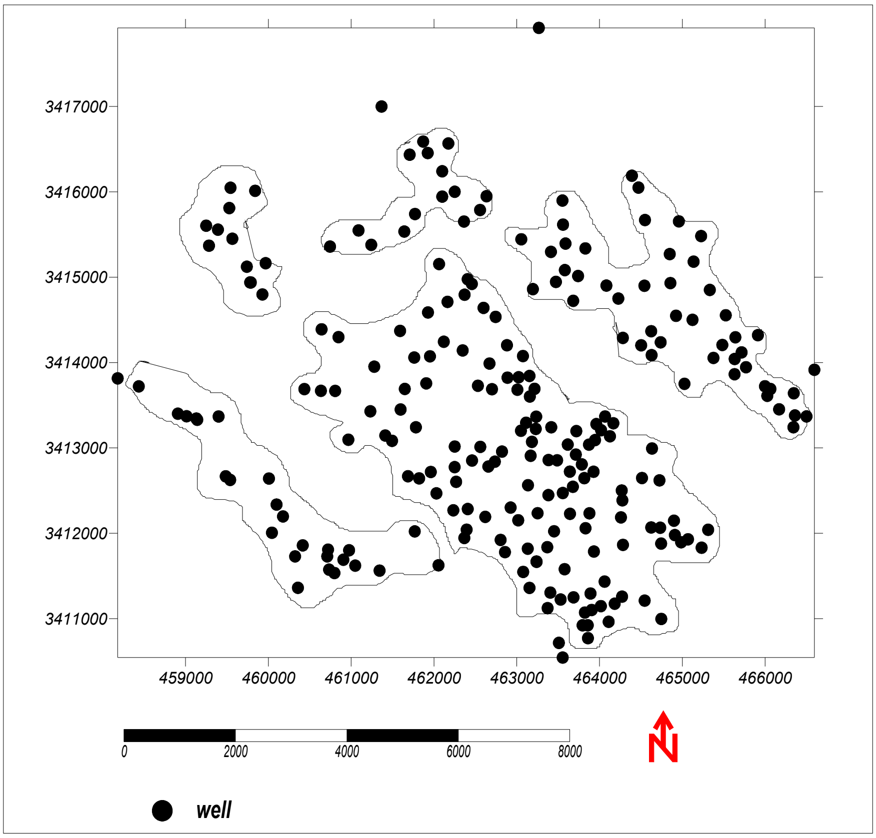

Fig. 9 Groundwater temperature map of the Kalacho plain.

the groundwater flow and slope in the Clachu plain follows the topographic slope and flows northwest and west to the center and southeast of the plain. Fig. 9 shows classification of exploitation wells in Klacho plain. The 858 m curve is located in the northwestern plain of the plain and represents the highest groundwater level of the aquifer. Groundwater flow direction is from north and northwest to south and south east and outlet of plain. The hydraulic gradient also reaches a maximum of about 4 per thousand in the north and east of the plain, which is the groundwater inlet and aquifer feeding site. Gradually, toward the center and outlet of the plain in the south-south-east, its intensity decreases to about 3 in a thousand. The average groundwater slope in this plain is estimated at about 3.5 per thousand. The average groundwater slope in this plain is estimated at about 3.5 per thousand. Fig. 10 shows satellite map of Kalacho spring and summer zones. Fig. 11 shows the map of critical areas of the Kalacho Plain that overly on map of Classification of exploitation wells in Klacho plain

6. Critical Map of the Kalacho Plain and Its Adaptation to Satellite Imagery

The most important hard formation is the Asmari Formation. The karstic aquifer is important because of its crushing and seam breakage. The presence of karstic geomorphological phenomena is evidence of the karstic maturity of this formation. The karstic without the formation causes the downpours to penetrate into the formation rather than creating surface runoff through the crevices and crevasses and eventually enters the aquifer with appropriate hydraulic gradient and feeds the aquifer. The springs and lithology of this formation can be inferred that the karstic aquifers of the Asmari Formation are in a qualitative and quantitative condition in the area.

This formation due to its lithology is not suitable for hydrological and hydrological conditions. By penetrating surface or groundwater into the gypsum,

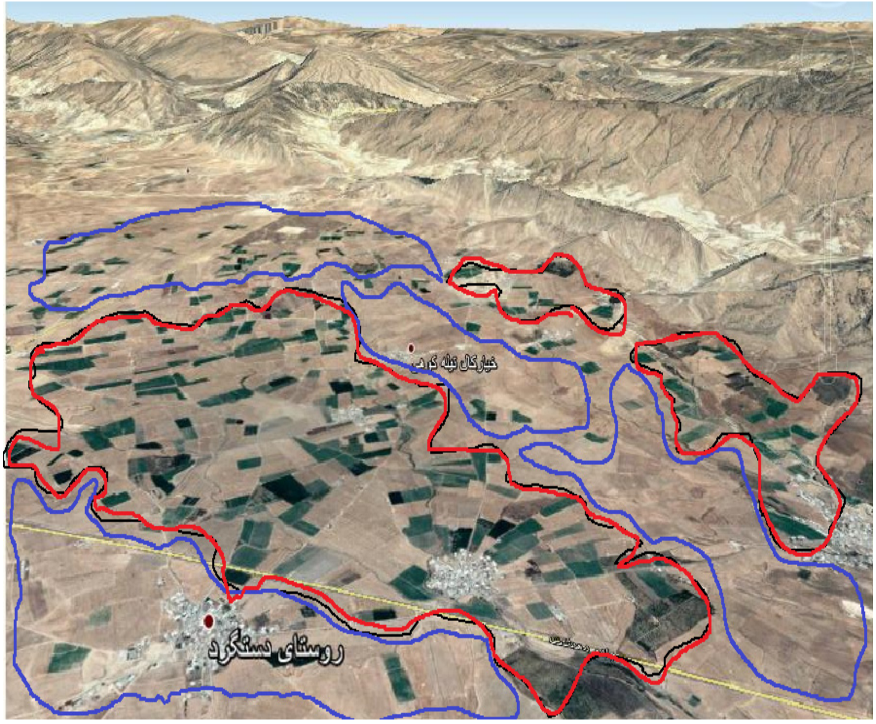

Fig. 10 Satellite map of Kalacho spring and summer zones.

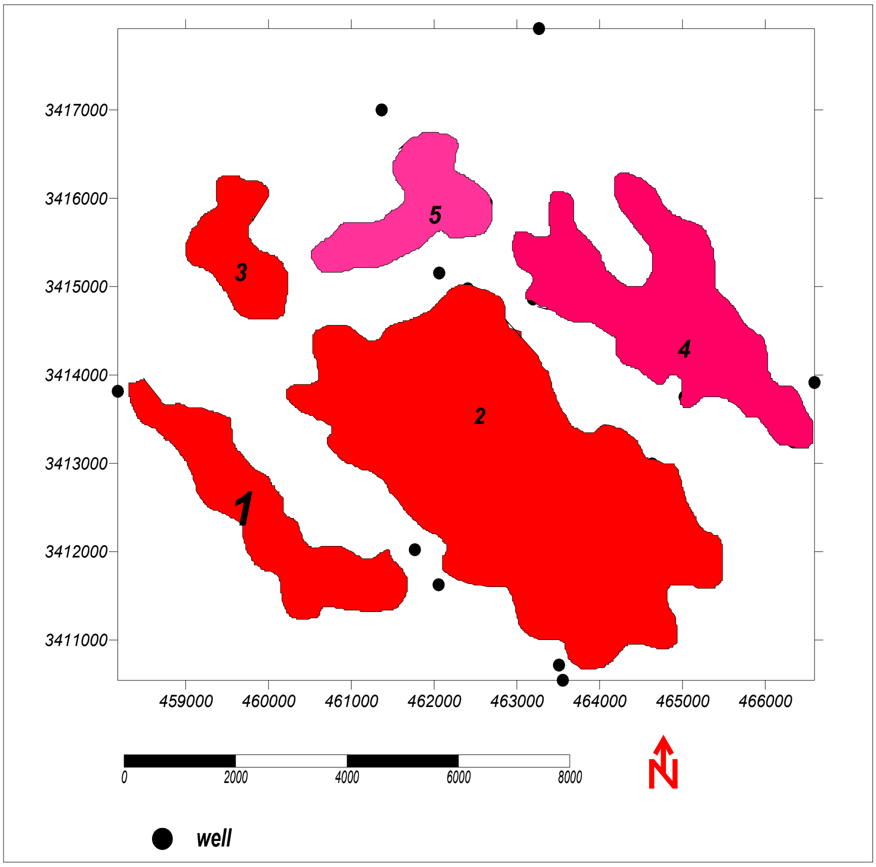

Fig. 11 Map of critical areas of the Kalacho Plain.

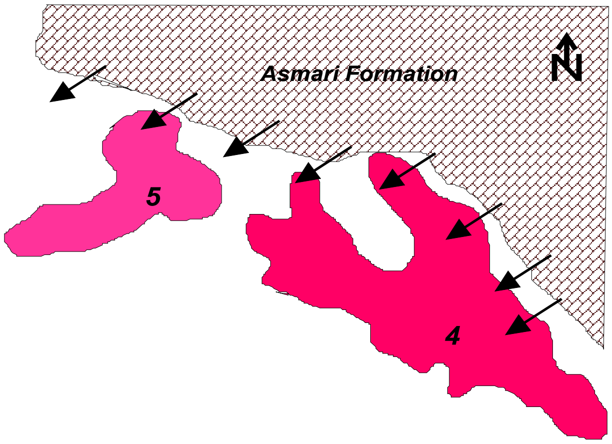

Fig. 12 Hydraulic relationships between the Asmari Formation and critical zones 4 and 5.

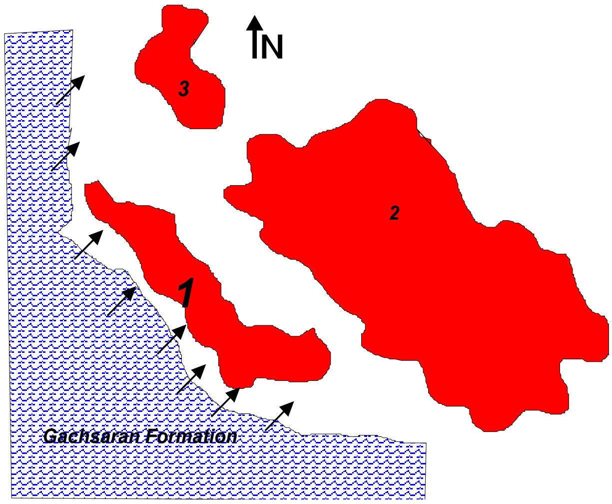

Fig. 13 Hydraulic relationship between zones 1, 2 and 3 and the Gachsaran Formation.

Fig. 12 shows hydraulic relationships between the Asmari Formation and critical zones 4 and 5. And also Fig. 13 shows hydraulic relationship between zones 1, 2 and 3 and the Gachsaran Formation. Layers and dissolving them, gypsum karstic aquifers have been created in the area that are discharged by multiple discharge springs with little discharge. Gypsum dissolves in the process. On the one hand, karstification leads to the sulfation of water and, on the other hand, increases the hardness of water. Hydrologically runoff flowing at the surface of the Gachsaran Formation has suspended charge, high concentrations of sulfate, chloride, calcium and sodium. In terms of water quality, all springs of the Gachsaran Formation are sulfate-calcic.

7. Conclusion

As our statistics show, our country is a dry and low water country. Proper management of water resources in our country requires a major change. If the current trend continues, then we will be vulnerable to events such as the drought of recent years and we will lose our rhyme. Nowadays, special attention is paid to environmental, economic, social and other aspects of water resources management especially in agriculture. Integrated and systematic management to ensure the sustainability of these resources has gained a prominent place in the planning of countries' heads. The climate of the region is semi-arid based on the Domartan method and the semi-arid climate based on the Umberg method. In terms of drinking, the northeast and southeast waters of the plain are in very good and good range, and the southwestern and northwestern waters and western margins of the plain are inappropriate due to contact with the Gachsaran Formation. The free aquifer floor, Aghajari Formation and dense clay transition from the Pabdeh and Gurpi Tang Hygon Formation and in parts of the plain, are asymmetric limestones of Asmari and Bakhtiari Ganglomera. The maximum alluvial thickness is in the center of the Kalacho Plain and about 110 m. The alluvial aquifer is located in the Kalacho Plain with an area of about 45 square kilometers.

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