Shahid Beheshti University

Sustainable Earth Review

Journal homepage: http://sustainearth.sbu.ac.ir

The effect of geological formations on the quality and quantity of groundwater (case study: Imamzadeh Jafar Gachsaran plain)

Mohammadtaghi Avand[a*], Mohammadreza Ekhtesasi[b]

[a] Department of Rangeland and Watershed Management, Faculty of Natural Resources and Marine Sciences, Tarbiat Modares University, Tehran, Iran
[b] Department of Rangeland and Watershed Management, Faculty of Natural Resources, Yazd University, Yazd, Iran

ABSTRACT

Groundwater has a fundamental role and is a key factor in economic development and environmental protection in our country. In recent years, due to drought-induced rainfall, the extraction of groundwater has increased at a widespread level that could have environmental and geological hazards. Imamzadeh Jafar plain with an area of more than 60 km^2 located in the northeast of Gachsaran city has a very good and prone position for agriculture. Abundant use and abandonment of the aquifer by more than 40 wells has led to the criticality of water resources and the loss of static levels, especially during the droughts in this plain. Boolean logic has been used to investigate the impact of watershed geological formations on the quantity and quality of wells. In this study, in order to investigate the spatial relationship between these wells and existing geological formations in the studied watershed, 4 buffers with distances of 1, 3, 5 and 10 km were created around each well. The results of these buffers showed that at 1, 3, and 5 km distances, Quaternary formations (Qft) with an area of 80.82, 47.13, and 35.19 percent had the greatest impact on the water quality of the wells, respectively, while at a distance of 10 km. The impact of the Fars Group formations, especially the Gachsaran Formation (Mgs), had the greatest impact on the water quality with an area of 26.92%.

ARTICLE INFO

Keywords:
Imamzadeh Jafar plain
Geology formations
Groundwater
Quantity and quality

Article history:
Received: 02 Sep 2020
Accepted: 12 Oct 2020

*corresponding author
E-mail address:
Mt.avand70@gmail.com
(M. Avand)

1. Introduction

In hot and dry areas, in addition to water scarcity, there is a risk of water degradation. Water quality degradation is caused by a number of factors that are mainly affected by destructive geological formations or the influx of salt water due to the excessive removal of underground resources. The geological formations are the main source of salt in surface and groundwaters, which make up the greatest amount of degradation among the Neogene mares indicated by the abbreviation Ngm (Shahbazi and Feyznia, 2011). (Bahrami et al., 2013) studied the role of geomorphology in the hydrological and chemical properties of the Kangir watersheds. Their results showed that due to the young karst system in the area and the contact with the bedrock, the runoff evacuation time is prolonged, eventually increasing the amount of cation and anion in the water and increasing the electrical conductivity of the water.

Shahbazi and fayznia (2011), investigated the impact of geological formations on groundwater and surface water quality of Cheshmeh Ali Damghan watershed. Their results showed that the spread of marlies in the pediment and playa is the main cause of degradation of groundwater quality. As well as the impact of geology on chemical compounds in the northern part of the northern coast of Serbia, the main factor controlling water quality has been investigated (Nichik and Vidovich, 2007). After studying the effect of geological formations on the quality of water of the Dehdasht aquifer, it was concluded that geochemistry organizations of Gachsaran, Mishan and Aghajari formations have the most impact on the quality of groundwater resources of this region (Behzad et al., 2009). From the geological point of view, the Imamzadeh plain of Jafar is located along the northwest-southeast in the Zagros Zagros zone.

Different geological structures outcrop from the Jurassic to Quaternary sediments within the studied area. In the northern part of the plain, the Asmari Formation with lithology of the limestone is cremated up to a brown color and its slope is to the plain, it is well characterized in its prominent outcrop with its seams and gaps. In the southern part of the plain, the Mishan Formation is exposed with lithology of shellfish lime and gray marls, which in some regions has also been converted to coral lime, due to the slope and extension of this expansion layer in alluvial plains of the plain. Based on the evidence of geology and stratigraphy, the rock formation forms the units of Gachsaran Formation in the study area. The thickness of alluvial plains varies from zero in the range of up to about 132 meters in the center. In the northern region, alluvial and alluvial fan materials along the alluvial fans are often coarse, such as crushed stone, gravel, sandstone, in the central and near-outflow zones, sedimentary materials are often fine-grained sediments such as silt, clay and limon. For the flow of groundwater in the plain from northwest to south east, the average aquifer thickness is about 79 meters and the minimum and maximum groundwater depth is about 90 (in the north) and about 20 meters (in the southern plain).

2. Material and Methods

2.1. Geographical location of the area

Imamzadeh Jafar plain is located 5 km north-east of Gachsaran city and in the tropical and dry region of southern Kohgiluyeh and Boyerahmad province between 30° 16'and 30°, 28' north longitude, 50° 52'to 51°2° The Eastern is located (Fig. 1). The catchment area of this plain is from a subsurface of the catchment area of the Zohreh River with an area of 220 km, about 130 km of that mountainous, and the rest of the plain is relatively flat and its average height is 720 m.
The average annual temperature and precipitation in this plain are 394.5 mm and 23°C, respectively. The climate is semi-arid with very hot summers and moderate winters. Geologically, the Imamzadeh Jafar plain lies along the northwest-southeast of the folded Zagros region. Different geological formations from the Jurassic to Quaternary deposits have been exposed in the study area. The thickness of alluvial plain ranges from zero in the range of altitudes up to about 132 m in its center. The direction of groundwater flow in the plain was from northwest to southeast. The average aquifer thickness is about 79 m and the highest and lowest groundwater depths are about 90 m (in the northern regions) and about 20 m (in the southern regions) respectively (Azizi and Mohammadzadeh, 2012).

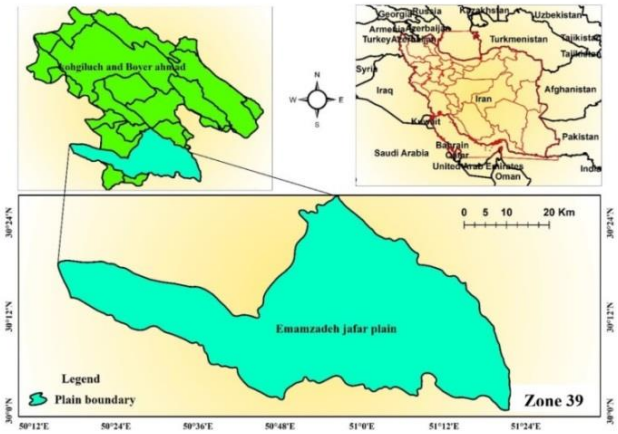

Fig. 1. Location of the study area

2.2. Collection and analysis of statistical data

The measured quality parameters of about 40 wells and piezometers of this plain were obtained from Yasuj Regional Water Company. After reconstructing the statistical deficiencies, a nine-year period was selected from the data from 2004-2014 and then the nine-year period was converted to three three-year periods based on previous studies (Mohammadzadeh et al., 2016).

2.3. Water quality survey with software Chemistry

Chemistry software is one of the most important water quality survey and monitoring software for agriculture, industry and drinking, written and designed within Visual Basic and Excel software. It does not require setup and can be used on personal computers running Microsoft Office. The design of the program is based on the requirements of the Atlas of Water Resources Studies and the Department of Energy guidelines. At the same time, the program enables the exchange of water quality data and information with other software.
In this software, first the qualitative data on the ions in mEq / l unit were converted to mg / l using Equation (1) and then entered into the software. Concentration in milligrams per liter = equivalent weight * Concentration in mEq / l

3. Results and Discussion

3.1. The Effect of Geological Formations on Water Wells

In order to study the effect of geological formations in the plain and in the watershed to the plain, first, around 1, 3, 5, 10 km of buffers were first utilized and then disconnected with the geological layer and Boolean logic method was first identified for 4 buffer zones generated from wells, type of formations and percentage and area of formation involved in water wells and the results were compared with the wells (fig. 2). By studying the geological map and separating the existing formations in the region, the table 1 is presented (fig. 3 and 5).

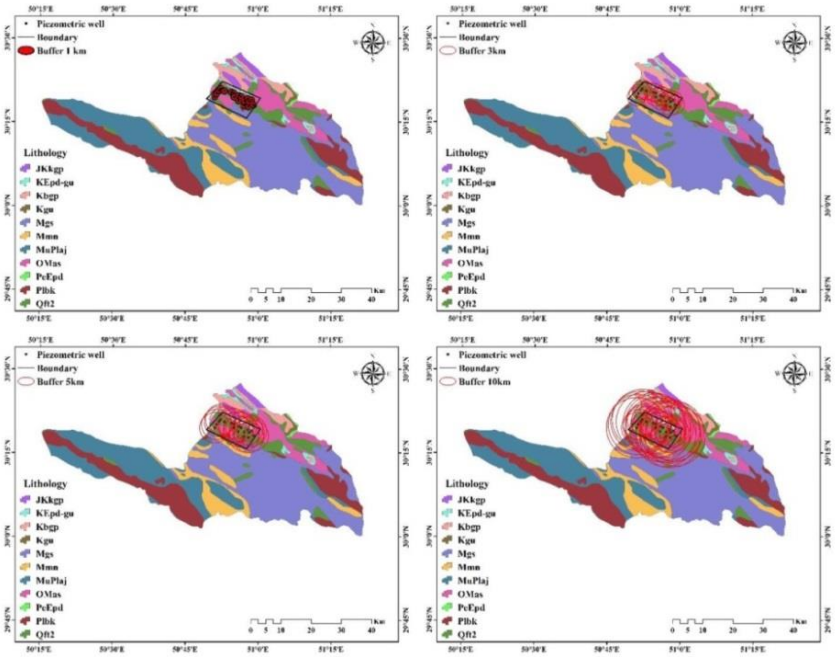

Fig. 2. Buffer with 1, 3, 5, 10 km distance of wells.

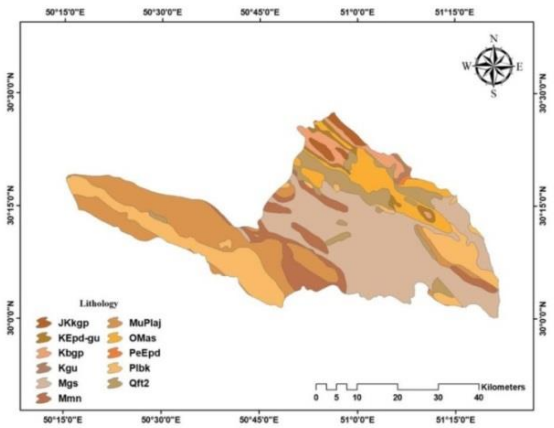

Fig. 3. Geological map of the region.

Table 1. Production Capacity and Effect of Dissolution of Formations in Plain and Watershed Areas

Abbreviation	Formation	The period	Type of water	Quality
Qt2	Alluvial fan sediments	Quaternary	.....	Very good
Oma	Asmari	Miocene	Carbonate	Good
Plb	Bakhtiari	Paliocene	Carbonate	Bad
Ek	kajhdami	Cretaceous	Sulfate	Inappropriate
Mgs	Gachsaran	Miocene	Sulfate	Inappropriate
Ma	Aghajari	Miocene	Sulfate	Inappropriate
Mm	Mishan	Miocene	Sulfate and chlorine	Inappropriate
Jkk	Fahliyan-Gadwan and Daryan	Jurassic - Cretaceous	Carbonate	Very good
Kgu	Gurpi	Cretaceous	Sulfate and chlorine	Bad
Ep	Pabdeh	Poliogeny	Carbonate	Bad
Kb	Kazhdumi-Sarvak and Ilam	Cretaceous	Carbonate	Good
Kd	Fahliyan and Daryan	Cretaceous	Carbonate	Good

3.2. Groundwater quality classification of Emamzadeh Jafar plain

Water classification was performed qualitatively during the nine-year period and in the three-year period for piezometric wells and operation wells using chemistry software and then their formation type was determined. Examination of the qualitative classification map of the plain showed that the dominant type of carbonated groundwater and its dominant formation are calcic. Hydrogeological studies on springs in the Ghezel Ozen catchment area also showed that the water quality of the area was in the good to acceptable range based on the Schuler diagram and in the agricultural area was desirable. The dominant type of water for almost all springs exiting the Karaj Formation, Precambrian metamorphism, and Soltanieh dolomites is calcic bicarbonate type and conforms to the type (Nasseri and Dadravan, 2005). In the distance of 1 km from the exploited wells, 80.82% of the formations affecting the exploitation wells are contiguous quaternary sediments with an area of about 34.86 km^2 with good water quality, 3 kilometers from the wells, 47.13 percent of the formations are quaternary sediments with an area of about 65.28 km^2 with good water quality, at a distance of 5 kilometers of the wells used, 35.19% of the formations were quaternary sediments with an area of 86.63 km^2 with good water quality and 10 km from the wells of the exploiter With an area of about 171.26 square kilometers. The Gachsaran Formation from the Miocene period with 26.92 percent and improper water quality forms an area of about 141.26 square kilometers with 22.21 percent quaternary sediments and good water quality are formed (fig. 4).

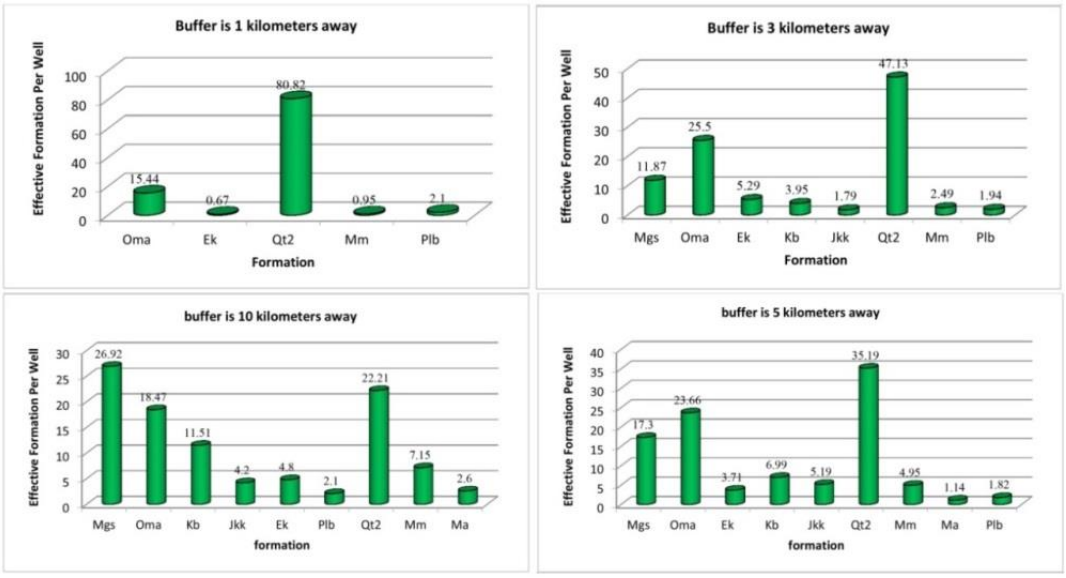

Fig. 4. Frequency of effective formations at distances of 1, 3, 5, 10 km

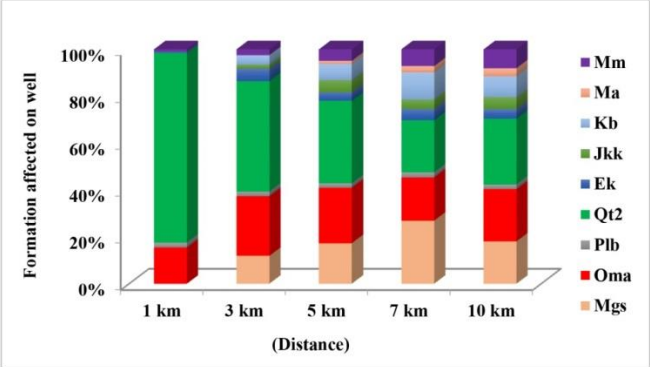

Fig. 5. Frequency of formations in the plain studied

3.3. Check the quantity of water

According to the map of the zoning of the plain and its adaptation to the geological maps of the region, the highest level of staging on the karst formations, especially the Asmari Formation, is very good in terms of water quality and an almost large area from the north and northeast the plain is included. The highest drop in water is in the northwest formations and southeastern formations. The annual hydrograph of this plain shows the highest water deficit in the years 87-89 (fig. 6).

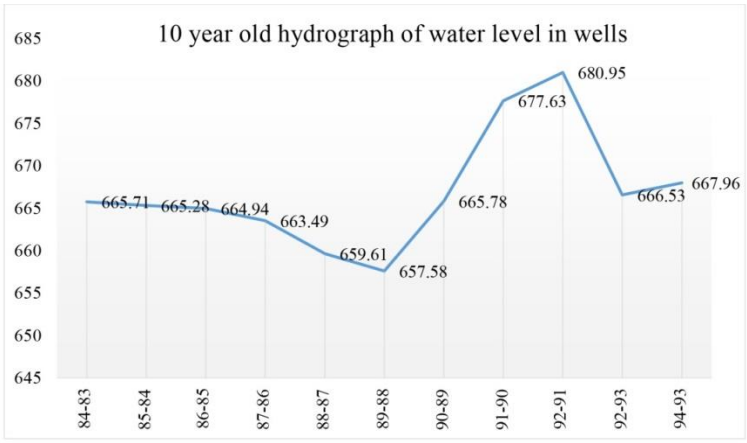

Fig. 6. 10 year old hydrology of water level in well

Groundwater drop in the Imamzadeh Jafar plain is not the same and is proportional to the distribution of wells and the flow of groundwater in different locations. Changes in the level of groundwater during the 9-year period showed that the highest drop is about 0.5 m during all three 3-year periods in agriculture and Quaternary formations. The results of groundwater type descents were divided into three types of carbonate, sulfate and chlorine in terms of quality. The northern part of the plain and part of the eastern part of the plain adjacent to the Asmari Formation is very good with the water type, while most of the reservoir formation in this plain is located in the formation of Fars group, especially the southern plain, adjacent to the Gachsaran Formation with an unsuitable water type. The qualitative distribution of groundwater resources in the plain shows that the northern and eastern regions (adjacent to the Asmari Formation) have good and acceptable quality, the center of the plain (adjacent quaternary sediments) is moderate and the southern part (the proximity of the formations of the Fars group) has inadequate quality. As well as, since a large part of the central part of the plain is formed by the quaternary formations, which have good water quality, it has led to a large part of agriculture in this area, which results in an unplanned impression Groundwater in the area has caused that the north of the area is the level of groundwater level lower than the southern part of the plain. In the study of effective formations, it was also found that the most influences were foundations that were

located at a maximum distance of 3 km from the water sources. The effect of formations that were located at greater distances was very slight. The results of this study were compared with the results of research Tolaei Nejad et al. (2005) in the Izeh plain Ghaffari et al. (2008) in Zanjan-e-Rud and Kazemi et al. (2005) in Lar Karstic region in terms of better water quality in terms of agriculture and drink within the confines Correspond. It is also consistent with the results Naseri et al. (2005) of the influence of non-quaternary formations that can produce carbonate and chlorine water.

4. Conclusion

The issue of water quality in arid and semi-arid regions of Iran is a very important and negligible issue, but in recent years due to reduced rainfall caused by subsequent droughts, groundwater extraction has increased widely. Much of the Imamzadeh Jafar plain forms the Quaternary Formation with young alluvial sediments covering an area of 141.21 km2, which is of great importance for aquifer enrichment in the plain studied. The results showed that the plain was composed of two types of different quality of northern and southern water and the southern part of the plain had a significant impact on some wells. The northern part of the plain and part of the eastern part of the plain are adjacent to the Asmari Formation with very good water type, while most of the watershed formations form the Fars Group. Especially the southern part of the plain which is adjacent to the Gachsaran Formation and has poor water type. The qualitative segmentation of the groundwater resources of the plain shows that the northern and eastern regions (adjacent to the Asmari Formation) have good and acceptable quality, the center of the plain (adjacent to the Quaternary sediments) of moderate quality and the southern part (adjacent to the Fars Group Formations). The quality is inadequate. Since much of the central part of the plain is composed of Quaternary-era formations that have good water quality, as a result much of the agriculture is concentrated in this area, causing excessive groundwater harvesting and Groundwater loss over a ten-year period was 15 meters.

References

Azizi, F. & Mohammadzadeh, H., 2012. Evaluation and zoning of the aquifer quality and vulnerability in Emamzadeh Jafar Gachsaran using DRASTIC and the GWQI Quality Index, *Water Resources Magazine*, 5(13), 1-17.

Bahrami, SH., Zanganeh Asadi, MA. & Rhabar, H., 2013. Investigating the role of geomorphology in hydrological and chemical characteristics of the Kangir watershed basins. *Journal of Geography and Urban-Regional Planning*, 7, 84-71.

Ardavan, B. & Hamzeh, F., 2010. Investigating the Effect of Geological Formations on Water Quality, West Dehdasht Aquifer. *Quarterly Journal of Geography*, 3(11), 93-112.

Ghaffari, G., Chudoshi, C. & Ahmadi, H., 2009. Effect of Land Use Change on Hydrology Responses of Watershed (Case Study: Zanjan-e-Rood Basin). *Water and Soil Conservation Research Journal*, 16(1), 163-180.

Kazemi, R., Ghayomiyan, J. & Jalali, N., 2005. Investigating the Role of Structural Factors in the Frequency of Water Resources in Lar Karstic Region Using Remote Sensing and GIS. *Journal of Research and Development in Natural Resources*, 3(73), 33-41.

Mohammadzadeh, F., 2015. *Quantitative and qualitative comparative study of groundwater resources and their relationship with geological formations and land use*. Master's Degree, Yazd University, Faculty of Natural Resources and Desertification (in Persian).

Mohammadzadeh, F., Ekhtesasi, M.R. & Hosseini, Z.A., 2017. Investigating the Effect of Geological Formations on Groundwater Quality Using Boolean Logic, Case Study: Basin of Bajestan Plain Basin, *Journal of Engineering and Watershed Management*, 9(1), 11-21.

Naseri, H. & Farhad. D., 2004. Hydrochemistry of hard formations part of the Ghezel Ozan Basin. *The 21st Earth Science Conference, Geological Survey of the Iran*.

Nasseri, H.R. & The prosecutors, F., 2005. Hydro-chemical cementitious formations of the Ghezelous watershed. *Twenty First Earth Science Forum*, Geological Survey of Iran.

Nikic, Z. & Vidovic, M., 2007. Hydrogeological conditions and quality of ground waters in northern Banat, Pannonian basin. *Environmental geology*, 52(6), 1075-1084.

Shahbazi, R. & Feyznia, S., 2011. The Effect of Geological Formations on Reduction of Surface Water and Groundwater Quality in Iran's Central Desert Watershed. *Environmental Erosion Research*, 1(1), 93-104.