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Determination the effects of physico-chemical parameters on groundwater status by water quality index (WQI)

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ABSTRACT

The quality of drinking water, in addition to the presence of physicochemical parameters, depends on the type and geographical location of water sources. In this study, groundwater quality was investigated by sampling total dissolved solids (TDS), electrical conductivity (EC), total hardness (TH), Cl^-, Ca^{2+}, and Mg^{2+} parameters in 13 sites, and 40 water samples were sent to the laboratory. Electrometric, titration, and spectrophotometer methods were used. In the next step, the water quality index (WQI) was used to investigate the impact and weight of each parameter in the groundwater. The results showed that only the mean of magnesium ion (40.88 mg L^{-1}) was lower than the guidelines of World Health Organization (WHO). Interpreting the WQI based on the WHO guidelines showed that the statuses of 21, 11, and 7 samples were very poor, poor, and average quality, respectively, and one sample had excellent quality. Among the studied parameters, the means of EC (2,087.49 mS cm^{-1}) and Cl^- (1,015.87 mg L^{-1}) exceeded the global and national limits. Classifying water quality about TH was very hard (87.5%), hard (7.5%), and moderate (5%), respectively. Based on the geographical distribution, the drinking water index in sites 4 and 11 did not have acceptable quality. Chloride ion was identified as the responsible pollutant and the most important ion for raising the index. The outputs of statistical tests and Spearman correlation had significant and direct correlation ($p < 0.05$, $r > 0.7$) between TDS, EC, and chloride, EC and chloride, as well as TH, Ca^{2+}, and Mg^{2+}.

Keywords: Water quality index; Groundwater; Chloride; GIS; Garmsar

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1. Introduction

It has been proven in the past that the formation of human societies, social colonies, and consequently, agriculture requires water for food supplement and industrialization. The concept of water stress is probably to keep the cycle of growth, production, and water consumption balanced [1].

In addition to meeting the daily water needs of human beings for various purposes, drinking water is the main way to supply the elements and minerals needed by the body such as calcium and magnesium. The amount of these elements in groundwater is usually higher than other sources [2].

The presence of various contaminants and parameters in drinking water first affects the appearance of water and, then, can cause various disorders and diseases in consumers. Long-term consumption of contaminated water can also lead to an increase in water-borne infectious disease or, in more acute conditions, cause death [3].

In the central regions of the Islamic Republic of Iran (IRI), groundwater resources are prioritized compared to other sources due to the lack of access to surface water (rivers and lakes) [4].

Groundwater quality, in addition to human interactions, is largely influenced by the type and element of soil layers, the contaminants in its bed, evaporation, and the amount of air humidity [4,5]. On the other hand, metal pipes of transmission lines and distribution networks can be responsible for releasing metal and trace elements into water. This is because over time and upon increasing the life of metal and galvanized pipes, their walls are damaged, which leads to releasing various elements or increasing the concentration of some metals in water. Accordingly, it is important to study the quality of drinking water from aquifers up to the point of consumption [6].

Not only the quantity but also the quality of groundwater can be affected by the climate and weather conditions of an area. In fact, as the amount of rainfall decreases, the volume of groundwater that can be harvested decreases, and the depth of water withdrawal from the well increases. This issue is more important in areas with arid climates, because compared to other climates, it has less rainfall and more water harvesting volume, which leads to water extraction from the lower soil layers and, consequently, changes in water quality [1,7].

In desert areas, which have hot and dry weather on most days of the year, due to reduced water quality, especially high salinity and changes in water taste, people are forced to use home water purifiers, which could increase the cost and other problems [8].

Water quality is a major global challenge, especially for developing countries. Therefore, for the sustainable development of a community and preservation of the ecosystem of a region that uses groundwater in particular for its main activities, it is necessary to study water quality [9].

The water quality index (WQI) can be used to measure water characteristics. This index of water quality is based on the relative weight of various physicochemical parameters. In calculating this index, all units of measurement should be standardized [10].

This index is one of the most basic and widely-used methods for measuring water quality and shows the effect of each parameter based on their weight and relative importance [11]. In fact, due to its flexibility, this index can be used for a variety of water resources all over the world [12].

Due to the disapproval of water consumers in the study area regarding its taste and the use of the term “salinity” by stakeholders to express water quality to foreigners, the following objectives were considered:

- measuring groundwater quality in desert areas using the WQI,
- comparing the values of different parameters with the guidelines of the World Health Organization (WHO) and national standards,
- And spatially distributing the presence of parameters in the sites.

2. Study method

2.1. Location and climate

Water is more essential for the survival of humans and animals in hot and dry areas than other areas. This study was conducted in one of the residential areas in the central desert of Iran, Semnan Province, Garmsar city in 2020. The principle source of water for consumers in these regions with the area of ~50 km^2 was groundwater used by its inhabitants for drinking and daily consumption.

The closest mountain to the studied groundwater aquifers is the Alborz heights, which has the distance of ~40 km from the study area. Annual rainfall in this area is less than 120 mm, humidity is less than 45%, and air temperature in the summer season exceeds 65°C. Finally, this city is known as a region with hot and dry climate, in which consumers need a large volume of water per day [4].

2.2. Water sampling

In this area, water is extracted from the groundwater aquifer; after injecting chlorine as a disinfectant, drinking water is injected into the distribution network. The study area was divided into 13 homogeneous sites and 40 samples of house faucets (consumption points) of these sites were taken randomly. Each of the sites in this study represented a groundwater aquifer. The population covered by these 13 sites was 2,190 people. The information of the sampling areas for each site is prepared in Table 1.

For sampling, non-reactive polyethylene bottles with water samples with the volume of 250 mL were used. The samples were transferred to the laboratory in a cold box in the temperature range of 0°C–4°C. To avoid any errors in the calculations, all the necessary specifications were recorded on the bottle labels and kept until the end of the test. Finally, the samples were taken by the laboratory expert and were examined.

2.3. Water quality index

The WQI estimate and its outputs can be used to simplify the intricate concept of water quality and evaluate its physical, chemical, or biological properties. This index has many advantages. For example, it can examine the quality

Table 1
Information of the study area

Sample point	Lang. E (°)	Lat. N (°)	Population	No. of samples
S1	52 25 30	35 10 56	148	7
S2	52 23 06	35 11 30	237	2
S3	52 26 30	35 12 10	26	1
S4	52 26 51	35 10 32	545	3
S5	52 22 03	35 12 54	264	2
S6	52 24 07	35 12 39	207	3
S7	52 27 00	35 11 16	326	3
S8	52 24 23	35 11 00	342	7
S9	52 22 52	35 11 22	102	3
S10	52 23 04	35 11 41	245	2
S11	52 22 10	35 12 18	84	1
S12	52 25 46	35 12 53	318	2
S13	52 25 53	35 10 54	66	4

of water in one type of resource and can also compare different sources. It also facilitates the understanding of water quality for stakeholders or non-experts in specific fields by providing a dimensionless number. On the other hand, when planning and deciding on various organizations, using one number is easier than using multiple quantities/amounts of different water properties [13,14].

To measure the quality of groundwater used in routines, parameters including total dissolved solids (TDS), electrical conductivity (EC), total hardness (TH), chloride (Cl^-), calcium (Ca^{2+}), and magnesium (Mg^{2+}) were measured. TDS and EC were measured by electrometric methods, Digital Water Tester device, pH, and TDS meter (model; IDEALHOUSE, 6954917666573). Also, TH and chloride were measured by EDTA titration, and calcium and magnesium ions were analysed by spectrophotometer. All the steps of laboratory analysis were done according to the instructions of Standard Methods for the Examination of Water and Wastewater book.

2.4. Techniques

After sampling, by equalizing the units of measurement, the WQI was calculated by the following equations.

First, Eq. (1) was used to calculate the quality rating scale:

$$Q_i = \frac{C_i}{C_p} \times 100 \tag{1}$$

where Q_i is the quality rating scale, C_i is the concentration of the measured parameter, and C_p explains the maximum permissible limit related to the desired parameter.

Then:

$$\text{RW} = \frac{W_v}{\sum_i^n W_v} \tag{2}$$

where RW represents the relative weight and W_v is a multiple of the weight value or importance of each parameter to the summation (Σ) of the weights of all parameters. The weight value range of each parameter is integers 1–5 and its number is selected based on the type of drinking water and the importance of that parameter.

The studied parameters, the considered value for each parameter, and their relative weights are shown in Table 2. The standard of some parameters in Iranian (IRI) was different from the guideline of WHO. So, two standards were considered.

It is necessary to note that the total relative weights of the parameters must be equal to one ($\Sigma\text{RW} = 1$).

In the next step, the role of each parameter as the sub-index (SI_i) was calculated based on its relative weight:

$$\text{SIi} = \text{RW} \times Q_i \tag{3}$$

In Eq. (4), based on the previous equations, the WQI was calculated:

$$\text{WQI} = \sum_i^n \text{SIi} \tag{4}$$

This index is interpreted as follows: if the WQI is:

- Less than 50, water quality is excellent,
- 50 to less than 100, water quality is good,
- 100 to less than 150, we will have almost moderate quality,
- 150 to 200, water is of poor quality and,
- More than 200, water quality is poor, which needs to be treated based on the type of application.

Data distribution was examined by the Smirnov-Kolmogorov test, kurtosis, and skewness to find the correct method of interpreting information. In the next step, non-parametric and Spearman correlation tests were used to examine the correlation of the studied parameters. All the statistical tests and dispersion indices were calculated with the Statistical Package for the Social Sciences (SPSS IBM version 25) software.

Also, spatial analysis and design of maps related to the parameters in the sampling sites were performed using Geographic Information System (ArcGIS, version 10.0) software.

3. Results

The results of descriptive statistics of groundwater hydrochemical parameters are shown in Table 3. Measuring these parameters showed that the highest values were related to EC (3203.40 mS cm^{-1}) and, among the ions; the mean values of chloride (1,015.87 mg L^{-1}) were higher than that of other ions. Examining the range of changes also showed that the standard deviation (SD) of EC was more than the rest.

Comparing the mean parameters with the WHO guidelines showed that only the mean of Mg^{2+} (40.88 mg L^{-1}) was lower than the stated guidelines (50 mg L^{-1}). Comparing the mean parameters with the national standard showed the mean values of TDS, TH, and Mg^{2+} were lower than the IRI standard limits.

The WQI in the study sites is summarized in Table 4. The percentage demonstrate the status and quality of drinking water according to the guidelines of the WHO and IRI standards. The results of the WQI (based on the WHO guidelines) showed these regions did not have good quality samples and only one water sample had excellent quality and complied with the guidelines of the WHO and national standards. Also, 21 samples equal to 52.5% of the total had very poor status.

Table 2
The permissible limit, weight value, and the relative weight of parameters

Parameter	WHO guideline	IRI standard	W_v	RW
TDS (mg L^{-1})	500	1,500	5	0.227
EC (mS cm^{-1})	1,000	1,000	4	0.182
TH (mg L^{-1})	200	500	3	0.136
Cl^- (mg L^{-1})	250	600	4	0.182
Ca^{2+} (mg L^{-1})	75	75	3	0.136
Mg^{2+} (mg L^{-1})	50	50	3	0.136

4. Discussion

All components of the planet are somehow dependent on water and access to water is essential for population growth, progress in industrialization, agricultural prosperity, and most importantly, health [15]. Numerous studies have approved the importance of providing safe drinking water. Nevertheless, the issue of water quality is even more important in arid and desert areas, especially the residential zones, in which is no access to other water resources. The reason is that the only accessible water source is via groundwater aquifers. In addition to meeting the water needs of the permanent residents, the water needs of people who have made reverse migration should be provided.

According to the latest information, approximately 87.5% of samples had very hard water and the mean of hardness was 371.35 ± 153.79 mg L^{-1}. Also, these regions had no soft water samples. In general, water hardness is known as measuring the water capacity for soap deposition. Soap is mainly precipitated by calcium and magnesium ions. Other polyvalent ions may precipitate soap, but they often contain organic compounds and their role in water hardness and definition may be complex. Total hardness (TH) is defined as the sum of the concentrations of calcium and magnesium, both in mg L^{-1} of calcium carbonate. The main cause of hardness is calcium and magnesium ions in the gypsum and calcareous soil. As a result, these ions are more likely to occur and increase the hardness of the

Table 3
Descriptive statistics of groundwater hydrochemical parameters

Statistic	Parameters (mg L^{-1} except EC; mS cm^{-1})					
	TDS	EC	TH	Cl^-	Ca^{2+}	Mg^{2+}
Min.	222.6	401.85	114	121.44	31.92	14.30
Max.	1,718.70	3,203.40	741	2,098.08	200.64	122
Mean	1,021.74	2,087.49	371.35	1,015.87	113.01	40.88
SD	324.03	655.18	153.79	473.38	45.15	28.42

Table 4
WQI classification and groundwater status

WQI	Water status	Percentage of samples (WHO guideline)	Percentage of samples (IRI standards)
<50	Excellent	2.5	2.5
50–100	Good	0	22.5
100–150	Moderate	17.5	47.5
150–200	Poor	27.5	20
>200	Very poor	52.5	7.5

water in groundwater aquifers, especially in desert areas. Concentrations of magnesium and calcium ions in groundwater up to 50 and 100 mg L^{-1} are common, respectively, but higher concentrations cause a reaction in the consumer due to taste and side effects [16].

As shown by the results in Table 3, the calcium and magnesium cations exceeded the set standards at their maximum values. It can be concluded that the two important ions played a significant role in increasing the total hardness of drinking water in the study areas.

The results of Arul Nangai et al. [17] study showed that the mean hardness of the studied water samples was 402 mg L^{-1}, which was approximately close to the results of the present study, in which the mean of TH was 371.35 mg L^{-1}. Also, based on prior studies [18], water hardness that exceeded the set limits caused damage to the gastrointestinal and urinary tracts or even damage to the blood supply system.

Total dissolved solids represent mineral salts and little amounts of organic matters in water, and electrical conductivity is the amount of conductivity created by these materials in water. There is a corresponding correlation between EC and TDS; these two parameters are related by a coefficient as "*k*". The coefficient increases with the rise of ions in water. So, with increasing TDS, the electrical conductivity of water also enhances. Although this relationship is not always linear and direct, it is intimately related to the activity and strength of ions in water [19].

The results of chemical tests showed that the mean of TDS in the samples was higher than the guidelines of the WHO. These values can be affected by the presence of considerable amounts of chloride, calcium, and magnesium ions.

The laboratory results of the present study showed the average concentration of chloride ions was higher than the amount declared by the WHO guidelines and national standards. The presence of chloride ions in groundwater aquifers can be due to aeration, leakage of soil and rock sediments into the water, or presence of polluting sources such as effluents from municipal and industrial wastewater treatment plants [20]. In understudy regions, due to the considerable distance of water supply systems from industrial sewage outputs, water resources were presumably more affected by soil quality, substrate, and leachate of agricultural activities, especially fertilizer utilization. More specifically, the groundwater aquifers of these areas are located principally nearest to agricultural estates [21]. A study was spread by Wang et al. [22] in Yinchuan Plain in 2004 and 2014 to evaluate the level of groundwater pollution. The study area has been mainly agricultural land, and intensive agricultural activities have been carried out. Also, the plentiful use of fertilizers has been confirmed. They explain that excessive application of agricultural nitrogen/phosphate fertilizer has a significant impact on groundwater quality that can increase the concentrations of regional chemical composition in groundwater. Another study was done by Amiri et al. [23] to estimate the quality status of groundwater resources in Yazd province, a central region of Iran. The results showed the minimum and maximum concentrations of sulfate and chloride are 35.5–9,230 and 9.6–1,485.6 mg L^{-1}, respectively, which have a wide range of concentrations. Regarding the most important source of these variables, the dissolution of evaporates seems to play a decisive role in controlling the concentration of the mentioned parameters. Again, the sodium concentration in the range of between 5.75–4,800.1 mg L^{-1} can be

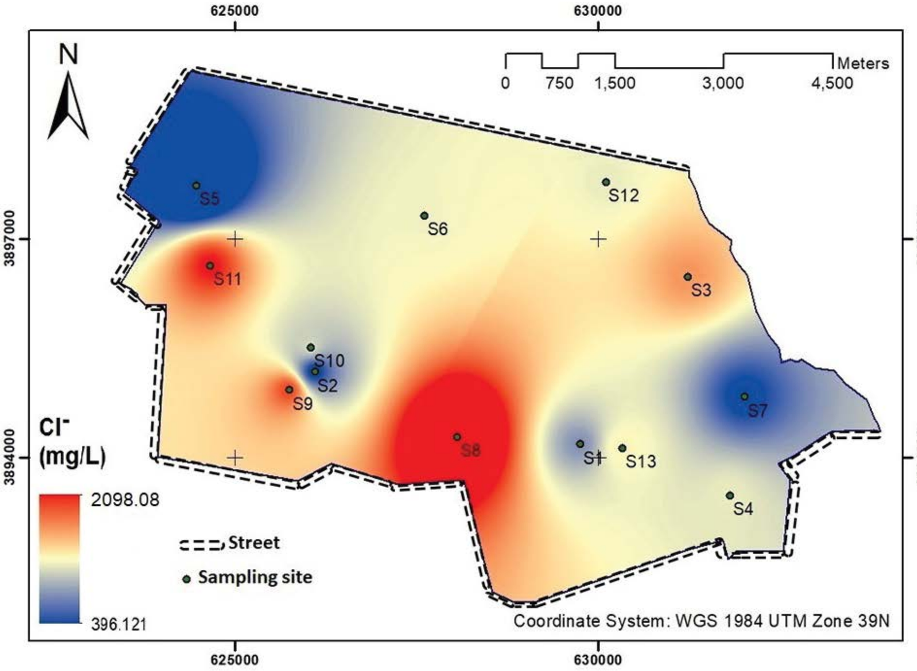

Fig. 1. Geographical distribution of chloride in sampling sites.

considered a role in the mechanism managing the two parameters SO_4 and Cl^-.

The consequences of the study by Shekhar et al. [24] for assessing groundwater quality by GIS based on WQI showed that calcium, magnesium, and sulfate ions were within the acceptable range of the WHO, while the concentration of TDS and chloride ions was higher than the allowable values.

Chloride is usually present in nature in the form of calcium, sodium, and magnesium salts, and highly mobile chloride ions can be leached from soil to water. But, among its various salts, calcium chloride is more soluble in both hot and cold water than other salts. Chloride salt concentrations of more than 250 mg L^{-1} cause a taste in water and beverages made from it and lead to consumer discomfort, while water is not contaminated if it has chloride ions less than 10 mg L^{-1} [25].

Among the analysed ions, chloride with the maximum amount (2,098.08 mg L^{-1}) has the most distinguished rank. According to the results of other studies, chloride in water sources has a soil origin. Because chloride plays a good role in corrosion in soil and water, chloride ions and their alkaline salts in the soil can be a corrosive agent for iron and galvanized pipes, causing both surface corrosion and pitting corrosion [26]. A study by Oladosu and Adeleke [27] in Nigeria proved that chloride ion was one of the most disturbing elements in groundwater resources, which is compatible with the results of the present study. Also, a study was done by Fytianos and Christophoridis [28] in Greece and, the result showed the chloride concentration varied from 11.6 to 475 ppm. They declared it was related to leakage of seawater to groundwater aquifers and therefore causes an excessive chloride.

Fig. 1 is used to better explain the geographical distribution of chloride ions in the study areas. This map showed that the amount of chloride ion in sites 3, 8, 9, and 11 was higher than 2,000 mg L^{-1} and the sampling sites were marked in red. Of course, in sites 5 and 7, where the color spectrum of the map changed to blue, the amount of this ion was higher than the guidelines of the WHO (250 mg L^{-1}), but they had better adaptability with the national standard (600 mg L^{-1}).

Chloride in groundwater sources can represent other pollutants such as sodium and calcium salts that are produced due to human interactions in nature, use of chemical fertilizers, and improper discharge of municipal/agricultural wastewater, and appear in the form of various kinds of pollution in groundwater aquifers. A study by Ghosh et al. [29] in India for assessing groundwater quality based on health risk assessment showed a significantly positive correlation between Ca^{2+} and NO_3 and a significant correlation between NO_3 and Cl^-. It can be claimed that by examining and confirming the presence of some contaminants in groundwater, the appearance of other contaminants such as nitrate, phosphate, fluoride, and their decomposition products can be traced. Another part of the results of mentioned study based on the WQI showed that a small number of water samples were potable, and 59.5% and 24.3% of the samples remained in poor and very poor quality [29]. The results of this section are similar to the results of the WQI in the present study because 52.5% and 27.5% of the samples were of poor and very poor quality, respectively, therefore not approved for drinking and routine consumption.

The spatial distribution of the WQI according to the guidelines of the WHO based on the GIS maps in the study areas are shown in Fig. 2. According to this figure, groundwater aquifers in sites 4, 5, and 11 did not have acceptable quality and the number of the index was around 332. Also,

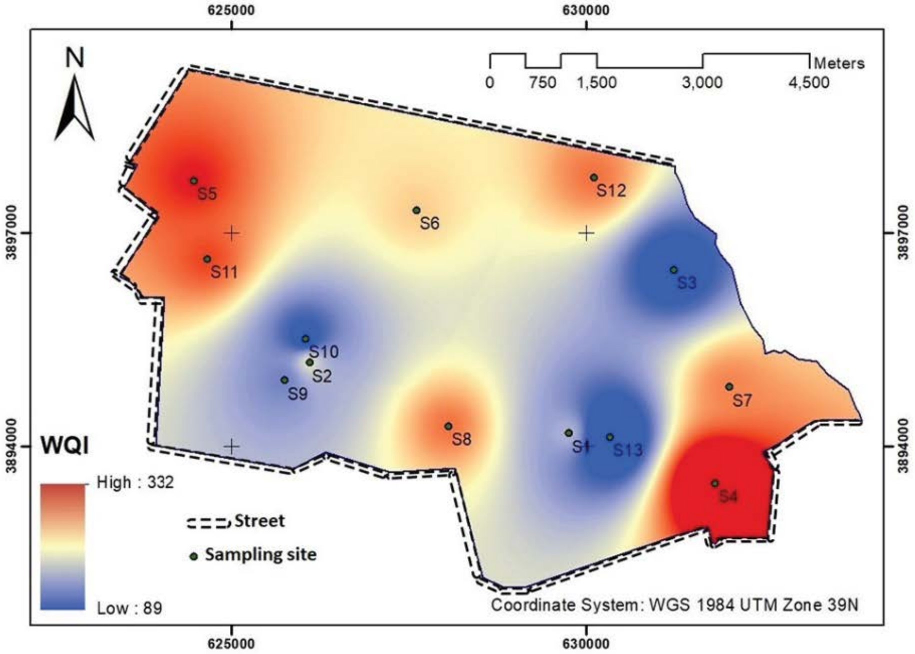

Fig. 2. Spatial distribution of the WQI in groundwater sampling sites.

this index was in the range of 150 to 200 in sites 6, 7, 8, and 12, which was in a poor range status. For a better interpretation of this index, Fig. 3 is presented. This proved that in sites with a high index, the value of chloride ions was higher than other elements and was identified as the responsible pollutant. Also, among the mentioned indexes, the amount of Cl^- in sites 4 and 11 was higher than the rest.

The results of the study by Panneerselvam et al. [30] which used the WQI to evaluate the quality of groundwater for drinking and agricultural applications showed that 20.89% and 7.46% of the samples had moderate and poor quality, respectively. Another study in India examined the quality of drinking water with a WQI. The results showed that 63.5% of water samples had poor quality. Also, magnesium and chloride are significantly interrelated, and the analysis demonstrates that the groundwater of the area requires some degree of treatment before consumption [31].

Climate change, decreasing annual rainfall, and increasing water demand and water extraction from the lower layers change the quality of the water extracted [32]. Alimohammadi et al. [33] study on the water quality of wells in Saveh County showed that, at the beginning of the study, 62% of water wells had acceptable quality, but after 11 years, only 13.8% of the wells maintained the previous quality. Also, over time, the value of magnesium ions in the wells, increased significantly and the wells that passed the standards at the beginning of the study did not have much success at the end of the study. The study was not very satisfied with the chloride amount in water wells and proved that its values increased over time. Comparing the results of this study with the present issues was widely consistent, especially when the water quality in these areas was judged based on the Schoeller diagram. According to this diagram, the studied samples in Garmsar city, especially for Cl^- had poor quality.

Another study in Algeria [34] examined the quality of water consumed and water discharged from a pharmaceutical company with the WQI. The results showed that various parameters, especially calcium, alkalinity, electrical conductivity, chloride, and magnesium, in the output had a significant increase; to maintain the balance of the environment and reduce the elements to the specified limits, the effluent must be treated.

Data analysis of the current study did not have a normal distribution in SPSS software. Therefore, the Spearman correlation test was used to evaluate the correlation of the elements. This test with a significance level ($p < 0.05$, sig. 2-tailed) has a correlation coefficient (r) from –1 to +1. If r is greater than 0.7, there is a strong correlation between the two parameters; if $0.4 < r < 0.7$, it can be concluded that the two parameters are on average interdependent. A negative sign also indicates an inverse relationship.

When the Spearman correlation matrix was set for the elements of this study (Table 5), the results confirmed that EC and Cl^- with TDS, Cl^- with EC, calcium and magnesium ions with TH, and Ca^{2+} with Mg^{2+}, respectively, had strongly positive correlations ($r > 0.7$).

The results of the study of Kothari et al. [35], which examined water quality in rural areas using the water quality index, showed that TDS has the highest correlation with conductivity, sulfate, and chloride ion concentration and was in line with our results.

Based on previous information, the amount of chloride is related to the electrical conductivity of water; when it increases, the corrosive property of water increases. As a result, the destruction potential of metal pipes in the distribution network will increase.

Based on what has been said, the groundwater aquifers in the study areas are contaminated with chloride ions, because on average, the amount of chloride in the samples of this study is higher than 1,000 mg L^{-1}; among the parameters, the electrical conductivity dedicates the highest rank to itself. The study of Lee et al. [36] evaluated the groundwater quality in 55 wells in Korea was in line with this section of the present study and showed high EC levels achieved over 1.6 km inland and high Cl^- values were observed up

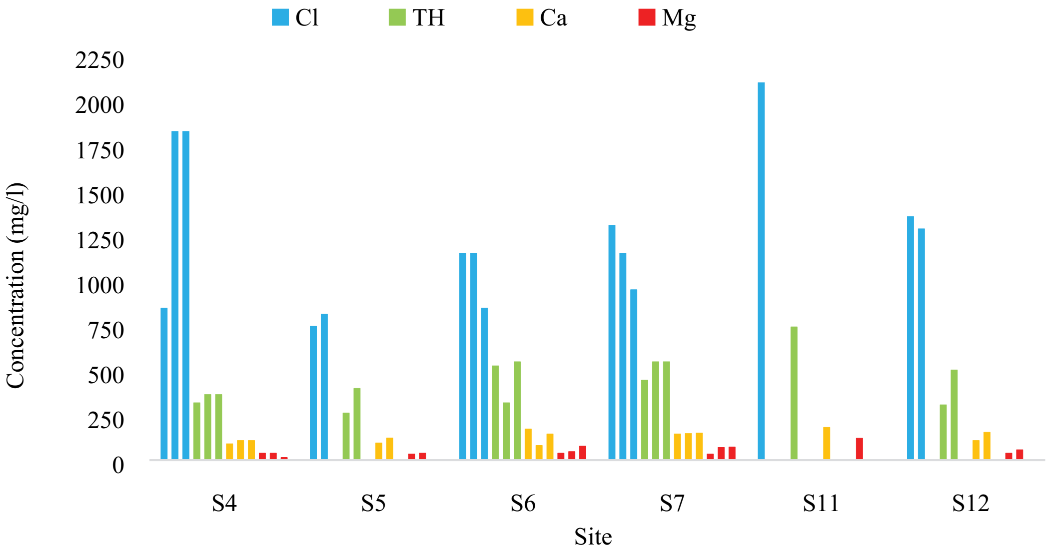

Fig. 3. Concentrations of parameters in the most polluted sites.

Table 5
Correlation coefficient matrix in Spearman analysis

	TDS	EC	TH	Cl^-	Ca^{2+}	Mg^{2+}
TDS	1.000					
EC	**0.903**	1.000				
TH	0.594	0.439	1.000			
Cl^-	**0.918**	**0.768**	0.652	1.000		
Ca^{2+}	0.567	0.399	**0.929**	0.619	1.000	
Mg^{2+}	0.614	0.457	**0.748**	0.595	**0.734**	1.000

The bold cases had $r > 0.7$ and strong correlation and significantly at the 0.05 level (2-tailed).

to 1.2 km inland. The Cl^- concentrations and EC levels had highly positively associated.

In the next ranks, based on our results, TH, Ca^{2+}, Mg^{2+} with TDS, calcium, and magnesium with Cl^- had moderate and direct correlations ($0.4 < r < 0.7$). Of these, EC had a poor association with calcium.

A study by Tiwari et al. [37] in a western region of India showed that 21% of the water samples had poor quality and could be drunk when the treatment requirements were met. The results of their study are consistent with parts of the findings of the present research, because 27.5% of the samples in this study had poor quality and 52.5% had very poor quality. Therefore, it can not be drunk with the current cleaning process (extraction, filtration, chlorination, and transfer to the distribution network) and requires other purification steps such as aeration, oxidation with chemical agents, and ion exchange.

The Spearman correlation results showed that the levels of TDS and EC in the water samples with the 95% confidence interval had a significantly direct relationship ($p < 0.05$ and $r > 0.7$). On the other hand, the average level of TDS in the studied sites (1,021.74 mg L^{-1}) was higher than the guidelines of the WHO and the parameter's maximum level (1,718.70 mg L^{-1}) was higher than the national standards. As a result, the water resources of this region were considered "brackish" [27].

5. Conclusion

Groundwater quality can depend on natural factors or routes of contamination by human hands. Natural factors include climate change in an area, soil and rocks erosion, or even the movement of water in different directions in the soil. On the other hand, agricultural activities, animal husbandry, use of various chemical fertilizers, and extraction of water from the deeper layers of the soil in response to human needs are all the reasons for the pollution of water resources. One of the appropriate indicators for evaluating water quality, without restrictions on the type of source, is the use of the WQI. One of the strengths of this index is the equivalence of different parameters and quality judgment based on a dimensionless number. But, an important note on using the WQI by the weight value method is the conflict in determining the relative weight of each parameter. If the weight of the parameter is considered too large, magnification is created in its share; if it is considered very poor, miniaturization is created. Therefore, it is suggested that the parameters should be selected based on the type of water supply source to ascertain their true effect on quality.

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Declaration of competing interests

The authors of this article declare no conflict of interests.

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