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Evaluation of well Water Quality for Domestic utilization in Fayda District, Southern Duhok Governorate, Kurdistan Region- Iraq

Musher R. Ahmed, Rami N. Saleem*, Marwa M. Rashed

Department of Environmental Science, Faculty of Science, University of Zakho, Iraq.
*Corresponding Author.

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Abstract

This study was conducted for the purpose of measuring the quality of water in the wells of the Fayda District by measuring the water quality index, On the basis of chemical and physical standards that were measured using modern devices, techniques and classical methods. 168 samples were collected and analyzed based on several parameters involving, Water temperature, pH, Electrical Conductivity(EC), Total dissolved solid, Turbidity, Alkalinity, NO_3^{-2}, Cl^-, Ca^{+2} Mg^{+2} SO_4^{-2}, Dissolved Oxygen(DO) and Total hardness(TH). The data showed variation of the investigated parameters in samples as follows: 18.417 to 22.567 °C and 7.65 to 8.39 for water pH, 5.685 to 8.283mg/L for DO, 1.200 to 3.225 NTU for Turbidity, 456.25 to 2300.00 µS/cm for EC, 259.33 to 1471 mg/L and 204.08 to 1363 mg/L for TDS and TH , 204.42 to 435.75 mg/L and 122.67 to 622.08 mg/L for TA and Calcium, 85.33 to 747 mg/L and 12.842 to 100.100 mg/L for Magnesium and Chloride, 20.450 to 200.833 mg/L and 2.200 to 7.350 mg/L for Sulfate and Nitrate. the water quality index (WQI) in the districts of Bakr 167.33–183.32 , Krebany 115.4–124.069, Fayda 108.44–113.07 , Domes1 104.96–119.87, Domes2 109.66–119.90, Kranke 101.58–111.35 and Jambor 99.89–110.24 District are higher than the allowable limits according to the World Health Organization standards (WHO) for drinking water. The (WQI) for the 168 samples ranged from 78.15 to 183.32. Krebany, Fayda, Domes 1, Domes 2, Kranke and Jambor wells all exceeded the value of 100. About 61.3% of water samples were of poor quality for drinking purposes.

Keywords: Chemical and physical parameters, Fayda villages, Water contamination, Water quality Index, Well water.

Introduction

The water quality, whether used for domestic drinking, purposes, recreational purposes or food production has an important impact on health[1]. The challenges posed by the difficulties in attaining unhindered and sustainable access to potable water supply have resulted in people seeking alternative means of water supply amongst others, like bore-holes, anddeep and shallow hand-dug wells. These alternatives are also not without challenges, due to increasing population, poor sanitary facilities, stormwater run-offs, and continuous use without proper treatment may result in outbreaks of several water-borne diseases[2].

The present study was carried out in an area where 90% of the population uses well water as their staple water supply. Therefore, assessing the quality of well water where many lives are dependent upon, is of vital importance[3]. In Kurdistan region of Iraq, many villages developed and increased their requirement for well water. Most villages in the Kurdistan Region rely on well water for the majority of their domestic freshwater needs. Contamination of drinking water become dangerous to the life of the people living in. In village areas, more than a thousand wells have been built to provide drinking water to the Kurdistan region.

Furthermore, an increase in urbanization, construction, agricultural activities, industrial applications, and natural processes has adversely impacted the quality of surface water and groundwater, and its effects on human health throughout the world. Although well water is of better quality than river water, it can be polluted and contribute to the contamination of drinking water supplies[4]. The majority of the Kurdistan region's wells were drilled close to residential homes, which could result in sewage from the septic tank flowing into the well, which would increase the amount of nitrates in the water. Wastewater from the septic tank flows into well water, which is used for domestic purposes. Freshwater pollution by wastewater can come from septic tanks, raw wastewater, leaks in sewer pipes, and partially untreated wastewater[1, 5]. Well water has become the main source of water in villages to meet livestock, agricultural and domestic needs (including drinking water).

The composition of animal and human excreta from wastewater (faces urine, manure, etc.) contains a number of organic, inorganic and microbescontaminants, which can adversely affect quality of well water. The increasing use of pesticides and chemical fertilizers has further aggravated the situation[6]. All these pollutants cause health problems because well water is the main source and is easily used for domestic use in all villages. Likewise, the geological nature of the area, which varies from one well to another, has an impact on the flow of water and pollutants into the well. Higher nitrate values in drinking water have adversely affected well water quality and its impact on human health[3,7] , Assessment of the water quality in terms of physical, chemical and bacteriological parameters for different uses is desirable. This is because water quality plays an important role in groundwater protection, quality conservation as well as sustainability. It is very important to assess the quality of water not only for its present use but also from the viewpoint of a potential source (s) of water for future consumption[6].

Water quality assessment requires collectingand analysingof datasets from different water quality parameters. A range of tools, the water quality index (WQI), physical, chemical, and biological, have been developed to evaluate the water quality of aquatic systems[2], This was supported by earlier research in which examined the water quality of six different wells in the city of Erbil and came to the conclusion that all of the wells are safe for consumption by humans[8]. Came to the conclusion that the water in the Dohuk lake dam is adequate for irrigation after assessing the trophic status and the water quality of the Lake water Due to the presence of a significant amount of sulfates and phosphorus[9].

The objective of the present study is to assess the physical and chemical variables of some well water in Fayda District and their suitability for drinking purpose. Geology of the study area:

1- Fragmental detritus: represented by small rocks fragments. The quaternary is represented by alluvial and diluvia deposit.

2- Kolosh: represented by alteration of clay marl, dolomite marl, and clay limestone polemicist sand stone.

3- Gecus: represented by an alteration of dolomite marl, marl dolomite and siltstone with some gypsum rocks.

4- Pelaspi limestone represented by slightly dolomite limestone and dolomite[10].

Materials and Methods

The Study Area Description

Well water samples were collected in Fayda district, south of Duhok city, Iraqi Kurdistan region. The study area includes many villages with a population of 500,000 people. The villages surrounding the study area all use water from drilled wells. Geographically, Duhok has an area of 10,715 km2 and is located between latitude 36°52'4.46"N and longitude 42°56'55.89"E. Duhok city is located in northwest Iraq and west of the Kurdistan Region,

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approximately 470 km north of Baghdad and at an altitude of 430-450 m above sea Fig. 1.

The Fayda region is known for its varied landscape, which includes a tall mountain (Zawah's mountain) as well as rough and complicated sections, yet the majority of the land is categorized as agricultural land. Because of this, numerous wells have been dug to irrigate farmland, and the region's geology is dominated by sedimentary rocks. The Köppen-Geiger classification of climate states[11] that Fayda, like the majority of cities in upper mesopotamia, has a hot summer climate with long, dry summers and short, chilly, wet winters. The colder months experience heavier rainfall, which is greatest in late winter and early spring. The rainy season is almost all over by late autumn.

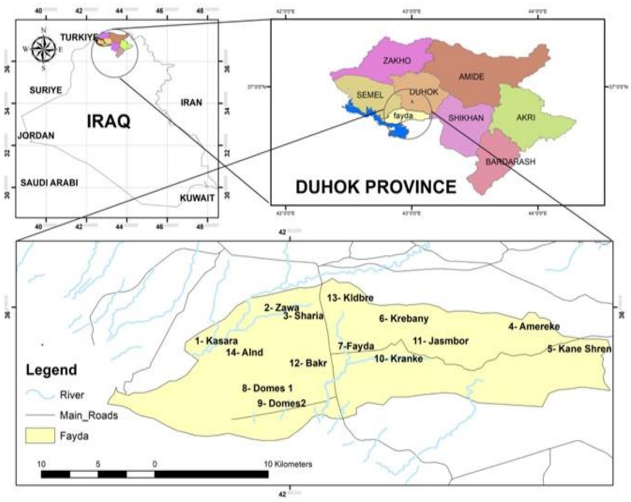

Figure 1. Study area (Fayda, Duhok, Iraq)

Sample Collection and Analysis

A total of 168 water samples were collected from 14 selected wells in Fayda District, Duhok Province, Kurdistan-Iraq Region. Fig. 1. Monthly samples were collected from March 2020 to February 2021. That is 1-Kasara, 2-Zawa. 3- Sharia, 4-Amreke, 5-Kane shren, 6-Krebany, 7-Fayda, 8-Domes1, 9-Domes2, 10-Kranke, 11-Jambor, 12-bakr, 13-Kldbreand, 14-Alnd. at different depths, ranging from 30 meters (Jumbor) to 85 meters (Zawha), and different water levels ranging from 20 meters to 72 meter, which varied from one well to another according to the geology of the area. Well water samples were collected in 1 liter polyethylene bottles, washed with detergent, acidified with 2% HNO_3 for 12 hours and rinsed with distilled water. Finally, all samples collected from the study area were labeled and stored in iceboxes at 4°C and tested for 12 chemical and physical parameters related to total alkalinity, temperature, pH, conductivity, total dissolved solids, turbidity, temperature, pH, alkalinity, NO_3^{-2}, Cl^{-1}, Ca^{+2} , SO_4^{-2}, dissolved oxygen and total hardness. According to standard procedures of [12]. Standard characteristics are recommended for well water quality by [13] and each survey site is identified to verify the suitability of water for domestic purposes in the study area. Temperature (T°C): was determined in the field due to their unstable nature. A mercury filled centigrade thermometer calibrated from 00 ◦C to 1000◦C was used for temperature measurements. Electrical conductivity (EC) in µs/cm: conductivity was estimated by electrical conductivity meter. Lonlab EC, TDS level HANNA instrument, WTW the prop was calibrated monthly by buffer solution, on the reading the conductivity values were converted to specific Conductivity at 25◦C. Total Dissolved solid (TDS) in mg/l: the amount of the total dissolved solids in water was estimated by TDS meter lonlab EC, TDS, level HANNA instrument WTW, Hydrogen ion concentration (pH), the pH was measured directly by using portable pH meter lonlab pH level 2, HANNA instrument , WTW pH meter was calibrated with three buffer solution of pH 4, 7 and 9. Dissolved oxygen (DO) in mg/l. Determination of oxygen was carried out according to the winklers methods (Azide modification).As describing by[12]. Total hardness (TH) in mg /l: Estimated of total hardness was made by titrating water sample against EDTA disodium salt with Eriochrome black T, indicator at pH 10 (using ammonium buffer), [12]. Total alkalinity (TA) in mg/l: was determined by titration with 0.02 N sulfuric acid. Chloride (CL^{-1}) in mg/l: was determined by argentometric titration method. Nitrates (NO_3^{-2}) in mg/l: Nitrate ions was measured according to[12] by using 2ml HCl (1N) added to the diluted sample (5ml of sample to 50ml deionized water), then measured by UV-spectrophotometer at wave length 220nm. model 6800 uv/vis, Jenway, Sulfate (SO_4^{-2}) in mg/l: was determined nepthalometrically using ELICO-52 Nepthalometer.

STATISTICAL ANALYSIS: Data on physicochemical parameters of well water samples were presented as standard deviation, mean, minimum and maximum values and analyzed using descriptive analysis.

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Calculating of Water quality index (WQI)
Is one of the best tools for monitoring surface and groundwater pollution and can be effectively employed in the execution of programs to improve water quality. Additionally, WQI can be used to gather data on water quality characteristics at various times and locations and convert this data into a single value specifying the relevant time and spatial unit[14]. We also applied the water quality index equation and compared the values with the table established by the World Health Organization for drinking water, to know the quality of water used by people in these areas, such as below [15].

$$WQI = \sum_{i=1}^{i=n} w_i \times q_i / \sum w_i$$

Where as:
wi: the relative weight of each adjective.

qi: A measure of the degree of quality for each adjective.

Table 1. Classification of drinking water quality according to WHO[16]

Water Quality Index Level	Water Quality Status
< 50	Excellent
50-100	Good
100-200	Poor
200-300	Very poor
> 300	Unsuitable

Results and Discussion

Water Temperature: The average water temperature value obtained from well samples ranges from 18.417 - 22.567°C as shown in the Fig. 2, applied for physical and chemical characteristics Temperature values obtained in well water in this project are similar as the study conducted by [17] the maximum value was observed at Baker site while the lowest value was observed at Kane Sheren site. Water temperature values for all well water samples were within the permissible limit according to [18] for drinking water of 25°C. We notice a difference in temperatures for all samples even though they were collected at the same time, and this can be explained by the fact that the characteristics of the well differ from one site to another in terms of geological nature, depth, and location.

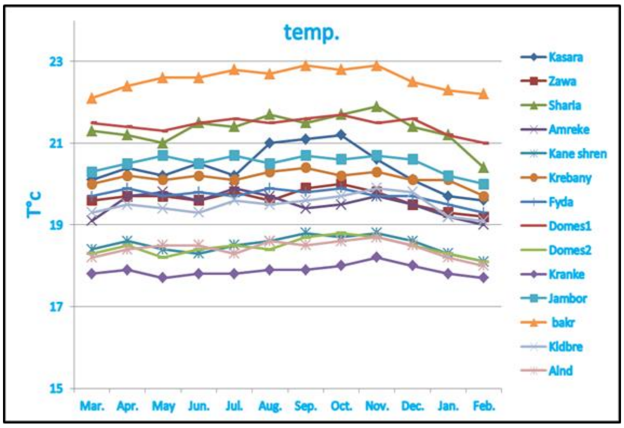

Figure 2. Temperature variation between selected wells water for the study period ◦C

Electrical conductivity: The average concentration of all samples ranged between 456.25 - 2300,000 µs/cm In most locations, as shown in the Fig. 3, measured conductivity concentrations showed that all water samples tested had concentrations above the allowable level according to [13] 1000 µs/cm. High conductivity concentrations in well water are due to high dissolved solids content. Therefore, high conductivity means high salinity which indicates high amount of dissolved substances in the water. The maximum value was observed at the Baker location while the lowest value was observed at the Alnd location. The EC values obtained in well water in this study were similar to those in the study conducted by [19].

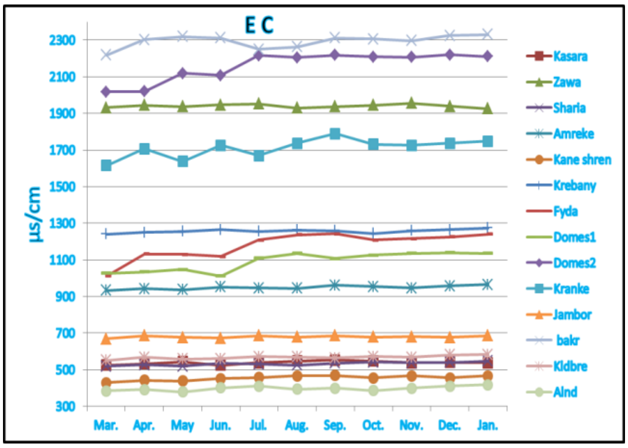

Figure 3. Shows variation in Electrical conductivity (EC), (µs/cm)

Total Dissolved Solids: Mean values (TDS) obtained from groundwater samples ranged from 295.33 - 2300 mg/L as shown in the Fig. 4, High concentrations of total dissolved solids due to water pollution occur when untreated sewage and wastewater from industrial and domestic areas are discharged into pits, lagoons and ponds, eventually seeping into water from wells. High total dissolved solids in well water can also be due to the dissolution of weathering substances from rock formation[20]. Excessive presence of (TDS) in water represents water pollution. These results are consistent with a study conducted[17]. The desired level for Total Dissolved Solids is 500 mg/l and the maximum level is 1,000 mg/l due to [18] regulations for living purposes. Most well water samples exceeded the WHO allowable limit 500 mg/L. Maximum total dissolved solids at the Kranke, Zawa, Domes2 and Baker sites were above the 1000 mg/L maximum limit which is indicative of salt water.

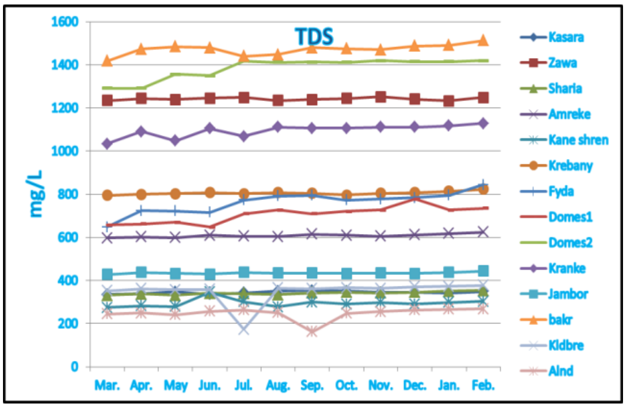

Figure 4. Total dissolved solids (TDS) variation between selected wells water for the study area

pH: The average concentration of ground water samples ranged between 7.675 - 8.39 as shown in the Fig. 5, The allowable pH concentration level for drinking water is specified in the range from 6.5 to 8.5 prescribed by [13]. The values of all well water samples were within acceptable limits according to WHO standards of 6.5 to 8.5 [18] . Changes in pH levels are due to geological formations, domestic waste, agricultural and seasonal changes. Most well water samples are slightly alkaline due to carbonate content. These results are consistent with a study conducted [21].

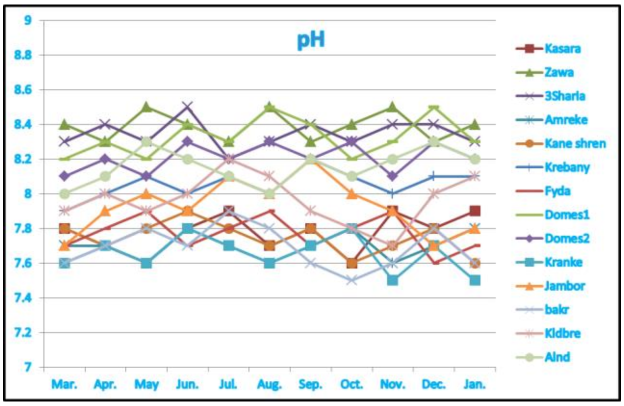

Figure 5.pH variation between selected wells water for the study period

Dissolved oxygen (DO) is the most important parameter for water quality and an indicator of water pollution. Low levels of DO in water indicate microbial contamination [22]. The average value of (DO) in well water samples ranged from 5.858 - 8.283 mg/L as shown in the Fig. 6, Based on analysis of the results, all well water samples had values (DO) within the acceptable level of the standard [18] for drinking water, 5 to 7 mg/L. These results are similar to the study conducted by [23]. The (DO) content in natural water decreases with increasing water temperature and high organic value due to microbial activity.

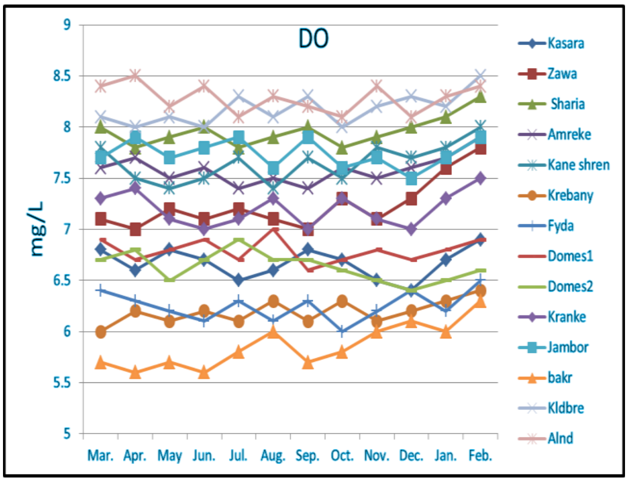

Figure 6. (DO) variation between selected wells water for the study period, (mg/l)

Total Hardness (as $CaCO_3$) Water hardness is due to the presence of magnesium ions (Mg^{+2}) and calcium ions (Ca^{+2}). The average value of (TH) recorded in water samples was between 204.08 - 1363.92 mg/L as shown in the Fig. 7, The higher water hardness value in well water may be due to the dissolution of dolomite and gypsum rocks,

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which cause water hardness. The allowable limit for total hardness in beverages is 300 mg/L and the maximum allowable limit (TH) for drinking water is 500 mg/l according to[18], for the standard about potable water. The (TH) value exceeded the allowable level of 300 mg/L at most sampling points. While the Krebany, Fayda, Domes1, Kranke and Bakr locations all exceeded the maximum allowable limit. According to this result, the water from the well is very hard. In this article, the level was lower than that reported by [24].

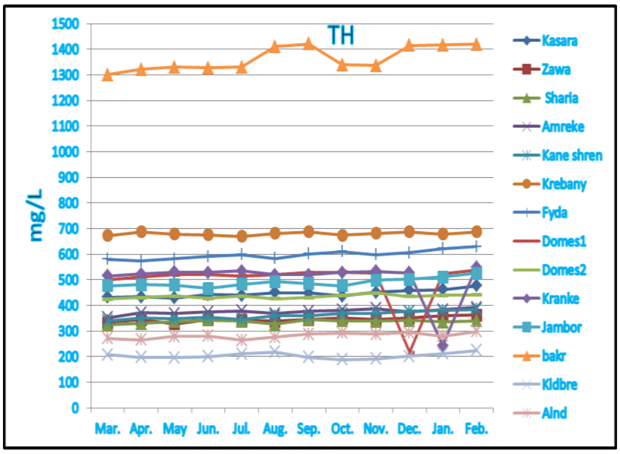

Figure 7. Total hardness (TH) Variation between selected wells water for the study period, (mg/l)

Calcium hardness: Both calcium and magnesium cause hardness in water, in this study the average value of calcium ranged from 122.67-622.05 mg/l., the permissible limit of calcium in drinking water is 75 mg/l.The results indicate that all sites exceeded the concentration of calcium from their desirable limits as per WHO of 75 mg/l. Fig. 8, show the high values of calcium hardness recorded in Krebany, Fyda, Domes1, Kranke and Baker site in the study area. (Ca^{+2}) can naturally occur in groundwater through the dissolution of carbonate minerals and the decomposition of sulfate, phosphate, and silicate minerals The (Ca^{+2}) concentrations obtained in this study were similar to those in the study conducted by[25].

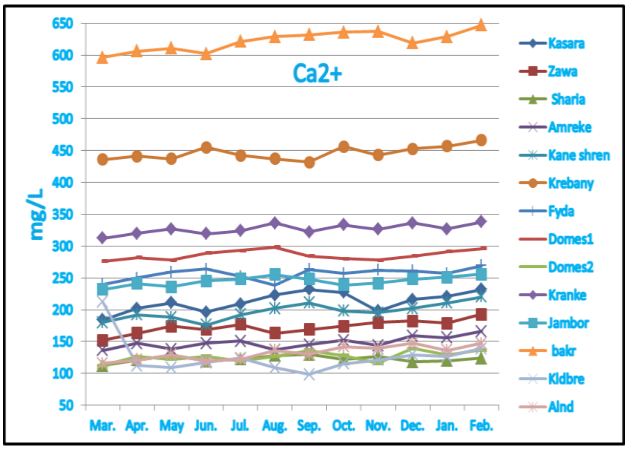

Figure 8. Calcium hardness variation between selected wells water for the study period, (mg/l)

Magnesium hardness: The concentration of magnesium hardness in the well water samples ranges from 85.33-747 mg/l. Fig. 9 shows the distribution of (Mg^{+2}) in the study area. High magnesium values were observed at the sites Krebany, Fayda, Domes1, Kranke and Baker from regional study. The results indicate that all sites exceeded the concentration of magnesium from desirable limits as per WHO of 30 mg/l. The maximum permissible limit of Mg^{+2} concentration of drinking water is specified as 100 mg/l. The Iraqi drinking water standard has less than 50 mg/L Mg. Increasing of Mg^{+2} may be due to continuous weathering of aquifer material[1, 25].

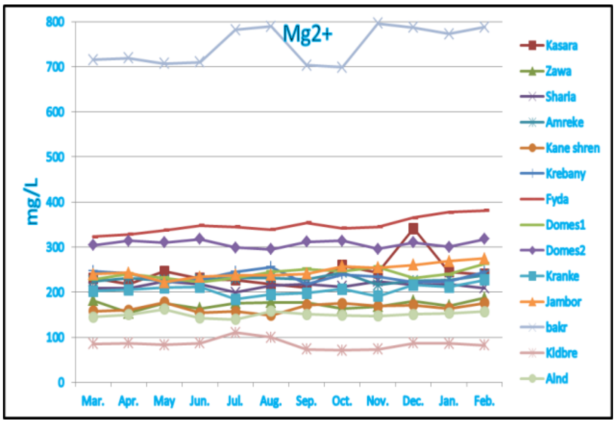

Figure 9. Magnesium hardness between selected wells water for the study period, (mg/l)

Chloride ion: The average concentration of Cl^{-1} in water samples ranged between 12.842 - 100.100 mg/L as shown in the Fig. 10, The Cl^{-1} values observed in all water samples were within the (WHO) permissible limit [13] for drinking water, 250 mg/L. These changes in value may be due to

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differences in geographical formation. Higher chloride values in well water can be caused by pollution sources such as septic tanks and domestic wastewater [26].

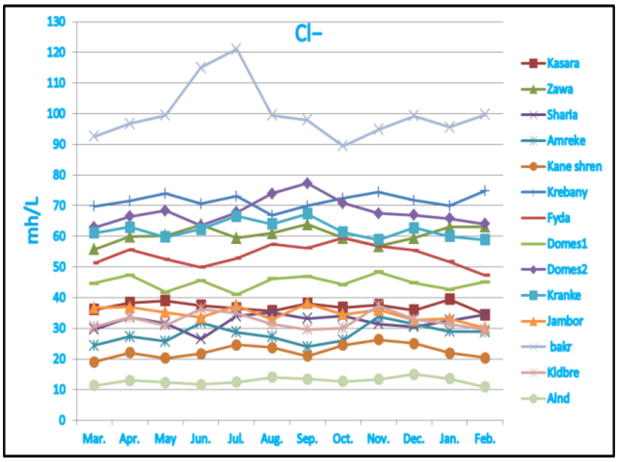

Figure 10. Chloride variation between selected wells for the study period, (mg/l)

Total alkalinity: The average value of well water samples ranged between 204.42 - 435.75 mg/L as shown in the Fig. 11, The alkalinity of water is usually due to the presence of carbonates and bicarbonate hydroxides, which include potassium, sodium and calcium. According to [18], the desired limit and maximum allowable limit of (TA) in drinking water are 200 and 600mg/l. Total alkalinity is within the maximum allowable limit value of the standard [13]. In this article, the number is higher than that reported by [27].

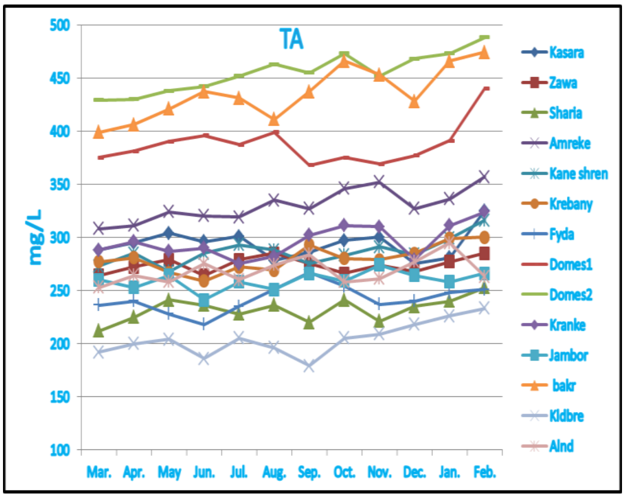

Figure 11. Total alkalinity variation between selected wells for the study period, (mg/l).

Nitrate (NO_3^{-2}): Nitrate is produced by fertilizer and chemical plants, fruits and vegetables, animals, and domestic and industrial waste. Nitrate concentrations in ground water samples ranged from 2,200 - 7.350 mg/L as shown in the Fig. 12, NO_3^{-2} is stable and highly soluble in water and can be easily transported through soil to well water. All groundwater sample concentrations were within the permissible limit [18] or 45 mg/L for drinking water. According to WHO (World Health Organization), drinking water should not contain more than 50 mg/L of nitrate. High nitrate values in well water in rural areas are due to leachate from the on-site sanitation system (septic tank).

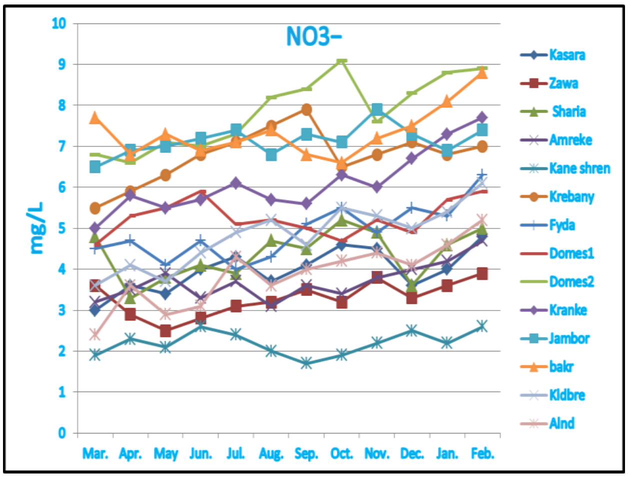

Figure 12. Nitrate between selected wells water for the study period, (mg/l)

Sulfate (SO_4^{-2}). Sulfate is the result of H_2S oxidation by certain bacterial activities such as Thiobacillus thiooxidans and their minerals. Sulphate may come into well water by anthropogenic additions in the form of Sulphate fertilizers or industrial. The sulphate concentration of well water samples for all locations lie within the permissible limits of 250 mg/L [27]. The average concentration of SO_4^{-2}, recorded in well water samples, ranges from 20,450 - 200,833 mg/L as shown in the Fig. 13, Sulfate concentration within the limit allowable is 250 mg/L [13]. In this paper, they are lower than reported by [22].

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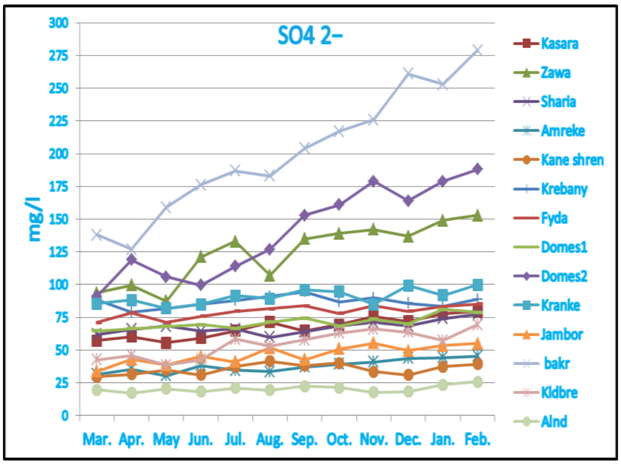

Figure 13. Sulfate variation between selected springs for the study period, (mg/l)

Turbidity: Turbidity is a measure of the degree to which water loses its transparency due to the presence of suspended particles. In this study, the turbidity concentration of ground water samples ranged from 1.200 - 3.225 NTU as shown in the Fig. 14, The recorded turbidity concentration shows that all well water samples have values within the allowable limit according to [18] for drinking water below 5 NTU.

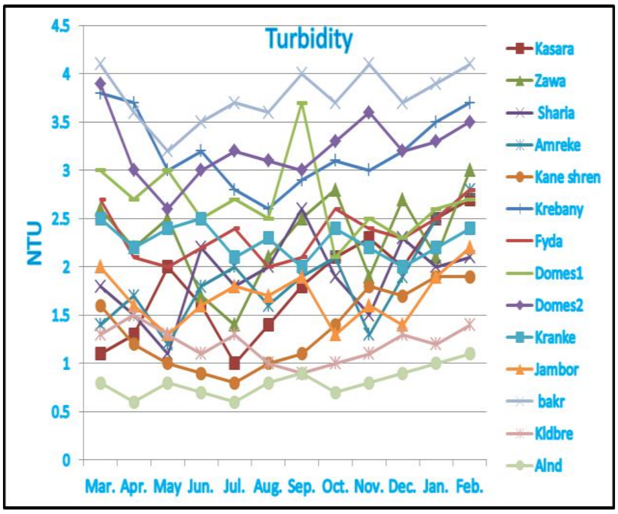

Figure 14. variation of Turbidity among the studied wells during the study period (NTU).

Through recorded water quality index values, well water in the Bakr region exceeds 100 in all seasons of the year, the lowest value is 167.33 in May and the highest is 183.32 in February. The wells in Krebany, Fayda, Domes 1, Domes 2, Kranke and Jambor all exceeded the water quality index value of 100, but they were less polluted than the wells in the Bakr region. Therefore, these wells are considered polluted and unfit for consumption Table 1and 2.

According to the water quality index, these wells are classified as poor, which can be explained by the geological nature of this area and the influence of sedimentary rocks on well water, which increases electrical conductivity due to the Elevated cation measurements affect taste and smell. Thus having a significant impact on user acceptance of potable water [28].

This is an indirect measure of the total amount of dissolved salts as well as the distance between the wells and the Mosul Dam Lake, which can influence the properties of the well water. The observed alkalinity values were significantly higher than the permissible levels recommended by the WHO for drinking water [29] and it was reported that wastewater pollution and its decomposition appeared to be the likely cause. can lead to high alkalinity values in water.

Total hardness (TH) is also an important parameter evaluating water quality, whether it is used for domestic, industrial or agricultural purposes. Results obtained from water analyzes carried out within the framework of this investigation show that TH values are generally higher than the minimum allowable levels recommended by WHO for drinking water. The results clearly show that the concentration of SO_4^{-2} and NO_3^{-2} in Fayda well water increased significantly. For this reason, these wells need to be filtered and treated chemically and physically before being put into use.

Generally, increasing the value of the water quality index is considered a negative indicator due to the increase in concentrations of pollutants present in the water, which in turn negatively affects human health and causes many problems such as poisoning, urinary tract infection and the formation of stones and Urinary Cast in the kidneys and bladder. There are numerous studies that support this, including one by Tariq that assessed different liquid industrial wastes in the Hayatabad Industrial Area of Peshawar. Tariq looked at the potential effects of these liquid wastes on the quality of groundwater and came to the conclusion that the characteristics of the liquid wastes discharged from different industries varied and they posed a threat. possible contamination of the groundwater[30,31] .Al-Safawy also did research on the groundwater's

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quality in the Nineveh Governorate's Al-Kasak region. To show the water's compatibility, the Water Quality Guide was used to classify the well water's quality in accordance with international standards. Since the majority of the standards that were measured yielded extremely high results, the water quality was deemed unfit for human consumption human[32]. As for practical applications, small stations must be established or built to filter and purify well water before using it for drinking, and continuous testing of the water must be conducted to ensure that it is free of harmful pollutants.

Table 2. WQI value for all wells water

Months / Sites	**Mar.**	**Apr.**	**May**	**Jun.**	**Jul.**	**Aug.**	**Sep.**	**Oct.**	**Nov.**	**Dec.**	**Jan.**	**Feb.**
Kasara	93.27	93.64	100.7	97.07	92.90	95.14	98.68	102.90	102.62	106.44	104.84	**108.28**
Zawa	100.47	96.07	100.82	94.11	93.49	97.94	100.03	102.50	96.65	102.65	99.46	**107.76**
Sharia	97.18	95.25	94.18	101.89	96.40	99.59	104.42	98.67	97.29	102.08	100.37	**101.09**
Amerke	94.38	98.12	93.53	98.72	99.62	96.62	98.54	102.40	94.48	99.39	104.18	**107.97**
Kane shren	100.02	89.20	94.31	86.84	87.47	87.12	90.80	91.57	95.32	94.90	95.92	**97.31**
Krebany	121.76	121.39	115.41	118.02	116.16	116.01	115.87	118.97	116.94	120.46	120.96	**124.069**
Fayda	111.84	108.63	108.60	109.95	112.05	108.44	111.42	113.07	112.44	113.02	114.98	**118.1**
Domes 1	113.43	112.38	113.92	111.41	112.37	113.88	119.87	108.81	112.40	104.96	112.61	**116.83**
Domes 2	117.74	119.90	109.66	114.16	114.82	113.86	114.46	116.84	116.08	115.26	115.13	**118.12**
Kranke	106.69	106.15	106.57	107.49	103.11	105.76	103.25	108.41	104.43	104.70	101.58	**111.35**
Jambor	104.38	103.53	99.89	102.32	105.52	103.78	106.87	101.90	104.43	102.28	107.85	**110.24**
Bakr	171.59	169.38	167.33	168.90	176.81	178.10	174.33	171.31	181.16	179.17	179.52	**183.32**
Kldbre	84.60	83.19	81.50	81.97	85.25	79.92	78.15	78.62	80.95	83.87	83.18	**86.21**
Alnd	85.02	85.03	87.12	85.59	83.07	86.81	87.40	85.44	87.15	87.92	88.74	**90.32**

Conclusion

Assessing water quality is the main factor determining the level of pollution. The WQI for the 168 samples ranged from 78.15 to 183.32. Krebany, Fayda, Domes 1, Domes 2, Kranke and Jambor wells all exceeded the water quality index value of 100. About 61.3% of water samples were of poor quality.

Most wells are in a serious state of pollution. This means that water in most places is undrinkable. Total hardness and total dissolved solids exceed the maximum allowable limit of 500 mg/l according to WHO, which can be harmful to health in the long term. Analysis shows that well water in the study area needs to be treated to a certain extent before being used. Based on the results and analysis of water samples, it is recommended to use water only after boiling and filtering or by Reverse Osmosis treatment for drinking purpose by the individuals. However, for other domestic purposes, water can be used if the WQI shows status of water quality either good or excellent. It is thus recommended that wastewater treatment plants must be established. Further, efficient environmental laws and social awareness program must be undertaken for inhabitants of the estate and in the surrounding area with respect to potential threat the environment.

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Authors' Declaration

- Conflicts of Interest: None.
- We hereby confirm that all the Figures and Tables in the manuscript are ours. Furthermore, any Figures and images, that are not ours, have been included with the necessary permission for re-publication, which is attached to the manuscript.
- The author has signed an animal welfare statement.
- No human studies are present in the manuscript.
- Ethical Clearance: The project was approved by the local ethical committee at University of Zakho.

Authors' Contribution Statement

Each of the three researchers shared the research and worked together for the success of the research plan. Each of the researchers, Ms. Marwa and Mr. Musher, collected the samples monthly and brought them to the laboratory and conducted chemical and physical tests. As for Mr. Rami, in cooperation with Mr. Musher, he wrote the research and analyzed the results, as Mr. Rami performed the largest part. From analysis and follow-up to publishing the research in your magazine, Baghdad Magazine.

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تقييم نوعية مياه الآبار للاستخدام المنزلي في ناحية فايدة، جنوب محافظة دهوك، إقليم كردستان – العراق

مشير رشيد أحمد، رامي نافع سليم، مروة مشير رشيد

قسم علوم البيئة، كلية العلوم، جامعة زاخو، العراق.

الخلاصة

اجريت هذه الدراسة لغرض قياس جودة المياه في أبار منطقة فايدة عن طريق قياس مؤشر جودة المياه على أساس معايير كيميائية وفيزيائية تم قياسها باستخدام الأجهزة والتقنيات الحديثة، وأيضاً باستخدام الطرق الكلاسيكية التقليدية, تم جمع وتحليل 168 عينة بناءً على عدة عوامل تشمل: درجة الحرارة، ودرجة الحموضة، والتوصيلية الكهربائية، والاملاح الكليه الذائبه، والعكورة، والقلوية، و NO_3^{-2} و Cl^{-1}، Mg^{+2}، Ca^{+2}، SO_4^{-2} ، الاوكسجين المذاب العسرة. وكانت نتائج عينات مياه الآبار على النحو التالي: درجة الحرارة، 18.417 إلى 22.567 درجة مئوية؛ الاس الهيدروجيني، 7.675 إلى 8.39، الأوكسجين المذاب، 5.6858 إلى 8.283 ملغم /لتر، العكورة، 1.200 إلى NTU 3.225، التوصيلية الكهربائية، 456.25 إلى 2300.00 مايكروسيمينز/ سم، العسره الكلية، 259.33 إلى 1471ملغم / لتر، الاملاح الذائبة، 204.08 إلى 136 ملغم / لتر، القلوية الكلية، 204.42 إلى 435.75 ملغم/لتر، الكالسيوم، 122.67 إلى 622.08 ملغم/لتر، المغنيسيوم، 85.33 إلى 747ملغم/ لتر، كلوريد، 12.842 إلى 100.100ملغم/لتر، كبريتات، 20.450 إلى 200.833 ملغم/لتر، والنترات، 2.200 إلى 7.350ملغم/ لتر.و مؤشر جودة المياه في مناطق بكر 167.33 –183.3، كريباني 115.41–124.069، فايدة 108.44–113.07، دوميز 1 104.96–119.87، دوميز 2 109.66 –119.90 ومنطقة كرانكي 101.58 –111.35 وجمبور 99.89 –110.24 كانت أعلى من الحدود المسموح بها وفقًا لمعايير منظمة الصحة العالمية لمياه الشرب. وتراوح مؤشر جودة المياه (WQI) للعينات الـ 168 من 78.15 إلى 183.32. وتجاوزت جميع آبار كريباني وفايدة ودوميز 1 ودوميز 2 وكرانكي وجمبور قيمة مؤشر جودة المياه البالغة 100. وكانت حوالي 61.3% من عينات المياه ذات نوعية رديئة لأغراض الشرب.

الكلمات المفتاحية: القياسات الفيزيائية والكيميائية، دليل جودة المياه، قرى فايدة، ملوثات المياه، مياه الابار.