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ARTICLE

Assessment of Groundwater Quality and Suitability for Irrigation Purpose in Northern Babil Governorate

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ABSTRACT

Groundwater is considered a vital source for agriculture, especially in areas that suffer from a shortage of surface water resources. Accordingly, this study was conducted to evaluate the concentrations of some polluting elements and some chemical properties of well water north of Babylon city to show its suitability for irrigation purposes. The (pH, EC, calcium, magnesium, sodium, potassium, chloride, carbonates, bicarbonates, sulfates, nitrates, and boron) and some heavy elements (cadmium, lead, copper, and nickel) were estimated over four time periods (July 2023, October 2023, January 2024, April 2024) and for the regions (Latifiya, Al-Musayyab, Haswa, and Alexandria). The results showed that the electrical conductivity of well water falls within the category that causes a severe salinity problem, according to Ayera and Westcot, and the pH of the water was within the normal range, tending toward light alkalinity. The sodium values fell within the category that causes a severe problem, and that the chloride concentrations were high and within the category of water that causes a severe problem according to the classification of Marsh. The concentration of boron was low to moderate for sensitive crops. Regarding the nitrate content, well water is classified as no problem. The concentrations of all heavy metals were within the permissible limits, except for cadmium, which exceeded the permissible limits according to the global specifications of the World Health Organization.

Keywords: Heavy Metals; Water Pollution; Groundwater; Cadmium; Alkalinity

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1. Introduction

Groundwater is considered one of the basic sources for residential complexes, especially when surface water is limited or non-existent. It is no wonder that villages and cities develop and flourish around these water sources [1]. As approximately 18 million people live in the United States of America depending on 613 groundwater sources, 67% of them supply approximately 2.8 million people directly without filtering or sterilizing them, which leads to them contracting various diseases [2]. As for Iraq, the percentage of wells used for drinking purposes is about 75% out of a total of 2454 wells, noting that only 38% of them are suitable for drinking [3]. This is in terms of domestic uses and drinking, but in terms of using well water for agricultural purposes, the quality of irrigation water is one of the basic factors that affect the productivity of agricultural crops, in addition to its direct impact on the growth of agricultural crops through its effect on the chemical and physical characteristics of the soil [4]. Well water in general contains varying percentages of dissolved salts, and therefore studying its quality is very necessary to know the problems that may result from its use in irrigating agricultural lands, especially since groundwater is affected by the quality of the rocks and salts that it passes through in the interior of the earth's crust. It is also affected by the quality of the surface water from oceans, seas, lakes and rivers, in addition to atmospheric humidity [5]. The tremendous development in the agricultural and animal fields and the establishment of industrial and population centers around wells has increased the problems of their pollution and has become a health threat to the consumers of the water of these wells. The penetration of sewage water and industrial waste through the soil into the aquifers is a dangerous source of groundwater pollution and deterioration of its quality [6]. The absence or poor quality of sewage and drainage networks in the city of Babylon led to a rise in groundwater levels, making it more vulnerable to pollution and salinization. Many studies have shown that the water quality of most wells located in Babylon Governorate differs in their classification and characteristics, chemical and environmental. From this standpoint, this study aims to estimate some chemical properties and some heavy elements in well water and evaluate its suitability for irrigation purposes.

Surface water is a valuable natural resource that currently suffers from multiple problems, including natural factors such as increased evaporation and low rainfall, in addition to human impacts such as the discharge of liquid waste into it without prior treatment. Water pollution is one of the most serious environmental threats we face today, and occurs when toxic substances enter rivers, where they dissolve, suspend, or settle in the water, leading to a decrease in water quality [7].

The importance of studying the quality of irrigation water lies in the fact that irrigation water, regardless of its sources, contains different concentrations of dissolved salts, and that many of the current problems of irrigation agriculture in many parts of the world are a direct result of the salts accumulated in the soil, the source of which is the added water. Likewise, the importance of studying the quality of irrigation water comes from the fact that it determines whether this type of water causes toxicity to plants and agricultural crops when irrigated. Thus, it is useful in determining the necessary management methods that must be carried out to avoid and reduce the damage resulting from the use of this type of water. The general drain is one of the major development projects in Iraq due to its great importance in serving agricultural lands estimated at 1.5 million hectares by using its water in addition to its role in transporting millions of tons of salts annually from the drains to the Arabian Gulf and reducing the pollution of the Tigris and Euphrates rivers with the drain water that was poured into them before the start of work on the general drain, which is one of the main important sources in our country that can be used for agricultural development purposes with good management in a way that limits its damage and studies its quality and evaluates the state of pollution with heavy elements according to the approved international classifications and employs some environmental indicators to evaluate its suitability for consumption and irrigate crops according to its content of environmental pollutants that are dangerous to the health of living organisms, whether plant or biological, which reach them directly and indirectly through ecosystems such as soil, water and air. Therefore, according to the Ministry of Higher Education's orientation towards addressing the problem of water scarcity, this project was chosen for the current study.

As for soil pollution, it is defined as the presence of substances at higher than normal concentrations, especially heavy elements, which are a major problem because they are non-degradable in the soil, and most of them cause a toxic effect on plants and living organisms. The most important sources of these elements include original materials, industrial waste transmitted through the air, fertilizers, pesticides, and sewage[8].

Heavy elements are natural elements whose density is at least five times higher than the density of water, and they are used in various fields such as agriculture, industry, and medicine. Plant, animal, and human tissues contain some of these elements, such as copper and zinc, in natural, non-toxic quantities that help the body perform its functions. However, toxicity occurs when an organism absorbs excessive amounts of these elements.

It is estimated that about 80% of global wastewater and industrial wastewater is discharged into surface waters without any prior treatment, especially in less developed countries that lack adequate treatment facilities. Part of this water is used for crop irrigation, leading to the accumulation of heavy elements in surface waters, soil, and plants. For this reason, there has been increased interest in pollution problems that may be transmitted to humans through drinking water or the food chain through contaminated plant and animal products, causing multiple health risks.Therefore, it is important to conduct studies to identify the sources of heavy element pollution, assess the degree of environmental pollution, and evaluate potential environmental and health risks. Solutions and treatments for the causes of this pollution must also be proposed, and efforts must be made to control it. Many agricultural areas suffer from a shortage of irrigation water needed to meet the needs of agricultural crops. Although water provision is a challenge, its quality plays a crucial role in achieving sustainable productivity. Poor quality or polluted water negatively affects the physical and chemical composition of the soil, leading to a deterioration in the quantity and quality of crops. Refined Research Objectives: Quantify seasonal fluctuations (July 2023–April 2024) in physicochemical parameters (pH, EC, Na^+, Cl^-, NO_3^-, B) affecting irrigation suitability in northern Babil's groundwater. Assess heavy metal concentrations (Cd, Pb, Cu, Ni) against WHO thresholds to identify contamination risks. Classify water suitability using FAO/Ayers-Westcot criteria and Marsh Sodic Hazard indices, emphasizing cadmium's unique threat in an already salinity-stressed context.Provide actionable recommendations for farmers and policymakers to mitigate risks, particularly for cadmium-sensitive crops.

2. Materials and Methods

2.1. Study Area

The study area included four areas located north of Babylon city, namely Latifiya, Musayyib, Haswa and Alexandria, to study the specifications of well water according to[9, 10] the coordinates in **Table 1**.

Table 1. Study site coordinates.

	Location	N	E
1	Latifiya	44.352964	32.985834
2	Musayib	44.278565	32.766936
3	Haswa	44.393154	32.879743
4	Alexandria	44.352665	32.895946

2.2. Water Samples

Water samples were taken for the period from 1-7-2023 to 1-4-2024, in four seasons: (July–October) 2023–(January–April) 2024. The electrical conductivity and pH readings were taken immediately after taking the samples and were placed in plastic bottles. It was stored until tests were performed on it.Samples were collected according to the facts mentioned in the study, where each study site was collected over a full year, during the period . Samples were collected using sealed plastic bottles that were washed with sample water before filling them with it.

All samples were filtered using filter paper, and coloring materials were added to them to prevent fungal growth, in order to estimate negative and positive ions. Nitric acid was added only to samples designated for the estimation of heavy elements, to prevent their precipitation. Samples were stored at a temperature of 4 °C in the refrigerator until the required analysis was performed.

In addition, additional samples (4 replicates) were collected during July and September (2022), and were transferred directly to the laboratory for the purpose of estimating the biological and chemical oxygen demand (BOD and COD).

2.3. Laboratory Work

Chemical analyses were conducted according to the methods in[11–13]. As for the total heavy metals (lead, cobalt, nickel and zinc), they were estimated according to the method described by (Norvell and Lindsay, 1978) using an atomic absorption spectrophotometer and according to the wavelength of each element. The suitability of well water for irrigation purposes was evaluated based on the [14] classification in addition to the determinants mentioned by researchers [15] to indicate its suitability for agricultural purposes.

2.4. Field Analyses of Water Samples

The water temperature of the study sites was measured in the field during the sample collection process, between (8–12) am using an electronic meter dedicated to measuring the temperature in the water, by immersing it for two minutes. The degree of reaction (pH) was also measured using a pH meter, and the electrical conductivity was measured using an EC meter. In addition, total solids were measured using a TDS meter, and dissolved oxygen using a DO meter, all of which are portable field devices.

2.5. Laboratory Analyses of Water Samples

Laboratory water analyses were conducted in the laboratory of the Department of Soil Sciences and Water Resources and the Central Laboratory. Some analyses were also conducted in the Water Laboratory of the Environment Department, according to the methods described by and the American Public Health Association.

2.6. Dissolved Cations and Anions [16]

- Calcium (Ca^{2+}) and magnesium (Mg^{2+}) ions:
  Were determined using the titration method with EDTA (0.01 M), with different indicators; E.B.T. indicator for magnesium and ammonium molybdate indicator for calcium after adjusting the reaction rate.
- Potassium (K^{+}) and sodium (Na^{+}) ions:
  Were determined using a flame photometer.
- Carbonate ($–CO_3{}^2$) and bicarbonate ($–HCO_3$) ions:
  Were determined using the titration method with dilute sulfuric acid (0.01 M), with phenolphthalein indicator for carbonate and methyl orange indicator for bicarbonate.
- Chloride ions (–Cl):
  Estimated using the titration method with silver nitrate ($AgNO_3$ 0.005 M), using potassium chromate indicator (K_2CrO_4).
- Sulfate ions ($–SO_4{}^2$):
  Estimated using the precipitation method with barium chloride ($BaCl_2$) in acidic medium to form a turbid barium sulfate complex. The intensity of turbidity was measured using a spectrophotometer at a wavelength of 492 nm.
- Nitrates ($–NO_3$):
  Estimated using a spectrophotometer by taking 10 mL of the sample and adding 2 ml of hydrochloric acid (HCl 1N), then measuring the absorbance at a wavelength of 206 nm.
- Phosphate ($–PO_4{}^3$):
  It was determined by taking 50 ml of the sample and adding 2 ml of ammonium molybdate ($(NH_4)_2MoO_4$), followed by drops of stannous chloride ($SnCl_2$) until a blue complex was formed. The intensity of the color absorption was measured using a spectrophotometer at a wavelength of 690 nm.

2.7. Estimation of Heavy Elements

Heavy elements (Copper Cu, Zinc Zn, Lead Pb, Cobalt Co, and Nickel Ni) were estimated using a German-made Atomic Absorption Spectrophotometer, model GBC 933plus. These measurements were made in the central laboratory.

2.8. Estimates of Water Sample Properties

2.8.1. Total Dissolved Salts (TDS)

It was estimated by taking an appropriate volume of water samples (10 ml) after shaking the sample well. The sample was placed in a dry, clean, and known-weight ceramic bowl (b). The sample was dried at (105) °C for 24 hours, and the bowl was weighed again (a) and the amount of total dissolved solids was calculated through the difference in the bowl weight.

= (a – b)×103/ V of sample T.D.S (mg L^{-1})

Hydrogen (pH): The soil reaction value was measured using a pH meter according to the method described.

Electrical conductivity (ECw): The electrical conductivity was measured using an EC meter according to the method described in (954).

2.8.2. Soluble Ions

Soluble ions (Cations and Anions): The dissolved positive and negative ions were estimated according to the methods mentioned in [16] as follows:

• Carbonate and bicarbonate ions: Estimated by titration with 0.01N H_2SO_4 in the presence of Phenolphthalein and Methyl Orange indicators.

• Chloride ions: Estimated by titration with silver nitrate ($AgNO_3$) and using potassium dichromate ($K_2Cr_2O_7$) indicator.

• Sulfate Ion: Estimated by precipitation using barium chloride ($BaCl_2$).

• Calcium Ion: Estimated by titration with ferrous sulfate solution (0.01N) Na^{2-} EDTA and using Murexide indicator.

• Magnesium Ion: Estimated by titration with ferrous sulfate solution and using Erichrome Black indicator.

• Sodium and Potassium Ions: Estimated using a flame photometer.

• Nitrate: Estimated using chromotropic acid.

• Boron: Estimated by the colorimetric method (Carmine) using a spectrophotometer.

Estimation of heavy metals concentration in water samples

Heavy metals (lead, cadmium, copper and nickel) were measured using an atomic absorption spectrophotometer.

Estimation of some chemical and physical properties of soil, including:

• Soil reaction (pH): The soil reaction value was measured using a pH meter according to the method described in [16].

• Electrical conductivity (ECe): The electrical conductivity of soil samples in the saturated paste extract was measured using an EC-meter according to the method described in.

• Soluble ions and anions:

Soluble ions and anions are estimated according to the methods described in [16] as follows:

• Carbonate and bicarbonate ions: Estimated by titration with 0.01N H_2SO_4 in the presence of Phenolphthalein and Methyl Orange indicators.

• Chloride ions: Estimated by titration with silver nitrate ($AgNO_3$) and using potassium dichromate ($K_2Cr_2O_7$) indicator.

• Sulfate ions: Estimated by precipitation with barium chloride ($BaCl_2$).

• Calcium ions: Estimated by titration with ferrous nitrate solution (0.01N) Na^{2-} EDTA and using Murexide indicator.

• Magnesium ions: Estimated by titration with ferrous nitrate solution and using Erichrome Black indicator.

• Sodium and potassium ions: Ions were measured in soil samples using a flame photometer.

• Volumetric distribution of soil particles: The hydrometer method was used as described in [16].

• Soil organic matter (SOM): It was measured by wet digestion according to the Walkley and Black method and as mentioned in [16].

• Mineral carbonate minerals: It was measured by calcemeter [16].

• Cation exchange capacity (CEC): It was measured by saturation with sodium oxalate as mentioned in [16].

3. Results and Discussion

3.1. Chemical Properties of Well Water

3.1.1. Electrical Conductivity

The results shown in **Figure 1** showed that the well water varies in terms of the concentration of salts in it according to the location and date of the sample, ranging between (3.5–9.5) ds m^{-1}. This difference between the wells may be attributed to the difference in salinity of the water of the nearby drains, and it becomes clear that salinity values decrease in January 2024 than compared to July 2024, and the reason for this is attributed to water scarcity, as it leads to an increase in salinity. As for the month of January, dilution processes increased as a result of the release of water into nearby rivers, as well as rainfall and when water is classified. According to the classification of [14, 15], the salinity of all wells falls within the category that causes a severe problem.

It is also clear that salinity values decrease in December compared to June, due to the scarcity of water in the Tigris and Euphrates rivers in the latter, which led to farmers using the general estuary water for irrigation purposes through irrigation randomly and without checking the side effects that this procedure could have in the long term and the increase in soil salinity. As for December, dilution operations increase as a result of the increased water releases in the Tigris and Euphrates rivers, and consequently the decrease in water salinity concentration.

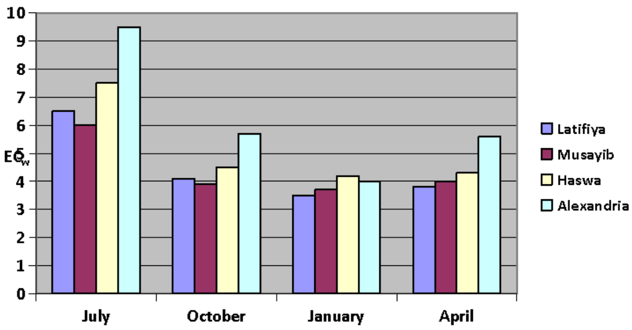

Figure 1. Electrical conductivity in the study wells.

3.1.2. Sodium Adsorption Ratio

The results of **Figure 2** indicate that the values of the sodium adsorption rate vary seasonally and locally, as a relative increase is observed in the months of July and October compared to January and April. This may be attributed to the behavior of the sodium adsorption rate consistent with the behavior of the electrical conductivity values and the increase in the rate of sodium ions to calcium and magnesium, and when classifying water according to the classification of[14], the results indicate that the class falls between an increase in the problem and a severe problem.

Magnesium is an essential element for living organisms, as it plays a fundamental role in the synthesis of chlorophyll and photosynthesis, and contributes to the activity of enzymes in plants. In addition, it plays an important role in the synthesis of nucleic acids and in maintaining blood vessel tension in humans.

Despite the importance of magnesium for plants, increasing its concentration in irrigation water leads to a decrease in the concentration of potassium and calcium in the plant due to competition or ion antagonism in the soil and plant cells. Also, increasing the concentration of magnesium leads to water hardness, which may cause negative health effects on humans, such as cardiovascular diseases. The results shown in **Figure 2** show that the lowest value of the seasonal average of magnesium concentration was recorded at the site during the winter, where the concentration reached (25 mg L^{-1}). As for the highest value, it was recorded at the Al-Busif site during the fall, with a concentration of (45 mg L^{-1}).

This may be attributed to the increase in the ratio of sodium ions to calcium and magnesium as we move towards the south, as it is clear from this that the behavior of the sodium adsorption ratio is consistent with the behavior of the electrical conductivity values. When classifying the water according to the American Salinity Laboratory classification it falls within the category (C4S1–C4S2) within the index of the sodium adsorption ratio and electrical conductivity.classification, it falls within the category of weak (Poor) to very weak (Very poor), with the exception of the Shomali sample for the month of June, which falls within the category of unsuitable (Unsuitable). According to the[14] sodium classification, the results indicate that it falls within the category of a severe problem for sensitive plants. The adjusted sodium adsorption ratio was also calculated to determine the problem of sodium, as it takes into account the possibility of calcium or magnesium precipitation from irrigation water when it comes into contact with the soil for all water samples and different sites. indicates that 15 Adj. SAR values ranged between (11.42–30.32) and thus are higher than the normal SAR values and the reason may be due to the concentration of calcium ions adjusted according to the ratio of HCO_3/Ca^{+2} present in the water, as calcium tends to precipitate in the form of calcium carbonate which reduces its concentration and this leads to a relative increase in Adj.SAR values, and the water is classified as a severe problem according to the classification[15].

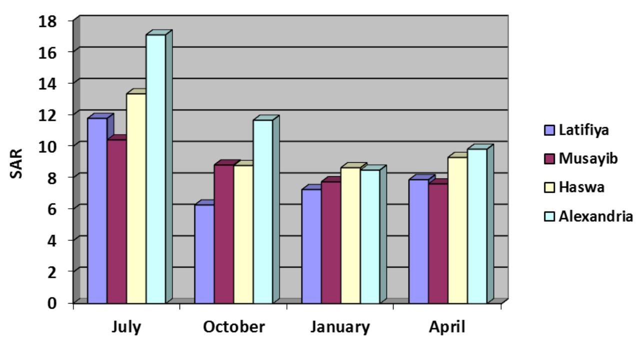

Figure 2. The values of the sodium adsorption ratio (SAR) in well water.

3.1.3. Chloride

The results of **Figure 3** show high chloride concentrations in well water, as its concentration exceeds 10 mmol L^{-1} in all study sites and during the study period, and all waters fall within the waters that cause a severe problem according to the classification[16]. According to the classification[15], all of them fall within the waters that cause problems for sensitive crops, and it is noted that they are directly proportional to the increase in electrical conductivity.

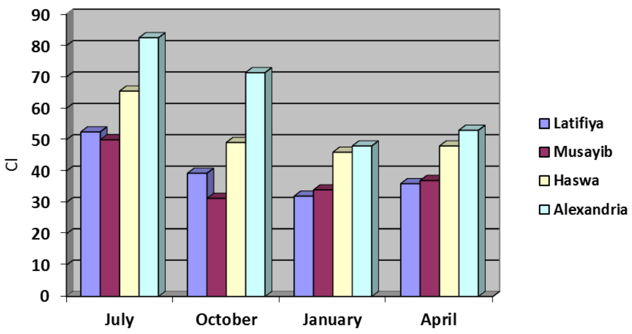

Figure 3. Chloride concentrations in well water (mg L^{-1}).

3.1.4. Boron

Boron behaves similarly to electrical conductivity and SAR. It is noted from **Figure 4** that the boron problem is small to moderate for sensitive crops, as its value does not exceed 2 mg LL^{-1}, according to the classification . According to[14] classification, the boron concentration falls between no problem and an increase in the problem.

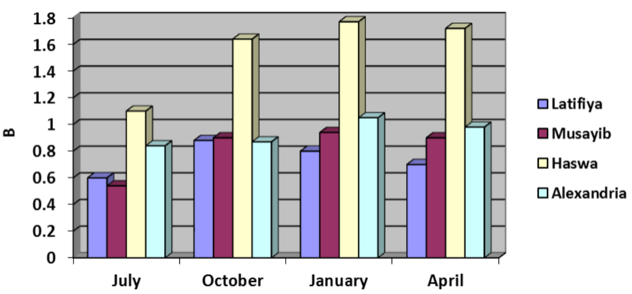

Figure 4. Boron concentrations in well water (mg L^{-1}).

3.1.5. Nitrates

It is clear from **Figure 5** that the values of nitrate concentration range from (0.4–1.5) mg L^{-1}. An increase in nitrates is observed in the winter and spring months due to the use of fertilizers in operations. Nitrates may be carried by leachate water and become abundant during times of rain. As for the apparent decrease in nitrate values in the summer and fall months, it may be attributed to the consumption of nitrate by phytoplankton, whose growth flourishes in these two seasons, or as a result of the lack of dissolved oxygen in the water in the summer as a result of the high temperature, and this reflects negatively on the conversion of nitrite into nitrate. In general, well water is classified with respect to its nitrate content as no problem according to the classification[15]. Refs.[16–18] pointed out that nitrates resulting from water pollution are considered hazardous pollutants that enter into the composition of chemical and organic fertilizers, as these agricultural and animal fertilizers are widely used in soil, which leads to the transfer of nitrates to water through surface runoff, soil infiltration, and agricultural land erosion. Pesticides and fertilizers used in agricultural operations also flow into streams, rivers, and groundwater, contributing to about 50% of nitrate pollution. The European Union member states have set the permissible limit for the level of nitrates in drinking water, not to exceed 50 mg L^{-1} according to the specifications contained in Annex (2014). According to the US Environmental Protection Agency, the normal level of nitrates in surface water should be less than 1 mg L^{-1}, as concentrations higher than 10 mg L^{-1} are considered toxic to aquatic organisms. Controlling nitrate levels in water requires implementing strict policies to regulate the use of fertilizers and pesticides, and to limit the discharge of untreated agricultural and industrial waste into water sources.

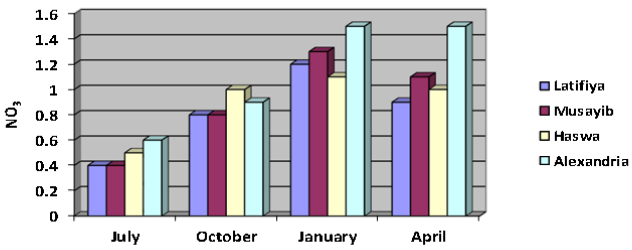

Figure 5. Nitrate concentrations in well water (mg L^{-1}).

3.2. Bicarbonate

In terms of bicarbonate concentration, well water is classified as water that causes few to moderate problems when used, because the bicarbonate concentration in it falls within the range approved by (Ayers and Westcot, 1985), as shown in **Figure 6**.

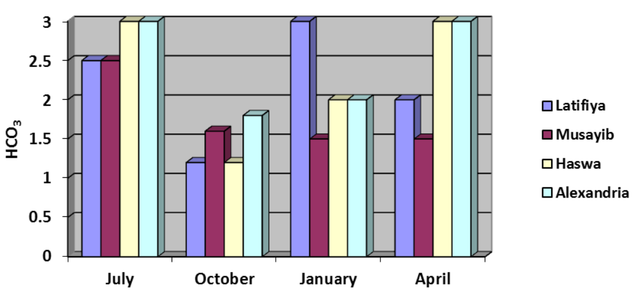

Figure 6. Bicarbonate concentrations in well water (mg L^{-1}).

3.3. Heavy Metals in Well Water

3.3.1. Cadmium

The results of **Figure 7** showed that the values of cadmium concentrations ranged between (0.010–0.021 mg L^{-1}), which was within the permissible limits according to the Iraqi specifications (1996), while according to the global specifications of the World Health Organization [19], it exceeded the permissible limits. The reason for water contamination with this element may be due to fertilizers and pesticides and their leakage into wells with seepage water [20].

The results for all regions for the cadmium element show that it exceeded the limits permitted by the World Health Organization [19], which determined the critical limit for the cadmium element in plants (0.20) mg kg^{-1} dry matter. This indicates the contamination of the plant in the vegetative part and the root part with this element, which may be due to fertilization in agricultural areas, which may contribute to increasing the concentration of heavy elements in the vegetative and root parts.

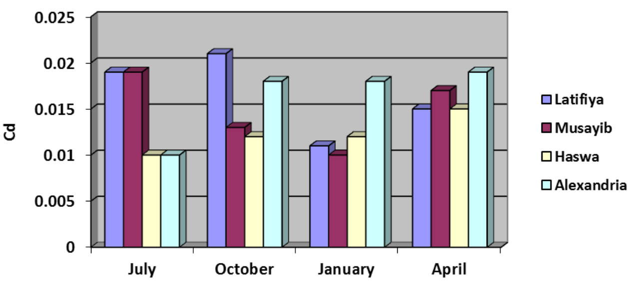

Figure 7. Cadmium concentration in well water (mg L^{-1}).

3.3.2. Lead

The results of **Figure 8** indicate that the concentrations of lead ranged between (0.018–0.204 mg L^{-1}) for the various study sites. When classifying lead according to the Iraqi specifications 1996, these concentrations fall within the permissible limits, except for the month of July in the Alexandria region, when it reached 0.204 mg L^{-1}, which exceeded the permissible limits. The increase in concentration may be due to high temperatures in the summer, especially in July, and an increase in the concentration of elements. The decrease in concentration in the winter may be due to increased rainfall, which leads to a dilution of the concentration and perhaps its disappearance. However, when comparing these concentrations with the global limits of the [19], they did not exceed the permissible limits.

The results for all regions show that the lead element is within the limits permitted by the World Health Organization [19] Table 12, as the critical limit for the lead element is 5 mg kg–1 of dry matter. It is noted that the concentration of lead in the root part is greater than it is in the vegetative part due to the lack of movement and transfer of the lead element within the plant, as it is concentrated in the root area. This is consistent with what [21] found in her study on the effect of some heavy elements on physiological changes and plant growth.

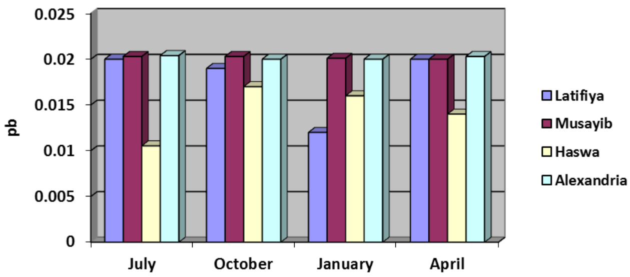

Figure 8. Lead concentration in well water (mg L^{-1}).

3.3.3. Copper

It is noted from **Figure 9** that the copper concentration ranged from (0.095 mg L^{-1}) to (0.035 mg L^{-1}) and these concentrations did not exceed the limits permitted by the Iraqi specifications for the system of maintaining rivers from pollution No. 25 of 1967 for all sites and months as well as the global limits set by the [19] have not been exceeded.

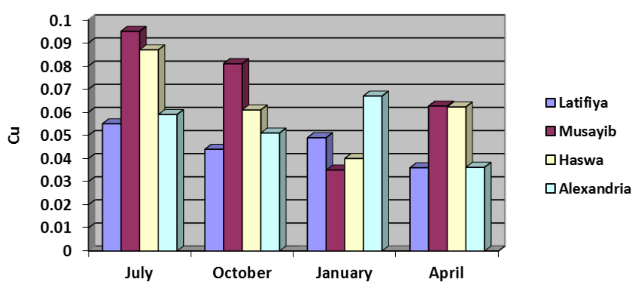

Figure 9. Copper concentrations in well water (mg L^{-1}).

3.3.4. Nickel

The results of **Figure 10** showed that the concentrations of nickel in the water ranged between (0.002–0.021 mg L^{-1}) and that these concentrations did not exceed the permissible limits within the 1996 Iraqi specifications, nor did they exceed the permissible limits by the [19, 22].

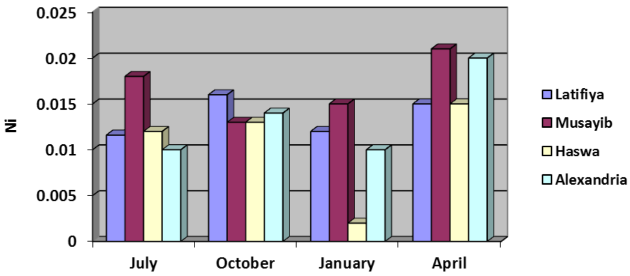

Figure 10. Nickel concentrations in well water (mg L^{-1}).

4. Conclusions and Recommendations

4.1. Conclusions

The salinity of well water varies spatially and temporally according to the availability of water sources, as well as various agricultural processes and water management. Most of the water falls into the category that causes a severe salinity problem according to [23–25] classification, and the ion that has the most influence on the value of electrical conductivity in well water is the sodium ion compared to other ions. The concentrations of heavy metals in the well water were within permissible limits, except for cadmium [26–29].

4.2. Recommendations

It is necessary to monitor the quality of well water and follow all precautions that prevent water pollution and maintain its quality. Projects can also be established to desalinate well water to benefit from it in various fields.

Author Contributions

Conceptualization, methodology, software, validation, formal analysis, investigation, resources, data curation, writing—original draft preparation, writing—review, editing, visualization and supervision M.M.H.; Conceptualization, methodology, software, validation, formal analysis, investigation, resources, data curation, writing—original draft preparation, writing—review, editing, visualization and supervision R.F.S.; Conceptualization, methodology, software, validation, formal analysis, investigation, resources, data curation, writing—original draft preparation, writing—review, editing, visualization and supervision M.T.A.A.

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Not applicable.

Informed Consent Statement

Not applicable.

Data Availability Statement

The authors declare that data will be available on a request.

Conflicts of Interest

The authors declare no conflict of interest.

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