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Evaluate the Distribution of Heavy Elements that Dissolved in Ground Water Using IDW in AL-Wafa City, Al-Ramadi,Iraq

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Abstract

Groundwater can be assessed by studying water wells. This study was conducted in Al-Wafa District, Anbar Governorate, Iraq. The water samples were collected from 24 different wells in the study area, in January 2021. A laboratory examination of the samples was conducted. Geographical information systems technique was relied on to determine the values of polluting elements in the wells. The chemical elements that were measured were [cadmium, lead, cobalt and chromium]. The output of this research were planned to be spatial maps that shows the distribution of the elements with respect to their concentrations. The results show a variation in the heavy elements concentrations at the studied area groundwater. The samples show different values of concentrations; for Cadmium (0.218-1.624) ppm, Lead (0.217-1.157) ppm, Cobalt (0.014-0156) ppm, and for Chromium (0.045-0263) ppm. The distribution of the materials concentrations differs for each element which is refer to the sources of pollution are not relate to industry, but it could be relate to fertilization.

Article Info.

Keywords:
Pollution elements, groundwater, GIS, IDW, water quality.

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1. Introduction

Water is one of the most important necessities for life to exist. All living things need it to survive, and it is also used in agriculture, industry, and other parts of life. Rivers, seas, and groundwater are all examples of natural water sources, and surface water is scarce in semi-arid and desert environments, and thus groundwater plays an important role in sustaining life. Soil, rocks and rain sink into the ground to generate groundwater, which is used for a variety of purposes such as drinking, irrigating crops, industry, poultry farms, etc. [1,2].

Non-renewable groundwater, which is gathered in the earth and contributes to the water supply annually, and natural renewable groundwater, which is added to the water stock annually from rainwater and retained for a long time, are two forms of shared groundwater. Iraq suffers from a significant shortage of water for agricultural and human consumption, and as a result questions have been raised about the use of water resources other than high-quality fresh surface water for the purpose of agricultural growth horizontally to ensure food security. Lots of water usage solutions have been implemented in order to build cost effective plan and other solutions [3]. In addition to many pollutants such as pesticides, fertilizers, and industrial waste, there is chemical contamination in well water. This has recently emerged as one of the concerns that is steadily reflecting groundwater quality. All of these pollutants have a direct impact on the quality of groundwater, rendering it unfit for human consumption, necessitating the development of solutions to lower contamination rates or predict their values and treatment requirements [4, 5]. The idea of applying spatial interpolation methods, which involves predicting an unknown value from two known values, is one of such solutions. There are many different methods of interpolation, all of which have been evaluated in order to select the optimal method for the job. The aim of this study is to evaluate the distribution of heavy metals dissolved in groundwater using the inverse distance weight (IDW) method. IDW method was found to be the most consistent with the data presented during the evaluation procedure. When there is an increase or decrease in the number of points, this strategy is applied, the closer points have a greater effect than the farthest points, and when the points in an area are uniformly and consistently spread out, the interpolation with IDW is good, which allows the production of maps and the preparation of a database for that area. The following equation represents the IDW approach:

$$\lambda_i = \frac{1/\mathrm{d}_i^P}{\sum_{i=1}^{n} 1/d_i^P} \qquad \textbf{(1)}$$

where d_i is the distance between xo and xi, xi is the power factor, n is the numbers of sample, p is the power value, and λ is the weight of point. Researchers have repeatedly identified the problem of pollution in earlier investigations. Awawdeh and Nawafleh (2008) aims, in his study, to determine the sensitivity of groundwater surface contamination using the EPIK method and to compare the results with the chemical data of water chemistry collected from wells [6]. Al-Zarqa (2010) pointed out the causes and consequences of reducing groundwater pollution, which affects the aquifers located under the non-affiliated governorates of Gaza and the central governorates in addition to that the research contains disease. Dueto microbiological contamination of water. In these places, it has an impact on human life [7, 8]. The objective of Shimal (2019) research was to examine the quality of groundwater in Salah El-Din Governorate in Baiji and Samara, using Geographical Information Systems (GIS) techniques [9].

2. The study area

Anbar Governorate is an Iraqi governorate located in the western part of the country. It is the largest Iraqi governorate in terms of area and represents a third (1/3) of the country's total area. The area of the selected location, Al-Wafa'a sub-district, is (1844000 m²) It is a sub-district of Ramadi district in Anbar province, it contains important water bodies such as the Euphrates, Tharthar and Habbaniyah lakes. It is adjacent to important governorates: Baghdad, Salah al-Din and Karbala, and it is located between latitudes (33.39 and 33.4) north and longitudes (42.846 and 42.866) east. Fig.1represents the location of the studied area. The UTM projection used in the study was 38N region.

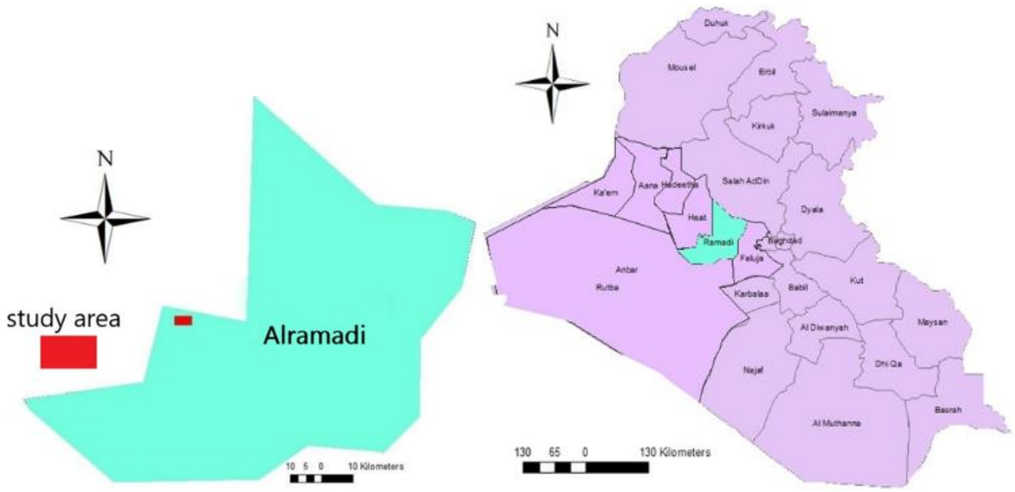

Figure 1: The study area.

3. WHO standardization

The World Health Organization is a health system organization that takes the lead in solving public health challenges and issues, sets rules and guidelines, as well as articulates evidence-based practices, and provides health and technical assistance to countries. It was created on April 7, 1948in Geneva, Switzerland, where the current headquarters of the organization is based. This organization established 62 principles, including the physical properties, chemical properties and microbiological properties of water [10, 11]. Table 1, shows the concentration limits of some metals that are suitable for human use.

Table 1: World Health Organization (WHO) standardization [10].

Element	Symbol	WHO Limit(mg/l)	WHO Limit(μg/l)
Cadmium	Cd	0.003	3
Lead	Pb	0.01	10
Chromium	Cr	0.005-0.008	5-8
Cobalt	Co	0.005	5

4. Methodology

The data collection time, for this study, was in January 2021.The work plan included collecting water samples from24wellsin the studied area. The depth of the wells ranged from 50 to 75 meters. Laboratory tests were conducted at the Iraqi Ministry of Science and Technology. Laboratory measurements for heavy metals (cadmium, lead, cobalt, chromium), were carried out for each sample with an atomic absorption device. The second step was implementing the spatial data by using (ArcGIS 10.8) software. The spatial analysis process was applied to demonstrate the data. IDW interpolation was used to estimate the distribution of the concentrations for each element. The followed step was calculating the area of each class of the concentrations.

5. Results and discussion

After analysing the data, the results were used to evaluate the concentrations of heavy elements in Al-Wafa/Al-Ramadi sub-district. The results were compared with WHO standards. The results of the four elements used in this study with tables showing the area of each element.

Fig. 2 shows the distribution of Cadmium concentration. Cadmium is formed in water due to industrial factors and waste materials. Table 2, illustrated the classes that been segmented to evaluate the concentrations of Cadmium metals.

Table 2: The value of each cadmium class.

Classes	Value_Min	Value_Max	Area (m^2)
0	0.218	0.359983545	4562
1	0.359983545	0.483428722	21810
2	0.483428722	0.59075603	125000
3	0.59075603	0.684069931	341100
4	0.684069931	0.791397239	590300
5	0.791397239	0.914842416	611800
6	0.914842416	1.056825961	119900
7	1.056825961	1.220131871	17900
8	1.220131871	1.407962232	9723
9	1.407962232	1.624	1694

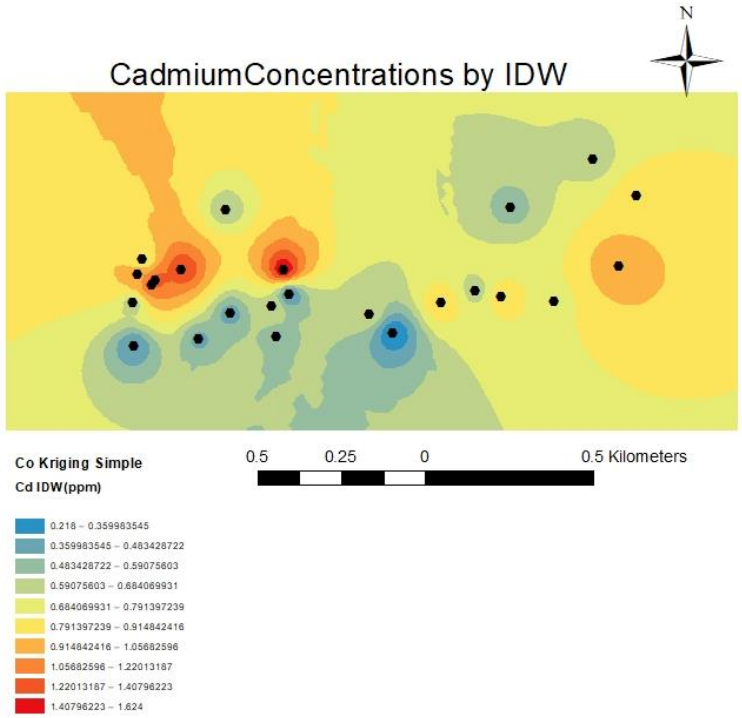

Figure 2: Cadmium concentrations.

Lead is one of the most harmful and abundant chemical elements in nature. They are abundant in groundwater and cause serious harm to humans if exceeds the limits. Fig.3 shows the lead concentration in the study area.Table 3, illustrated the classes that been segmented to evaluate the concentrations of lead metals.

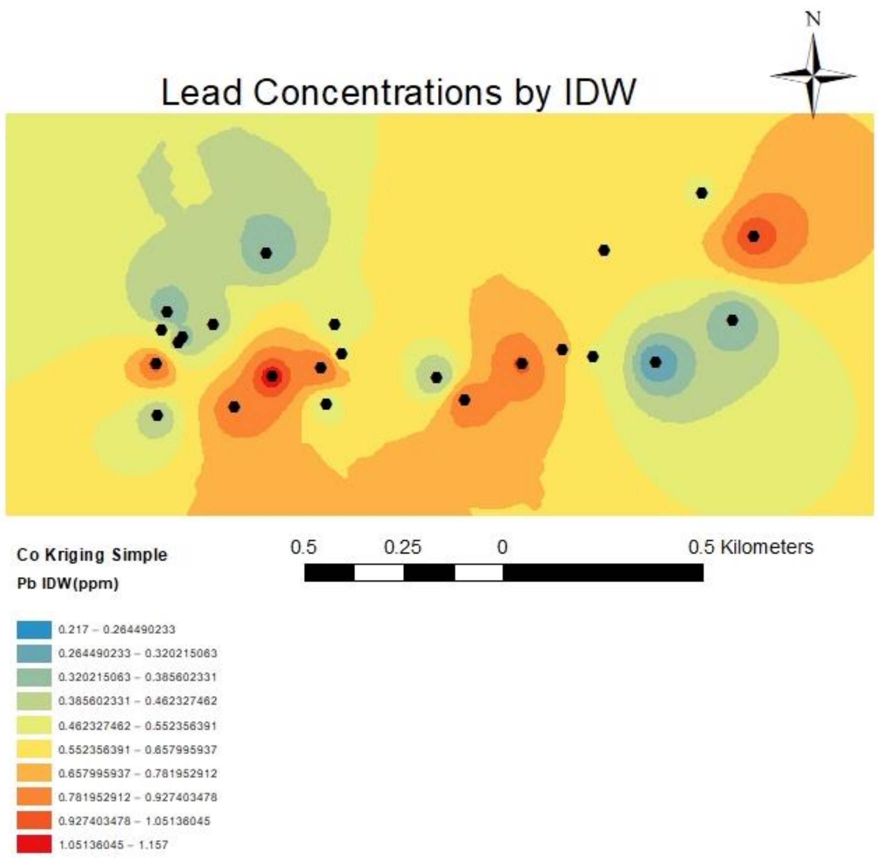

Figure 3: Lead concentrations.

Table 3: The value of each lead class.

classes	Value_Min	Value_Max	Area(m^2)
0	0.217	0.26449	0
1	0.26449	0.320215	5872
2	0.320215	0.385602	43310
3	0.385602	0.462327	187500
4	0.462327	0.552356	513100
5	0.552356	0.657996	696000
6	0.657996	0.781953	309100
7	0.781953	0.927403	75120
8	0.927403	1.05136	12160
9	1.05136	1.157	1763

Fig. 4 shows the Cobalt concentration distribution in water at the studied area. It was found in varying proportions in water.Table 4 shows the area for each class that refer to a certain amount of concentration for Cobalt metals.

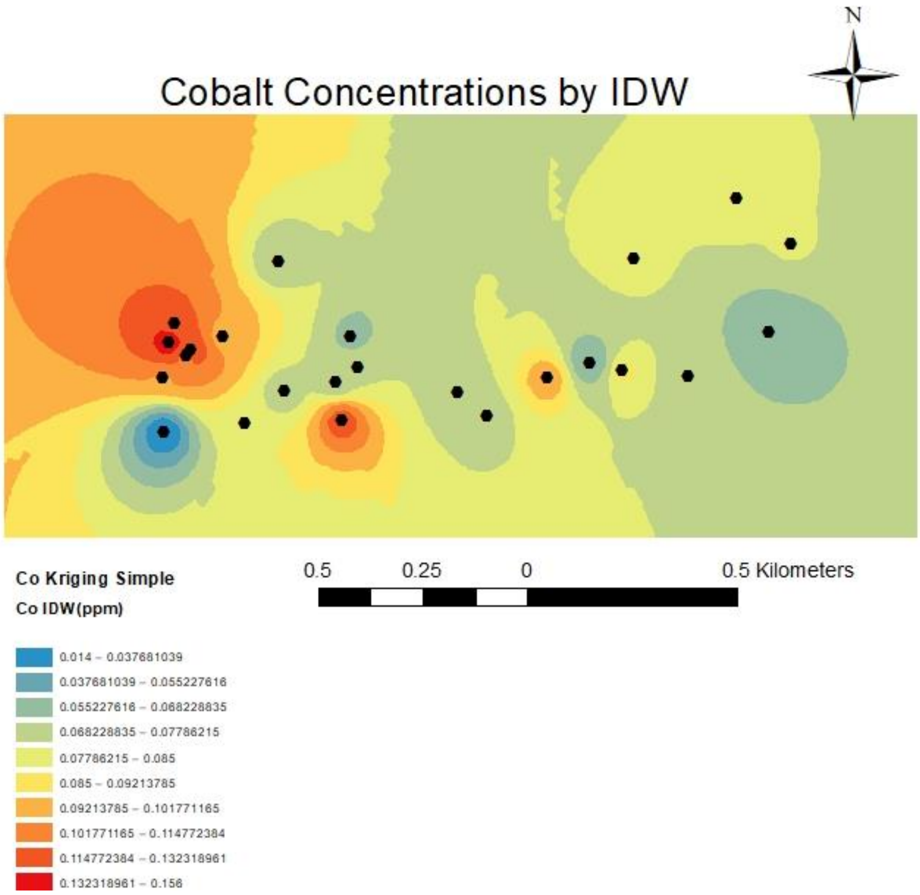

Figure 4: Cobalt concentrations.

Chromium is usually found in groundwater and is toxic to humans and poses a threat to the life if it found in high concentrations. Fig. 5 shows the concentration of chromium according to the different categories of the wells under study.Table 5 shows the classes of chromium in the study area which shows that the lead concentration distribution and their associate area.

Table 4: The value of each cobalt class.

classes	Value_Min	Value_Max	area(m^2)
0	0.014	0.037681	5975
1	0.037681	0.055228	24610
2	0.055228	0.068229	226700
3	0.068229	0.077862	836600
4	0.077862	0.085	410200
5	0.085	0.092138	110100
6	0.092138	0.0101771	133300
7	0.101771	0.114772	44670
8	0.114772	0.132319	47520
9	0.132319	0.156	4308

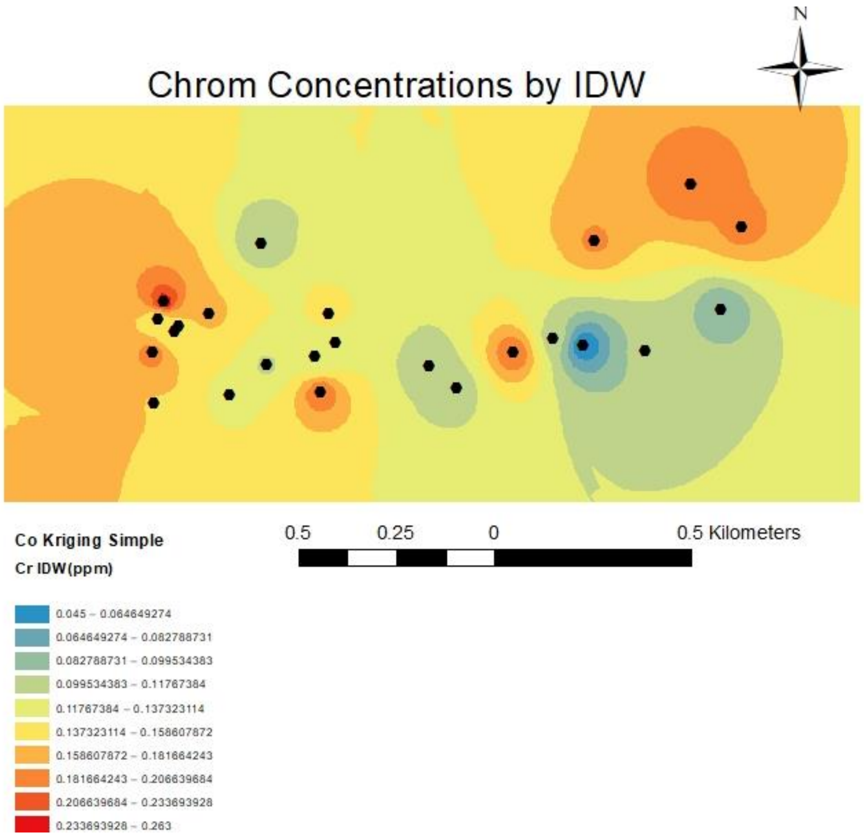

Figure 5: Chromium Concentrations.

Table 5: The value of each chromium class.

classes	Value_Min	Value_Max	area(m^2)
0	0.045	0.064649	3055
1	0.06469	0.082789	6134
2	0.082789	0.099534	28560
3	0.099534	0.117674	227200
4	0.117674	0.13723	593000
5	0.137323	0.158608	466800
6	0.158608	0.181664	445000
7	0.181664	0.20664	70710
8	0.20664	0.233694	2785
9	0.233694	0.263	637.4

6. Conclusions

The results showed the presence of many chemical pollutants that affects the quality of water. This affects human health and causes him many diseases. The reason for the presence of these elementsreferto the presence of factories in the studied area that produce environmental pollutants that affect groundwater. In general, the water of the studied area can be used for the purposes of irrigating crops and animals but it is unsuitable for human consumption.

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Conflict of interest

Authors declare that they have no conflict of interest.

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تقييم توزيع العناصر الثقيلة الذائبة في المياه الجوفية باستخدام IDW في مدينة الوفاء / الرمادي - العراق

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الخلاصة

يمكن تقييم المياه الجوفية من خلال دراسة آبار المياه. أجريت هذه الدراسة في مديرية الوفاء، محافظة الأنبار، العراق. جمعت عينات المياه من 24 بئراً مختلفاً في منطقة الدراسة في شهر كانون الثاني 2021، وتم إجراء الفحص المعملي للعينات. تم الاعتماد على تقنية نظم المعلومات الجغرافية لتحديد قيم العناصر الملوثة في الآبار. كانت العناصر الكيميائية التي تم قياسها هي [الكادميوم والرصاص والكوبالت والكروم]. تم التخطيط لمخرجات هذا البحث لتكون خرائط مكانية توضح توزيع العناصر بالنسبة لتركيزاتها. أظهرت النتائج تبايناً في تراكيز العناصر الثقيلة في المياه الجوفية بمنطقة الدراسة.