Evaluation the Quality of The Wells Water in Hilla City by Water Quality Index and Applying in Visual Basic Program

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Abstract:

In the present study, ground water samples were gathered from differentregions located inHillacity during period from October 2014 to September ,2015.

Water samples were taken from ten wells (monthly two samples from each well) in different regions for analyzing laboratory for thirteen parameters, they are: Temperature, pH , Electrical conductivity (EC), Total hardness (TH), Calcium (Ca^{+2}), Magnesium (Mg^{+2}), Chloride (Cl^{-1}), Sulphate (SO_4^{-2}), Nitrate (NO_3^-), Sodium (Na^+), Potassium (K^+) and Total Dissolved Solid (TDS) . The evaluation of water suitability of the present study for drinking and other irrigated purposes was achieved by means of arithmetic method of WQI depending on guideline values of (WHO,2004) and Iraqi Standard No.417 for (2004) .

Values of WQI ranged from (97.230 - 79.100)at Hilla city which is not suitable for human consumption according to the classification of Iraqi Standard No.417 for (2004) and WHO ,2004. These values belong to high water electrical conductivity and chloride of the studied wells comparable with other parameters. Also, correlation coefficient supports this interpretation where there are strong positively correlation between WQI values and both electrical conductivity and chloride values (0.997, 0.919 respectively).While in the assessment of ground water quality for irrigation, electrical conductivity, pH, sodium absorption ratio (SAR), chloride,slphate, sodium, calisum and magisumwere used to calculateWQI values which range from (98.074- 83.187). These values are associated with both EC and Cl^- in a strong negatively correlation (-0.968, -0.969 respectively).

Application of Visual Basicsoftware is a good tool to explain the WQI index for all types of rivers and streams in Iraq, that will be useful to give fast indication about WQI index.

Keywords: well water quality , water quality, WQI.

الخلاصة:

في هذه الدراسة تم اخذ نماذج المياه الجوفية من مناطق مختلفة من مدينة الحلة خلال الفترة من تشرين الاول 2014 ولغاية ايلول 2015.

تم اخذ نماذج للمياه من عشرة ابار(نموذجين من كل بئر شهريا) في مناطق مختلفة ليتم تحليلها مختبريا لاثني عشر محدد: درجة الحرارة، الحامضية، التوصيلية الكهربائية، العسرة الكلية ، الكالسيوم، المغنيسيوم، الكلورايد ، الكبريتات، النترات، الصوديوم ، البوتاسيوم، الاملاح الذائبة الكلية. حساب (نسبة امتصاص الصوديوم، النفاذية، نسبة الصوديوم، المغنيسوم) مهمة جدا لتقييم نوعية المياه لاغراض الري .لذلك في هذه الدراسة تم تقييم نوعية المياه لاغراض الشرب ولاغراض الري بالاعتماد على الطريقة الحسابية في استخراج (WQI) وبالاعتماد على المواصفات القياسية العراقية رقم 417 لسنة 2004 .

معدل قسم معامل نوعية المياه يتراوح بين(97.230 – 79.100) والذي يعتبر غير جيد للاستخدام البشري طبقا للمواصفة القياسية العراقية رقم 417 لسنة 2004 ولمنظمة الصحة العالمية لسنة 2004 وهذا يعود الى القيمة العالية للتوصيلية الكهربائية وقيم الكلورايد التي ساهمت بزيادة قيمة معامل نوعية المياه.وهذا ما اثبته تحليل الارتباط الخطي بين معامل نوعية المياه وقيم التوصيل الكهربائي وبينه وبين قيم الكلورايد بقيمة معامل ارتباط (0.997, 0.919) على التوالي . اما قيمة معامل نوعية المياه لمياه الابار لاغراض الري فتم اخذ ثمانية محددات مهمة لتقييم الابار لاغراض الري وهي : التوصيلية الكهربائية ، الحامضية، نسبة امتصاص الصوديوم، الكلورايد، الكبريتات، الصوديوم، الكالسيوم، المغنيسيوم، استخدمت جميعها لحساب قيمة معامل نوعية المياه والذي كان بحدود (83.187 –98.074) وبتقييم قيمة معامل الارتباط مع بقية العناصر او المحددات فان اعلى قيمة ارتباط كانت مع التوصيلية الكهربائية والكلوريد بحدود .(−0.969, −0.968) على التوالي ولكن بقيمة سالبة.

لذا فان تطبيق برنامج الفيجوال بيسك لحساب قيمة معامل نوعية المياه يعتبر اداة سريعة ومهمة لاعطاء القيمة الصحيحة والسريعة لتقييم نوعية المياه والانهر في العراق.

الكلمات المفتاحية: نوعية مياه الابار، نوعية المياه، معامل نوعية المياه.

Introduction

Water, a prime natural resource and precious national asset, forms the chief constituent of ecosystem. Water sources may be mainly in the form of rivers, lakes, glaciers, rain water, ground water etc. Besides the need of water for drinking, water resources play a vital role in various sectors of economy such as agriculture, livestock production, forestry, industrial activities, hydropower generation, fisheries and other creative activities. The availability and quality of water either surface or ground, has been deteriorated due to some important factors like increasing population, industrialization, urbanization etc. (Shweta , et al., 2013).

Water quality of any specific area or specific source can be assessed using physical, chemical and biological parameters. The values of these parameters are harmful for human health if they occurred in more than the defined limits. Therefore, the suitability of water sources for human consumption has been described in terms of Water quality index (WQI), which is one of the most effective ways to describe the quality of water. WQI utilizes the water quality data and helps in the modification of the policies, which are formulated by various environmental monitoring agencies. It has been realized that the use of individual water quality variable in order to describe the water quality for common public is not easily understandable (Bharti, and Katyal, ,2011) . That's why, WQI has the capability to reduce the bulk of the information into a single value to express the data in a simplified and logical form Babaei,et al., 2011).

It takes information from a number of sources and combines them to develop an overall status of a water system (Das, at el.,2012). They increase the understanding ability of highlighted water quality issues by the policy makers as well as for the general public as users of the water resources (Nasirian. ,2007).

Objectives and Approach

The objectives are important tools, used in a framework of provincial and federal environmental assessment, risk management, and the application of best available treatment technology, which support the management, protection and enhancement of the ground water resources of the province. The main objective of this paper usedarithmetic index method for assessing water quality to assess the general water suitability of drinking and irrigation and calculate overall water quality index (WQI) for evaluatingground water in study area by using Visual Basic program for this calculation.

Materials and Methods

Water samples collected from ten sampling wells selected for the analysis were given site bellow: W_1andW_2; Al-thwra, W_3: Alkarama; W_4: Alaskan; W_5 and W_6: 60 Street; W_7 and W_8: Nader2; W_9 andW_{10}: Al-bakrli.as shown in Figure (1) with depth 6m-10m . Samples for analysis were collected in sterilized bottles ($100cm^3$,size) using the standard procedure for grab (or) catch samples in accordance with standard methods previously of American Public Health Association (APHA), (1998)., were carried out as the methods described in APHA (1998). All the chemicals and reagents used were of analytical gradeas shown in Table(1),samples were stored at 4°c to protect it from evaporation and biological operation.

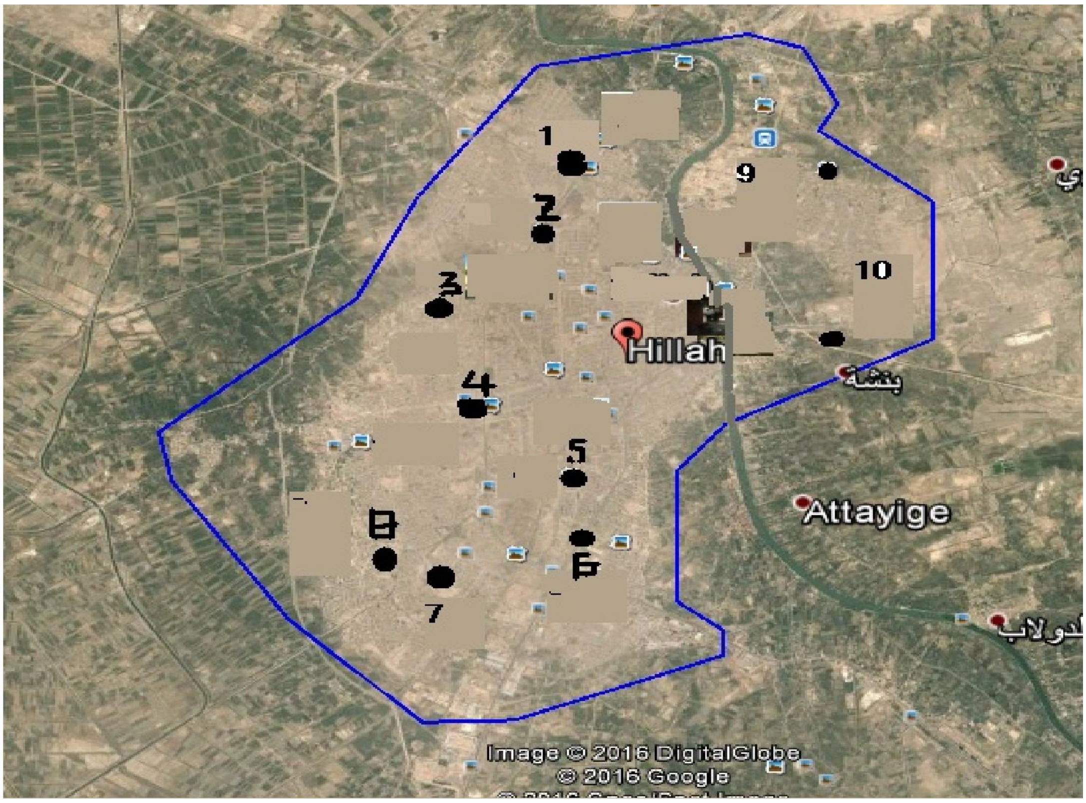

Figure1: location of wells samples in Hilla City.(google earth)

Water Quality Index calculation

Water quality indices are tools to determine conditions of water quality and, like any other tool it require knowledge about principles and basic concepts of water and related issues (Nikbakht, 2004). It is a well-known method of expressing water quality that offers a stable and reproducible unit of measure which responds to changes in the principal characteristics of water (Brown et al., 1972).

WQI is a mechanism for presenting a cumulatively derived numerical expression defining acertain level of water quality (Bordalo et al., 2006). In other words, WQI summarizes large amounts of water quality data into simple terms (e.g., excellent, good, bad, etc.) for reporting to the management and the public in a consistent manner.

The calculation of WQI was made using weighed arithmetic index method using thirteen parameters ,it classified the water quality according to the degree of purity by using the most commonly measured water quality variables. The method has been widely used by the various scientists and the calculation of WQI was made by (Rown, et al.,1972) using the following equation:

The quality rating scale (qn) for each parameter is calculated by using this expression (Das, et al., 2012):

$q_n = 100\,[V_n - V_{io}]/[S_n - V_n]$…… …………………………………….(1)

(Let there be n water quality parameters and quality rating or sub index (qn) corresponding to nth parameter is a number reflecting the relative value of this parameter in the polluted water with respect to its standard, maximum permissible value).

Where:

q_n = Quality rating for the nth water quality parameter.

V_n = Estimated value of the nth parameter at a given sampling point.

S_n = Standard permissible value of the nth parameter.

Vio = Ideal value of nth parameter in pure water (i.e. 0 for all other parameters except the parameter pH and Dissolve Oxygen (7.0 and 14.6 mg/L respectively).
Unit weight was calculated by a value inversely proportional to the recommended standard.
value Sn of the corresponding parameter.
Where:
Wn = K/Sn.
Wn = unit weight for the nth parameters.
Sn = standard value for the nth parameters.
K = Constant of proportionality and it is calculated by using the expression given in Equation (2):(Das, et al., 2012)
K = [1 / (∑1/ Sn=1,2,..n)]…… …… (2)
The overall WQI was calculated by aggregating the quality rating with the unit weight linearly.(Das, et al., 2012)

$$WQI = \frac{\sum q_n w_n}{\sum w_n} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

Results and discussion:

The analysis of various physico – chemical parameters namely Temperature, pH , Electrical conductivity (EC), Total hardness (TH), Calcium (Ca^{+2}), Magnesium (Mg^{+2}), Chloride (Cl^{-1}), Sulphate ($SO4^{-2}$), Nitrate (NO^{-3}), Sodium (Na^{+}), Potassium (K^{+}), Total Dissolved Solid (TDS) for ten wells ,Temperature of water was within the range (18-35)°C, the increasing temperature of water in summer season can be noticed.

Electrical conductivity was within the range (1590-5540)µm/s for all wells, the reason of higher electrical conductivity in summer season was due to either leaching process carrying with salts from other lands or increasing temperature and more solution of salts in the soil, total dissolved solids were within the range (1033.5-3601) mg/l with high range in wells far away from the river ,obviously more thanthat in wells near the river.

pH was within the range (7.3-8.5) ,it can be noticed that no variation in pH in one season while , total alkaline ($CaCo_3$) was (232-1050)mg/l with less variationamong ten wells and that the total hardness was the same ,Calcium and Magnesium with the values (244-4324.5), (32-590),(40-695) respectively. The variation of Ca and Mg were due to ion exchange.

Potassium and Sodium were within the range (10-65) and (35-518) respectively, sulfate and chloride were within the range (345-3970) and (60-870) .

Table(1) and Table(2) explain thecalculation of water quality index (WQI) for human consumption and irrigation purposes for well No.1 as example of other wells.The ranges of WQI, the corresponding status of water quality and their possible domestic and irrigation use respectively are summarized in Table 3and Table 4.

Table 1: Calculation of WQI for well No.1. for human consumption.

No.	parameters	Observed value	Iraq Standard 2004	Unit weight (w_n)	Quality rating (q_n)	$w_n . q_n$
1	EC(µs/cm)	1580	1000	0.0055	158	0.869
2	TDS(mg/l)	2880	1000	0.0055	288	1.584
3	PH	7.5	6.5-8.5	0.6548	88.23	57.77
4	TH(mg/l)	247	500	0.0111	49.4	0.5483
5	Ca(mg/l)	53	200	0.0278	26.5	0.7367
6	Mg(mg/l)	75	50	0.1113	150	16.695
7	CL(mg/l)	675	250	0.0222	270	5.994
8	NO_3(mg/l)	4.5	50	0.1113	9	1.0017
9	SO_4(mg/l)	390	250	0.0222	156	3.4632
10	Na(mg/l)	240	200	0.0278	120	3.336
Summation=				0.9995		91.9667
WQI=∑wn.qn/∑wi=91.9667/0.9995=92.012						

Table 2: Calculation of WQI for well No.1 for irrigated purposes.

No.	parameters	Observed value	Iraq Standard 2004	Unit weight (w_n)	Quality rating (q_n)	$w_n . q_n$
1	EC(µs/cm)	1580	1000	0.0063	158	0.9954
2	PH	7.5	6.5-8.5	0.7514	88.23	66.296
3	CL(mg/l)	675	250	0.0111	270	2.997
4	SO_4(mg/l)	390	250	0.0255	156	3.978
5	Na(mg/l)	240	200	0.0319	120	3.828
6	Ca(mg/l)	53	200	0.0319	26.5	0.845
7	Mg(mg/l)	75	50	0.1277	150	19.155
8	SAR	54	--	--	--	--
Summation				1.0002		98.094
WQI=∑wn.qn/∑wi = 98.094/1.0002 = 98.074						

Table 3: WQI scale for human consumption.(WQI, 2004)

WQI	0-25	26-50	51-75	76-100	> 100
Water quality designation	excellent	good	poor	Very poor	unsuitable

Table4: Irrigation water quality index characteristics.(WQI, 2004).

WQI	Recommendation	
	soil	plant
100-85	May be used for the majority of soils with low probability of causing salinity and sodicity problems, being recommended leaching within irrigation practices, except for in soils with extremely low permeability	No toxicity risk for most plants
85-70	Recommended for use in irrigated soils with ligh texture or moderate permeability, being recommended salt leaching. Soil sodicity in heavy texture soils may occur, being recommended to avoid its use in soils with high clay levels 2:1	Avoid salt sensitive plants
70-55	May be used in soils with moderate to high permeability values, being suggested moderate leaching of salts.	Plants with moderate tolerance to salts may be grown.
55-40	May be used in soils with high permeability without compact layers. High frequency irrigation schedule should be adopted for water with EC above 2 ms/cm and SAR above 7.	Should be used for irrigation of plants with moderate to high tolerance to salts with special salinity cotrol practices, except water with low Na, Cl, and HCO_3 values
0-40	Should be avoided its use for irrigation under normal conditions. in special cases, may be used occasionally. Water with low salt levels and high SAR require gypsum application. In high saline content water soils must have high permeability, and excess water should be applied to avoid salt accumulation.	Only plants with high salt tolerance, except for waters with extremely low values of Na, Cl and HCO_3.

As application of the same approach to calculate the water quality index(WQI) for other wells samples as shown in Table 5.

Table 5: Calculation of WQI for Ten Wells for drinking and irrigated purposes.

No. well	WQI for Drinking water	WQI for irrigated water
1	92.012	98.074
2	88.765	94.123
3	97.122	96.234
4	87.990	89.410
5	79.100	90.100
6	96.234	88.109
7	89.501	92.761
8	97.230	92.102
9	83.431	83.187
10	89.606	88.902

It can be shown from all the values of WQI that all wells are not suitable for human consumptions but they are good values for irrigated purposes based on WQI values as shown in Figure (2).

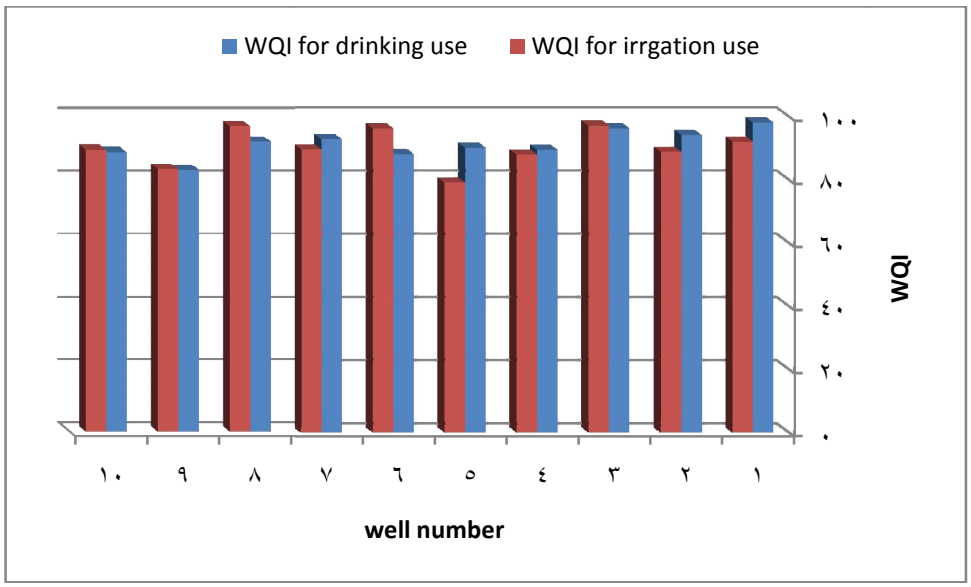

Figure2: The Values of WQI for Drinking and Irrigation use with well numbers.

Application of Visual Basic Program

Visual Basic enables the rapid application development (RAD) of graphical user interface (GUI) applications, so, it can be applied in the research for that reason. **(**Plant,2007).as its shown in Figure (3).

Figure 3: Water Quality Index (WQI) values as application in Visual Baic.2013.

Conclusions

Most common important conclusion can be explain as follows:

1. Values of WQI ranged from (97.230 - 79.100) at Hilla city and rated unfit to human consumption according to the classification of Iraq Standard ,2001 and WHO ,2004. These values belong to high water electrical conductivity and chloride of the studied wells comparable with other parameters. Also, correlation coefficient supports this interpretation where there are strong positive correlation

between WQI values and both electrical conductivity and chloride values (0.997, 0.919 respectively).

2. The assessment of ground water quality for irrigation, electrical conductivity, pH, Sodium absorption ratio (SAR), chloride, sulphate, Sodium, Calcium and Magism were used to calculate WQI values which ranged from (98.074- 83.187). These values associated with both EC and Cl^- in a strong negative correlation (-0.968, -0.969 respectively).
3. From all above result we can see that all of WQI are(76-100) and this means that WQI type is very bad for drinking use and is suitable for soil with low salinity with no toxic on plants since WQI were (85-100) for irrigated purposes.

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