Assessment of ground water quality at Basrah , Iraq by water quality index(WQI).

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Abstract:

The assessment of water quality is very important for knowing its suitability for various purposes. Water quality index (WQI) indicates the quality of water in terms of index number for any intended use. It is defined as a rating reflecting the composite influence of different water quality parameters were taken for calculation of water quality index. In the present study, ground water samples were gathered from two regions located at Basrah governorate during culturing period in Autumn 2011. They are Bergussia and Zubair. Ten well samples were taken from each region for analyzing twelve parameters they are: electrical conductivity (EC), bicarbonate (HCO_3^-), total hardness (TH), Calcium (Ca^{+2}), Magnesium (Mg^{+2}), Chloride (Cl^-), Sulphate (SO_4^{-2}), Nitrite (NO_2^-), Nitrate (NO_3^-), Sodium (Na^+), Potassium (K^+) and Boron (B^+). The evaluation of water suitability of present study for human drinking and other domestic purposes was achieved by means of WQI depending on guideline values of WHO (2006) for : electrical conductivity , total hardness, Calcium , Magnesium, Chloride, Sulphate , Nitrite, Nitrate, Sodium , Potassium and Boron. Values of WQI ranged from 2052 to 3511 at Burgussia and from 2219 to 3743 at Zubair and rated unfit to human consumption according to the classification of Tiwari and Mishra (1985). These values belong to high water electrical conductivity and chloride of the studied wells comparable with other parameters. Also, correlation coefficient support 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 at 25°C (EC_W), Sodium adsorption ratio (SAR), chloride, boron, bicarbonate and nitrate were used to calculation WQI values which ranged from 67.41 to 77.99 at Burjessia and from 67.43 to 77.48 at Zubair. These values associated with both EC_W and Cl^- in a strong negatively correlation (-0.968, -0.969 respectively).

Key words: ground water- assessment-water quality- WQI.

الخلاصة :

إن تقييم نوعية المياه ضروري جدا" لمعرفة ملائمته لمختلف الاغراض. ويشير مقياس نوعية المياه (WQI) الى نوعية المياه بدلالة رقم مقياسي لاي أستخدام مطلوب. ويعرف على أنه تصنيف يعكس التأثير المشترك لعوامل مختلفة لنوعية المياه والتي أتخذت لحساب مقياس نوعية المياه. في الدراسة الحالية، جمعت عينات المياه الجوفية من منطقتين تقعان في مدينة البصرة خلال موسم الزراعة في خريف عام ٢٠١١ هما البرجسية والزبير . حيث أخذت العينات من عشرة آبار لكل منطقة لتحليل أثني عشر عاملا" هي: الايصالية الكهربائية (EC)، البيكاربونات (HCO_3^-)،العسرة الكلية (TH)، الكالسيوم (Ca^{+2})، المغنسيوم (Mg^{+2})، الكلوريد (Cl^-)، الكبريتات (SO_4^{-2})، النتريت (NO_2^-)، النترات (NO_3^-)، الصوديوم (Na^+)، البوتاسيوم (K^+)والبورون (B^+). إن تقييم نوعية مياه الدراسة الحالية لغرض شرب الانسان والاستخدامات المنزلية الاخرى أنجز بواسطة WQI أعتمادا" على القيم المقياسية لمنظمة الصحة العالمية WHO (2006) وذلك لكل من الأيصالية الكهربائية، الكلوريد، العسرة الكلية، الكالسيوم،المغنسيوم، الكبريتات، البوتاسيوم، الصوديوم، النتريت، النترات والبورون. إذ تراوحت قيم WQI بين ٢٠٥٢ الى ٣٥١١ في البرجسية ومن ٢٢١٩ الى ٣٧٤٣ في الزبير وصنفت على أنها غير ملائمة للأستهلاك البشري أعتمادا" على تصنيف Tiwari and Mishra (1985) وهذه القيم تعود الى الأيصالية الكهربائيةوالكلوريد في مياه الآبار المدروسة مقارنة بالعوامل الأخرى. كذلك فقد دعم معامل الأرتباط هذا التغيير حيث وجدت علاقة أرتباط موجبة قوية بين قيم WQI وكلا" من الايصالية الكهربائية والكلوريد (0.919,0.997 على التوالي) . بينما في تقييم نوعية المياه لغرض الري أستخدمت الايصالية الكهربائية عند درجة حرارة ٢٥ م° (EC_W) ونسبة أمتزاز الصوديوم (SAR) و الكلوريد والبورون والبيكاربونات والنترات في حساب قيم WQI والتي تراوحت من 67.41 الى 77.99 في البرجسية ومن 67.43 الى 77.48 في الزبير. حيث كانت تسعة آبار في البرجسية والزبير ضمن

القسم الثاني II والعاشر ضمن القسم الثالث III وقد أرتبطت مع كلا" من EC_W و Cl^- بأرتباط سلبي قوي (0.969-,0.968-) على التوالي).

الكلمات المفتاحية: المياه الجوفية – التقييم – نوعية المياه – مقياس نوعية المياه.

1. Introduction:

Water, a natural resource which has been used for different purposes, namely for drinking, domestic, irrigation and industrial, mainly depends on its intrinsic quality. People around the world have used ground water as a source of drinking water, and even today more than half the worlds population depends on ground water for survival (Dagar, 2009). Until the 1970_S , it was believed that the soils and sub soils worked as filters, retaining the contaminants before they could reach the ground water. However, more recently, it was verified that the contaminants can, in fact, reach ground water (Andrade et al., 2010). Once the ground water is contaminated, its quality can not be restored by stopping the pollutants from the sources. Therefore, the assessment of water quality is very important for knowing its suitability for various purposes. Water quality index (WQI) indicates the quality of water in terms of index number for any intended use. It is defined as a rating reflecting the composite influence of different water quality parameters were taken for calculation of water quality index (Rao et al.,2010). The concept of indices to represent gradations in water quality was first proposed by Horton (1965) then it developed by several researchers like Brown et al (1970) and improved by Deininger (Scottish development department, 1975). The objective of this study is to assessment suitability of ground water for various uses (human drinking, domestic and irrigation purposes). In Iraq, many researchers have been studied ground water quality for different purposes. Mahmoud and Zangana (1990) made a simple comparison of their data with the water quality criteria to state the suitability of the ground water quality for human drinking use. Mustafa (2006) used Horton´s model for assessment of ground water quality at Sulimaniya city for drinking, irrigation and industrial uses. Al-Tamir (2007) studied variation in Erbil ground water quality. Lateef (2011) used water quality index for evaluation ground waters at Tikrit and Samarra cities for drinking purpose.

2. Material and methods:

Many desert regions, located at south western side of Basrah governorate south of Iraq, had been utilized for agriculture and farms of cattle depending on ground waters. In the present study, ground water samples were gathered from two regions, characterized by glendive (loam) soils, located at Basrah governorate during culturing period in Autumn 2011 as shown in figure 1, they are Bergussia and Zubair which characterize by culturing Tomato, onion and Garlic (Abdalaali, 2011, Disher, 2011). Ten well samples were taken from each region for analyzing twelve parameters they are: electrical conductivity (EC), bicarbonate (HCO_3^-), total hardness (TH), Calcium (Ca^{+2}), Magnesium (Mg^{+2}), Chloride (Cl^-), Sulphate (SO_4^{-2}), Nitrite (NO_2^-), Nitrate (NO_3^-), Sodium (Na^+), Potassium (K^+) and Boron (B^+).

Electrical conductivity was measured at sampling sites by using Horiba model W-2030 MFG. NO.812003 .Other parameters were analyzed at laboratory like bicarbonate, total hardness, Calcium, Magnesium, Chloride, Sodium, Potassium and Boron according to APHA, (1998). Both Nitrite and Nitrate were analyzed according to Strickland and Parson (1972).

Figure 1: ma p of the studied regions

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In order to assessment of ground water quality at Bergussiua and Zubair regions for drinking and irrigation, water quality index (WQI) was applied on each well sample by using the following formula as shown below:

$WQI = \sum W_i q_i$ (1)

W_i : is the weight given to each parameter depending on its relative importance to over all water quality.

q_i : is the quality rating given to each parameters depending on specific guidelines.

For assessment of ground water quality for human drinking and other domestic purposes, guidelines of World Health Organization (2006) were used to estimation of both weight (table 1) and quality rating for EC, Cl^-, TH, Ca^+, Mg^{+2}, SO_4^{-2}, K^+, Na^+, NO_2^- , NO_3^- and B^+ depending on Tiwari and Mishra (1985) as follow:

$W_i = K/ S_i$ (2)

$K = \sum W_i * \sum S_i$ (3)

Where : $\sum W_i$ is equal to 1.

S_i : is the guideline values of WHO 2006

q_i = parameter value/ S_i * 100 (4)

While in the assessment of ground water quality for irrigation, EC at 25°C (EC_W) , Sodium adsorption ratio (SAR), Cl^-, B^+, HCO_3^- and NO_3^- were used . EC_W was calculated according to Mustafa (2006) as shown below:

$EC_W = EC (t) - 0.02(T-25) EC_{(t)}$ (5)

Where:

EC_W : electrical conductivity at 25°C in ms/cm .

EC (t): electrical conductivity at field temperature in ms/cm.

T: field temperature.

SAR was calculating by the following equation given by Richards (1954) :

Table 1: Result of WQI weights calculation for drinking and domestic uses.

Drinking water	
parameters	weight
EC	0.653485857
Chloride	0.000653486
Total hardness	0.000326743
Calcium	0.002178286
Magnesium	0.001633715
Sulphate	0.001616815
Potassium	0.013614289
Sodium	0.000653486
Nitrite	0.00204034
Nitrate	0.00012242
Boron	0.326742928
$\sum W_i$	1

$$SAR = \frac{Na}{\sqrt{[Ca + Mg]/2}} \quad (6)$$

Where all ions are expressed in meq/l.

Cl^- and HCO_3^- were converted to milli equivalent per liter (meq/l), B^+ concentrations were in milligram per liter (mg/l) while NO_3^- concentrations were converted to milligram per liter (mg/l). The parameter weight as shown in table 2 was estimated by applying the equation used by Al meini (2010) as bellow:

$$W_i = 1/a_k / \sum 1/a_k \quad (7)$$

Where a_k : is the proposed temporary weight of parameter based on a scale of importance from 1 (very important parameters) to 4 (less important parameters) therefore, EC_W is given the highest weight while both NO_3^- and HCO_3^- were given the lowest weight between them other parameters were given the intermediate weights .

Table 2: result of WQI weights calculation for irrigation.

irrigation	
parameters	weight
EC_W	0.333333
SAR	0.111111
EC_W - SAR	0.166667
Chloride	0.111111
Boron	0.111111
Nitrate	0.083333
Bicarbonate	0.083333
$\sum W_i$	1

Values of q_i were calculated by SPSS regression equations based on crop tolerance limits (sensitive, moderately sensitive, moderately tolerant and tolerant) and degree of damage for both crop and soil (non, slight, moderate and severe) according to Richards (1954), Mass (1984), Rhoades (1977), Oster and Schroer (1979), Ayers and Westcot (1985) and Hopkins et al. (2007) as shown below in table 3.

Table 3 : quality rating (q_i) estimation of parameters for calculation irrigated water quality index.

q_i	EC_W (ms/cm)	SAR	EC_W - SAR		Cl^- (meq/l)	B^+ (mg/l)	HCO_3^- (meq/l)	NO_3^- (mg/l)
			EC_W	SAR				
85-100	1-4	0-9	6-14	< 35	1-1.9	0.75-0.9	1-1.4	1-4
60-85	5-9	10-17	6-14	> 35	2-6	1-1.9	1.5-4.5	5-17.5
35-60	10-14	18-26	6-14	No effect	7-10	2-3.9	4.6-8.5	17.6-30
0-35	15-20	≥ 27	6-14	No effect	≥ 11	4-6	≥ 8.6	≥ 31

Finally, for demonstrate the variance of all parameters between the two regions the statistical analysis was achieved by applying T-test. Also, a correlation coefficient was applied between water quality indices and the studied parameters.

3. Results and Disscussion:

3.1. Asssessment of ground water for drinking and domestic purposes:

3.1.1. Chemical analysis:

The descriptive statistic of the present study was summarized in table 1. There are no spatial significant variations between Burgussia and Zubair regions except for potassium ($p < 0.01$), sodium ($p < 0.05$) and boron ($p < 0.01$) where the highest mean of these parameters were registered at Zubair. These variations may be belong to the difference in geological structure of their rocks (Al-Tamir, 2007, Mohammed et al., 2010).The evaluation of water suitability of present study for human drinking and other domestic purposes was achieved by means of WQI depending on guideline values of WHO (2006).

. Water Salinity results, as expressed in the present study as electrical conductivity, ranged from 7.76 ms/cm at Bergussiua to 14.07 ms/cm at Zubair which exceeded the WHO permissible limits of 0.25 ms/cm by 31 to 56 fold respectively, they are extremely saline water. So, they considered unsuitable for human drinking.

Chloride values of all the studied wells exceeded the WHO guideline of 250 mg /l, High levels of chloride exceeding this guideline may impart a salty taste (Bacha et al., 2010). These values may be resulting from the dissolution of halite minerals, sea water intrusion, in addition to discharge of waste water into ground waters (Hamad, 2008, Rao et al.,2010, Muthana, 2011,).

Total hardness is a measure of the ability of water to cause precipitation of insoluble calcium and magnesium salts of higher fatty acids from soap solution. The principle hardness causing ions are calcium, magnesium bicarbonate and carbonate (Rao et al., 2010). In the present study, total hardness values exceeded the WHO permissible limit of 500 mg/l, and they classified as highly hardness according to Lind (1979). High values of total hardness may be attributed to the dissolution of carbonate minerals in rocks (Meireles et al., 2010).

Table 4 : Summary statistics of ground water analysis for drinking and other domestic purposes.

parameters	regions	minimum	maximum	Mean	Standard deviation
EC (ms/cm)	Burjussia	7.76	13.26	10.22	1.50
	Zubair	8.24	14.07	10.76	1.75
Cl^- (mg/l)	Burjussia	1299.60	2999.07	2089.35	459.72
	Zubair	11996.28	25991.94	1874.42	453.06
TH (mg/l)	Burjussia	2100.00	2900.00	2420.00	278.34
	Zubair	1600	2600	2070.00	275.49
Ca^{+2} (mg/l)	Burjussia	521.04	801.6	649.30	79.74
	Zubair	400.80	681.36	519.04	95.09
Mg^{+2} (mg/l)	Burjussia	48.60	291.60	194.40	75.62
	Zubair	97.20	267.30	188.33	55.12
SO_4^{-2} (mg/l)	Burjussia	1248.00	1920.00	1641.60	184.00
	Zubair	1056.00	1632.00	1353.60	189.20
K^+ (mg/l)	Burjussia	39.00	59.65	50.01	5.42
	Zubair	18.36	73.41	51.05	19.86
Na^+ (mg/l)	Burjussia	540.20	797.41	661.24	65.49
	Zubair	555.33	888.19	702.09	100.61
NO_2^- (µg/l)	Burjussia	10.36	71.18	19.90	17.85
	Zubair	9.41	56.59	20.72	13.66
NO_3^- (µg/l)	Burjussia	18.24	55.42	34.14	10.99
	Zubair	24.92	43.00	32.49	6.52
B^+ (mg/l)	Burjussia	0.00	0.07	0.03	0.03
	Zubair	0.00	0.19	0.08	0.06

Values of calcium ions exceeded WHO guideline of 75 mg / l at both regions. The source of of calcium in ground water is the dissolution of carbonate minerals such as calcite, aragonite ($CaCO_3$), and dolomite ($Ca\,Mg(CO_3)_2$) of rocks (Hamad, 2008).

The source of magnesium ion in ground water is the dissolution of dolomite minerals (Naseem et al., 2010).The magnesium ion values of the studied wells showed that the minimum ones were below WHO guideline of 100 mg/l while the maximum ones exceeded it at both regions. Low intake of magnesium ion had associated with osteoporosis, metabolic syndrome and increasing risk of cardiovascular disease while higher intake caused cathartic effect especially when associated with sulphate (Basha et al., 2010).

The Sulphate values exceeded WHO guideline of 250 mg/l . Higher levels of sulphate in ground water may be due to dissolution of gypsum and potassium sulphate added to soil as fertilizers (Al-Tamir, 2007, , Lateef, 2011). According to Rao et al (2010), the concentrations of sulphate ion associated with magnesium ion have laxative effect on persons un accustomed to them.

Potassium ion values exceeded WHO guideline of 12 mg / l. Its source is from dissolution of potassium content minerals in rocks and the luxury of using chemical fertilizers (Meireles et al., 2010, Lateef, 2011) which may be interpreted the significant variations between the two present studied regions.

Sodium in drinking water is not of health concern for most people but may be an issue for someone with high heart disease, kidney disease, and circulatory illness. Recent researches have proven that hypertension associated with elevated sodium in diet (Bacha et al., 2010). In the present study, sodium ions values exceeded WHO guideline of 250 mg/l which may be result from dissolving of halite during the movement of ground water through sediments (Meireles et al., 2010).

Nitrite and nitrate are toxic ions for human when they occur in high amounts in drinking water, nitrate transformed to nitrite in the digestive system which caused blue baby syndrome (Basha et al.,2010 , Mohammed et al., 2010). The present results of both nitrite and nitrate did not exceed the WHO permissible limits of 3 mg / l and 50 mg / l respectively.

Boron is naturally occurring in ground water primarily as a result of leaching from rocks and soils containing borates and borosilicate. It accumulated in human bones more than other parts affecting on their forms and function (Malakootian et al., 2007). Also, there are some investigations give evidence of a possible toxicity of high concentrations of boron for male reproductive system (Queste et al., 2001). In the present study, boron ion values were below the WHO guideline value of 0.5 mg / l and the statistical analysis, as mentioned formerly, showed significant variations between the two studied regions due to their difference in geochemical nature of the drainage area, proximity to sea water (Arabian gulf) and inputs from agricultural and domestic effluents (Malakootian et al., 2007).

3.1.2. Water quality index:

Values of WQI were illustrated in figure 2 which ranged from 2052 to 3511 at Burgussia and from 2219 to 3743 at Zubair and rated as unfit to human consumption according to the classification of Tiwari and Mishra (1985) as shown in table 5. These values belong to high water salinity (EC) and chloride of the studied wells (table 4) comparable with other parameters. Also, correlation coefficient support this interpretation where there are strong positively correlation between WQI values and both EC and chloride values (0.997, 0.919 respectively).

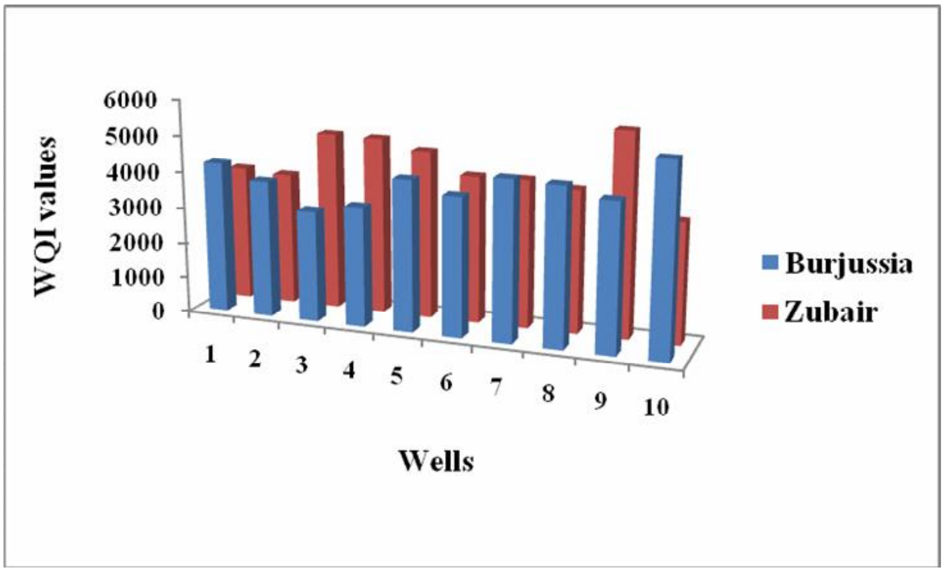

Figure 2: WQI values for human consumption.

Table 5:Water quality index scale for human consumption.

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

3.2. Asssessment of ground water for irrigation:

3.2.1. Chemical analysis:

It is commonly accepted that the problems originating from irrigation water quality vary in type and severity as a function of numerous factors including the type of soil and crop. Nevertheless, there are now a common understanding that these problems can be categorized into the following major groups: (a) salinity problem, (b) infiltration (permeability) problem, (c) specific ion toxicity and (d) miscellaneous problems (Al meini, 2010, Muthanna, 2011). In the present study, six parameters were used to illustrate these problems in the studied regions as shown in table 6.

salinity problem : Irrigation water salinity values, as expressed as EC_W in the present study, did not exceed the guideline values established by Maas (1984), as shown formerly in table 3, where the minimum ones were within the class II suitable for irrigation moderately sensitive crops while the maximum ones were within the division III and IV suitable for irrigation moderately tolerant and tolerant crops respectively. According to Ayers and Westcot (1985), waters at both Bergussiua and Zubair are classified as highly saline. An increase in salinity affects crop growth and will result in yield reductions (Mariniy and Piccolo, 2004). However, there are examples were irrigation water of high salt concentrations are being used for long periods of time with no indication of salinization, in central Asia and in some Middle Eastern countries. The reason for no salinization hazard is possibly due to light soil texture and good natural drainage. Additionally, specific crop varieties used in such areas are highly salt tolerant (Hamad, 2008 , Dagar, 2009 , Mohammed et al., 2010 , Naseem et al., 2010).

Table 6 : Descriptive statistics of parameters used in ground water analysis for irrigation purpose.

parameters	regions	minimum	maximum	Mean	Standard deviation
EC_W	Burjussia	8.54	14.59	11.24	1.69
	Zubair	9.06	15.48	11.70	1.92
SAR	Burjussia	0.51	0.72	0.60	0.06
	Zubair	0.62	0.97	0.74	0.10
Cl^- (meq/l)	Burjussia	36.65	84.57	58.92	10.50
	Zubair	33.83	73.30	51.95	10.15
B^+ (mg/l)	Burjussia	0.00	0.07	0.03	0.03
	Zubair	0.00	0.19	0.08	0.06
HCO_3^- (meq/l)	Burjussia	0.49	1.18	0.81	0.22
	Zubair	0.98	1.57	1.21	0.24
NO_3^- (ug/l)	Burjussia	18.24	55.42	34.14	10.99
	Zubair	24.91	43.00	32.49	6.52

Infiltration problem: Irrigation water containing large a mounts of sodium is of special concern due to sodium's hazard on both soil and crop. A sodium hazard (sodicity) is usually expressed in term of sodium adsorption ratio (SAR) (Obiefuna and Sheriff, 2011). When a soil is irrigated with a high sodium water (high SAR), a high sodium surface soil develops which weakens soil structure, the surface soil aggregates then disperse to much smaller particles which affecting the availability of the water to the crop (Al-Hawas, 2002, Marini and Piccolo, 2004, Opoku-Duah et al., 2000).This hazard may also be caused by an extremely low calcium and magnesium content of the surface soil. The infiltration problem results from the collective effect of both salinity and SAR. A high salinity water will increase infiltration while a water with a high sodium to calcium and magnesium ratio (SAR) will decrease infiltration. Both factors may operate at the same time (Ayers and Westcot, 1985). According to Rhoades (1977), Oster and Schroer (1979) slight infiltration problem were occurring when values of EC_W were between 6 ms/cm and 14 ms/cm and SAR values were > 35 respectively As illustrated formerly in table 3. So, the present results did not show infiltration problem at the studied regions.

Specific ion toxicity: Crop toxicity was resulting from Certain ions (sodium, chloride, or boron) in soil or water accumulate in a sensitive crop to concentrations high enough to cause crop damage and reduce yields (Opoku-Duah et al., 2000). Sodium and chloride are the primary ions absorbed through leaves, and toxicity to one or both can be a problem with certain sensitive crops, as concentrations increase in the applied water, foliar damage develops more rapidly and becomes progressively more severe (Mass, 1984, Al-Hawas, 2002). In the present study, Sodium in term of SAR values showed spatial variations ($p< 0.05$) where the highest mean were registered at Zubair and they were < 10 at both regions which classified as excellent for irrigation according to Richards (1954). While chloride values were > 10 meq/l which considered unsuitable for irrigation (Ayers and Westcot, 1985). Boron is an essential micronutrient for plant growth required it at small amounts but higher levels caused severe damage for cultured crops. According to Hopkins et al. (2007), values of the studied region were below the guideline value of 0.75 mg/l which considered suitable for sensitive crop irrigation but within the guideline value of < 0.5 which considered suitable for irrigating extremely sensitive crop.

Miscellaneous problems: Several parameters caused different problems to cultured cops these parameters include: pH, bicarbonate and nitrate. The source of bicarbonate in the irrigation water is from dissolving of carbonate rocks (Naseem et al., 2010, Muthana, 2011). In the present study, bicarbonate ions did not exceed the guideline values established by Ayers and Westcot (1985) at both regions which caused unsightly deposits on fruit or leaves. Also, nitrate values did not exceed these guideline values which supplies nitrogen to the crop and may cause excessive vegetative growth, lodging, and delayed crop maturity (Opoku-Duah et al., 2000). So, there are no problems associated with both bicarbonate and nitrate in the present study.

3.2.2. Water quality index:

In order to demonstrate the composite effect of the studied problems on suitability of ground waters for irrigation, WQI was applied and its values were illustrated in figure 2 which ranged from 67.41 to 77.99 at Burjessia and from 67.43 to 77.48 at Zubair. These values can be interpreted depending on divisions presented by Bernardo (1995) and Holanda and Amorim (1997) as shown in table 7 in which WQI values of nine wells at both Burjessia and Zubair are within division II and the tenth one was within division III. Statistically, these values associated with both EC and chloride in a strong negatively correlation (-0.968, -0.969 respectively). As we demonstrated above in the assessment of ground water for irrigation purpose that the studied wells at both regions showed no infilteration and miscellaneous problems except of salinity problem and toxicity of chloride only. These problems differ in their effect depending on soil texture and tolerance limits of cultured crops. Both Burjessia and Zubair are characterized by glendive soil contains high amount of sand and more silt than clay (Abdalaali, 2011, Disher, 2011) where the salinity hazard more effected on heavy texture soil (clay type) than light texture (glendive type) one because of clay soils have relatively high water holding capacity and are slow to drain. Conversely, glendive soils retain less water and are faster to drain hence; salts will be leached beneath the root zone (Sakatchewan, 1987).

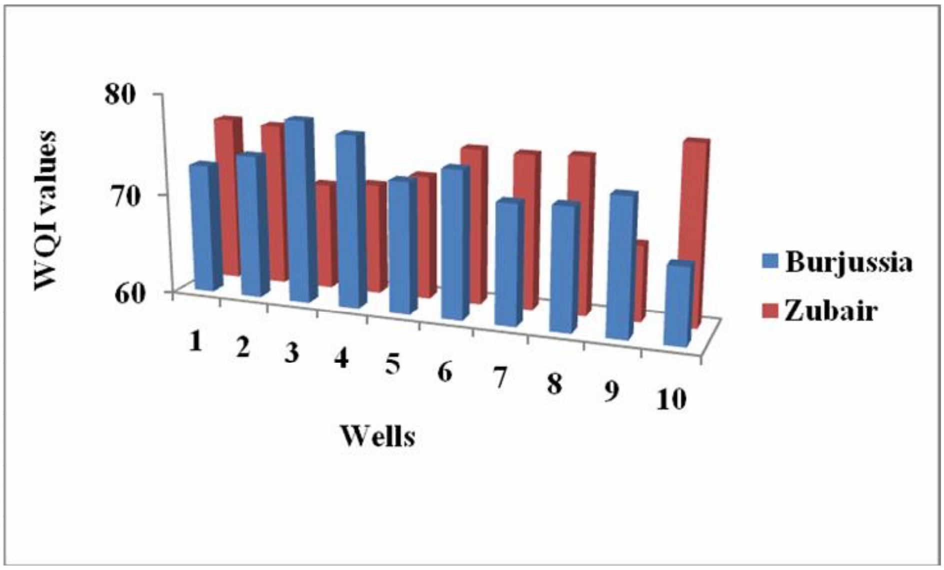

Figure 3: WQI values for irrigation uses.

Table 7: Irrigation water quality index characteristics.

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.

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