EVALUATION OF SPRINGS WATER FOR IRRIGATION OF AIN TALAWI AREA AND THE SURROUNDING VILLAGES N- W OF IRAQ.

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ABSTRAC

Quantity and quality of water available for irrigation vary from place to another. The evaluation of water quality has been carried out to determine suitability of spring water for irrigation. Six spring water samples were collected from the study area located in Ain Talawi area and the surrounding villages, northern Iraq. Quality assessment was made through the analysis of Ca^{++}, Mg^{++}, Na^{+}, K^{+}, Cl^{-}, SO_4^{-2}, HCO_3^{-1}, pH, TDS, and EC. Based on these analyses, parameters like sodium adsorption ratio, sodium percent, residual sodium carbonate, potential salinity, magnesium hazard and permeability index were calculated. All above parameters approximately are fit for irrigation purpose except Salinity of water which is very high due to the dissolution of gypsum in Fatha formation. It may be concluded that these spring water are suitable only for irrigating crops with high salt tolerance under special system of soil management.

INTRODUCTION

Although Iraq benefits from two big rivers, Tigris and Euphrates, their water and that of tributaries is only utilized in a narrow belt along river valleys in north Iraq and in the Mesopotamian plain of central and south Iraq . The present total area irrigated by surface water covers only about 25% of Iraq. Ground water will thus play an important role in the development of the remaining 75% of the country (Jasim and Goff, 2006). The fields were irrigated mainly during late spring and summer months. Due to shortage of rainfall during the last years, supplementary irrigation were applied during late winter and spring to irrigate field crops especially wheat and barely. The aim of this paper is assessment of spring water quality for irrigation purposes. The concentration of dissolved ions in ground water generally governed by lithology, velocity of ground water flow, nature of geochemical reactions, solubility of salt and human activities (Bhatt and Saklani ,1996). The studied area is located north –western of Iraq , at a distance about (90) km west of Mosul city between longitude (42^{o} 07′ → 42^{o} 14′) and latitude (36^{o} 16′ → 36^{o} 23′) Fig (1) . The climate of the area is semi-arid, according to the meteorological data of the last (20) years. The mean annual rainfall rate is (340) mm/yr (Meteorological station in Telafar ,2002).

The geological sequence extends from Dihiban formation to Quaternary deposits, Fatha formation consist of alternating layers of marl, limestone, gypsum, red clay and siltstone, this formation contains many fractures and joints which considered the main aquifer in the villages of bad water quality due to the presence of gypsum and marl. The field investigation and chemical analysis of springs water indicates that all springs water comes from Fatha aquifer.

Part of MSc. Thesis of the first author

Received 18 /12 /2008 accepted 4/6/ 2009

MATERIALS AND METHODS

Springs water samples were collected during August 2002 from six springs in the study area Fig (1), pH, and EC were measured in the field using digital meters immediately after collecting samples .Total dissolved solid TDS, and major ions (Cations), also (Anions) were carried out using standard method for water analyses as suggested by the American Public Health Association (APHA, 1975), Ca^{++} and Mg^{++} were determined by Titration using EDTA , Cl^{-} was determined by $AgNO_3$ titration , HCO_3^{-} was determined Titration using H_2SO_4, Na^{+} and K^{+} were measured by Flame photometer and SO_4^{-2} was determined by Spectrophotometer the laboratory work was completed within two week after of water samples collections. The result of springs water analysis is in table (1). The major cations and anions for the analyzed springs water were plotted on a Piper diagram (Piper, 1944) after converting the concentration from mg/l to meq % to determine the water type fig (2). According to this diagram two type of water were found in this area, calcium – sulphate $CaSO_4$ and magnesium-sulphate $MgSO_4$ the first type belongs to springs No.(1,2,4 and 6) while the second type belong to the springs No.(3 and 5) .the sources of these two types come from gypsum , dolomite, calcite and clay minerals .

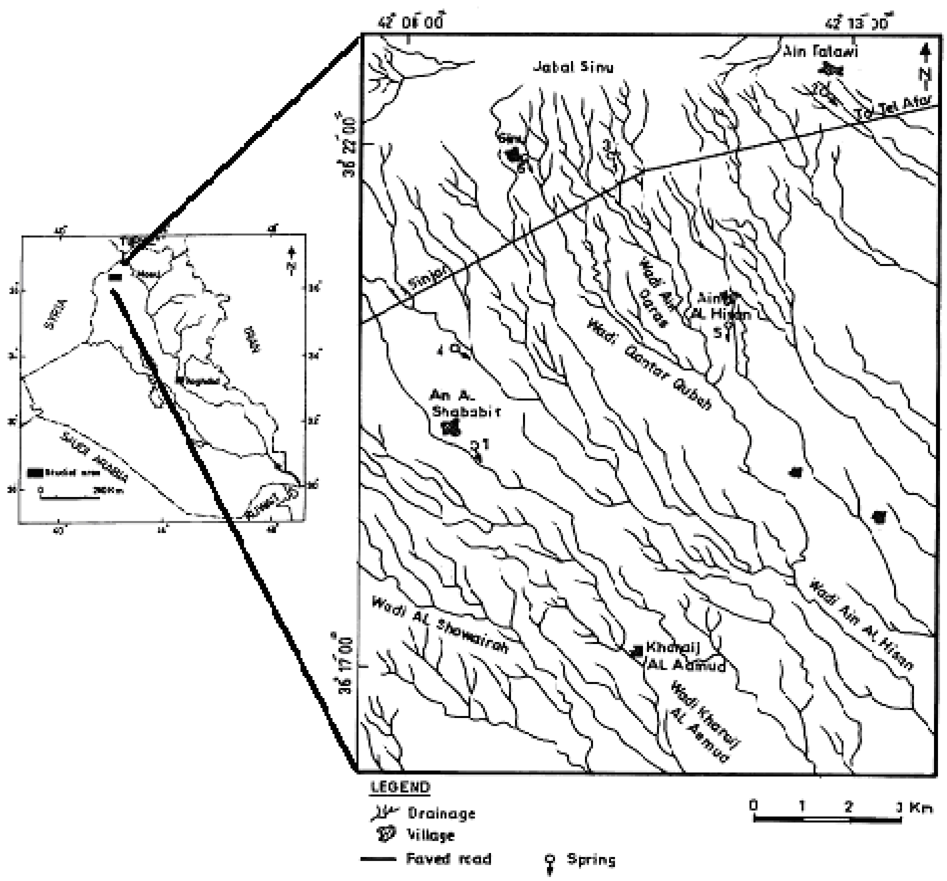

Fig (1): Location map of the study area showing locations of springs.

RESULTS AND DISCUSSION

1-Salinity: Concentrations of soluble salts in irrigation water can be expressed by EC for the purpose of classification, as low (EC < 0.25 $dS.m^{-1}$), medium (EC: 0.25 to 0.75 $dS.m^{-1}$), high (EC: 0.75-2.25 $dS.m^{-1}$) and very high (EC: > 2.25$dS.m^{-1}$)

salinity zones (Richard, 1954). Higher EC in water generates a saline soil and reduces crop yield beside irrigation water must be applied in excess quantities to leach salts from the soil. The electrical conductivity EC ranged between (2.84-3.52 $dS.m^{-1}$) see Table (1) and Fig (3), the high salinity of water comes from dissolution of gypsum rocks in the water of Fatha aquifer. This water is not suitable for irrigation water under ordinary circumstances. It can be used only on crops that are very tolerant of salts.

Table (1): chemical analysis of spring water and irrigation parameters in the study area.

Parameters and Units	Springs Number					
	1	2	3	4	5	6
pH	6.95	7.23	7.19	7.03	7.28	7.36
EC $dS.m^{-1}$	3.32	2.84	2.92	3.49	3.52	2.99
TDS mg/l	3268	3014	3025	3289	3461	2980
Ca^{++} mg/l	635	572	525	648	426	600
Mg^{++} mg/l	270	218.6	326.3	283.9	417.7	177.8
Na^{+} mg/l	39.3	29.3	32.7	36.2	33.7	78.8
K^{+} mg/l	2.9	2.9	2.5	2.4	2.7	2.7
Cl^{-} mg/l	358	212.7	283.6	359	415	319
SO_4^{-2} mg/l	1658	1548	1659	1612	1714	1519
HCO_3^{-} mg/l	273.4	412.1	384.4	325.8	468	195.4
SAR	0.32	0.26	0.27	0.29	0.27	0.72
Adj. SAR	0.98	0.82	0.86	0.94	0.89	2.02
Na%	3.17	2.79	2.71	3.03	2.67	7.25
MH%	41.2	38.7	50.6	41.9	61.7	32.7
P.S meq/l	27.3	22.1	25.2	26.9	29.5	25.5
RSC meq/l	-49.4	-39.8	-46.7	-46.6	-47.8	-41.4
P.I %	6.85	8.08	7.21	7.24	7.43	10.84
Irrigation water class*	C_4S_1					
Irrigation water class**	**Unsuitable**	**Doubtful to unsuitable**	**Doubtful to unsuitable**	**Unsuitable**	**Unsuitable**	**Doubtful to unsuitable**

* US Salinity classification
** Wilcox classification

2-Sodium adsorption ratio (SAR): can be calculated using this equation

$$SAR=\frac{Na}{\sqrt{\frac{Ca + Mg}{2}}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where all ionic concentrations are expressed in meq/l
Also Adj. SAR calculated using the equation

$$Adj.SAR = \frac{Na}{\sqrt{\frac{Ca + Mg}{2}}} \quad [9.4- p (k_2-kc)-p (ca +mg)-p (Alk)] \text{ ....(2)}$$

The values of p (k_2-kc), p (ca +mg) and p (Alk) founded from specially table (Ayers,1975),the calculation adj.SAR produced higher values than for the SAR (Table 1). There is a significant relationship between SAR values of irrigation water and the extent to which Na^+ is absorbed by the soils. If water used for irrigation is high in Na^+ and low in Ca^{++}, the complex may become saturated with Na^+, which destroys soil structure, because dispersion of clay particles however springs water is high in calcium and low of sodium.

SAR ranged between (0.26-0.72) while Adj. SAR ranged between (0.82-2.02) indicate low sodium in water and can be used for irrigation on almost all soils with little danger of developing harmful level of exchangeable sodium (Richard , 1954).

A plot of data on the diagram (US salinity Laboratory Staff, 1954) diagram showed that all present spring water samples fall in the field C_4S_1, which is very high in salinity degree hazard and low sodium hazard which consider Bad water quality.

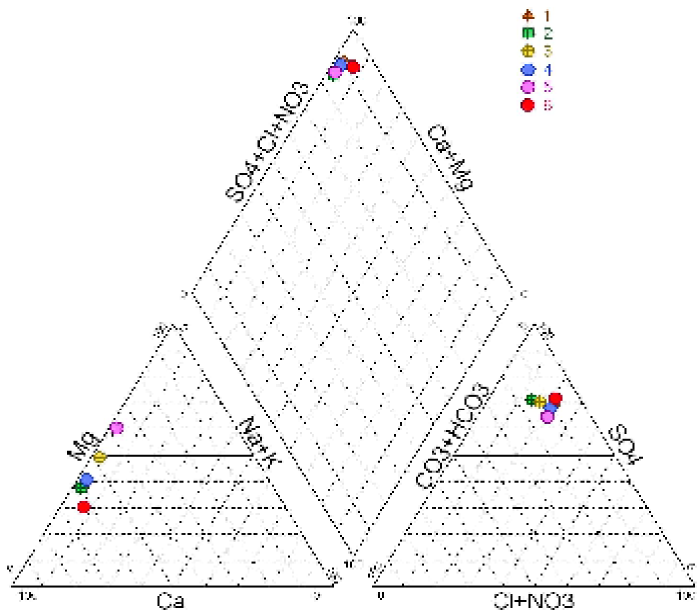

Fig (2): Piper diagram of springs water analyses illustrating water types

3-Sodium Percent: Sodium concentration is important in classifying irrigation water because sodium reacts with soil to reduce its permeability. The percent of sodium is obtained by the equation:

$$\%Na = \frac{Na + K}{Ca + Mg + Na + K} \times 100 \text{ .... (3)}$$

where all ionic concentrations are expressed in (meq/l)

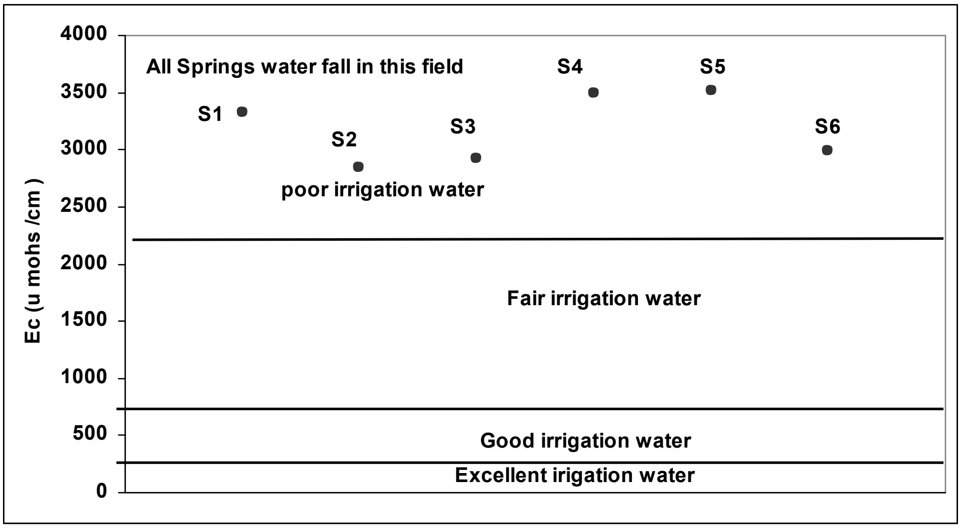

Fig (3): classification of salinity of water according to (US Salinity Laboratory Staff, 1954)

Sodium percent of samples ranged between (2.6 to 7.25)% table (1). The EC and Na% values plotted on (Wilcox, 1955) diagram. The result illustrated that spring water (2, 3 and 6) fall in the fields category doubtful to unsuitable, while spring water (1, 4 and 5) fall in the fields unsuitable category for irrigation.

4-Residual sodium carbonate (RSC): The quantity of bicarbonate and carbonate in excess of alkaline earths (Ca + Mg) influence the suitability of water for irrigation purposes. When the sum of carbonates and bicarbonates is in excess of calcium and magnesium, there may be possibility of complete precipitation Calcium and magnesium (Ragunath, 1987). To quantify the effects of carbonate and bicarbonate, residual sodium carbonate (RSC) has been calculated by the equation:

$$RSC = (CO_3 + HCO_3) - (Ca + Mg) \quad \ldots\ldots\ldots\ldots\ldots(4)$$

A high value of RSC in water leads to an increase in the adsorption of sodium in soil (Eaton, 1950). Water having RSC values greater than 2.5 meq/l are considered harmful to the growth of plants, while water with RSC values between 1.25-2.5 meq/l are marginal irrigation class. However RSC values are below 1.25 meq/l considered suitable for irrigation. All the samples of the springs water below that 1.25 meq/l and range between (-39.8 to –49.4) meq/l indicate excellent for irrigation fig (4).

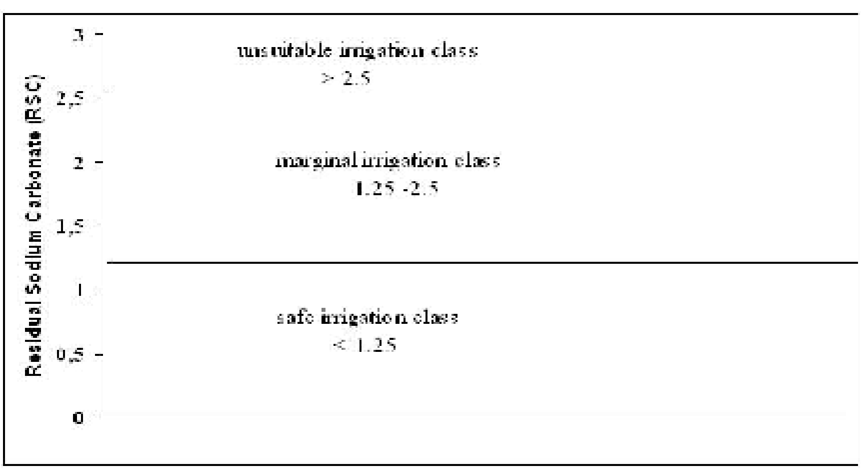

Fig (4): irrigation class depend on RSC (Wilcox, 1955)

5-Potential salinity: Potential salinity can be calculated from the equation

$$P.S = Cl + 0.5\ SO_4 \quad \ldots\ldots\ldots\ldots\ldots (5)$$

concentrations are expressed in (meq/l)

Potential salinity ranged between (22.1-29.5) meq/l the table (1),equation indicated the increase of chloride and sulphate leads to the elevation of salinity of water which limitation the usage of water for irrigation (Doneen, 1964) .

6-Magnesium hazard (MH): (Szabolcs and Darab, 1964) proposed magnesium hazard (MH) value for irrigation water as given below

$$MH = Mg / (Ca + Mg) \times 100 \quad \ldots\ldots\ldots\ldots\ldots (6)$$

MH > 50 % are considered harmful and unsuitable for irrigation use. In the analysed springs waters only samples No.3 and 6 greater than 50% fig (5).

7-Permeability index: The irrigation water can be classified by depending on the permeability index (PI), and can be estimated by using the equation:

$$\text{Permeability Index (PI)} = \frac{Na + \sqrt{Hco_3}}{Ca + Mg + Na} \times 100 \quad \ldots\ldots\ldots (7)$$

Where all ionic concentrations are expressed in (meq/l). According to PI values Table (1), all ground water samples in the study area can be designated as class I which is excellent category for irrigation, as in fig (6)

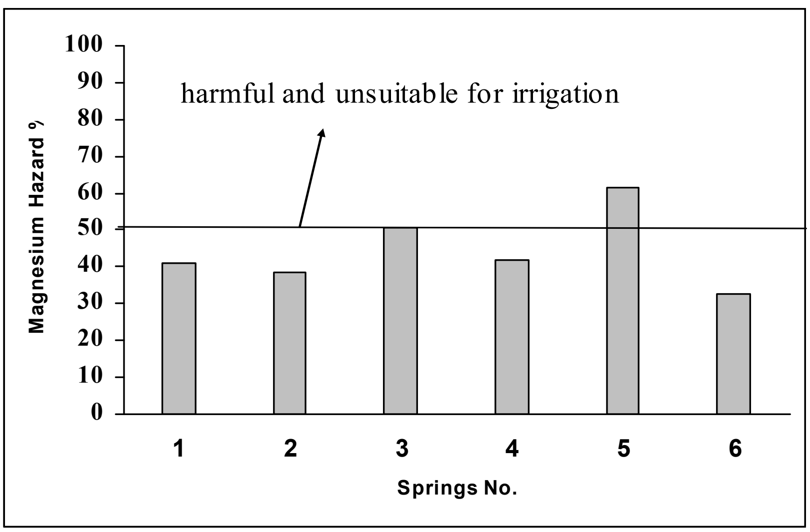

Fig (5): values of magnesium hazard % for all the samples

The quality assessment showed that, spring water is not suitable for irrigation due to its high electrical conductivity, total dissolved solids, sulphate and magnesium which come from the dissolution of gypsum and other rocks during water- rock interactions in Fatha Aquifer. In addition leaching, dissolution of soil salts and application of chemical fertilizers high salinity of springs water clearly indicated the limitation of this quality of water for Agriculture purposes. Adequate drainage and the introduction of alternative salt tolerant crops are required; however, there is no problem of sodium by using this water for agriculture dispersion and permeability. Results indicated that Sodium Adsorption Ratio, Sodium Percent, Residual sodium carbonate and Permeability index are within the safe limits for irrigation except Magnesium hazard in samples No. 3 and 6 which contains more than 50 % and considered harmful, as well as magnesium content.

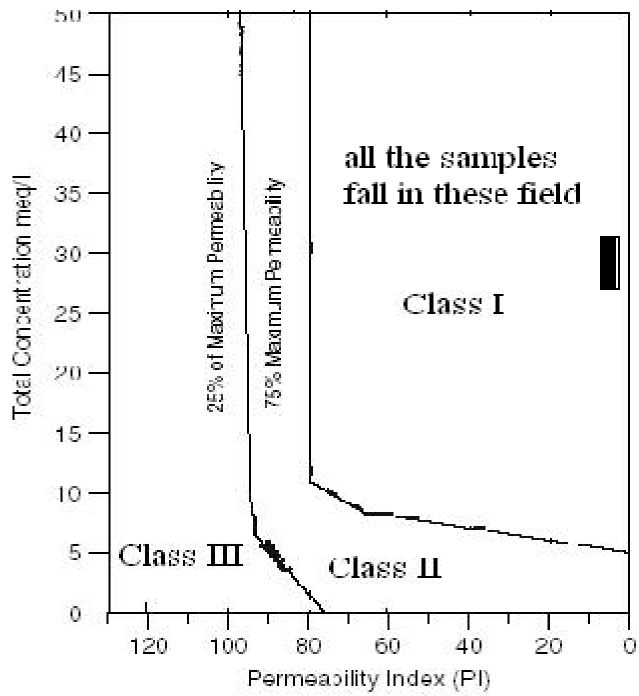

Fig (6): classification of irrigation water based on the Permeability index depend on (Doneen, 1964).

We recommending Management strategies such as, leaching, altering irrigation methods and schedules, changing tillage techniques, and/or flushing the soil with excessive of irrigation with fresh water before use of springs water.

تقييم مياه العيون لاغراض الري في منطقة عين طلاوي والقرى المحيطة بها شمال غرب العراق

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الخلاصة

تختلف كمية ونوعية المياه المستخدمة لاغراض الري من مكان الى اخر. ولتقيم نوعية مياه العيون وتحديد صلاحيتها لاغراض الري جمعت ستة نماذج من العيون في قرية عين طلاوي وماحولها في منطقة الدراسة. اجري تقيم لنوعية مياه العيون من خلال تحاليل الكالسيوم ، والمغنسيوم ، الصوديوم ، البوتاسيوم ، الكلوريد ، البيكاربونات ، الكبريتات ، الدالة الحامضية ، الاملاح الذائبة الكلية والتوصيلية الكهربائية . وبالاعتماد على التحاليل اعلاه تم حساب نسبة امتزاز الصوديوم ، النسبة المئوية للصوديوم ،كاربونات الصوديوم المتبقية ، الملوحة النشطة ، مخاطر المغنسيوم ومعامل النفاذية ،بصورة عامة كانت جميع المعاملات اعلاه ضمن الحدود الامنة للري بمياه العيون باستثناء الملوحة التي كانت بتراكيز عالية بسبب اذابة الجبسوم في تكوين الفتحة مما يجعل مياه هذه العيون صالحة فقط لري المحاصيل المقاومة للاملاح تحت نظام خاص لادارة التربة .

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