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Assessment of Groundwater Quality using water quality index (WQI) and Evaluation for irrigation uses in Rutba Area western Iraq

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Abstract. Groundwater is the main wellspring of water for the Rutba region. This review meant to research the water quality for Rutba region rely upon the water quality index(WQI) and Assessment of Groundwater quality for Water system employments. The groundwater tests in the review region are viewed as new to marginally water and low alkalinity. Chadha chart, shows the water type are Ca - Mg - Cl water type, with the exception of well (2), (12) the water type are Na - Cl water type and well (6) the water type are Ca - Mg – HCO3 water type. The water quality list (WQI) is Brilliant to great water for human drinking. As a rule, the groundwater quality in the read up region is reasonable for water system.

Keywords: irrigation water, hydrochemistry, Chadha diagram, Rutba.

Introduction

Groundwater is one of the important resource on earth for industrial development and human survival . Groundwater is very essential in terms of its down to earth utility for drinking, industrial, irrigation, and domestic purposes, and it also plays an important role in the world's living organisms. As a result, assessing groundwater quality for irrigation and drinking has turned into an important and critical task for future groundwater quality administration. [1]. Rutba area is based on groundwater in possessing different economic activate including livestock and agriculture purposes. Groundwater is considered as the only secure supply of water in the region. The studied area 1548 km^2 represents the Rutba area which is located within the Western Desert of Iraq between latitudes (32˚54′00″ – 33˚11′00″) North and longitudes (40˚7′10″- 40˚38′00″) East, (Figure 1).Tectonically, Rutba area is located on stable shelf within Rutba-Jezira zone [2]. Geologically, The major geological Formations in study area (from older to younger) (Fig. 2): Gaara Fn., Mulussa Fn., Zor Hauran Fn., Ubaid Fn., Mauddud-Nahr Umr Fn., Rutba Fn., Ms`ad Fn., Hartha Fn., and Quaternary Sediments: Include depression sediments and valleys [3]. The metrological data were recorded in Rutba station during 1988 – 2018 the total yearly rainfall was 111.77 mm, and evaporation of 2840.27 mm, with a monthly average temperature of 20.76 °C, relative humidity was 45.9, wind speed of 2,24 m/s, and sunshine length of 8.97 h/day. The climate in the research region is classified as arid. Hydrogeologically, The Mulussa aquifer represents the major groundwater aquifer exists (limestone and dolomite) beds [4].The aims research proposed to evaluate the groundwater in the Rutba region using water quality (WQI) and irrigation use evaluation.

Data and Methods

The groundwater sampling was taken on September 2019 carried out in Fifteen wells from the study region. The analyzes was carried out in the laboratory of General Commission of Groundwater/ Ministry of Water Resources. Each of these groundwater samples were analyzed for 11 parameters, these are Ca^{2+}, K^{+}, Na^{+}, Mg^{2+}, SO_4^{2-}, Cl^{-}, HCO_3^{-}, NO_3^{-}, TDS, EC and pH using a standard procedure of [6].

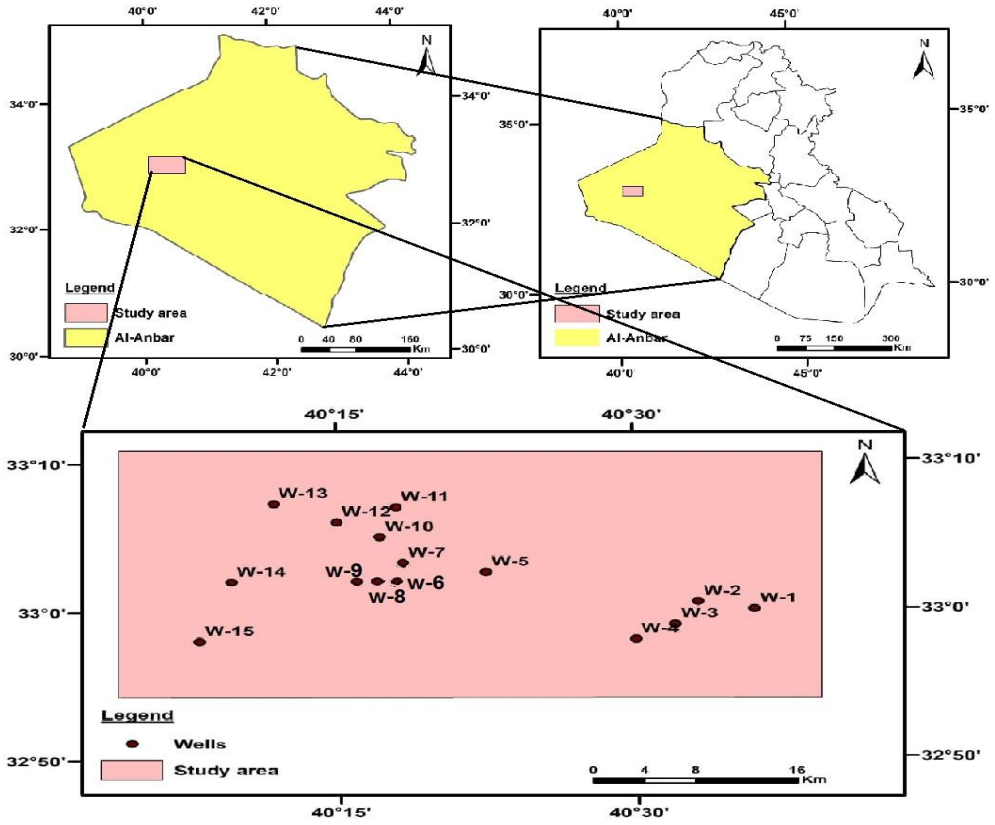

Fig.1: The review region's locations

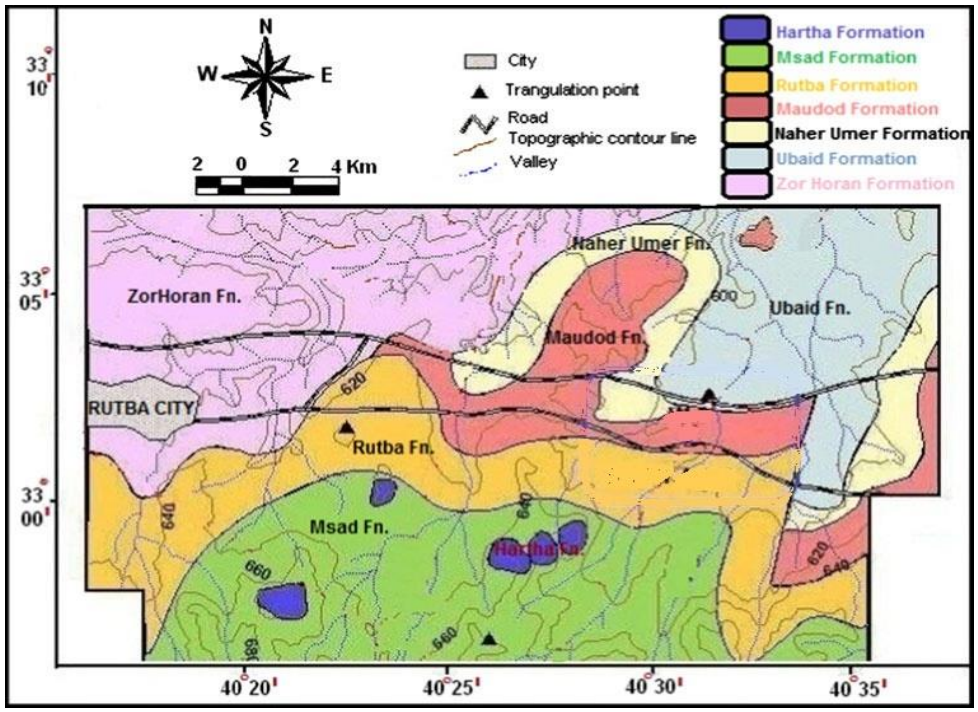

Fig. 2. Geologic guide of the review locale, Modified from [5]

Results and discussion

Parameters of physio-chemical

Table 1 show the detailed results of the physio-compound properties of groundwater tasters in the investigate area.

Table 1 physio-compound parameters of groundwater samples in the study area.

Well no.	Longitude	Latitude	pH	EC	TDS	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	Cl^{-}	HCO_3	SO_4^{2-}
W-1	E 40˚36' 00"	N 33˚ 00' 00"	7	1210	748	120	46	69	0	160	229	238
W-2	E 40˚33' 10"	N 33˚ 00' 30"	8	1102	618	54	25	135	0	135	201	170
W-3	E 40˚32' 00"	N 32˚ 59' 00"	7.4	960	568	74	45	50	0	153	131	170
W-4	E 40˚30' 00"	N 32˚ 58' 00"	7.5	980	613	82	55	51	0	153	183	170
W-5	E 40˚22' 30"	N 33˚ 02' 35"	7.6	676	353	44	27	46	0	62	168	87
W-6	E 40˚18' 00"	N 33˚ 02' 00"	7.3	609	348	58	21	38	0	49	192	67
W-7	E 40˚18' 19"	N 33˚ 03' 15"	8	1785	998	136	76	101	0	399	156	208
W-8	E 40˚17' 00"	N 33˚ 02' 00"	8	1800	1181	120	45	201	0	189	270	320
W-9	E 40˚16' 00"	N 33˚ 02' 00"	8	3210	1908	224	82	354	0	650	22	365
W-10	E 40˚17' 10"	N 33˚ 05' 00"	7.7	1273	795	90	48	105	0	209	165	245
W-11	E 40˚18' 00"	N 33˚ 07' 00"	7.7	2105	1265	198	66	184	0	380	253	380
W-12	E 40˚15' 00"	N 33˚ 06' 00"	8	1000	650	23	22	200	0	182	78	235.2
W-13	E 40˚03' 30"	N 33˚ 08' 30"	8	960	574	62	29	110	0	124	189	144
W-14	E 40˚09' 39"	N 33˚ 02' 00"	8	980	715	68	50	115	0	192	183	187
W-15	E 40˚08' 00"	N 32˚ 58' 00"	8	1087	605	122	19	70	0	124	265	138

The reasonable pH scope of drinking and water system water is 6.5-8.5 [7]. The pH shifts in groundwatere tests between (7.3 - 8). The pH upsides of groundwater tests are of low alkalinity. Huge TDS varieties in various groundwater tests were distinguished. In view of the TDS esteems, the groundwatere tests are viewed as new to marginally water (348 - 1908 mg/l). The source and synthetic nature of the water types were portrayed well from the water ionic creation. Cations and anions in water are requested in diminishing bounty as Ca2+> Na+> Mg2+> K+ and SO42-> HCO3-> Cl-in the groundwater tests.

Hydro-chemical Facies

The groundwater samples have been classified depend on their major anion and cation using the Chadha diagram. Chadha diagram is a somewhat modified of Flute player graph so as to broaden its relevance in displaying the geochemical data of water investigation in the least difficult manner conceivable [8].. Plotting the major ions constituents of groundwater samples in the Chadha diagram[9], shows that the samples for September 2019 are falling in the field number six that mean the water type are Ca - Mg -Cl water type, except well (2), (12) is falling in the field of seven that mean the water type are Na -Cl water type and well (6) is falling in the field of five that mean the water type are Ca - Mg –HCO_3 water type(Fig. 3).

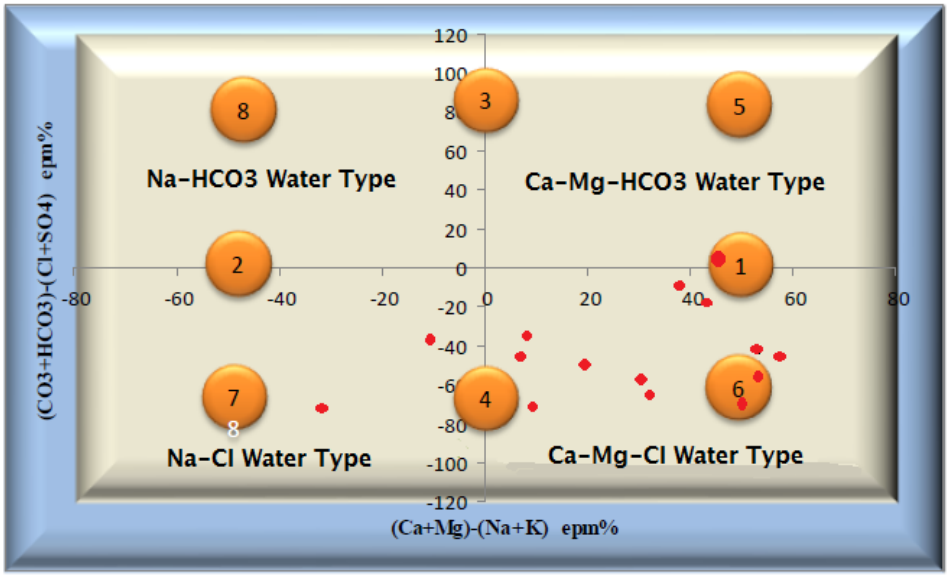

Fig. 3. Chadha classification of groundwater samples of the review region

Drinking-Water Quality Index (WQI)

The water qualityindex (WQI) may provide clear information about the subsurface geologic conditionsin which the water is found [10].It's a numerical device utilized for changing over enormous amount of water quality information into a solitary number that addresses the degree of water quality [11]. In this study physiochemistry parameters Ca^{2+}, K^{+}, Na^{+}, Mg^{2+}, SO_4^{2-}, Cl^{-}, HCO_3^{-}, NO_3^{-}, TDS, EC and pH have been used for evaluate of groundwater suitability for human consumption to develop (WQI) model. For calculation of WQI model, the standards for human consumption, according the World Health Organization's [7] standard.

In this study, the calculating (WQI) Fifteen groundwater samples were taken throughout the research region. According to [12], the WQI for groundwater samples in the study area is Excellent to Good water for human drinking are shown in (Fig. 4).

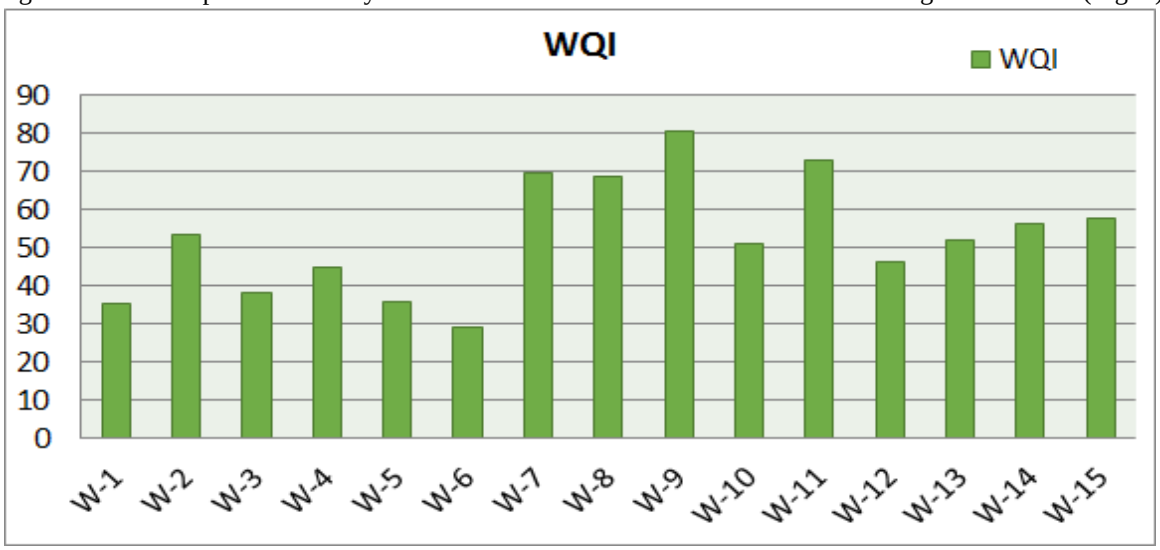

Fig. 4. The computed WQl for each well

Assessment parameters of irrigation water

The use of poor water quality has led to a number of problems such as toxicity, salinity, water infiltration and miscellaneous [13].The productivity of any crops are depending on the quality of plants, environmental conditions, methods of irrigation, properties of soil structure, climate conditions, the content of organic materials and crop type. The suitability of irrigation water is determined by mineral constituents and the kind of the dirt and plant to be flooded [14].To evaluate water quality in study region for irrigation uses, numerous boundaries were utilized like TDS, EC, Sodium Retention Proportion (SAR), Sodium rate (Na%), Remaining Sodium Carbonate (RSC) and Porousness File .

Fifteen samples of the study area for water system overall dependent on dependent on TDS (went from 348 to 1908 mg/l), EC went from (609 µS/cm to 3210 µS/cm), SAR (went from 1.07 to 7.2), RSC (ranged from -14.08 to -1.38) , Sodium percentage (ranged from 20 to 75) and PI (ranged from 34 to 84) (Table 2)(Fig. 5). Thus, the Fifteen samples of the study area belong to a fresh to slightly water class of TDS [15], good to a permissible except well (9) classified doubtful for irrigation of EC [16], no problem of SAR except well (12) classified increasing problem [17], good to permissible water except well (12) classified Doubtful for irrigation of Na% [18], ok for water system of RSC [19] and suitable water except wells (2, 12) classified unsuitable for irrigation of PI [20] (Fig. 5).

Table 2. The calculated values of SAR, Na%, RSC and PI of samples for each well in September2019

Well no.	SAR	Na %	RSC	PI
W-1	1.3	23	-5.89	39
W-2	3.8	55	-1.38	72
W-3	1.1	23	-5.11	38
W-4	1.07	20	-5.46	37
W-5	1.3	31	-1.59	57
W-6	1.09	26	-1.41	55
W-7	1.7	25	-10.26	34
W-8	3.9	47	-5.14	59
W-9	5.1	46	-14.08	52
W-10	2.2	35	-5.6	48
W-11	2.9	34	-10.97	43
W-12	7.2	75	-1.62	84
W-13	2.9	47	-2.29	64
W-14	2.6	40	-4.36	54
W-15	1.5	28	-3.26	48

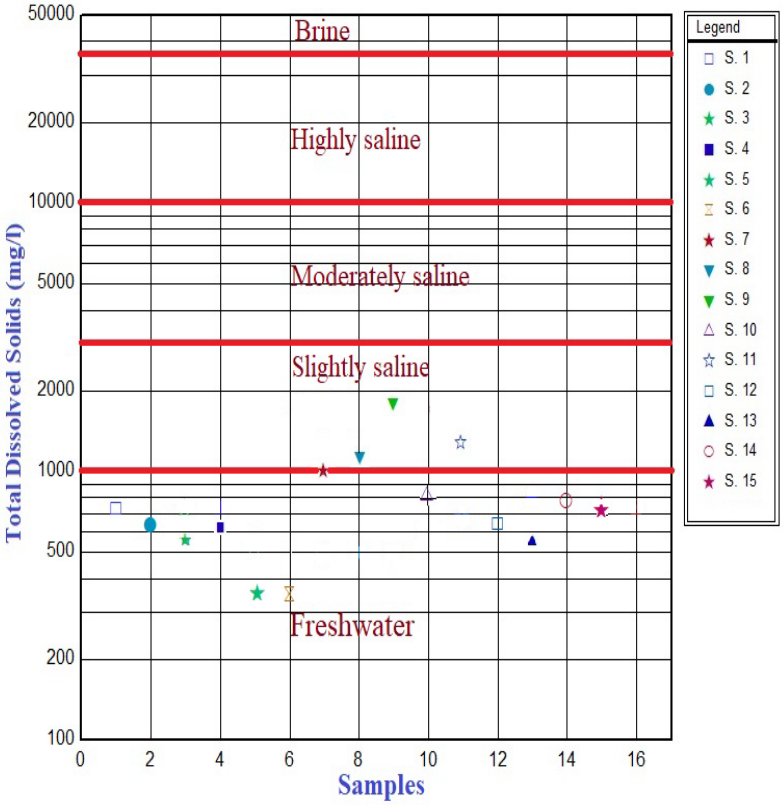

Fig. 6. a. Reasonableness irrigational water dependent on TDS [15]

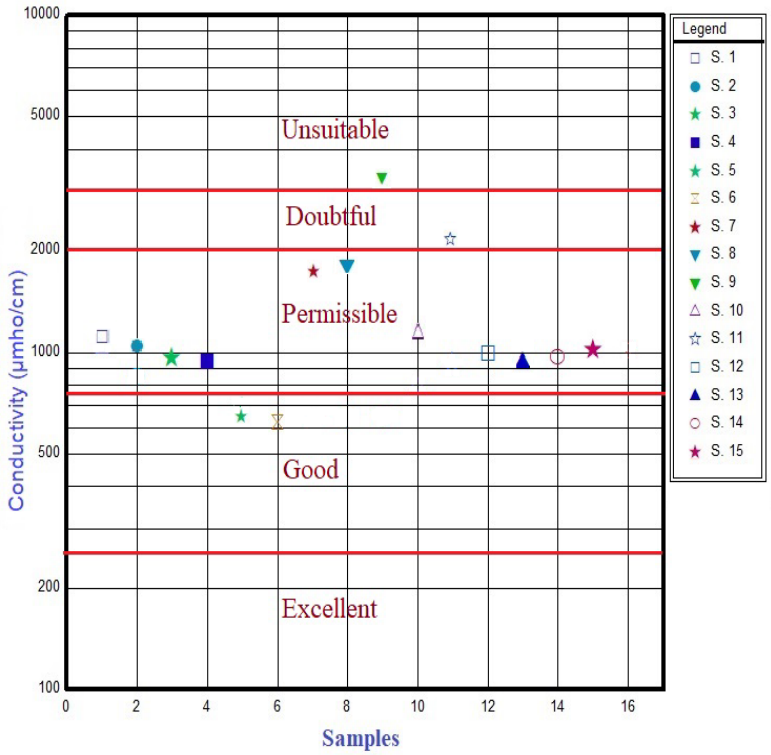

Fig. 6. b. Reasonableness irrigational water dependent on EC [16]

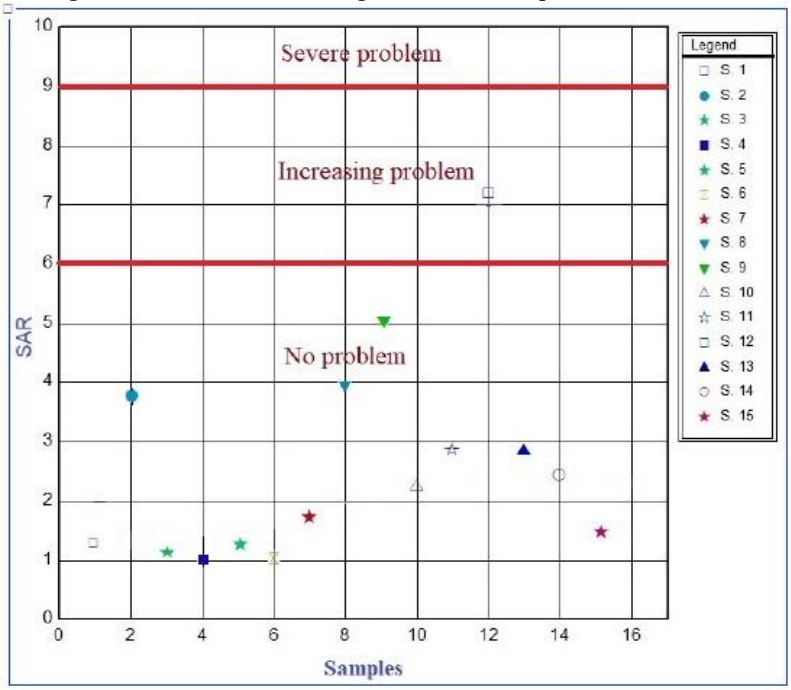

Fig. 6. c. Appropriateness irrigational water dependent on SAR [17]

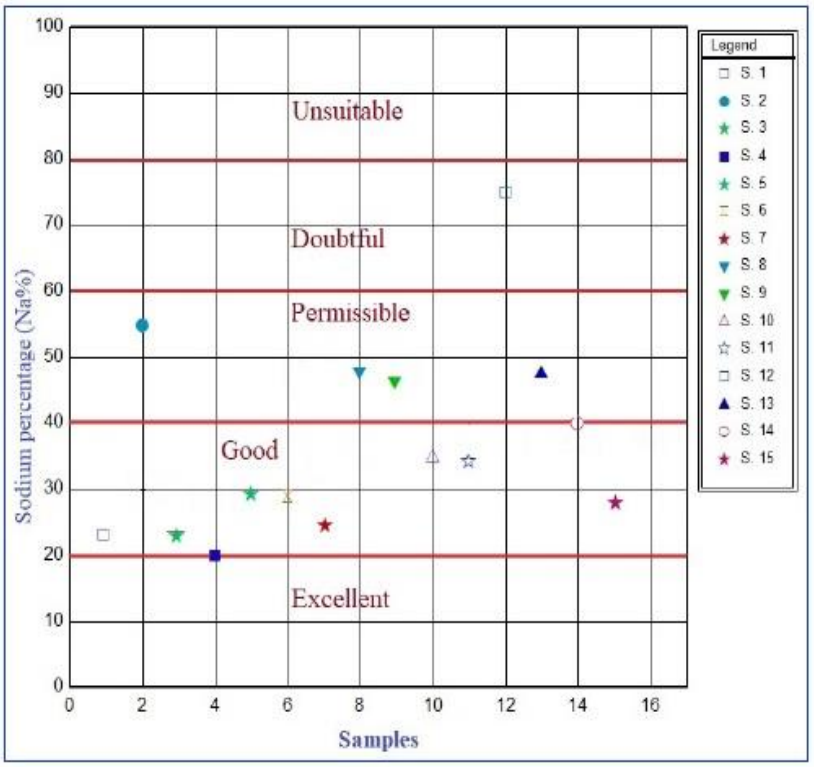

Fig. 6. d. Reasonableness irrigational water dependent on Na% [18]

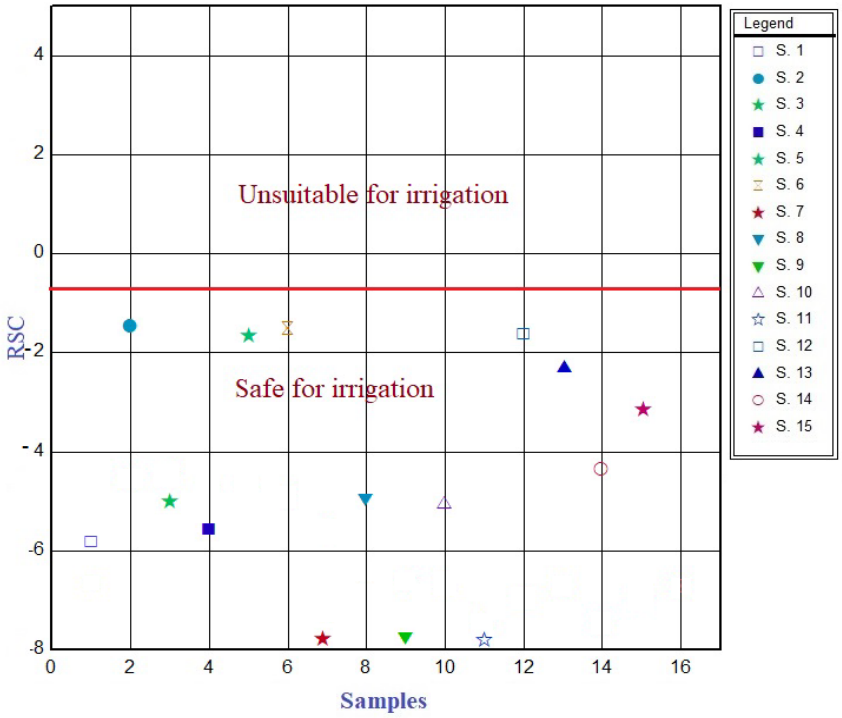

Fig. 6. e. Reasonableness irrigational water dependent on RSC [19]

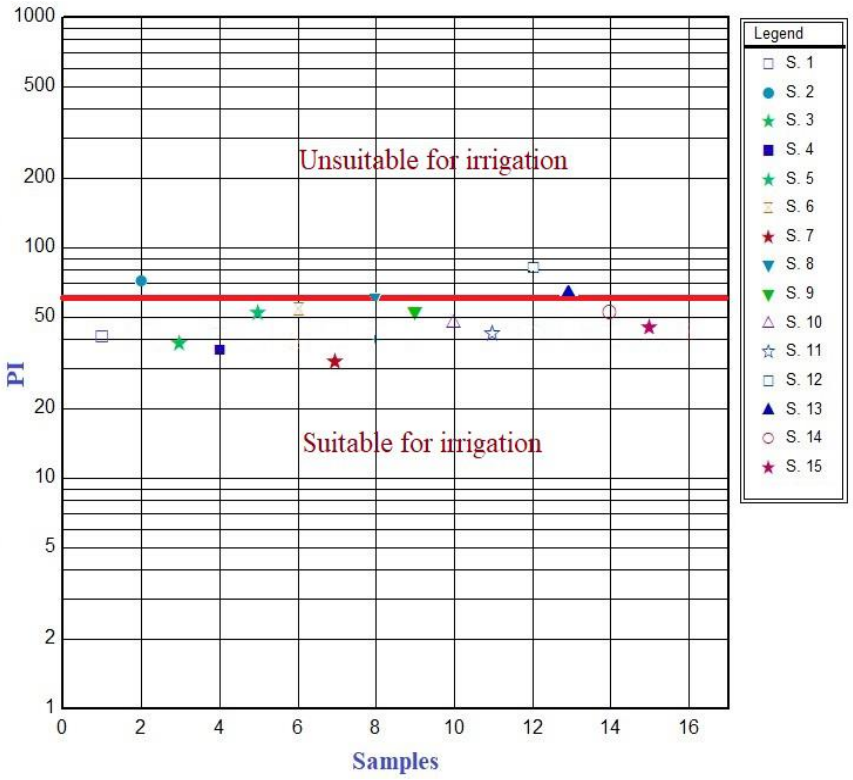

Fig. 6. g. Reasonableness irrigational water based on PI [20]

Conclusions

Based on the TDS and pH values, the groundwater tests in the review region are considered fresh to slightly water and low alkalinity. Chadha diagram(1999), shows that the samples for September 2019 are falling in the field number six that mean the water type are Ca - Mg -Cl water type, except well (2), (12) is falling in the field of seven that mean the water type are Na -Cl water type and well (6) is falling in the field of five that mean the water type are Ca - Mg - HCO_3 water type. Fifteen groundwater samples in the research area have water quality indices ranging from excellent to good for human consumption. The appropriateness of groundwater for irrigation has been determined using the following parameters: EC, TDS, SAR, Na present, RSC, and PI. The groundwater quality in the research region is generally appropriate for water system purposes, according to these classifications.

References

1. Olusola, F. O. (2020). Groundwater quality evaluation for drinking, domestic and irrigation uses in parts of ode irele local Government area of Ondo State, Nigeria. *Water Conservation and Management*, *4*, 32-41.
2. Jassim, S. Z., Buday, T., &Cicha, I. (2006). Tectonic framework. *Geology of Iraq. Czech Republic: Published by Dolin, Prague and Moravian Museum, Brno*, 35-52.
3. Al-Kubaisi, Q. Y., & Al-Kubaisi, M. H. (2018). Hydrogeologic Conditions of Mulussa Aquifer Between Rutba and Dhabaa in Al-Anbar Governorate. *Iraqi Journal of Science*, *59*(2A), 687-696.
4. Hussien, B. M., & Fayyadh, A. S. (2014). Preferable districts for groundwater exploitation based on hydrogeologic data of Aquifers-West Iraq. *Journal of Water Resource and Protection*, *6*(12), 1173.
5. Hussien, B. M. (2013). Modeling the impact of groundwater depletion on the hydrochemical characteristic of groundwater within Mullusi carbonate aquifer-west Iraq. *Environmental earth sciences*, *70*(1), 453-470.
6. APHA. (2005). Standard methods for the examination of water and wastewater. APHA. *American Water Works Association and Water Environment Federation, 21st ed.; American Public Health Association: Washington, DC, USA*.
7. WHO (2011). Guideline for drinking water quality. 4th edn. *World Health Organization*, Geneva, pp.1-564.
8. Aghazadeh, N., &Mogaddam, A. A. (2010). Assessment of groundwater quality and its suitability for drinking and agricultural uses in the Oshnavieh Area, Northwest of Iran. *Journal of Environmental protection*, *1*(01), 30.
9. Chadha, D. K. (1999). A proposed new diagram for geochemical classification of natural waters and interpretation of chemical data. *Hydrogeology journal*, *7*(5), 431-439.
10. Logeshkumaran, A., Magesh, N. S., Godson, P. S., &Chandrasekar, N. (2015). Hydro-geochemistry and application of water quality index (WQI) for groundwater quality assessment, Anna Nagar, part of Chennai City, Tamil Nadu, India. *Applied Water Science*, *5*(4), 335-343.

11. Hussien, B. M. (2010). Application of environmental isotopes technique in groundwater recharge within Mullusi carbonate aquifer-West Iraq. *Journal of Iraqi desert studies*, *2*.
12. Vasanthavigar, M., Srinivasamoorthy, K., Ganthi, R. R., Vijayaraghavan, K., & Sarma, V. S. (2012). Characterisation and quality assessment of groundwater with a special emphasis on irrigation utility: Thirumanimuttar sub-basin, Tamil Nadu, India. *Arabian journal of Geosciences*, *5*(2), 245-258.
13. Ayers, R. S., & Westcot, D. W. (1985). *Water quality for agriculture* (Vol. 29, p. 174). Rome: Food and Agriculture Organization of the United Nations.
14. Dawood, A. S., & Ahmed, A. N. (2016). Using GIS for Assess the Groundwater Quality in Southwest Side of Basrah City. *Muthanna Journal of Engineering and Technology (MJET)*, *4*(2), 75-87.
15. Freeze, R. A., & Cherry, J. A. (1979). Groundwater. New Jersey: Prentice-Hall geochemical parameter distribution in a ground water system contaminated with petroleum hydrocarbons. *Journal of Environmental Quality*, *30*, 1548-1563.
16. Richards, L. A. (1954). Diagnosis and improvement of saline and alkali soils. Washington. *US Department of Agriculture*.
17. Bouwer, H. (1978). Groundwater quality. *Groundwater Hydrology, McGraw-Hill Kogakusha Ltd*, 339-375.
18. Wilcox, L. (1955). *Classification and use of irrigation waters* (No. 969). US Department of Agriculture.
19. Eaton, F. M. (1950). Significance of carbonates in irrigation waters. *Soil science*, *69*(2), 123-134.
20. Doneen, L. D. (1964). Notes on water quality in agriculture, water science and engineering. *Department of Water Sciences and Engineering, University of California, Davis*.