Journal of Advanced Laboratory Research in Biology
E-ISSN: 0976-7614
Volume 4, Issue 4, October 2013
PP 135-140
https://e-journal.sospublication.co.in

Research Article

Water Quality Assessment of Some Well Water in Erbil City by Quality index, Kurdistan Region-Iraq

Janan J. Toma*, Zhalla S. Assad and Dnya R. Baez

Environmental Science Department, College of Science, University of Salahaddin-44002, Erbil, Iraq.

Abstract: The present work is aimed at assessing the water quality index (WQI) for the six well in Erbil city. This has been determined by collecting groundwater samples and subjecting the samples to a comprehensive physicochemical analysis. For calculating the WQI, the following 8 parameters have been considered: EC, TDS, pH, Alkalinity, Hardness, NO_3, Ca^{+2}, Mg^{+2}. The WQI for these samples ranges from 24.825 in Rizgari well No. 1 to 84.048 in Azadi well No. 8. The results indicated that water quality of wells (Azadi 8, Ankawa 9, Ronaky 1 and Badawa 13) remains Good and Tayrawa well No. 1 remains excellent in the years 2004, 2005, and 2012. But well of Rizgari No. 1 changed from good in year 2004 and to excellent in 2012.

Keywords: Well water, WQI, Erbil, Kurdistan, Iraq.

1. Introduction

Water is an essential commodity to humankind, and the largest available source of freshwater lies underground. Increased demands for water have stimulated development of underground water supplies. The Old Testament contains numerous references to groundwater, springs & wells (Todd, 1959). Groundwater can be defined as water that occurs in the open space below the surface of the earth. Usable groundwater occurs in voids or space in various layers of geological material such as sand, silt, sandstone and limestone (Nabi, 2004). The quality of groundwater depends on the composition of the recharge water, the interactions between the water and the soil, soil-gas and rock with which it comes into contact in the saturated zone (Toma, 2013). It is well known that clean water is essential for several purposes for healthy living, according to WHO organization; about 80% of all the diseases in human beings are caused by water (Toma, 2013). Within Erbil province, Kurdistan region of Iraq, the major source of water supply drawn from groundwater, and there is a great abundance of groundwater drilled wells in the province, all this issue provides a perennial source of water for drinking purposes and numerous activities (Toma, 2006). Once the groundwater is contaminated, its quality cannot be restored by stopping the pollutants from the source. It, therefore, becomes imperative to regularly monitor the quality of groundwater and to devise ways and means to protect it (Chauhan and Singh, 2010). The increase in population and expansion of economic activities undoubtedly leads to increasing demand of water use for various purposes (Toma, 2006). Water quality index (WQI) is one of the most effective tools to communicate information on the quality of water to the concerned citizens and policy makers. It, thus, becomes an important parameter for the assessment and management of groundwater. WQI is defined as a rating reflecting the composite influence of different water quality parameters (Ramakrishnaiah *et al*., 2009). The objective of this study is the drinking water quality assessment in six well in the city of Erbil. Monitored parameters of the samples were also determined by using standard analytical methods. We have used the Water Quality Index (WQI) to evaluate the drinking water quality as well as the mathematical processing of the data.

*Corresponding author:
E-mail: janan_toma@yahoo.com.

2. Description of the areas

Erbil province is the capital of Kurdistan of Iraq and is situated in the northeast of Iraq. Erbil covers about 18170 square kilometers. It is bounded to the north-west by the Greater Zab River and to the southeast by the Lesser Zab River. Boundaries extend from longitudinal 43°15¯E to 45°14¯E and from latitude 35°27¯N to 37°24¯N. Details of climate, geology and Limnology of the area are given in (Rzoska, 1980 and Zohary, 1950). Twenty-four samples were collected in six wells (Tayrawa No. 1, Azadi No. 8, Ronaky No. 1, Rizgari No. 1, Badawa No. 13, and Ankawa No. 9) in the Hawler city on four replications to each well during November and December 2012.

3. Materials and methods

Historical water quality data related to some well water in Erbil city collected in the years 2004 and 2005 (Nabi, 2004). Twenty-four samples of well water (Tayrawa 1, Azadi 8, Ronaky 1, Rizgari 1, Badawa 13, and Ankawa 9) were collected from different with Hawler city in Kurdistan region of Iraq for the period of November and December 2012 with four replications. EC, TDS, pH, Alkalinity, Total hardness, Ca^{+2}, Mg^{+2} and NO_3 were analyzed using standard analytical methods (APHA, 1998). Eight water parameters were considered for calculation of water quality index (Padmanabha and Belagalli, 2005).

$$\text{Overall WQI} = \Sigma qiwi / \Sigma wi$$

$$\text{Water Quality Index (WQI)} = \Sigma qiwi$$

Where, qi (Water Quality Rating) = 100 X (Va-Vi) / (Vs-Vi),
When, Va = actual value present in the water sample; Vi = ideal value (0 for all parameters except pH and DO which are 7.0 and 14.6mg l-1 respectively); Vs = standard value.
The calculated unite weight (wi) values of each parameter are given in Table 1.
If quality rating qi = 0 means the complete absence of pollutants,

While 0 < qi < 100 implies that, the pollutants are within the prescribed standard.

Table 1. Drinking water standards and unit weight of the water quality parameters.

Parameters	Unit	Water quality standards	Unit weight
pH	--	6.5-8.5	0.130
EC	µS/Cm	1000	0.001
Alkalinity	mg $CaCO_3$/L	200	0.005
TDS	mg/L	500	0.002
NO_3	mg/L	50	0.02
Hardness	mg $CaCO_3$/L	200	0.005
Ca^{+2}	mg/L	100	0.01
Mg^{+2}	mg/L	30	0.03

To include the collective role of various physicochemical parameters on the overall quality of drinking water, quality status is assigned on the basis of calculating values of water quality indices. Based on a number of water pollution studies, the following assumptions were made with reference to assess the quality of drinking water (Tiwari, 1986). The assumptions were: WQI < 50: fit for human consumption; WQI < and WQI >100: poor water quality.

4. Results and discussions

The physicochemical parameters have shown spatial variations. The results for the parameters tested are as given in (Tables 2-13). In this study area result of electric conductivity throughout this survey ranged between 260-620µs/cm, these variations depend on the climate, soil, geological origin and the content of ionic salts (Wetzel, 1975). The maximum acceptable level of conductivity as indicated by (USEPA, 2004) is a 1000µs/cm, and accordingly all studied wells were in permissible range for drinking purposes. Total dissolved solids concentration in this survey ranged from 170-300mg/L. Total dissolved solids comprise from inorganic salts and small amount of organic matter that is dissolved in water. Water containing TDS below 1000mg/L is usually acceptable to consumer (WHO, 2004). According to WHO standards, the highest desirable and the highest permissible level for total dissolved solids are 500mg/L and 1500mg/L respectively, therefore all wells lie within desirable level for drinking purposes according to WHO guidelines (WHO, 2004). pH is numerical expression of hydrogen ion concentration indicate in degree of acidic and alkaline, the result of this study showed the pH valued varied from 7.1 to 7.6, indicating that the water samples are on-alkaline side of neutrality, the obtained value of pH is considered as a usual condition because, generally in Iraq Kurdistan region the pH of water characterized by shift towards the alkaline side of neutrality due to the geological formation of the area which composed mainly of $CaCO_3$ (Nabi, 2004). The observed values of pH show a relative agreement with pH values of surface water, which lie within the recommended value of drinking purposes (WHO, 2004). The alkalinity value is ranged between 100 and 240mg $CaCO_3$/L. According to WHO standards, the highest desirable level of alkalinity concentration is 125mg $CaCO_3$/L and highest permissible level is 200mg $CaCO_3$/L, accordingly water of all studied wells lie within this limitation and thus are considered to be of a good quality (WHO, 2004). The maximum acceptable level of total hardness in drinking water according to WHO guideline is 500mg $CaCO_3$/l, all studied well considered safe for drinking purposes. The variations in total hardness may be due to geological formation of the catchment area and various humans activates, from the geological point of view the main

source of hardness is calcium and magnesium cations, Calcium concentration more than magnesium in the study area, these may attribute to the geological formation of Hawler area which is composed mainly of limestone and the solubility of calcite rock which is abundant in the study area is more rapidly than dolomite (Chauhan and Singh, 2010). Nitrate is generally more stable in groundwater than either nitrite or ammonium; this probably due to that nitrate is the final step of oxidation of ammonia and other nitrogen compound (Bartram and Balance, 1996). The nitrate concentration in ground and surface water is normally low but can reach a high level as a result of leaching or runoff from agricultural a consequence of the oxidation of ammonia and (WHO, 2004). According to WHO a guideline value of nitrate was 50mg NO_3/l was recommended (WHO, 2004), accordingly, all wells have lie with the recommended level of nitrate-nitrogen for drinking purposes.

The WQI was used to aggregate diverse parameters and their dimensions into a single score, displaying a picture of the historical water quality of the six well water (Tayrawa 1, Azadi 8, Ronaky 1, Rizgari 1, Badawa 13, and Ankawa 9) in Erbil city. It was observed from the computed annual The WQI for these samples ranges from 24.825 in Rizgari well No. 1 to 84.048 in Azadi well No. 8. The results indicated that water quality of wells (Azadi 8, Ankawa 9, Ronaky 1 and Badawa 13) remains Good and Tayrawa well No. 1 remain excellent in the years 2004, 2005 and 2012. But well of Rizgari No. 1 changed from good in year 2004 and to excellent in 2012.

Table 2. Variation of physicochemical parameters in Azadi well-8 in November & December 2012.

Parameters	R1	R2	R3	R4
EC	414	412	415	410
TDS	264.96	363.68	265.6	262.4
pH	7.4	7.4	7.5	7.5
Alkalinity	156	150	150	150
T. Hardness	250	248	250	244
Ca^{+2}	42.48	44.08	44.88	43.28
Mg^{+2}	35.0064	33.54	33.54	33.0616
NO_3	37.017	35.5307	35.44	37.0921

R= Replication

Table 3. Variation of physicochemical parameters in Badawa Well-13 in November & December 2012.

Parameters	R1	R2	R3	R4
EC	306	303	301	301
TDS	195.84	193.92	192.64	192.64
pH	7.6	7.5	7.4	7.4
Alkalinity	128	110	120	120
Hardness	184	202	204	208
NO_3	21.732	21.640	23.45	21.78
Ca^{+2}	64.128	67.33	48.096	63.326
Mg^{+2}	5.834	10.2102	20.420	12.155

R= Replication

Table 4. Variation of physicochemical parameters in Tayrawa Well-1 in November & December 2012.

Parameters	R1	R2	R3	R4
EC	489	491	482	485
TDS	312.92	314.24	308.48	310.4
pH	7.1	7.1	7.1	7.1
Alkalinity	174	170	170	174
Hardness	264	286	265	253
NO_3	39.166	34.241	35.966	37.074
Ca^{+2}	64.128	60.12	43.2864	41.6832
Mg^{+2}	25.2824	28.6858	35.9788	35.9788

R= Replication

Table 5. Variation of physicochemical parameters in Ronaky Well-1 in November & December 2012.

Parameters	R1	R2	R3	R4
EC	269	268	266	268
TDS	172.16	171.52	170.24	171.52
PH	7.4	7.4	7.5	7.4
Alkalinity	128	126	120	118
Hardness	184	188	180	220
Ca^{+2}	39.248	40.881	72.144	68.139
Mg^{+2}	20.906	20.9066	15.223	12.155
NO_3	12.3459	10.2943	9.9675	10.4032

R= Replication

Table 6. Variation of physicochemical parameters in Ankawa Well-9 in November & December 2012.

Parameters	R1	R2	R3	R4
EC	614	618	622	620
TDS	307	309	311	310
pH	7.3	7.4	7.3	7.3
Alkalinity	233	240	240	238
Hardness	291	290	295	298
Ca^{+2}	51	52	52	52
Mg^{+2}	39.2	40.1	41.2	42.1
NO_3	24	26	22	20

R= Replication

Table 7. Variation of physicochemical parameters in Rizgari Well-1 in November & December 2012.

Parameters	R1	R2	R3	R4
EC	465	486	472	477
TDS	232	240	236	333
pH	7.5	7.6	7.6	7.7
Alkalinity	186	176	180	182
Hardness	218	225	230	226
Ca^{+2}	54	57	60	56
Mg^{+2}	19.9	22	21	20
NO_3	24	28	25	26

R= Replication

Table 8. Calculation of water quality index for Azadi well No. 8.

Parameters	Observed values (mean)	Standard values	Unit weight (wi)	Quality rating scale (qi)	Water quality index (WQI)
EC	412.75	1000	0.001	41.275	0.041
TDS	264.16	500	0.002	52.832	0.105
pH	7.4	6.5-8.5	0.133	80	10.4
Alkalinity	151.5	200	0.005	75.75	0.378
T. Hardness	248	200	0.005	124	0.62
Ca^{+2}	43.68	100	0.01	43.68	0.4368
Mg^{+2}	33.78	30	0.03	112.6	3.378
NO_3	36.270	50.0	0.02	72.54	1.4508
			Σwi=0.025		**Σqiwi=2.104**

Overall WQI = Σ qi wi /Σ wi =84.048

Table 9. Calculation of water quality index for Badawa well waters No. 13.

Parameters	Observed value	Standard value	Unit weight WI	Quality rating scale	Water quality index (WQI)
EC	302.75	1000	0.001	0.30275	0.0003
TDS	193.76	500	0.002	38.752	0.077
pH	7.4	6.5-8.5	0.133	80	10.64
Alkalinity	119.5	200	0.005	59.75	0.298
T. Hardness	199.5	200	0.005	99.75	0.498
Ca^{+2}	60.7219	100	0.01	60.7219	0.607
Mg^{+2}	12.155	30	0.03	40.516	1.215
NO_3	22.109	50.0	0.02	44.218	0.884
			Σwi=0.025		**Σqiwi =1.77**

Overall WQI = Σ qi wi /Σ wi =71.096

Table 10. Calculation of water quality index for Tayrawa well waters No. 1.

Parameters	Observed value	Standard value	Unit weight WI	Quality rating scale	Water quality index (WQI)
EC	486.75	1000	0.001	48.675	0.048
TDS	311.52	500	0.002	62.304	0.124
pH	7.1	6.5-8.5	0.133	20	2.6
Alkalinity	172	200	0.005	86	0.43
T. Hardness	264.5	200	0.005	132.25	0.661
Ca^{+2}	52.304	100	0.01	52.304	0.523
Mg^{+2}	31.481	30	0.03	104.93	3.147
NO_3	36.612	50	0.02	73.224	1.464
			Σwi =0.025		**Σqiwi =1.124**

Overall WQI = Σ qi wi /Σ wi =44.985

Table 11. Calculation of water quality index for Ronaky well waters No. 1.

Parameters	Observed value	Standard value	Unit weight WI	Quality rating scale (qi)	Water quality index (WQI)
EC	268	1000	0.001	26.8	0.026
TDS	171.36	500	0.002	34.272	0.068
pH	7.4	6.5-8.5	0.133	80	10.4
Alkalinity	122.5	200	0.005	61	0.305
T. Hardness	193	200	0.005	96.5	0.482
Ca^{+2}	55.11	100	0.01	55.11	0.551
Mg^{+2}	13.492	30	0.03	44.973	1.34919
NO_3	10.752	50	0.02	21.504	0.430
			Σwi= 0.025		**Σqiwi =1.701**

Overall WQI = Σ qi wi /Σ wi =68.04

Table 12. Calculation of water quality index for Rizgari well waters No. 1.

Parameters	Observed value	Standard value	Unit weight WI	Quality rating scale (qi)	Water quality index (WQI)
EC	475	1000	0.001	47.5	0.047
TDS	260.25	500	0.002	52.05	0.104
pH	7.6	6.5-8.5	0.133	10	1.33
Alkalinity	181	200	0.005	90.5	0.452
T. Hardness	224.75	200	0.005	112.37	0.561
Ca^{+2}	56.75	100	0.01	56.75	0.567
Mg^{+2}	20.72	30	0.03	69.06	2.071
NO_3	25.75	50	0.02	51.5	1.03
			Σwi =0.025		**Σqiwi =0.620**

Overall WQI = Σ qi wi /Σ wi =24.825

Table 13. Calculation of water quality index for Ankawa well waters No. 9.

Parameters	Observed value	Standard value	Unit weight WI	Quality rating scale (qi)	Water quality index (WQI)
EC	618.5	1000	0.001	61.85	0.061
TDS	309.25	500	0.002	61.85	0.123
pH	7.3	6.5-8.5	0.133	60	7.98
Alkalinity	237.75	200	0.005	118.87	0.0594
T. Hardness	293.5	200	0.005	146.75	0.7330
Ca^{+2}	51.75	100	0.01	51.75	0.5175
Mg^{+2}	40.65	30	0.03	135.5	4.065
NO_3	23	50	0.02	46	0.92
			Σwi =0.025		**Σqiwi =1.87**

Overall WQI = Σ qi wi /Σ wi =74.96

5. Conclusion

On the bases of our results, we can conclude the following:

1. pH indicates that the water samples are on-alkaline side of neutrality.
2. According to WHO a guideline value of nitrate was 50mg NO_3/l was recommended, accordingly, all wells have lie with the recommended level of nitrate-nitrogen for drinking purposes.
3. With using of WQI we have gotten, the quality of some drinking water that belongs to the six well water. We found if they are suitable for drinking purpose or not. During this study well water quality classified to:

I. 2004
   1) Azadi – good
   2) Tayrawa – excellent
   3) Ankawa – poor
   4) Ronaky – good
   5) Badawa – good
   6) Rizgari – unsuitable

II. 2005
   1) Azadi – good
   2) Tayrawa – excellent
   3) Ankawa – good
   4) Ronaky – good
   5) Badawa – good
   6) Rizgari – good

III. 2012
   1) Azadi 8 – good
   2) Tayrawa 1 - excellent
   3) Ankawa - good
   4) Ronaky – good
   5) Badawa 13 – good
   6) Rizgari 1 – excellent

References

[1]. Todd, D.K. (1959). Groundwater Hydrology. John Wiley and Sons. Inc. 336p.

[2]. Nabi, A.Q. (2005). Limnological and bacteriological studies on some wells within Hawler city, Kurdistan region-Iraq. M.SC. Thesis Salahaddin University.

[3]. Toma, J.J. (2013). Evaluating Raw and treated Water quality of the Greater Zab River within an Erbil city by index analysis. *International Journal of Emerging Technologies in Computational and Applied Sciences*, 3: 147-154.

[4]. Toma, J.J. (2006). Physicochemical and Bacteriological Analysis for Ground Water Wells in Ainkawa, Erbil, Iraq. 4th International Conference Biol. Sci. (Botany), Egypt, 147-152.

[5]. Chauhan, A. and Singh, S. (2010). Evaluation of Ganga Water for Drinking Purpose by Water Quality Index at Rishikesh Uttarakhand, India. *Report Opinion*, 2(9): 53–61.

[6]. Toma, J.J. (2006). Study on Some of Physicochemical Properties in Shaqlawa Groundwater (some well) Erbil Iraq. *Zanco, Journal of pure and Applied Sciences*, 18(3): 9-14.

[7]. Ramakrishnaiah, C.R., C. Sadashivaiah and G. Ranganna, (2009). Assessment of water quality index for the groundwater in Tumkur Taluk, Karnataka State, India. *E-Journal of Chemistry*, 6: 523-530.

[8]. Rzoska, J. (1980). Euphrates and Tigris, Mesopotamian Ecology and Destiny. Vol: 38. Monographiae Biologicae, Dr. W. Junk bv Publishers, The Hague, Springer Netherlands, 122p.

[9]. Zohary, M. (1950). The Flora of Iraq and its Phytogeographical Subdivision. Dep. Agr. Iraq. Bull., 31: 1-201.

[10]. APHA (1998). Standard Methods for the Examination of Water and Wastewater. American Public Health Association, 20th edition, Washington. D.C.

[11]. Padmanabha, B. and Belagali, S.L. (2005). Comparative study on the water quality index of four lakes in the Mysore city. *Indian Journal of Environmental Protection*, 25, 873-876.

[12]. Tiwari, T.N., Das, S.C. and Bose, P.K. (1986). Weighed geometric Water Quality Index for river Jhelum in Kashmir. *Journal of M.A.C.T.*, 19**:** 33-41.

[13]. Wetzel, R.G. (1975). Limnology. W.B. Saunders Co. Publ. 2nd Edition, Philadelphia, London, 741P.

[14]. USEPA (2004). Drinking Water Standards and Health Advisories. Office of Water, United States Environmental Protection Agency. Washington, DC.

[15]. WHO (2004). Guideline for Drinking-Water Quality. 3rd Edition Vol. 1 Recommendation Geneva.

[16]. Bartram, J. and Balance, R. (1996). Water Quality Monitoring: a practical guide to the design and implementation of freshwater quality studies and monitoring programmes. United Nations Environmental Programme- UNEP- and WHO. E & FN Spon, an imprint of Chapman & Hall. London, U.K. 400P.