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Water Quality Index of Delizhiyan Springs and Shawrawa River within Soran District, Erbil, Kurdistan Region of Iraq

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ABSTRACT

Water quality index (WQI) was applied in Delizhiyan springs and Shawrawa river within Soran district, Kurdisdtan region, in order to certain the quality of water for public consumption, recreation and other purposes. In this study water quality index was determined on the basis of twelve physico-chemical parameters like pH, electrical conductivity, turbidity, total alkalinity, total hardness, sulfate, chloride, nitrate, calcium, sodium and potassium. The relative weight assigned to each parameters ranged from 1 to 5 ,based on the important parameters for aquatic life and drinking purposes. Because water quality index is one of the most effective tools to communicate information on the quality of water to the concerned citizen and policy makers. The results indicated that water quality of springs and river declined from poor water.
KEYWORDS: Fresh water, Surface water, Ground water, Water Quality Index.

1- INTRODUCTION

All life forms on the earth planet are water dependent [1].Water is not only essential to life but it is also a vital component of healthy functioning of any ecosystem [2]. The fresh water is critical concern for mankind, since it is directly linked to human welfare [3]. In the last few decades, there has been a tremendous increase in the demand for fresh water. Approximately 20% of the world population lacks safe drinking water and nearly half the world population lacks adequate sanitation, this problem is acute in many developing countries ,which discharge an estimated 95% of their untreated urban sewage directly into surface water. Iraq which is one of nine middle eastern countries have insufficient fresh water [4].The surface water bodies rivers, streams, ponds and lake, which are the most important sources of water for human activities are unfortunately under sever environmental stress and are being threatened as a consequence of developmental activities [5].

Ground water found beneath the land surface like springs, wells and underground channels. It is occurs not only in a single widespread aquifer but also in thousand of local aquifer systems and compartments that have similar characters. Knowledge of the occurrences , replenishment and recovery of ground water has special significance in arid and semi-arid regions due to discrepancy in rainfall [6].Natural ground water as spring fluxes are typically slow, emerges naturally from opening in rock and generally found near hill or mountain [7].The quality of these water bodies vary widely depending location and environmental factors. Among the factors determining the qualities of natural waters ,ground water and springs in particular ,are the chemical composition of the underlying rocks, soil formation and the length of time that the water body has been trapped underground [8].

In Kurdistan water sources are streams, rivers, springs and wells, so a huge number of springs and streams making the main river in Kurdistan. The location of the springs has become a popular tourist center in the Soran district and is believed to be a mystery water source. The springs are also the main source of domestic water supply for the villagers. However, surface and ground water contamination occur by natural processes or human activities, which is vary with the hydro geologic and climatic settings. The water quality index (WQI) is a numeric expression used to transform large number of variables data into a single number, which represents the water quality level .Numerous water quality indices have been formulated all over the world which can easily be judged out the overall water quality within a particular area promptly and efficiency [9]. In Kurdistan region of Iraq, few studies have been done conducted on water quality index Shekha [10] applied water quality index for both Erbil wastewater channel and great Zab river. Alobaidy *et al.*, [11] formulated application of water quality index for assessment of Dokan Lake ecosystem.

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The present study focus on the water qualities of Delizhiyan springs and adjoining river determined by the physico-chemical properties are compared with data international WHO together with recommended water guidelines for drinking and domestic uses.

2- MATERIALS AND METHODS

2-1 Description of the study area.

In this studied, 5 sites to be sampled presented in Table (1) and figure (1), all sites are situated Diyana within Soran district include Delizhiyan and Shawrawa villages. Soran district has four sub-district, being Diyana, Khalifan, Rawanduz , and Sidekan, as coordinates with 36°39′N 44°32′E / 36.65°N 44.53°E / about 150 km northeast of Erbil province which lies in the southern part of Iraqi Kurdistan region. It is located on the Hamilton Road not only connecting Erbil city to sulemaniya and Duhok provinces but also connecting Erbil to Iran through Hajomaran [12]. Two distinct region can be distinguished in relation to geology ,topography and probably water quality.The first is mountain region located at high fold or thorn zone, this zone consists of upper most mountain area along Iraqi-Iranian and Turkish border. Soran is located on the mountain area like Goraz and Hassan mountain from north, Korek mountain from south, Handren mountain from east, and Bradost mountain from west. The whole area is underlain by the upper faris formation (the upper Miocene age), consists of igneous or volcanic rocks with sediments of Mesozoic age [13].While the second region is low fold and foothills zone, which is a transition zone between alluvial plains and mountains which are characterized asymmetrical folds. The geology of the area varied from Bakhtiari, Paleocinous, Cerateous to recent sediments .

The climate of the Kurdistan Region is semi-arid continental, climate of the Soran is similar to that of other part of Iraqi Kurdistan region characterized by hot dry summer and cold wet winter more rainfall in northern than central and southern part [14]. Soran is famous by natural beauty and historical sites. It has become a tourist destination and wonderful in which thousands of tourists visit them to spend their times, not only in Kurdistan but also from down south of Iraq and even from the neighbor countries. Most villages in northern Iraq have orchards, which are usually irrigated during summer, and produce a considerable variety of fruit trees that tolerate cold winters are probably best adapted to the environment, especially apple, pear, cherry, and walnut [15].

Table (1) : The location and altitude of springs and river sites within Soran district

Village	Sites	Locality	X (UTM)	Y (UTM)	Z(altitude)m m.a.s.l.
Delizhiyan	1	house kany	3850457683	4060224	679 m
	2	kany herow spring	3850458146	40609015	702 m
	3	large mosquite spring	3850457512	4060715	691 m
Shawrawa	4	kany khat spring	3850454758	4061291	588 m
	5	Shawrawa river	3850454919	4061193	581 m

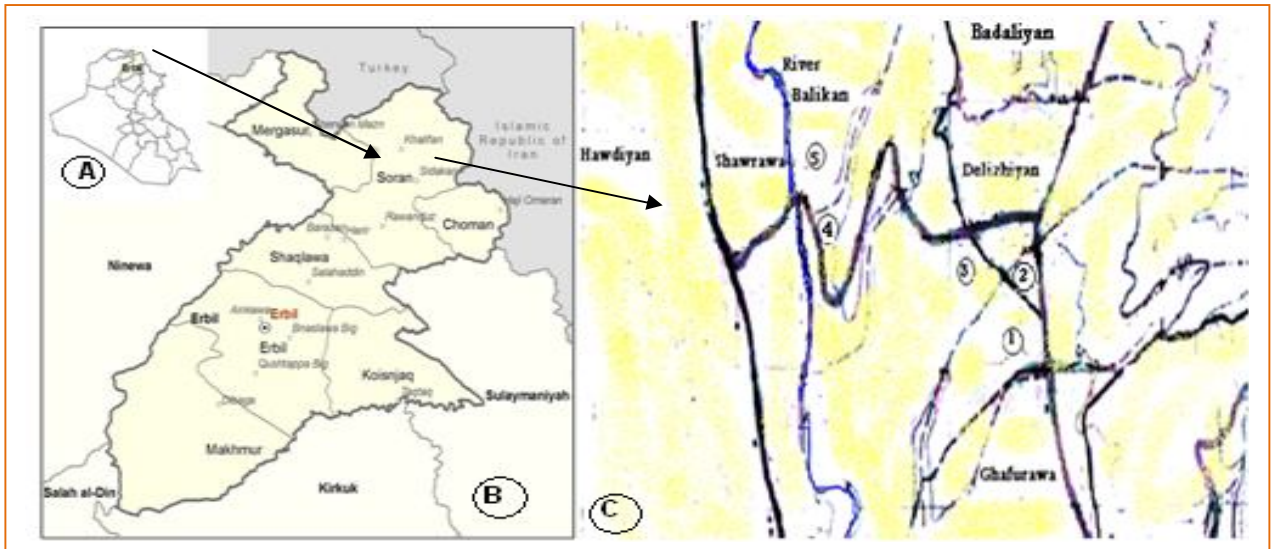

Figure (1) Map of Iraq, Iraqi Kurdistan region and Erbil province showing the position of sample collection. A-Iraq., B- Iraqi Kurdistan., C-Delizhiyan and Shawrawa village.

Water samples were collected from five locations of delizhiyan and shawrawa village through January to June 2011 ,each sample is collected was made for PH, electrical conductivity and total dissolved solute were monitored at the sampling site, also measured at the field are coordinates and elevation of each of the locations sampled using Global Position System (GPS) the results of X and Y axis were expressed in Universal Trensvers Mercator (UTM) system unit which used in a software program (Map info) to drawing the map of the studied area presented in Figure (1). All the water samples were collected in 2 L plastic bottles which were washed and triple-rinsed with distilled water and with the collection water before sampling and transporting them to the laboratory like turbidity, total alkalinity, total hardness ,sulfate, chloride, nitrate, calcium, sodium, and potassium were analyzed in the laboratory as per the standard procedures of [16]. Statistical analysis was conducted for the data using software program (SPSS version 11). All data are expressed as mean± SE. Table (2)

Table (2): Physico-chemical properties of Deliziyan springs and Shawrawa river, data represented as mean ± SE. with minimum and maximum values, during six months.

Variable	Springs				River
	1	2	3	4	5
pH	6.73 ± 0.21	6.72 ± 0.22	7.19 ± 0.24	6.84 ± 0.16	7.42 ± 0.32
	6.7-7.12	6.5-7.12	6.5-8.13	6.4-7.4	6.4-8.37
Electrical conductivity (µS.cm-1)	1050.16 ± 128.78	1133.3 ± 92.77	922.3 ± 203.188	894.16 ± 180.29	710.6 ± 235.88
	749-1455	940-1455	300-1455	460-1455	300-1456
Total dissolved solid (mg.l-1)	513.41 ± 66.37	566.6 ± 46.38	461.16 ± 101.59	447.41 ± 90.06	355.3 ± 117.94
	374.5-727.5	470-727.7	150-727.5	230-727.5	150-728
Turbidity (NTU)	1.06 ± 0.75	2.34 ± 1.34	14.21 ± 10.37	1.69 ± 0.66	71.11 ± 40.26
	0.12- 4.82	0.08- 8.33	0.28- 64.8	0.2 - 3.93	0.47- 259
Total alkalinity (mg.l-1)	360.83 ± 9.30	350.16 ± 11.93	265.33 ± 32.189	315.83 ± 33.72	184 ± 11.82
	337-390	312-382	154-379	150-364	143-364
Total hardness (mg.l-1)	359.13 ± 61.36	374.4 ± 27.46	280.43 ± 34.12	351.36 ± 17.03	235 ± 17.62
	215.2-632	288.8-467.6	178.6-392.4	289-400	178-290
Sulfate (mg.l-1)	225.85 ± 81.44	203.03 ± 75.3	134.20 ± 48.47	149.14 ± 50.40	106.27 ± 36.63
	0-389	0-364	0-221	0-222	0-167
Chloride (mg.l-1)	1.43 ± 0.41	1.45 ± 0.16	0.90 ± 0.18	0.86 ± 0.23	0.46 ± 0.04
	0.74-2.6	1.01-1.96	0.42-1.38	0.54-1.75	0.33-0.6
Nitrate (mg.l-1)	22.36 ± 1.82	57.06 ± 13.05	58.2 ± 17.78	23.16 ± 5.148	11.95 ± 5.47
	18.64- 28.14	22.28 - 88.2	13-114.2	2.93-30.7	1-32.2
Calcium (mg.l-1)	61.6 ± 6.88	59.6 ± 9.68	34.3 ± 4.33	38 ± 8.18	27.6 ± 4.09
	48-70	49-79	27-42	27-54	20-34
Sodium (mg.l-1)	27.3 ± 2.33	28 ± 2	13.6 ± 1.76	20.3 ± 10.9	9.3 ± 0.66
	25-32	24-30	17-Nov	7-42	10-Aug
Potassium (mg.l-1)	7.01 ± 0.44	6.5 ± 1.76	0.63 ± 0.14	1.06 ± 0.18	0.65 ± 0.10
	6.45-7.9	4-9.9	0.4-0.9	0.7-1.3	0.5-0.85

2.3. Application of WQI

In this study, for the calculation of water quality index, twelve important parameters were chosen. In the formulation of WQI, the importance of various parameters depends on the intended use of water; here, water quality parameters are studied from the point of view of suitability for human consumption. The water quality index has been calculation by using the standards of drinking water quality recommended by the world Health Organization [17].When the WHO standard were not available, depending on [11].The calculation and formulation of WQI involved the following steps:

1- In the first step ,each of the twelve parameters has been assigned a weight (AWi) ranging from 1 to 5 depending on [5,11]. However, assigned a weight of 1 was considered as the least significant and 5 as the most significant,
2- In the second step, the relative weight (RW) was calculated by using the following equation calculated by using the following equation

$$Rw = \frac{AWi}{\sum_{i=1}^{n} AWi} \qquad (1)$$

where ,Rw =is the relative weight,
AW =the assigned weight of each parameters, n= the number of parameters.
The calculated Relative weight (Rw) values of each parameter are given in Table (4).

3- In the third step, quality rating scale (Qi) for all the parameter except pH and DO was assigned by dividing its concentration in each water sample by its respective standard according to the drinking water guideline recommended by the (WHO,2004), the results was then multiplied by 100.

$$Qi = \left[\frac{Ci}{Si}\right] \times 100 \qquad (2)$$

While, the quality rating for pH or DO (QpH,DO) was calculated on the basis of ,

$$QpH = \left[\frac{Ci-Vi}{Si-Vi}\right] \times 100 \qquad (3)$$

Where, Qi =the quality rating, Ci = value of the water quality parameter obtained from the laboratory analysis, Si = value of the water quality parameter obtained from recommended WHO or Iraqi standard of corresponding parameter, Vi = the ideal value which is considered as 7 for PH .

Equation 2 and 3 ensures that Qi=0 when a pollutant is totally absent in the water sample and Qi = 100 when the value of this parameter is just equal to its permissible value. Thus the higher value of Qi is more polluted [18].

Finally, the overall Water Quality Index was calculated by aggregating the quality rating with the relative weight linearly .

$$WQI = \frac{\sum Qi\, Rw}{\sum Rw}$$

Table 3. Water quality index (WQI) range and type of water can be classified according [6].

(Range)	Type of water
< 50	Excellent water
50-100.1	Good water
100-200.1	Poor water
200- 300.1	Very poor water
>300	Water unsuitable for drinking purposes .

Table 4 . Relative weight of the water quality parameters.

Parameter	Assign Weight (AW)	Relative weight (R)
pH	2.1	0.060869565
Electrical conductivity (µS.cm-1)	2.7	0.07826087
Total dissolved solid (mg.l-1)	5	0.144927536
Turbidity (NTU)	2.4	0.069565217
Total alkalinity (mg.l-1)	3	0.086956522
Total hardness (mg.l-1)	1.1	0.031884058
Sulfate (mg.l-1)	5	0.144927536
Chloride (mg.l-1)	5	0.144927536
Nitrate (mg.l-1)	2.2	0.063768116
Calcium (mg.l-1)	3	0.086956522
Sodium (mg.l-1)	1	0.028985507
Potassium (mg.l-1)	2	0.057971014
	34.5	

Table 5. Calculation of water quality index in Site 1

Parameter	Observed value	Standard value	Relative weight (Rw)	Quality rating (Qi)	RW Qi
pH	7.42	6.5-8.5	0.06	42	2.52
Electrical conductivity (µS.cm-1)	710.6	300	0.078	236.8666667	18.4756
Total dissolved solid (mg.l-1)	355.3	500	0.144	71.06	10.23264
Turbidity (NTU)	71.11	5	0.069	1422.2	98.1318
Total alkalinity (mg.l-1)	184	200	0.086	92	7.912
Total hardness(mg.l-1)	235	300	0.031	78.33333333	2.428333333
Sulfate (mg.l-1)	106.27	250	0.144	42.508	6.121152
Chloride (mg.l-1)	0.46	250	0.144	0.184	0.026496
Nitrate (mg.l-1)	11.95	50	0.063	23.9	1.5057
Calcium (mg.l-1)	27.6	75	0.086	36.8	3.1648
Sodium (mg.l-1)	9.3	200	0.028	4.65	0.1302
Potassium (mg.l-1)	0.65	-	0.057	65	3.705
			∑Rw= 0.99	∑Qi=2115.50	∑Rw Qi=154.35
water quality index =∑ Rw Qi / ∑ RW =155.90					

Table 6. Calculation of water quality index in Site 2

Parameter	Observed value	Standard values	Relative weight (Rw)	Quality rating (Qi)	RW Qi
pH	6.84	6.5-8.5	0.06	16	0.96
Electrical conductivity (µS.cm-1)	894.16	25o	0.078	357.664	27.897792
Total dissolved solid (mg.l-1)	447.41	500	0.144	89.482	12.885408
Turbidity (NTU)	1.69	5	0.069	33.8	2.3322
Total alkalinity (mg.l-1)	315.83	100	0.086	315.83	27.16138
Total hardness (mg.l-1)	351.36	100	0.031	351.36	10.89216
Sulfate (mg.l-1)	149.14	250	0.144	59.656	8.590464
Chloride (mg.l-1)	0.86	250	0.144	0.344	0.049536
Nitrate (mg.l-1)	23.16	50	0.063	46.32	2.91816
Calcium (mg.l-1)	38	100	0.086	38	3.268
Sodium (mg.l-1)	20.3	200	0.028	10.15	0.2842
Potassium (mg.l-1)	1.06	-	0.057	106	6.042
			∑Rw = 0.99	∑Qi=1048.28	∑RwQ i=103.28
water quality index =∑ Rw Qi/∑Rw = 104.32					

Table 7. Calculation of water quality index in Site 3

Parameter	Observed value	Standard value	Relative weight (Rw)	Quality rating (Qi)	Rw Qi
pH	7.19	6.5-8.5	0.06	19	1.14
Electrical conductivity (µS.cm-1)	922.3	250	0.078	368.92	28.77576
Total dissolved solid (mg.l-1)	461.16	500	0.144	92.232	13.281408
Turbidity (NTU)	14.21	5	0.069	284.2	19.6098
Total alkalinity (mg.l-1)	265.33	100	0.086	265.33	22.81838
Total hardness (mg.l-1)	280.43	100	0.031	280.43	8.69333
Sulfate (mg.l-1)	134.2	250	0.144	53.68	7.72992
Chloride (mg.l-1)	0.9	250	0.144	0.36	0.05184
Nitrate (mg.l-1)	58.2	50	0.063	116.4	7.3332
Calcium (mg.l-1)	34.3	100	0.086	34.3	2.9498
Sodium (mg.l-1)	13.6	200	0.028	6.8	0.1904
Potassium (mg.l-1)	0.63	-	0.057	63	3.591
			∑Rw= 0.99	∑Qi= 1645.85	∑Rw Qi=117.87
water quality index =∑ Rw Qi/∑Rw = 119.06					

Table 8. Calculation of water quality index in Site 4

Parameter	Observed value	Standard value	Relative weight (Rw)	Quality rating (Qi)	Rw Qi
pH	6.72	6.5-8.5 (8)	0.06	28	1.68
Electrical conductivity (µS.cm-1)	1133.3	250	0.078	453.32	35.35896
Total dissolved solid (mg.l-1)	566.6	500	0.144	113.32	16.31808
Turbidity (NTU)	2.34	5	0.069	46.8	3.2292
Total alkalinity (mg.l-1)	350.16	100	0.086	350.16	30.11376
Total hardness (mg.l-1)	374.4	100	0.031	374.4	11.6064
Sulfate (mg.l-1)	203.03	250	0.144	81.212	11.694528
Chloride (mg.l-1)	1.45	250	0.144	0.58	0.08352
Nitrate (mg.l-1)	57.06	50	0.063	114.12	7.18956
Calcium (mg.l-1)	59.6	100	0.086	59.6	5.1256
Sodium (mg.l-1)	28	200	0.028	14	0.392
Potassium (mg.l-1)	6.5		0.057	650	37.05
			∑Rw= 0.99	∑Qi= 2411.51	∑Rw Qi= 159.84
water quality index =∑ Rw Qi/ ∑Rw = 165.01					

Table 9. Calculation of water quality index in Site 5

Parameter	Observed value	Standard value	Relative weight (Rw)	Quality rating (Qi)	Rw Qi
pH	6.73	6.5-8.5 (8)	0.06	18	1.08
Electrical conductivity (µS.cm-1)	1050.16	250	0.078	420.064	32.764992
Total dissolved solid (mg.l-1)	513.41	500	0.144	102.682	14.786208
Turbidity (NTU)	1.06	5	0.069	21.2	1.4628
Total alkalinity (mg.l-1)	360.83	100	0.086	360.83	31.03138
Total hardness (mg.l-1)	359.13	100	0.031	359.13	11.13303
Sulfate (mg.l-1)	225.85	250	0.144	90.34	13.00896
Chloride (mg.l-1)	1.43	250	0.144	0.572	0.082368
Nitrate (mg.l-1)	22.36	50	0.063	44.72	2.81736
Calcium (mg.l-1)	61.6	100	0.086	61.6	5.2976
Sodium (mg.l-1)	27.3	200	0.028	13.65	0.3822
Potassium (mg.l-1)	7.01	701	0.057	1	0.057
			∑Rw= 0.99	∑Qi= 1616.63	∑Rw Qi= 117.34
Water Quality Index =∑ Rw Qi/∑Rw = 118.52					

Table (10): The correlation coefficient between water quality index (WQI) and ecological variables.

Parameters (units)	**Correlation coefficient (r) with WQI**	**Parameters** (units)	**Correlation coefficient (r) with WQI**
pH	-0.71	Sulfate (mg.l-¹)	0.39
Electrical conductivity (µS.cm-¹)	0.60	Chloride (mg.l-¹)	0.48
Total dissolved solid (mg.l-¹)	-0.66	Nitrate (mg.l-¹)	0.42
Turbidity (NTU)	-0.66	Calcium (mg.l-¹)	0.43
Total alkalinity (mg.l-¹)	0.64	Sodium (mg.l-¹)	0.63
Total hardness (mg.l-¹)	0.77	Potassium (mg.l-¹)	0.31

3- RESULTS AND DISCUSSION

Water quality index of the present and springs and river are established for important various physicochemical parameters for five sites, from Delizhiyan and shawrawa village within Soran district. The value of various physicochemical parameters for calculation of water quality index are presented in Table (2). Site wise water quality index calculations are depicted in the Table 5, 6, 7, 8, and 9.The results of several parameters in order to assess the water quality. Assembling different parameters into one single number purpose. On the basis of the WQI, The water quality index obtained for springs and river in different sites through six months are 155.90, 104.32, , 119.06, 165.01, 118.52, respectively, which indicate the poor quality of water.

The results of pH value in spring water from Table (2) varied from 6.4 to 8.13 , indicating that the water sample are almost neutral to sub-alkaline in natural. In Kurdistan region of the Iraq the pH of water characterized by a shift towards the alkaline side of neutrality ,due to the geological formation of the area, which composed mainly of $CaCO_3$ [19], this may be related to the soil and watershed characters of the mountain area. Thus ,water has been in contact with limestone for relativity short of time should have low pH and vise versa [20].In addition, the present of NO_3 and SO_4 may contribute in pH lowering [21].Whereas, pH value of river ranged from 6.4-8.37. This agree with the finding that recorded by [22]. pH is an important factor determines the suitability of water for various purpose [23].The observed values show a relative agreement with pH values of surface and ground water which lie within the range of 6.5 to 8.5 WHO [24]. The correlation coefficient between WQI and pH -0.71 demonstrated a rather negative relationship.

In the present study, the electrical conductivity and total dissolved solid value in spring water and river were ranged between 300 to 1455 ,1456 µS.cm-¹ and 150 to 727.5, 728 mg.l-¹ respectively . It is an indirect measure of total dissolved salts, because total dissolved solid estimated by conductivity [25]. High conductivity may rise through natural weathering of certain sedimentary rocks, or may have an anthropogenic source, e.g. industrial and sewage effluent [17].This is mainly depending upon the degree of mineralization, temperature, soil and geological formation [13].Conductivity more than 500 µS.cm-¹ in water system considered to be hard [26]. A similar result was obtained by [27].The results showed that EC values were slightly higher than permissible level recommended by WHO [26], for drinking water. The correlation coefficient between WQI and conductivity 0.60 demonstrated a rather positive relationship.

Turbidity is widely concerned as an important parameter for drinking water. The present investigation indicated that the turbidity value of spring water and river ranged between 0.08 to 64.8 NTU and 0.47-259 NTU respectively, in this studied turbidity level of spring water was characterized by low level ,the present results agrees with the results of [28].While The turbidity value of river was often higher than those of spring water as found by [22] Turbidity affected by the natural component present in water bodies like as silts, clay, silica component and other as well as may be it is affected by human activity [29].However, the observed values of turbidity from spring water were still within the permissible level recommended by the WHO [24], for drinking water.

The observed values of total alkalinity were slightly higher than the permissible level recommended by the WHO for drinking water. The total alkalinity in the area mainly composed of bicarbonate alkalinity, this agreed with [30].Thus more than 300mg may be not harmfull for aquatic life forms [31]. The correlation coefficient between WQI and conductivity 0.64 demonstrated a rather positive relationship.

The total hardness is also an important parameter of water quality whether to be used for domestic, industrial or agricultural purposes. The total hardness of spring water and river ranged between 178.6 to 632 and 178 to 290 mg.l-¹ . In this investigation showed that total hardness values were often higher than the minimal permissible level recommended by the WHO [17], for drinking water. The results of present investigation come in accordance to the finding given previous workers by [22].In fresh water, the principle

hardness –causing ions are calcium and magnesium, originated from the sedimentary rocks, the most common being limestone and chalk [32].Furthermore, guideline value of water hardness is reported still the possible cause of kidney disturbance and the fish tolerance to toxic metals in hard water have been reported [33]The correlation coefficient between WQI and total hardness 0.77 demonstrated a rather positive relationship.

The sulfate concentrations of spring water and river in this investigation were ranged 0 to389 and 0-167 $mg.l^{-1}$ respectively. Generally , Iraqi Kurdistan region inland waters usually contain significant amount of sulfate. While the dissolution of gypsum from sedimentary rocks required a period of time contacting with ground water, so shallow aquifers containing low concentration of sulfate [19], due to the formation of the area which is rich in gypsum and the values were higher of that in other parts of the world [33].The results come in agreement with the results of previous worker in Kurdistan [27, 30].In this study, sulfate concentration values relatively were high but within the permissible level recommended by the WHO [17],for drinking water. The correlation coefficient between WQI and sulfate 0.39 demonstrated a rather positive relationship.

Chloride is one of the most important parameter in assessing the water quality. In the present study the concentration of chloride from spring water and river fluctuated between 0.42 to 2.6 and 0.33-0.60 $mg.l^{-1}$.Thus all study sites considered as fresh water because they were containing low levels of chloride [25], therefore it is within minimum permissible level recommended by the WHO [24], for drinking water. The correlation coefficient between WQI and chloride 0.48 demonstrated a positive relationship.

As shown in the results, Nitrate concentration in spring water and river ranged from 2.93 to 114.2 and 1 to 32.2 $mg.l^{-1}$ .Nitrate is generally more stable in ground water than either nitrite or ammonium. Elevation nitrate level don't occur naturally in ground water may estimated seasonal ground water recharge from irrigation, precipitation rate and infiltration rate, also depending on the location, fertilized soil, and manure from farm livestock. Furthermore, the major problem shallow aquifer in rural area, oxygen can diffuse into system aquifer confining condition, with present a suitable temperature may all NH3 converted by microbial activity to NO_3 [34]. Furthermore, high level of nitrate in drinking water can have serious and even deadly effect on infant from birth to three month age [35].In this investigation showed that nitrate values in sites 3 and 4 were often higher than the permissible level recommended by the WHO [24], for drinking water. The correlation coefficient between WQI and chloride 0.42 demonstrated a positive relationship.

In the present study the calcium ion of spring water and river fluctuated between 27 to 79 and 20-34 $mg.l^{-1}$. The range of calcium ion in the ground water is largely dependant on solubility of calcium carbonate, sulfate, and rarely chloride [36],due to the distribution of calcareous rocks in natural waters. In this investigation showed that calcium values within the permissible level recommended by the WHO for drinking water. The correlation coefficient between WQI and chloride 0.43 demonstrated a positive relationship.

Sodium and potassium values in different site throughout this investigation comes in accordance to the general known levels of these elements in other parts of the world. The values of sodium were found to be always higher than potassium and much less than that of calcium Potassium is a fixed requirement for life in plants, whereas apparently sodium is not absolutely necessary for plant growth [37].The differences between sodium and potassium values in the different sites, possibly are related to the soil formation within Erbil province [38].

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