Valuation of water quality for drinking and domestic purposes using WQI: A case study for groundwater of Al-Gameaa and Al-Zeraee quarters in Mosul city/Iraq.

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Abstract. The current study aims to assess the groundwater quality of some area in the left side of Mosul city, the samples were collected randomly from 11 wells (five replicates from each well), to measure the physicochemical and bacteriological properties using weighted mathematical model (WQI). The results indicated that the studied groundwater were ranged from poor to unsuitable qualities for drinking and domestic purposes. This deterioration in water quality is due to as a result of the high levels of electrical conductivity, total hardness, sulfate ions, total number of bacteria and faecal coliform bacteria, which reached 3605 µS. Cm⁻¹, (2760, 477) mg. l⁻¹, 8.0 ×10³ cell. ml⁻¹ and 16< cell. 100ml⁻¹ respectively.

Key word: Groundwater quality of Mosul city, weighted mathematical model (WQI)

Introduction:

The adequate provision of water for human use has become difficult problems facing the world in many areas, particularly in the third world countries; as large numbers of human diseases transmitted through water and cause various kinds of diseases and even serious ones, which may cause death, such as cholera and typhoid viral hepatitis and shigellosis... etc (Al-Saffawi and Al-Assaf, 2018). As bringing the number of people suffering from the contamination problem of drinking water, especially children, to more than one billion poor people in both Africa and Asia and South America societies (Meyer & Reed, 2001), especially children, to more than 1 billion people in poor societies of Africa, Asia and South America (Meyer & Reed, 2001), and that 450 million people in 29 countries suffer from a critical water shortages, studies indicate the occurrence of more than 3 million deaths annually due to the use of unsafe drinking water, especially diarrheal diseases among children in poor communities (Reed et al., 2000).

Therefore, it is necessary to continue studies to follow the quality of water and investigate pollution problems to take the necessary solutions to reduce the aggravation of environmental problems resulting from it. The WQI concept of water quality for different uses was suggested by Horten in1965 (Ramadhan et al, 2018 ; Al-Saffawi and Al-Shuuchi, 2018 ). which reflects the interrelated effects of the studied standards in determining water quality and is one of the most effective methods of monitoring surface water pollution (Devojee et al, 2018). As it gives one value instead of the large amount of data that confuses the reader, and thus be understood by the specialist and non-specialist (Al-Hamdany and Al-Saffawi, 2018).

The studies conducted in Nineveh Governorate to evaluate the quality of groundwater using water quality index (WQI) are limited compared to other regions in the world. The
work in this field has started significantly in the last ten years, many studies were conducted in Nineveh Governorate on water quality.

Al-Tamer (2015) used water quality index (WQI) to assess groundwater quality in northwestern of Mosul. The results showed deterioration of the water quality of the studied wells, Al-Saffawi et al (2018a) studied the water quality in the village of Gliukhan in northeastern Iraq using WQI as an important source of water in the village. The results indicated that the water quality was not suitable for drinking and domestic uses. Al-Saffawi and Al-Sardar (2018) conducted their studies on the reality of ground water in the villages of Abu Jarbo’a and Darwish in the Baishika district. The results of the WQI values indicated that the studied groundwater quality is unsuitable for drinking and civil uses. Al-Hamdany and Al-Saffawi (2018) studied the groundwater on the left side of Mosul using the Canadian CCMEWQI water quality index, which indicated the lack of potable water for drinking and domestic uses. Therefore, the current study came to identify the reality of the groundwater of Al-Gameaa and Al-Zeraee quarters in Mosul city for drinking and domestic uses.

Materials and Methods:

The study was conducted on groundwater of Al-Gameaa and Al-Zeraee quarters in left side of Mosul city, Northern part of Iraq, which that rely on groundwater as the main source of water for drinking, washing and bathing in the last years, as a result of the great destruction that occurred in Mosul city as shown in (Table 1) and (Fig.1).

| Locations        | Well No. | N          | E          | Depth (m) |
|------------------|----------|------------|------------|-----------|
| Al-Gamea quarter | 1        | 36°38’92"  | 43°18’56"  | 42        |
|                  | 2        | 36°38’93"  | 43°18’71"  | 36        |
|                  | 3        | 36°38’73"  | 43°18’70"  | 5.0       |
|                  | 4        | 36°38’74"  | 43°18’72"  | 14        |
|                  | 5        | 36°38’91"  | 43°18’29"  | 48        |
|                  | 6        | 36°38’93"  | 43°18’97"  | 33        |
|                  | 7        | 36°39’02"  | 43°18’76"  | 45        |
| Al-Zeraee quarter| 8        | 36°35’63"  | 43°14’87"  | 13        |
|                  | 9        | 36°35’58"  | 43°14’91"  | 13        |
|                  | 10       | 36°35’48"  | 43°14’56"  | 23        |
|                  | 11       | 36°35’39"  | 43°14’44"  | 9.0       |

The geological formation in it is Al-Fatha (Lower Fars) which containing mainly of evaporated salts, anhydrite (CaSO₄), gypsum (CaSO₄·2H₂O), limestone and marl etc., which leads to deterioration of the groundwater quality passing through in it (Al-Hamdany and Al-Saffawi, 2018; Al-Sardar et al, 2018).

In present investigation fifty-five water samples taken from eleven different borehole wells, seven of them at Al-Gameaa quarter and the remainder at Al-Zeraee quarter (from February to April, 2018) were collected between February to April, 2018 in polyethylene bottles, which were cleaned with distilled water; followed by rinsing the sample container with the groundwater sample before it is filled (APHA. 1998). The parameters such as Temperature, pH, Electrical conductivity (EC_{25}), Total Alkalinity (T. alk.), Total Hardness (TH), Chloride, Sulfate, Phosphate, Nitrate, Total Plate count of bacteria (TPC) and Fecal
Figure (1): Map of the left side of the city of Mosul showing the study areas.

coliform were estimated by using standard methods (APHA, 1998).

Estimation of Water Quality Index (WQI):

Eleven physico-chemical parameters consisting of Temperature, EC, pH, T.Alk, T. Hard., Cl⁻, SO₄²⁻, NO₃⁻, PO₄³⁻, Total Plate Count of bacteria (TPC) and Fecal coliform (F. Colif.) were considered in the calculation of WQI. Water Quality Index (WQI) calculation involve three stages (Boateng et al, 2017).

1. In the first stage, each of the 11 parameters has been assigned a weight (wi) according to its relative importance in the overall quality of water for drinking purposes as shown in (Table 2).

| Parameter    | Si* | wi | Wi   |
|--------------|-----|----|------|
| Tempt. °C    | 25  | 1  | 0.027027027 |
| pH           | 6.5 – 8.5 | 4 | 0.108108108 |
| EC₂₅         | 1400 | 4 | 0.108108108 |
| T. Hard.     | 500  | 3  | 0.081081081 |
| T. Alkal.    | 200  | 2  | 0.054054054 |
| Cl⁻          | 250  | 3  | 0.081081081 |
| SO₄²⁻        | 400  | 4  | 0.108108108 |
| PO₄³⁻        | 10   | 1  | 0.027027027 |
| NO₃⁻         | 45   | 5  | 0.135135135 |
| TPC**        | 10   | 5  | 0.135135135 |
| F.colif.***  | 0.0  | 5  | 0.135135135 |
| Σ             | 37   |    | 0.999999995 |

*WHO, 2004, 2011., **×10³cell. ml⁻¹, *** cell. 100ml⁻¹

The maximum weight of 5 has been assigned to the parameter nitrate due to its importance in water quality assessment. Temperature and Phosphate are given the minimum weight of 1 which indicates that, it may not be deleterious.
2. In the second stage, the relative weight (Wi) is computed from the following equation (Howladar et al., 2017; Al-Hamadany and Al-Saffawi, 2018):

\[ W_i = \frac{w_i}{\sum_{i=1}^{n} w_i} \quad \cdots 1 \]

Where, Wi is the relative weight, wi is the weight of each parameter and n is the number of parameters. Calculated relative weight (Wi) value of each parameter are also given in Table 2.

3. Third stage, a quality rating scale (qi) for each parameter is assigned by dividing its concentration in each groundwater sample by its respective standard according to the guidelines by WHO (2004) and the result multiplied by 100 (Al-Saffawi and Alshuuchi):

\[ q_i = \frac{C_i}{S_i} \times 100 \quad \cdots 2 \]

Where, qi is the quality rating, Ci is the concentration of each parameter in each water sample, and Si is the WHO drinking water standard for each parameter.

For computing the WQI, the sub index (Sli) is first determined for each parameter, which is then used to determine the WQI as indicated by the following equation:

\[ S_{li} = W_i \times q_i \quad \cdots 3 \]

\[ \text{WQI} = \sum S_{li} \quad \cdots 4 \]

The calculated WQI values divided into five categories (Table 2) for drinking purposes (Pawar et al., 2014).

| Table 3: Classification of drinking water according to values. |
|---------------------------------------------------------------|
| WQI Values | < 50 | 50-100 | 100-200 | 200-300 | > 300 |
| degree      | I    | II     | II      | IV      | V     |
| category    | Excellent | Good | Poor | Very poor | Unsuitable |

Results and Discussion:

The calculated rating quality (qi), Sub-index (Sli) and water quality index (WQI) values of studied groundwater for drinking and domestic purpose are presented in (Tab. 3), where water quality ranked between poor quality in well (1, 7), very poor quality in well (6, 8) to unsuitable for drinking in well (2, 3, 4, 5, 9, 10, 11). Also, the table shows the heigh values of the quality rating (qi) for most studied characteristics, especially the total number of bacteria (TPC) and fecal coliforms, which increased the sub-index values (Sli) and therefore to reflect in the water quality index values (WQI). This deterioration in the quality of the groundwater at the Al-Gameaa and Al-Zeraee quarters is due mainly to the increase in the number of total bacteria and fecal coliform bacteria, as well as, high concentrations of salts (EC25), Total Alkalinity (T. alk.), Total Hardness (T. H.) and sulphate ions (SO4) as shown (Table 3).

Bacterial contamination indicators are one of the most important parameters to confirm the water quality such as Total bacteria (TPC) and coliform, they are essential to give an idea about the existence of faecal contamination and therefore the potential for pathogens existence (Al-Saffawi et al., 2018a), the mean values of total bacteria (TPC) and Faecal coliform were increased to reach (150 x 10^3 ) cell. ml^-1 and (16< )
Table (4): The quality rating, Sub index and WQI values of studied groundwater for drinking and domestic purpose.

| Wells | Temp | pH  | EC<sub>25</sub> | T.Alk. | T. H. | Cl | SO<sub>4</sub> | PO<sub>4</sub> | NO<sub>3</sub> | TPC | E. colf | WQI  | Water status          |
|-------|------|-----|----------------|--------|-------|----|------------|-----------|-----------|-----|--------|------|----------------------|
| 1     | Qi   | 84.0| 95.0          | 151    | 138   | 292| 39.0       | 51.0      | 2.00      | 26.0| 200    | 160 | 121 Very poor water quality |
|       | Sli  | 2.27| 10.27        | 16.32  | 7.46  | 23.68| 3.16       | 5.51      | 0.05      | 3.51| 27.03  | 21.62|                          |
| 2     | Qi   | 89.2| 95.20         | 176.9  | 166.5| 368 | 58.0       | 64.0      | 17.0      | 26.0| 910    | 800 | 317 Unsuitable for drinking |
|       | Sli  | 2.41| 10.29        | 19.12  | 8.99  | 29.84| 4.70       | 6.92      | 0.46      | 3.51| 123    | 108 |                          |
| 3     | Qi   | 65.6| 94.40         | 100.9  | 159.0| 107.0| 18.8       | 30.0      | 47.0      | 3.33| 1500   | 1600| 466 Unsuitable for drinking |
|       | Sli  | 1.77| 10.17        | 10.90  | 8.59  | 8.66 | 1.52       | 3.24      | 1.27      | 0.45| 203    | 216 |                          |
| 4     | Qi   | 85.0| 99.0          | 79.0   | 192   | 128 | 27.0       | 30        | 4.60      | 3.20| 2000   | 1260| 440 Unsuitable for drinking |
|       | Sli  | 2.30| 10.7         | 8.54   | 10.38| 10.38| 2.19       | 3.24      | 0.12      | 0.43| 270    | 170 |                          |
| 5     | Qi   | 91.0| 95.0          | 164    | 219   | 276 | 72.0       | 63.0      | 9.30      | 3.33| 910    | 910 | 322 Unsuitable for drinking |
|       | Sli  | 2.46| 10.27        | 15.78  | 11.84| 22.38| 5.84       | 6.81      | 0.25      | 0.45| 470    | 460 |                          |
| 6     | Qi   | 90.0| 121           | 165    | 171   | 280 | 41         | 70.3      | 4.40      | 10.7| 63.5   | 60.8| 202 Very poor water quality |
|       | Sli  | 2.43| 13.09        | 17.86  | 9.24  | 22.48| 3.31       | 7.59      | 0.12      | 1.44| 1000   | 135 |                          |
| 7     | Qi   | 89.0| 98.0          | 132    | 136   | 195 | 32.0       | 48.5      | 2.40      | 19.8| 1000   | 0.00| 196 Poor water quality    |
|       | Sli  | 2.41| 10.59        | 14.29  | 7.35  | 15.83| 5.24       | 5.24      | 0.06      | 2.67| 135    | 0.00|                          |
| 8     | Qi   | 97.0| 96.0          | 151    | 226   | 228 | 51.0       | 50.0      | 3.40      | 7.56| 830    | 800 | 291 Very poor water quality |
|       | Sli  | 2.63| 10.42        | 16.37  | 12.22| 18.45| 4.12       | 5.43      | 0.09      | 1.02| 112    | 108 |                          |
| 9     | Qi   | 86.0| 98.0          | 264    | 186   | 344 | 75.0       | 88.5      | 2.00      | 6.93| 1000   | 800 | 339 Unsuitable for drinking |
|       | Sli  | 2.35| 10.55        | 28.54  | 10.05| 27.9 | 6.10       | 9.57      | 0.05      | 0.94| 135    | 108 |                          |
| 10    | Qi   | 83.0| 90.0          | 134    | 166   | 198 | 35.0       | 46.0      | 3.20      | 7.56| 2000  | 460 | 394 Unsuitable for drinking |
|       | Sli  | 2.25| 10.85        | 14.46  | 8.97  | 16.1 | 2.82       | 4.97      | 0.09      | 1.02| 270   | 62.2|                          |
| 11    | Qi   | 88.0| 94.0          | 142    | 101   | 16.0| 21.0       | 4.20      | 6.36      | 405 | 800    | 108 | 557 Unsuitable for drinking |
|       | Sli  | 2.37| 10.77        | 10.2   | 7.68  | 8.21 | 1.30       | 2.27      | 0.11      | 0.86| 405    | 108 |                          |
Table 5: Physicochemical and bacterial analysis results parameters of the groundwater (mg.l$^{-1}$)

| Parameter | Well 1 | Well 2 | Well 3 | Well 4 | Well 5 | Well 6 | Well 7 | Well 8 | Well 9 | Well 10 | Well 11 |
|-----------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---------|---------|
| pH        | 6.73   | 6.75   | 6.88   | 6.98   | 6.98   | 6.98   | 7.06   | 7.06   | 6.91   | 6.97    | 7.11    |
| EC        | 1770   | 2065   | 1047   | 1829   | 1802   | 1602   | 1281   | 2223   | 1349   | 1345   | 2108   |
| T.Aik     | 264    | 308    | 280    | 348    | 342    | 336    | 282    | 329    | 290    | 267    | 97     |
| T.H       | 1040   | 1290   | 460    | 1050   | 1402   | 336    | 264    | 492    | 408    | 452    | 322    |
| Cl        | 80     | 119    | 63     | 89     | 84     | 33     | 107    | 1030   | 107    | 452    | 190    |
| SO$_4$    | 31     | 101    | 67     | 120    | 165    | 110    | 84     | 105    | 107    | 127    | 156    |
| NO$_3$    | 11.2   | 11.2   | 1.20   | 1.50   | 4.00   | 1.85   | 0.20   | 1.80   | 2.30   | 3.12   | 2.50   |
| PO$_4$    | 0.08   | 1.10   | 0.20   | 0.92   | 0.10   | 8.50   | 0.20   | 0.20   | 0.10   | 0.34   | 0.17   |
| TPC$^*$   | 0.27   | 0.06   | 0.15   | 0.15   | 1.01   | 0.40   | 0.12   | 0.01   | 0.17   | 0.30   | 0.01   |
| F.C$^{**}$| 16     | 8.00   | 0.15   | 9.2    | 9.1    | 0.91   | 0.12   | 0.01   | 0.17   | 0.30   | 0.01   |
| **min**   | 17.5   | 20.5   | 14     | 21.5   | 22.1   | 21.0   | 21.5   | 22.7   | 23.6   | 26.8   | 20.9   |
| **max**   | 24.0   | 22.5   | 21.4   | 24.5   | 24.6   | 22.7   | 24.3   | 22.7   | 24.3   | 26.0   | 21.4   |
| **mean**  | 21.0   | 20.0   | 16.4   | 22.7   | 22.7   | 21.3   | 21.6   | 22.3   | 22.3   | 22.6   | 21.9   |
| ± Sd      | 2.10   | 0.47   | 0.47   | 0.76   | 1.4    | 0.76   | 0.47   | 0.76   | 0.76   | 0.76   | 0.76   |
| **min**   | 14     | 16.4   | 14.0   | 21.5   | 22.7   | 22.7   | 21.5   | 22.7   | 22.7   | 22.7   | 22.7   |
| **max**   | 24     | 22.5   | 21.4   | 24.5   | 24.6   | 22.7   | 24.3   | 22.7   | 24.3   | 26.0   | 21.4   |
| **mean**  | 20     | 20.0   | 16.4   | 22.7   | 22.7   | 21.3   | 21.6   | 22.3   | 22.3   | 22.6   | 21.9   |
| ± Sd      | 1.4    | 0.47   | 0.47   | 0.76   | 1.4    | 0.76   | 0.47   | 0.76   | 0.76   | 0.76   | 0.76   |
| **min**   | 14     | 16.4   | 14.0   | 21.5   | 22.7   | 22.7   | 21.5   | 22.7   | 22.7   | 22.7   | 22.7   |
| **max**   | 24     | 22.5   | 21.4   | 24.5   | 24.6   | 22.7   | 24.3   | 22.7   | 24.3   | 26.0   | 21.4   |
| **mean**  | 20     | 20.0   | 16.4   | 22.7   | 22.7   | 21.3   | 21.6   | 22.3   | 22.3   | 22.6   | 21.9   |
| ± Sd      | 1.4    | 0.47   | 0.47   | 0.76   | 1.4    | 0.76   | 0.47   | 0.76   | 0.76   | 0.76   | 0.76   |
| **min**   | 14     | 16.4   | 14.0   | 21.5   | 22.7   | 22.7   | 21.5   | 22.7   | 22.7   | 22.7   | 22.7   |
| **max**   | 24     | 22.5   | 21.4   | 24.5   | 24.6   | 22.7   | 24.3   | 22.7   | 24.3   | 26.0   | 21.4   |
| **mean**  | 20     | 20.0   | 16.4   | 22.7   | 22.7   | 21.3   | 21.6   | 22.3   | 22.3   | 22.6   | 21.9   |
| ± Sd      | 1.4    | 0.47   | 0.47   | 0.76   | 1.4    | 0.76   | 0.47   | 0.76   | 0.76   | 0.76   | 0.76   |
| **min**   | 14     | 16.4   | 14.0   | 21.5   | 22.7   | 22.7   | 21.5   | 22.7   | 22.7   | 22.7   | 22.7   |
| **max**   | 24     | 22.5   | 21.4   | 24.5   | 24.6   | 22.7   | 24.3   | 22.7   | 24.3   | 26.0   | 21.4   |
| **mean**  | 20     | 20.0   | 16.4   | 22.7   | 22.7   | 21.3   | 21.6   | 22.3   | 22.3   | 22.6   | 21.9   |
| ± Sd      | 1.4    | 0.47   | 0.47   | 0.76   | 1.4    | 0.76   | 0.47   | 0.76   | 0.76   | 0.76   | 0.76   |
*TPC: Total plate count: ×10^3 cell. ml⁻¹, F. C.: Fecal coliform cell. 100 ml⁻¹ cell. 100 ml⁻¹ respectively, these results at all studied groundwater exceeded the permissible limit of potable water guided by WHO (2004) indicating that these groundwaters receive wastewater leakage from septic tanks, which contains amount of organic matters that provides an excellent source of nutrition for the growth and multiplication of microbes (Mallika et al, 2017). The results of electrical conductivity (EC) values varied between 1047 to 3605 μS.cm⁻¹(Table 4), which show that 98.7 of samples have more than the maximum admissible limit 1400 μS. cm⁻¹ set by WHO 2004, The high values due to the nature of the geological formations of the study areas rich with evaporite salts (Al-Saffawi, 2019; Al-Sardar et al, 2019). Total Alkalinity (T.alk.) values provide guidance in applying proper doses of chemicals in water and wastewater treatment processes. Water containing more than 200 mg. l⁻¹ is not considered desirable for drinking purpose. In the present study, the minimum average of total alkalinity value recorded was 272 mg.l⁻¹ and the maximum recorded was 452 mg. l⁻¹ during the study period. About 98.7 of these values are much higher than that of the standard permissible limit (WHO, 2004), which contributes sour and saline taste to water. The major source of groundwater alkalinity is may be due to the reaction of Calcite and Magnesium calcite with carbonic acid as given below (Al-Saffawi and Al-Sardar, 2018a ; Kablan et al, 2018) Eqs. (1, 2, 3):

$$\text{CO}_2 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{CO}_3$$  --------1
$$\text{CaCO}_3 + \text{H}_2\text{CO}_3 \rightarrow \text{Ca}^{2+} + 2\text{HCO}_3^-$$  --------2
$$\text{CaMg(CO}_3)_2 + 2\text{H}_2\text{CO}_3 \rightarrow \text{Ca}^{2+} + \text{Mg}^{2+} + 4\text{HCO}_3^-$$  -------- 3

According to WHO (2004), which showed that the standard limit of T. Hardness in terms of drinking water is 500 mg. l⁻¹. Our values for 89 of studied samples revealed higher values comparing with standard limitation, which ranged from 460 mg. l⁻¹ to 2230 mg. l⁻¹. These increases may be due to the reactions as given in the Eqs. (1, 2, 3) above.

The concentration of sulphate is likely to react with human organs if the concentration exceeds the maximum admissible limit of 400 mg. l⁻¹ and causes a laxative effect, gastrointestinal irritation and catharsis human system with the excess magnesium in groundwater (Al-Saffawi and Al-Shanona, 2013). Most of the water samples (87%) were within the prescribed value given by WHO as shown in (Table 4). Excessive chloride concentration increase rates of corrosion of metals, this can lead to increased concentration of metals in the drinking water, and small amounts of chlorides are required for normal cell functions in plant and animal life (Al-Saffawi et al, 2008). Chloride are leached from various rocks in the geological information and water by weathering (Al-Sardar et al, 2018). It present in groundwater samples are in the range of 30-189 mg.l⁻¹, the chloride content (% 100 of samples ) in the study area was found to be well within the admissible levels 250 mg. l⁻¹ as per WHO Standards.

Increased concentrations of nitrate ions above (45 mg. l⁻¹) have adverse effects on humans such as "Blue Baby Syndrome" disease, cancers, abortion of pregnant women, cerebral retardation of births, etc. when consuming water or foods containing high concentrations of nitrates (Al-Saffawi, 2018). Nitrate and Phosphate content at studied water samples ranged from (1.0 to 12) and(0.08 to 6.8) mg. l⁻¹ respectively, the source of these ions in groundwater occurs by direct anthropogenic pollution (septic tanks etc), and these values did not exceed the permissible limit according to WHO.

The pH of all the groundwater samples was within the range between 6.73 -7.50 indicating that the water was slightly acidic to neutral, which did not exceed the permissible standard limit. In fact, the geology of the sampling site could partly contribute to the final pH of the ground water. The pH values recorded in this study are similar to that of a previous study by Al-Saffawi. (2018b) which reported a values ranged from 6.33-7.78, and the
investigation of assessment of groundwater on Al-Mahalabia district in north of Iraq conducted by Al-Saffawi. (2018), which reported a values from 6.35-7.38.

Finally, high water temperature may impart undesirable taste and odour as well as increased the corrosive ability of the water, this may also promote the growth of microorganisms, consequently affecting the water quality (WHO, 2011). In the current study, the mean temperature values were between 16.4 and 24.7 °C (Table 4). These temperatures were all within the WHO maximum limit of 25 °C. This could be attributed to the environmental temperature as well as other geological conditions prevailing in the study area at the sampling period.

Conclusions and Recommendations:

This study proposes that the studied groundwater quality is influenced by high Salinity, Total Hardness and Sulphate ion and bacterial contamination indicators, a consequence to the infiltration of the wastewater from the septic tanks into the studied groundwater as well as, the effect of the geological formations of the studied area, which beyond the standard limits of WHO. Also, most of the WQI values (%64) of the studied groundwater are unsuitable quality for drinking and domestic uses.

Consequently, must control and conduct periodic tests to determine when the emergency cases for pollution and treatment of this water before it used for drinking as a technique of partial or complete freeze and thawing to remove salts and improved the water quality (Al-Saffawi and Al-Srdar, 2018b; Al-hamdani and Al-Saffawi, 2018b). Also, it needs to be protected from the risk of microbial contamination.

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