Physicochemical Properties and Water Quality Index of Groundwater of Selected Wells in Najaf City Southern Iraq

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Abstract: The area which located along the road area between the cities of Najaf and Karbala areas are very important from hydrogeological used towards the groundwater reservoir which called Dibdibba formation. The reveal part of this sandy formation allows for replenishing and keeping its water by the rainwater penetration and surface flood. Groundwater movement flows through the reservoir from the West to the East and Southeast direction, so, it is unconfined aquifer which means the top surface (water table) is open for permeable materials. This area between the two cities invested for decades due to its importance in addition to the hydrogeological feature of the water reservoirs and hydraulic specifications. Many groundwater wells were drilled in this area to use this water resource for many purposes of farming in particular. There are many water wells in this infiltrated water reservoir upper region represented by the composition Dibdibba formation have been exploited as a sandstone fan or fan-shaped (alluvial fans) according to its sedimentary environment. This water-based reservoir in part on natural nutrition where the rains start this reservoir depletion of stocks over exploited of water in addition to low levels of nutrition and natural reservoir groundwater and the exposure portion of the formation Dibdibba Sandy helped to renew and sustain its groundwater during the penetration of rainwater and surface water. This water-based reservoir in part on natural nutrition rain then this stock began gradually decreasing and downward due to over exploitation of water in addition to low natural nutrition levels of the groundwater reservoir. Groundwater quality in this reservoir characterized to be higher concentrated with dissolved salts. The results of Water quality index (Wqi) values display that the groundwater of present study location predicted to be severely contaminated and non-suitable for drinking usage at all sites of the wells.

Key words: Water quality index, hydrogeology, groundwater, physicochemical properties, contaminated, particular

INTRODUCTION

Dibdibba formation name which appears in all wells of this aquifer was first utilized by Macfadyen to beds revealed near the city of Basrah in Southern Iraq and Northern Kuwait where about 150 m of locally cross-beded sands, gravels and carbonate or argillaceous cement sand, clays, sandstones, conglomerates and siltstones are exposed (Fig. 1). Owen and Nasr described the formation from wells of the Zubair field, it comprises gravel and sand containing pebbles of igneous rocks and white quartz, often cemented into a hard grit (Owen and Nasr, 1958). Beds of limestone, marl and silt were reported from wells in Nahr Umr field, Kifl field and at Mussaiyiab field (Elliot et al., 1954; Kasim, 1960 and Kasim, 1962).

The formation ungraded and often cross-beded sequence of gravels and sands accompanied by subordinate intercalated beds or lenses of sandy clay, conglomerate carbonate or evaporite, cemented siltstone and sandstone (Alsharhan and Nairn, 1997).

In the region of Dibdibba formation southern Iraq the water supply is chiefly dependent on the rainfall, fortunately, high porosity of the sandstone and sands, plenty of the water may seep into the ground and be stored or may drain into local surface depressions in which some water gradually transpire into the ground and some evaporates and underground drainage is toward the Euphrates and Shatt al Arab rivers, down both dip and topographic slope (Al-Naqib, 1963). Wqi concept primarily used by Horton (1965), the quality of water from the side of their chemical, physical and biological parameters and ensure its quality is important before it is used for several purposes like potable water, agricultural industrial and recreational, etc. (Sargaonkar and Deshpande, 2003). The common Wqi was advanced
by Brown et al. (1970). Although, the Wqi founded on very serious parameters can show a simple indication of water quality (Yogedra and Puttaiah, 2008). Wqi is a classification shows the composite effect of diversified water quality parameters calculated count on the groundwater suitability for human consumption (Ramakrishnaiah et al., 2009).

In this study, the index includes the following eleven parameters: pH: potential Hydrogen ion concentration; EC: Electrical Conductivity; TDS: Total Dissolved Solids, calcium, magnesium, potassium, sodium, chloride, sulfate, bicarbonate and nitrate. In Iraq, many groundwater bodies recharger through vertical downward percolation of precipitation from the surface also indirect vertical seepage, about 100-300 mm of precipitation per year on the Mesopotamian flood plain and Jezira area and over half of Iraq situated within the semi-arid and arid zones (with <150 mm/year rainfall) (Alsam et al., 1990).

The goal of this study is to investigate the groundwater quality of Dibdibba aquifer in Najaf city in the South of Iraq to know if it suitable for human consumption by using then the concept of Water quality index (Wqi).

MATERIALS AND METHODS

**Study area:** This area is situated between longitudes (44°.1840-44°.3320) East and latitudes (32°.3088-32.1180) North in Najaf city South of Iraq about 120 km Southwest of Baghdad (Fig. 2). Variations of recent recharge during dry and wet years have reportedly ranged between 2.2 and 12 mm per year. for the Dibdibba formation in Iraq. From the tectonic side study area located in the Mesopotamian zone within stable shelf and contains the two rivers Tigris and Euphrates within central and South of Iraq also covered with the sediments of quaternary (Fig. 3) (Buday and Jassim, 1987; Al Kadhimi et al., 1996; Jassim and Goff, 2006).

The hydrological position of the study area is placed within the Mesopotamian plain aquifer system (Fig. 4) (Jassim and Goff, 2006). This formation is a continental environment originally, fed by rain and floods surface and so, it is natural that the groundwater of it is a continental environment either the quality in a range of calcium, sulfate and sodium chlorides. Total dissolved solids are generally high, it ranges between 2593-4777 mgL$^{-1}$ which not fit for human drinking purposes according to the standards adopted by the food and agriculture organization and Iraqi standards for drinking water (Anonymous, 2001). The soil nature in the area and depth of groundwater qualified this water to agricultural uses because it contains a high percentage of the sand which maintains only 20% of irrigation water to maintain what plants need from elements as though the groundwater depth is major than 5 m which helps to not collect water and salts within zone of plants root (Mohammad, 2012).

The Eastern borders of the reservoir end by the disappearing of the geological formation and its water reservoir then turn into a semi-confined reservoir then confined near the Euphrates river and a ration of the water is discharged into the quaternary sediments above it (Al-Jawad et al., 2001). An official survey found that
Fig. 2: Study area

Fig. 3: Tectonic map of Iraq. Buday and Jassim (1987), AlKadhimi et al. (1996) and Jassim and Goff (2006)

nearly 5000 wells were in use in this area in 1998; Abstraction for agricultural uses was estimated at around

370 MCM in the 1980s, a substantial side of the extracted water returns back to groundwater through the porous
pebbly sand soils (a return flow of about 84%) (Hassan et al., 1989). This formation has become hugely unsaturated in different regions, reversing the downward flow of groundwater from the Neogene to the Paleogene formations in heavy abstraction areas (UN-ESCWA and BGR., 2013).

**The physicochemical parameters:** Depending on the on a range of drilled water wells in the study area where they penetrated the sandy Dibdibba formation. The samples of groundwater were assembled in October 2013 from 23 wells with depth from (35-52 m). Water samples were obtained in the middle at mid-depth of each well and collected in clear (3 L) pre-sterilized polyethylene bottles which were washed with distilled water before sampling and transported to the laboratory using standard procedures recommended by standard method for the examination of water and wastewater by American Public Health Association (APHA et al., 1998).

Chemical analysis of water samples analyzed in the laboratories of the general authority of groundwater in Najaf province in the South of Iraq. Various physicochemical parameters pH, total dissolved solids, EC, magnesium, calcium, potassium, sodium, chloride, sulphate, bicarbonate and nitrate have been calculated for all water samples. Groundwater geochemistry is a (cross-sectional study) of water chemistry for the subsurface environment where the chemical structure of the groundwater is the consequence of the water which enters the groundwater reservoir and interactions with rocks that containing different minerals (Appelo and Postma, 1993). This wide range is the conclusion of the difference in origin (sea, air, birth, etc.) the rate of nutrition and interaction with the atmosphere, rock industrial pollution, temperature and pressure (Stuyfzand, 1999).

**Statistical analysis**

**Water quality index (Wqi):** Water quality index is the classification method that provides the combined effect of the individual water quality parameter on the total water quality (Singh et al., 2013). For determine Wqi, a weighted arithmetic index process was used in the present study. Microsoft Office Excel was used to
**Table 1:** Study wells values of parameters samples, all parameters units are in mg/L except for pH

| Well No. | pH   | Ee   | TDS  | Ca$^{2+}$ | Mg$^{2+}$ | Na  | K   | Cl$^{-}$ | SO$_4^{2-}$ | HCO$_3^{-}$ | NO$_3^{-}$ | NO$_2^{-}$ |
|----------|------|------|------|-----------|-----------|-----|-----|----------|-------------|-------------|------------|------------|
| W01      | 7.50 | 3870 | 2675 | 264       | 128       | 420 | 80  | 552      | 1013        | 460         | 5.2        |            |
| W02      | 7.30 | 4880 | 3218 | 332       | 157       | 536 | 118 | 716      | 1296        | 509         | 3.0        |            |
| W03      | 7.20 | 5580 | 3801 | 309       | 148       | 548 | 96  | 667      | 1296        | 489         | 1.3        |            |
| W04      | 7.23 | 5490 | 3734 | 301       | 145       | 542 | 95  | 662      | 1262        | 485         | 1.6        |            |
| W05      | 7.35 | 3750 | 3526 | 270       | 130       | 510 | 85  | 639      | 1104        | 465         | 2.3        |            |
| W06      | 7.54 | 5330 | 2599 | 258       | 122.2     | 402 | 673 | 518      | 984         | 421         | 5.4        |            |
| W07      | 7.50 | 3970 | 2630 | 290       | 140       | 440 | 102 | 869      | 1089        | 472         | 2.0        |            |
| W08      | 7.50 | 3920 | 2593 | 280       | 134       | 434 | 95.8| 596      | 1056        | 469         | 5.0        |            |
| W09      | 7.60 | 3860 | 2901 | 260.5     | 126.1     | 410 | 84  | 574      | 1002        | 450.7       | 5.3        |            |
| W10      | 7.30 | 4350 | 2879 | 314       | 148       | 494 | 110 | 667      | 1214        | 490         | 3.0        |            |
| W11      | 7.32 | 4020 | 2663 | 295       | 143       | 460 | 106 | 621      | 1142        | 475         | 3.0        |            |
| W12      | 7.28 | 4630 | 3058 | 312       | 142       | 510 | 95  | 680      | 1181        | 480         | 2.0        |            |
| W13      | 7.35 | 4860 | 3205 | 330       | 156       | 533 | 116 | 714      | 1286        | 508         | 3.0        |            |
| W14      | 7.30 | 4520 | 2988 | 300       | 138       | 480 | 85  | 650      | 1123        | 460         | 2.0        |            |
| W15      | 7.40 | 4460 | 2949 | 260       | 123       | 440 | 72  | 604      | 960         | 430         | 2.0        |            |
| W16      | 7.20 | 5080 | 3351 | 340       | 165       | 560 | 120 | 746      | 1363        | 512         | 2.0        |            |
| W17      | 7.12 | 5170 | 3754 | 356       | 173       | 580 | 125 | 781      | 1440        | 514         | 2.0        |            |
| W18      | 7.20 | 6570 | 3580 | 286       | 139       | 532 | 91  | 651      | 1190        | 481         | 2.1        |            |
| W19      | 7.30 | 4510 | 2981 | 298       | 136       | 470 | 83  | 645      | 1094        | 458         | 2.0        |            |
| W20      | 7.12 | 6930 | 4665 | 350       | 172       | 586 | 104 | 692      | 1536        | 508         | 1.1        |            |
| W21      | 7.12 | 7090 | 4777 | 345       | 170       | 609 | 110 | 705      | 1844        | 510         | 0.8        |            |
| W22      | 7.12 | 6970 | 4610 | 370       | 170       | 590 | 104 | 703      | 1526        | 506         | 1.1        |            |
| W23      | 7.18 | 6980 | 4617 | 360       | 180       | 612 | 106 | 715      | 1613        | 508         | 1.1        |            |
| Max.     | 7.60 | 7090 | 4777 | 360       | 180       | 612 | 125 | 869      | 1844        | 514         | 5.4        |            |
| Min.     | 7.12 | 3750 | 2593 | 258       | 122.2     | 402 | 672 | 518      | 960         | 421         | 0.8        |            |
| Median   | 7.30 | 4860 | 3205 | 301       | 143       | 510 | 96  | 667      | 1190        | 481         | 2.0        |            |

**Table 2:** Relative weight for each parameter, all units are in mg/L except for pH

| Chemical parameters | pH   | Ca$^{2+}$ | Mg$^{2+}$ | Na  | K   | Cl$^{-}$ | SO$_4^{2-}$ | HCO$_3^{-}$ | NO$_3^{-}$ | NO$_2^{-}$ |
|---------------------|------|-----------|-----------|-----|-----|----------|-------------|-------------|------------|------------|
| Highest permitted   | 8.5  | 200       | 150       | 200 | 12  | 600      | 400         | 200         | 50         |            |
| 1/Si                | 0.117647 | 0.005   | 0.00667   | 0.005 | 0.0833 | 0.00167 | 0.0025      | 0.005       | 0.020      |            |
| Wi = k/Si           | 0.475379 | 0.0202  | 0.02694   | 0.020 | 0.3367 | 0.00673 | 0.0101      | 0.0202      | 0.0808     |            |
| (21/Si)             | = 4.04072 |
| (2Wi)               | = 0.247  |

**Table 3:** The Iraqi standard for drinking purpose

| Parameters | pH   | TDS  | Ca$^{2+}$ | Mg$^{2+}$ | Na  | K   | Cl$^{-}$ | SO$_4^{2-}$ | HCO$_3^{-}$ | NO$_3^{-}$ | NO$_2^{-}$ |
|------------|------|------|-----------|-----------|-----|-----|----------|-------------|-------------|------------|------------|
| Iraqi standard, No. 417 | 6.5-8.5 | 1500 | 200       | 150       | 200 | 12  | 600      | 400         | 200         | 50         |            |

describe statistics of water quality parameters like (median, minimum and maximum) Table 1 and then calculate Wi for all studied wells.

**Step 1:** Calculating the constant of proportionality with Eq. 1 (Table 2) as below:

\[ K = \frac{1}{\sum_{i=1}^{n} \frac{1}{S_i}} \]  

Where:
- K : Constant of proportionality
- Si : Standard limit for each parameter
- n : Number of parameters

**Step 2:** Calculating relative Weight (Wi) of each parameter by using Eq. 2 as in Table 2:

\[ Wi = K \frac{Ci}{Si} \]  

**Step 3:** Calculating quality value scale (qi) for each parameter is allocated by dividing parameter concentration in each sample by its standard value according to Iraqi Standards for drinking purpose by Anonymous (2001) 100 as in Eq. 3:

\[ qi = (Ci/Si) \times 100 \]  

Where:
- qi : Quality rating
- Ci : Concentration of a single parameter in each sample (mgL$^{-1}$)
- Si : Iraqi standards for drinking purpose (Table 3)

**Step 4:** To computing Wqi, according to Ramakrishnaiah et al. (2009) the (SIi) specified for each parameter as in Eq. 4:

\[ S_i = Wi \times qi \]
Table 4: Water quality classification based on Wqi values

| Water quality       | Wqi values |
|---------------------|------------|
| Excellent           | <50        |
| Good water          | 50-100     |
| Poor water          | 100-200    |
| Very poor water     | 200-300    |
| Water unsuitable for drinking | >300 |

Table 5: Wqi for study wells

| Well No. | Wqi values | Water quality       |
|----------|------------|---------------------|
| 01       | 308.90     | Water unsuitable for drinking |
| 02       | 427.91     | Water unsuitable for drinking |
| 03       | 359.68     | Water unsuitable for drinking |
| 04       | 356.44     | Water unsuitable for drinking |
| 05       | 324.88     | Water unsuitable for drinking |
| 06       | 296.92     | Very poor water      |
| 07       | 377.53     | Water unsuitable for drinking |
| 08       | 357.79     | Water unsuitable for drinking |
| 09       | 305.58     | Water unsuitable for drinking |
| 10       | 402.09     | Water unsuitable for drinking |
| 11       | 388.86     | Water unsuitable for drinking |
| 12       | 356.06     | Water unsuitable for drinking |
| 13       | 421.99     | Water unsuitable for drinking |
| 14       | 324.69     | Water unsuitable for drinking |
| 15       | 283.60     | Very poor water      |
| 16       | 434.19     | Water unsuitable for drinking |
| 17       | 449.88     | Water unsuitable for drinking |
| 18       | 343.37     | Water unsuitable for drinking |
| 19       | 318.30     | Water unsuitable for drinking |
| 20       | 386.02     | Water unsuitable for drinking |
| 21       | 405.40     | Water unsuitable for drinking |
| 22       | 385.97     | Water unsuitable for drinking |
| 23       | 393.27     | Water unsuitable for drinking |

Sli is first specified for each chemical parameter. Water quality classification based on Wqi values (Table 4) and to calculate the Wqi as the following Eq. 5:

$$Wqi = \sum Sli$$  \hspace{1cm} (5)

**Water quality criteria for irrigation:** Calculating the Sodium Adsorption Ratio (SAR) in groundwater according to Richards (1954) from the following Eq. 6:

$$SAR = \sqrt{\frac{Na^+}{(Ca^{2+}+Mg^{2+})}}$$  \hspace{1cm} (6)

Sodium percentage (Na%) is used also for evaluating the suitability of water quality for irrigation (Wilcox, 1955). As for a following Eq. 7:

$$Na\% = \frac{(Na+K)}{(Ca+Mg+Na+K)} \times 100$$  \hspace{1cm} (7)

Water quality index (wqi) for all study wells are presented in Table 5.

**RESULTS AND DISCUSSION**

**The potential of Hydrogen (pH):** It is the negative logarithm of hydrogen ion activity, a measure of acidity and alkalinity in normal conditions of temperature and pressure (Langmuir, 1997). Solutions with <7 are acidic and if it’s >7 become alkaline, pH values of this study are ranged from 7.12-7.6 as shown in Fig. 5. The results present that the groundwater in this study resort to neutralize and partly alkaline.

**Electrical Conductivity (EC):** EC values of the present study are ranged from 3750-7090 as in Fig. 6. The conductivity of 1 cm of power at 25°C measured in µS/cm where electrical conductivity is dependent on water temperature increasing the water temperature by 1°C causes an increase in electrical conductivity of 2% and also increased by increasing the dissolved salts concentration (Hem, 1985; Detay, 1997).

**Total Dissolved Solids (TDS):** TDS values are ranged from 2593-4777 mgL⁻¹ as a display in (Fig.7), very high values of TDS were measured in all study wells much further Iraqi drinking water standards (Anonymous, 2001). These values considered not suitable for drinking water.

**Cations concentrations:** The examination of Calcium ions (Ca²⁺), Magnesium ions (Mg²⁺), sodium ions (Na⁺) and potassium (K⁺), display the range from 258-360, 122.2-180, 402.6-612 and 72-125 mgL⁻¹ as in Fig. 8-11.

**Anions concentrations:** The test range of Chloride ions (Cl⁻), Sulfate (SO₄²⁻), bicarbonate (HCO₃⁻) are 518-869, 960-1844 and 421-514 mgL⁻¹ as Fig. 12-14.

**Nitrate (NO₃⁻):** Various agricultural activities increase the concentration of nitrates in ground and surface water (Nas and Ali, 2006). The range of nitrate is from (0.8-5.4 mgL⁻¹) as a display in Fig. 15 where its concentration did not exceed the required limit in all samples values for study wells.

**Sodium Absorption Ratio (SAR):** Groundwater may also classify based on Sodium Absorption Ratio (SAR) as excellent 10, good 10-18, questionable 18-26 and unsuitable (>26) (Richards, 1954). In order to assess the suitability of the wells for irrigation in the study area Fig. 16.

**Sodium percentage (Na%):** Sodium concentration is an important role in evaluating the irrigational quality of groundwater where the soil of the area study is saline soil according to the high percentage of sodium shows a positive correlation with high salinity soil salinity Fig. 17, the significant positive correlation between soil salinity and the sodium percentage (Lehman et al., 2015).
The aquifer is essentially recharged from rainfall, since, it is located in an arid environment where rainfall is rare and restricted within slight Winter months, so, the aquifer is not fully saturated and many of its large parts are lacking sufficient groundwater, however, the saturated thickness is growing to the West. The aquifer is usually unconfined in its Western parts and moved towards the East, therefore, the clay and marl lenses inside the formation retain water in isolated sandy lenses.

The previous studies on this aquifer specified that the Western parts of it are nearly dry and therefore inappropriate for exploitation projects where the Eastern parts are more promising (Joshi et al., 2009; Al-Ani, 2004). The irregular investment of groundwater of this aquifer is very chancy where different parts of the aquifer set positive and negative productivity of water use together (Buxton and Smolensky, 1999; Leijnse and Hassanizadeh, 1994). The results are shown by the physical and chemical values of parameters of the study wells samples as agreeing with the Iraqi drinking water standards (Anonymous, 2001).

The pH observed values 7.12-7.6 are consistent with the Iraqi drinking water standards with ranges from 6.5-8.5 and showed that the groundwater head for neutralizing or slightly alkaline. The massive rates of TDS concentration due to the gypsum, sand and silty clay in
the chemical composition of the formation. The geological nature of this formation reflects the high and low concentration of calcium. The values of magnesium are within acceptable and permissible limits by comparing them to specifications Iraqi drinking water standards. Sodium is present in the groundwater due to the ease of melting of sodium salts in water (Desonie, 2008). The study showed high rates of potassium and these high concentrations minimizes plant uptake of calcium (Ayers and Westcot, 1985). High chloride concentration in dry areas due to its spread in all rocks and crust sediments where the chlorides are spread on the surface of the earth in the form of sodium and potassium chlorides the most important elements of water and the sense of salt taste of water depends on the positive side of chlorides and high concentration of chloride ion is often shaped as sodium chloride and gives the taste of salt (Berkowitz et al., 2008), this high concentration of chloride points out there is a high percentage of organic pollution can occur near sewage and waste of factories, results water distasteful and unsuitable for drinking and watering cattle (Chapman, 1998). High values of sulfate due to the presence of large amounts of gypsum materials where the sodium sulfate the main source of sulfate in groundwater and the high concentration of it causes a difference in the taste of water. All study wells tend to alkalinity due to the presence of hydroxide, carbonates and bicarbonates ions
Fig. 9: Mg$^{2+}$ values for all study wells

Fig. 10: Na$^+$ values for all study wells

in water (Merkel and Planer-Friedrich, 2008). Nitrate concentration is very low in all study wells which is below the Iraqi drinking water standards (Anonymous, 2001). The previous studies from the state company of geological survey and mining in Iraq presented that the groundwater flow direction of the study area is from west to East and from the Southwest to the Northeast (Ayob et al., 1995; Al-Jiburi, 2002).

This activity increased groundwater contamination due to dissolved rocks in different chemical composition through the distance traveled up to reach locations of selected wells. The other cause for the high values of wqi is a persistent emptying of agricultural flow. When comparing the positive and negative ion concentrations and the total salinity of the groundwater samples, there are no wells within the permissible limits for use for drinking purposes. Groundwater validity for irrigation purposes depends on the ion concentrations in the water mainly taking into consideration the salt content expressed by electrical conductivity (Ayers and Westcot, 1985) (Fig. 18 and 19).

Increased Na% in water leads to reduced soil permeability due to the exchange of calcium ion and magnesium with sodium in the soil (Rasul, 2000). Therefore, it is a risk and causes problems for irrigation, groundwater cannot be used for human consumption as a result of the high concentration of salinity and major ions in the wells. When using the (Richards, 1954)
Fig. 11: $K^{+}$ values for all study wells

Fig. 12: $Cl^{-}$ values for all study wells

Fig. 13: $SO_4^{2-}$ values for all study wells
Fig. 14: HCO$_3$ values for all study wells

Fig. 15: NO$_3$ values for all study wells

Fig. 16: Sodium Absorption Ratio (SAR) for all study wells
Fig. 17: Sodium percentage (Na%) for all study wells

Fig. 18: Classification of groundwater based on SAR and EC for irrigation purposes (after the US Salinity laboratory, Richards (1954))

Fig. 19: Wqi for all wells samples
classification which is based on the relationship between Sodium Adsorption (SAR) and Electrical Conductivity (EC) as in Fig. 18 and 19, it is not admissible for irrigation purposes.

It is necessary to place the wells in the study area under a periodic monitoring plan for the underground levels to ensure the safe and non-invasive exploitation of reservoirs of the underground reservoirs by devising a calculated plan for the number and areas of spread of the observation wells that can be drilled and to use them in determining the levels of fluctuation in the underground levels and calculating the natural recharge of the reservoirs and the limits of their variation and the circumstances affecting on it Fig. 19.

CONCLUSION

The Wqi for 23 samples ranges from 283.60-449.88 two wells samples show values between 283.60-296.92 which are very poor quality for drinking water and twenty-one wells samples display values between 305.58-449.88 and that is mean the water is unsuitable for drinking.

From Wqi values, it is very important to suggest further improvement is required to treat the wells for use for drinking purpose. The looseness of groundwater quality because of the high concentration of TDS and Sulfate SO$_4^{2-}$. The analysis offers that study area groundwater needs good processing and protection from the contamination before any consumption. Wqi values at all wells are much above 300 indicating unfit for drinking purpose.

According to Ramakrishnaiah et al. (2009), the main causes of quality degradation of groundwater are the high concentration of TDS and sulfate in study wells. The stratigraphic sequence of Dibidibha formation consists of several layers of sand permeated by clay and gravel deposits making it a good layer to contain the water and passes through it but the water storage of this reservoir began depletion as a result of the digging large number of short depth wells in addition to low levels of natural recharge of the rain and surface torrents as well as the limited deployment of the reservoir and its surface effects have another negative effect to not relying on this reservoir in the future but explore and study other formations located below it within the stratigraphic column of the area.

The elevation of alkalinity is due to presence hydroxide ions and bicarbonates in water as groundwater contains a small percentage of soluble matter and this indicates the presence of some organic substances soluble in water like calcium salts, magnesium, sodium, potassium, chloride, sulfates, nitrates and due to calcium, magnesium and their salts are the most common elements in the Earth’s crust.

The study concluded that geological formation is contributed as main determinants of groundwater quality, since, the existence of each of sulfate and chloride in the solubility of sulfur salts such as gypsum, anhydrite and halite which are commonly found in the majority of the study area. As for the use of irrigation, must be it treated very cautiously also it requires a series of irrigation measures and improve quality.

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