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ASSESSMENT OF GROUNDWATER QUALITY IN SABHA AREA – LIBYA

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ABSTRACT

Introduction: The groundwater quality in Sabha in Libya is not measured. Also, its impact on human lives and the environment is not being assessed. Objectives: Therefore, this study aims to assess the groundwater quality and its suitability for drinking at five places of Sabha state in Libya, including Sabha city, Samno, Tamnhent, Elzegen, and Godwa. The main aim is to assess 13 parameters of groundwater quality. Methods: From five places, groundwater samples were collected in safe containers and sent to the laboratories. Results: From November 2018 to March 2019, the water samples temperatures averaged were 18.1°C, pH values most of water samples are acidic, except for the Azzighan, which were alkaline, and it ranged from 6.4 to 7.2. In Azzighan, Samno and Sabha, the values of (TDS) and (Ec) exceeded far higher than the desirable limits. The Chloride (Cl) values ranged between 36.7 to 396.8 mg/L, and it was higher than the permissible limit in Azzighan, Tamanhint and Sabha. As for the Nitrate (No3) of well waters were within the desirable limits, except Sabha and Ghadduwah, which were high. high levels of (So4) and (Fe)were found in Azzighan and Samno, the values of (Mg++) recorded in the well waters were not of any concerned were within the prescribed limits. High levels of (So4) were found in Azzighan and Samno, reaching 2230 and 2419 Straight As the normal range does not exceed 150 mg/L Libyan standard. The most spread and comparatively higher E. coli counts in the Sabha well here it arrived 36 cm3. Discussion: The water quality index (WQI) revealed of well waters of study area as follows, the well waters of Tamanhint (WQI: 93.61) and Ghadduwah (WQI:83.76) They were slightly polluted (Class B), were good to drinking. Except (Cl) in Tamanhint and (K) in Ghadduwah all other parameters studied in these two places were well within their standard desirable limits. Moderately polluted well waters (Class C) were located in Azzighan (WQI: 61.06), they require suitable treatments. The well water of Samno (WQI: 45.77) (class D) however, was excessively polluted and Sabha (WQI: 38.86) Severely polluted (class E) and was not potable.Suitable suggestions were made to improve the quality of groundwater of SW Libya.

Keywords: Desirable limit, Libya, parametric ratio, physicochemical parameters, pollution, water quality index, well water

INTRODUCTION

The lack of renewable water sources is one of the most serious environmental issues impeding the sustainable development of developing countries in arid and semi-arid regions. Groundwater is the most important natural resource in these areas, and it is used for a variety of purposes. As a

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result, groundwater can only be used and maintained optimally if its quantity and quality are properly assessed. Groundwater pollution can be caused by both human activities and geological factors. As a result, evaluating groundwater quality is a critical step in selecting suitable groundwater (El-Hames et al., 2010).

Because of the effects on human health and ecological systems, groundwater pollution has gotten a lot of attention and raised public and regulatory concerns all over the world. Several complex processes govern the behaviour of heavy metals, nitrogen, organic, chemical contaminants, and pathogenic organisms in soil, and ultimately in groundwater. Qualitative and quantitative understanding of these processes is required to develop optimal strategies to prevent or mitigate the negative effects of these contaminants (Caracciolo et al., 2005). Problems with groundwater quality are widespread and range in scope and severity. They are classified into two types: those caused by contamination and those caused by overexploitation. Most problems have yet to be identified because they are hidden beneath the ground's surface. Because groundwater flows at such a slow rate, the impact of today's action may not be felt for several decades (Ramachandra, 2006). The activities may have a direct impact on groundwater. Pesticides and fertilizers, for example, applied to the ground surface may reach groundwater and accumulate to an unacceptable concentration in drinking water supplies, altering the water quality of the aquifers (Schmoll, 2006).

Over the last many decades, Libya has seen rapid growth in population. However, at the same time, it has seen heavy destruction of the infrastructure due to political turmoil and civil war conditions (Carboni & Moody, 2018). All these things together have increased exponential pressure on water (surface and underground) resources. These have resulted in greater demand for the supply of water resources in the country. Of the current estimated (or forecasted for 2020) total (12473.2 million cubic meters) water usage in the country, most (85 percent) of the water is taken by agriculture and industrial sectors, and only 15 percent (1881.66 million cubic meters) of the water is consumed in domestic activities (Lawgali, 2008). In 2012, it was reported that the total quantity of water for consumption had too much exceeded the quantity of water produced (Brika, 2018). Domestic water is further divided into safe drinking water and sanitation. Libya manages its water resources to meet different sectors' needs, but there are various challenges to sustainably manage drinking water quality (Daw, Ali, & Toriman, 2021). More than 98 percent of the water mainly comes from (or depends on) conventional non-renewable, fossil, and groundwater resources (FAO, 2017; Brika, 2018).

Libya is facing two main challenges related to water management: 1) demand has increased, but resources of safe drinking water have not increased- meaning Libya is facing the severest water shortage problem; 2) the available water resources are contaminated or polluted. Since Libya heavily relies on groundwater. The evaluation and assessment of groundwater pollution is an essential aspect because groundwater's physical, chemical and microbiological properties determine its suitability for agricultural, industrial, and domestic uses (Avtar et al., 2019). Convention water sources, primarily underground, are dependent on rainfall. Rainfall is scarce except in the narrow coastal strip. These sources are renewed by rain each year in coastal areas, but the country also has vast non-renewed reserves of water underlying the desert. As a result, the country has experienced heavy over-drafting and mining of aquifers associated with

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the growing problems of aquifer diminution, quality worsening; and pollution and saltwater intrusion have increased (Nairizi, 2017).

As said earlier, pollution or contamination of water is one of the significant concerns globally and in Libya, affecting water quality and a decrease in the supply of safe drinking water. Research shows that water pollution direly affects human lives worldwide (Schwarzenbach et al., 2010; Landrigan et al., 2018), but research on the impact of polluted water on human lives in Libya is exceptionally scarce or not available. There are often research efforts (Omran, Altawati, & Davis, 2018; Banana et al., 2016) to understand and assess the quality of water being affected by the chemicals and pesticides without offering details of the impact of polluted water on human lives, especially on poor peasants. Therefore, this research has focused on the relations between causes of underground water pollution, intensity (or scale) of pollution in Libya.

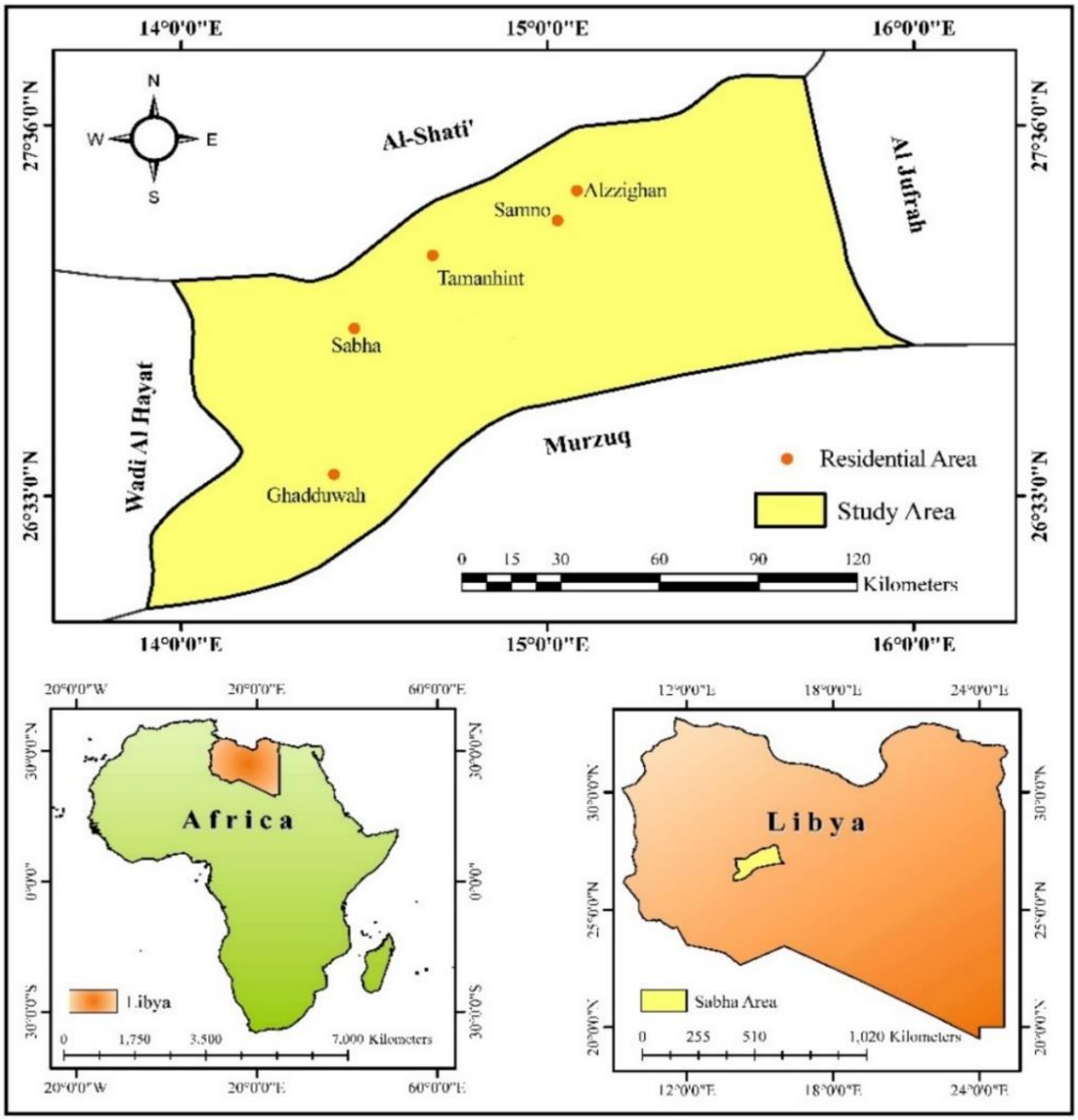
Groundwater is the only source of water in the region, as rain is very rare in it, and it is classified among the very dry areas, and the hydrological system of the region is part of the general system prevailing in the Fezzan Basin, where the area is located, at the periphery, Northeast of the basin. The suitable and exploitable groundwater is found in layers of sandstones that are usually interspersed with layers of clay and clay stones, differing in their number, thickness and depth of presence from one place to another. Sandstones are formed from them, these sandstones that are considered good aquifer reservoirs, the old age of which goes back to the time of ancient life (Cambrian to Devonian), and the most recent to the middle life time (Triassic-even the lower Cretaceous), and due to the difference in the characteristics of these hydraulic reservoirs, Regarding the quality of its water from the chemical point of view, the oldest part of it is described as the ancient LIFT reservoirs, and the later part is described as the LLT reservoirs (Abdulhadi, 2009).

The water quality index and physicochemical parameters of groundwater of five places in Libya were assessed during November 2018 and March 2019. Sabha city, Samno, Tamanhint, Azzighan, and Ghadduwah (see Fig. 1) were places. The water samples were assessed for their suitability for drinking. The main job of the people residing in these places is agriculture, and the primary source of water is groundwater for drinking, domestic, livestock, and agricultural purposes. The periodic monitoring of groundwater quality is necessary to safeguard its long-term sustainability. The water quality index indicates the composite influence of several water quality parameters that are significant for specific benefits.

LITERATURE REVIEW

Nitrogen loads are highest in areas with intensive cultivation and double or triple cropping. Excessive irrigation or irrigation that is not strictly controlled may result in high nitrogen leaching from the soil. The risk of nitrate contamination of groundwater is determined by the interaction of nitrogen loading and aquifer vulnerability. The term "vulnerability" can be defined as "the intrinsic properties of the strata separating a saturated aquifer from the land surface that determine that aquifer's sensitivity to being adversely affected by pollution loads applied at the surface." (Schmoll et al., 2006). The risk of groundwater pollution is determined by the interaction of pollutant load and vulnerability and capacity to attenuate pesticides and the soil and underlying aquifer pathway. The mode of nitrate application is critical. Pesticide-treated soil is more likely to be leached than leaf-acting compounds sprayed onto plants (Zurqani, 2021).

Figure 1: Map of Sabha Showing the Places in The Southwest of Libya from where Well Waters were Collected for Analyses



The Water Quality Index (WQI) is a very useful and effective method for evaluating the quality of water and its suitability for drinking. It is also a very useful tool for communicating information about the overall quality of water (Asadi et al., 2007). The water quality index (WOI) is calculated to reduce a large number of water quality parameters to a single numerical

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value. It reflects the overall water quality's composite effectiveness of various water quality parameters (Swarna & Nageswara, 2010; Hamad, Yaacob & Omran, 2021).

There are many previous studies (for instance, Mohamed (2020) and Mostafa and Ebraham (2020) that used the equations of studying water quality to determine the water suitability for use, Ashwani and Dua (2010) investigated the water quality of the River Ravi in Madhopur, Gurdaspur District, India, using the Water Quality Index (WQT). The WQI was calculated using eight water parameters: pH, total dissolved solids (TDS), total hardness (TH), calcium (Ca), magnesium (Mg), total alkalinity (Ta), dissolved oxygen (DO), and electrical conductivity (EC). The weightage and rating scale of the parameters were used to calculate the WQI. An index's goal is to convert complex water quality data into information that the general public can understand and use. WQI values indicated that the water was free of impurities at the sampling site, except for 2-3 months when it was less than 70. Whenever there are human activities, the water gets polluted to some extent, so the value of WQI decreases. It was found that the parameter which is required in the least amount contributes a high statistical value to the index. It is concluded that the WQI can be used to compare the water quality of various sources. It provides the general public with an overview of the potential water problems in a given area. The indices are among the most effective means of communicating information about water quality trends to the general public, policymakers, and water quality managers.

The (Al-alwani & Yassin, 2016) study used the water quality index method to determine the appropriate potability of water supplied to the Libyan city of Az-Zintan. To calculate the water quality index, first determine the sub index of the chemical parameter (Sli), and then calculate the WQI using the following equations ($WQI = \Sigma SIi$). The results show that high WQI values have been found in areas where the water is municipal water or groundwater. As a result, it is not suitable for drinking and must be treated before use. The low value of WQI, on the other hand, has been found in areas where the source of water is rainy water, and it is the most suitable for drinking purposes.

From November 2003 to March 2004, Nair et al. (2006) determined the physicochemical parameters and water quality index to assess groundwater quality and suitability for drinking in six locations in Libya: El-Marj, Albayda, Shahat, Susa, Ras Al-Hilal, and Dema. The water quality index for each of the six locations was calculated using this equation ($Win = k/1Vi$). Water samples had an average temperature of 15.1 oC. The pH values were alkaline, and the dissolved oxygen levels were within safe limits. Except for Susa, all of the above locations' electrical conductivity (EC), total dissolved solids (TDS), and water hardness were within standard limits. Except for Susa, the alkalinity of well water exceeded the chlorine and chloride levels in all six locations. The studies mentioned above found no fluoride or nitrate contamination in the wells. Only shallow phosphorus values, manganese, chromium, iron, and zinc were recorded; copper in the well water was generally high, and it exceeded the acceptable limit at Susa and Ras Al-Hilal. The WQI of the six tested samples revealed that the well water in Albayda and Shahat was safe to drink and only slightly polluted. On the other hand, El-Marj, Ras Al-Hilal, and Dema were moderately polluted (Imneisi & Aydin, 2020). Susa's well water, on the other hand, was extremely polluted and unsafe to drink. Appropriate recommendations were made to improve groundwater quality in Libya's north-eastern region (Zurqani, 2021).

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MATERIALS AND METHODS

Study area: The groundwater samples were collected from the wells of five places southwest of Libya. Their names, elevations, soil types, locality of wells, depth of wells, and well water use are given in Table 1.

Table 1: Location of Wells

Name of place	Elevation (m)	Type of soil	Locality of well	Depth of well (m)	Use of well water
Sabha	340	Rendzinas	Farm	248	Drinking, domestic, livestock, agriculture
Ghadduwah	600	Rendzinas	Residential	80	Drinking and domestic
Samno	625	Rendzinas	Residential	110	Drinking and domestic
Tamanhint	90	Red ferrosialithic	Farm	89	Livestock, agriculture
Azzighan	40	Red ferrosialithic	Residential	200	Drinking, domestic, livestock, agriculture

Source: The Researcher

Analysis of Well Water

Well water samples without any air bubbles were collected in polythene bottles as per the standard procedure. After the completion of the data collection stage; the process of data analysis was carried out to get results. the central laboratory at Sabha University and The Central Laboratory of Water in the General Company of Water was relied upon for the chemical and microbiological analysis of collected water sample. The results were later compared to global and Libyan standard water specifications. The collection date and time were recorded, and samples were analyzed for 13 parameters. Electrical conductivity, temperature, and total dissolved solids of the water were measured on the spot itself using Hanna auto-ranging microprocessor EC/TDS/°C meter and pH by Beckman pH meter, whereas the other parameters of water were analyzed in the laboratory. Total alkalinity, total hardness, and chloride were analyzed following APHA (1989) procedures using Hanna freshwater analysis kit. The other parameters of water were analyzed using Hanna multiparameter bench photometer. The parameters studied, and methods employed (given in brackets) are as follows pH, Total Dissolved Salts (TDS), Magnesium (Mg++), Sodium (Na), Potassium (K), Chlorides (CI), Total Hardness as Ca Co3 (TH), Nitrate (No3), Sulfate (So4), Calcium (Ca++), Phosphate (PO4), Iron (Fe) and E.coli. (Srinivas et al., 2000) was calculated using the values of different water parameters, using the hardness of water as a comparator.

Water quality index (WQI): The water quality index of well water was calculated following the procedures and equations given by Horton (1965), Ott (1978), Tiwari and Mishra (1985), and Kaur, Syal and Dhillon (2001).

To calculate WQI, fifteen parameters of water were selected. These were pH, Total Dissolved Salts (TDS), Magnesium (Mg++), Sodium (Na), Potassium (K), Chlorides (CI), Total Hardness as Ca Co3 (TH), Nitrate (No3), Sulfate (So4), Calcium (Ca++), Phosphate (PO4), Iron

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(Fe), and E.coli. The unit weights (Wi) of all factors were calculated (Table 2) based on the equation (1).

$$Wi \propto \frac{1}{Vi} \quad or\ Wi = \frac{K}{Vi} \qquad \text{(Equation 1)}$$

Where:
Wi = Unit weight of the factor.
Vi = Standard (desirable) limits.
K = Constant of proportionality.
The value of 'K' was calculated as the following (Equation 2).

$$k = \frac{1}{\sum_{i=1}^{13} \frac{1}{Vi}} \qquad \text{(Equation 2)}$$

The word unit weight implies the relative significance of each factor in overall water quality. It is dependent on the standard (desirable) limits in drinking water as prescribed The National Center for Standards Specification, Libya 2008 (Table 2). Factors having low permissible limits can essentially harm water quality, even slightly, and such factors have high weightings. On the other hand, factors with higher permissible limits have low weightings (Kaur et al., 2001).

Table 2: Water Quality Factors: Their Standards and Assigned Unit Weights

S. No.	Water quality factors	Standards (Desirable limits) (Vi)	Unit weights (Wi)
1	pH	<7.0-8.5>	0.008540427
2	TDS	<1000 mg/L	7.25936E-05
3	Mg	<150 mg/L	0.000483958
4	Na	<100 mg/L	0.000725936
5	K	<12 mg/L	0.006049469
6	Cl	<150 mg/L	0.000483958
7	TH	<200 mg/L	0.000362968
8	No3	<10 mg/L	0.007259363
9	So4	< 150 mg/L	0.000483958
10	Ca	< 200 mg/L	0.000362968
11	Po	< 0.1 mg/L	0.72593628
12	Fe	< 0.3 mg/L	0.24197876
13	E.coli	<10 Cm3	0.007259363

The National Center for Standards Specification, Libya (2008) WHO (1984)

Regarding the rating scale, each factor had been assigned a rating value to calculate WQI. The values fell between 0 and 100. To assign a rating value to a factor, the range of its concentration in water was divided into five intervals. The rating value = 0 implied that the chemical factor exceeded the standard (desirable) limit and polluted water. However, the rating value = 100 implied that the chemical factor had the most desirable clean water. The other ratings falling between these two extremes were rating value = 40, rating value = 60, and rating value = 80, representing intermediate water conditions (Table 3).

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To calculate WQI, the products of rating value and unit weights (Wi) of all 13 factors were summated

$$WQI = \sum (Wi\ Vr) \qquad \text{(Equation3)}$$

Table 3: Rating Values for Different Factors to Calculate WQI

Parameters	**Ratings**				
PH	7.0-8.5	8.6-8.7 6.8-6.9	8.8-8.9 6.7-6.8	9.0-9.2 6.5-6.7	> 9.2 < 6.7
TDS	0-250	251-500	501-720	751-1000	> 1000
Mg	0-37.5	38-75	75.5-112.5	113-150	>150
Na	0-25	26-50	51-75	76-100	>100
K	0-3	4-6	7-9	10-12	>12
Cl	0-37.5	38-75	75.5-112.5	113-150	>150
TH	0-125	126-250	251-375	376-500	>500
No3	0-2	3-5	6-8	9-10	>10
So4	0-37.5	38-75	75.5-112.5	113-150	>150
Ca	0-50	51-100	101-150	151-200	>200
Po	0-0.025	0.026-0.05	0.051-0.075	0.076-0.1	>0.1
Fe	0-0.07	0.08-0.14	0.15-0.21	0.22-0.30	>0.030
E.coli	0-2	3-5	6-8	9-10	>10
Retings (Vr)	100	80	60	40	0
Extent of Pollution	Clean	Slight Pollution	Moderate Pollution	Excess Pollution	Severe Pollution

The water quality index was calculated in this way for well water of all five places. WQI falling within the range of 0-39.99 stood for severely polluted water; between 40-59.99 for excessively polluted water; between 60-79.99 for moderately polluted water; between 80-99.99 for slightly polluted water, and 100 for absolutely clean water (Table 4).

Table 4: Classification of Water Quality

WQI	**Water quality**	**Designation**
100	Absolutely clean	Class A
80 – 99.9	Slightly polluted	Class B
60 – 79.9	Moderately polluted	Class C
40 – 59.9	Excessively polluted	Class D
0 – 39.9	Severely polluted	Class E

The water quality index was calculated to determine the suitability of the groundwater in the study region for drinking purposes. The WQI application was found to be useful in evaluating overall water quality in the current study. This method appears to be more systematic and provides a comparison of the water quality of sampling points. WQI, on the other hand, can help you understand the quality of water. According to (Nair et al., 2006; Elgali, 2012), who did the classification in some areas of Libya, the quality of the water is classified from absolutely clean to severely polluted using the WQI.

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RESULTS AND DISCUSSION

The physicochemical factors of well water were analyzed during November 2018 and March 2019 in five places in southwest Libya, and the average value of each factor is presented in (Table 5).

Table 5: Physicochemical Characteristic of Well Water of Southwest Libya

Gr	PH	TDS	Mg+2	Na+	K+	Cl	TH	NO3	SO	Ca	Po	Fe	E. coli	WQI
1	7.2	1298	33.5	98.5	1.91	318	501	0.5	2230	156	0.03	0.42	0	61.06
2	6.7	3872	48	222	4.5	124	818	0.478	2419.6	320	0.054	0.76	3	45.77
3	6.5	667	20.41	100	11	239.2	181	6.5	54.14	38.5	0	0.012	0	93.61
4	6.4	866.6	12.636	142	40	396.8	332	26.4	64.67	72	0.1	0.025	36	38.86
5	6.8	453.3	4.2	81.6	27	36.7	108	11	26.3	14	0.05	0.05	0	83.76

The water temperatures averaged 18.1ºC, and there were only very few variations in temperature between stations. This could be attributed to the winter seasons that prevailed during the period of investigation. Except for the Azzighan, the pH of water samples from all stations and wells in the region were acidic, which were alkaline, ranging from 6.4 to 7.2. The desirable limit for pH is 7.0-8.5, a safe range for drinking (WHO, 1984). In the present study, the pH is less than this limit. Generally, the pH of groundwater is influenced by the geology of the catchment area and buffering capacity of water (Weber and Weber, 1963)

The electrical conductivity, total dissolved solids, and total hardness of the well waters of all places except that of Tamanhint and Ghadduwah were higher than the standard desirable limits set for natural waters by WHO (1984) and Libya standard (2008) (EC: 1400□mho/cm; TDS: 1000ppm; total hardness: 500ppm). In Azzighan, Samno, and Sabha, the values of these parameters exceeded far higher than the desirable limits. Srinivas et al. (2000) opined that the higher value of EC in groundwater is due to the high dissolved solids, which may subscribe to the conductivity and directly bear the percentage of total solids. High TDS may be due to groundwater pollution by wastewaters discharged into pits, ponds, and lagoons and migrate down the water table (Rani et al., 2003). It may be true in the case of three wells of water of Azzighan, Samno, and Sabha, where large heaps of cattle and human wastes were seen dumped around the area. The primary sources of hardness in water are sedentary rocks, seepage, and runoff from soils, and hardness mainly originates in thick topsoil and Sandstone formation (Sawyer and McCarty, 1967). This condition prevailed in the study area, where the soils were Common dry limestone soils. Renn (1970) stated that hardness in groundwater is also due to calcium and magnesium ions in a natural water system. It passes through soils and rocks containing large amounts of these elements in mineral deposits.

The total hardness is due to the dissolved calcium and magnesium salts, usually expressed as the equivalent quantity of calcium carbonate. Concentration of hardness in water more than 200 mg/Letter can result in scale deposition. While soft waters with a hardness of less than 100 mg/Liter have a low buffering capacity and so may be more corrosive to water pipes WHO 2008. In groundwater quality, the hardness is usually due carbonates, bicarbonates,

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sulphate and chlorides of calcium and magnesium (Venkateswara et al., 2009). The spatial distribution of total hardness (TH) in the study area the rate of stiffness in the ranges from 108 - 818 mg / L. Looking Table 5, the highest rate is found in the Samno, reaching 818 mg/L. They are located in agricultural areas where fertilizers are used in large quantities. As for the lowest area, it was Ghadduwah, which reached 108 mg/l.

Chloride (Cl) is the second dominant ion in groundwater, and the higher content gives a salty taste to the water (Venkateswara et al., 2009). Chlorides exist in all-natural waters in different concentrations on a large scale. The chloride content usually increases as the mineral content increases (Bilgehan & Ali, 2010). The CI values ranged between 36.7 to 396.8 mg/L, and it was higher than the permissible limit in Azzighan, Tamanhint, and Sabha of the study samples. The Libyan National Centre for Standards Specification has set Cl's permissible limit in potable water from 200 to 300 mg/L. In natural water, chloride concentrations vary widely, and it is related to the mineral content of the water. As is well known, the Surface saline water intrusion is caused by the abnormal concentration of chloride. At the same time, the presence of soluble chloride from rocks leads to increased Cl concentration in the groundwater. At concentrations above 250 mg/L, the water acquires a salty taste (Swarna & Nageswara, 2010).

Sodium enters drinking water by a variety of human activities and by natural means. Evidence suggests elevated levels of sodium in drinking water may adversely affect health. Action should be taken to reduce the level of human exposure to sodium in drinking water (Moore &. Et, 1984). The safe percentage of sodium is less than 100 mg / L, WHO and Libyan specifications for drinking water. The percentage of wells contaminated with sodium is 60% of the total wells. The highest rate in the Samno, it reaches 222 mg/l.

Nitrate (No3) of well waters were within the desirable limits set for them (10ppm for nitrate) by Libyan standard (2008), except Sabha and Ghadduwah, which were high. High nitrate values in groundwater are possibly due to organic and sewage pollution(Pastén-zapata et al., 2014).

The values of (Mg) recorded in the well waters were not of any concern and were within the prescribed limits set for them by Libyan standard (2008), WHO (1984), Renn (1970), and BIS (1983). High levels of (So4) were found in Azzighan and Samno, reaching 2230 and 2419 Straight As the normal range does not exceed 150 mg/L the Libyan standards (2008).

The potassium is the most concentrated element in groundwater mostly due to the abundance of limestone in the upper layers (Khan, & et. 2020) and calcium salts contribute to filling part of the body's need for the purposes of building bones and teeth, but in return it is responsible for the hardness of water. High potassium can even cause a heart attack or death Unfortunately, many people do not feel symptoms of high potassium until it’s too late and their heart health worsens (Thomsen &. et. 2018). In the study area 58.3% of the wells are contaminated with potassium, where the Libyan specifications for drinking water are considered to be less than 12 mg / l, the safe rate for drinking, Looking at a (Table 5) that the largest rate of potassium is located in agricultural lands, as shown in the Sabha and Ghadduwah, with a value of 40 and 27 mg/L.

Iron (Fe) exists in large quantities in the soil and rocks, mainly in insoluble forms (Santi & Masters, 2001). Iron is biologically a vital element, which is essential to all creatures and present in the hemoglobin. Its high concentration causes slight toxicity (Swarna & Nageswara,

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2010). A slightly higher concentration of iron is found in the Azzighan and Samno parts of the region (Table 5). The Fe values ranged between 0 -0.3 mg/L.

The most spread and comparatively higher E.coli counts in the Sabha well here arrived 36 cm3, And the normal range (<10 Cm3) Libyan standard (2008) indicates that the groundwater in these areas has been contaminated with human liquid waste (sewage). It may be related to the weakness of the sewage network and the frequent presence of sewage tanks, thus overflowing the sewage and seep into groundwater reservoirs.

Table 6: Water Quality Index (WQI) of Well Waters of Different Places of Southwest Libya

Sample No	Places	WQI value	Water quality	Designation
1	Azzighan	61.06	Moderately polluted	Class C
2	Samno	45.77	Excessively polluted	Class D
3	Tamanhint	93.61	Slightly polluted	Class B
4	Sabha	38.86	Severely polluted	Class E
5	Ghadduwah	83.76	Slightly polluted	Class B

The water quality index (WQI) of well waters of five places in southwest Libya and their designations and water quality are presented in Table 6. The well waters of Tamanhint (WQI: 93.61), slightly polluted Class B, and Ghadduwah (WQI: 83.76) were slightly polluted and were suitable for drinking. Except for (Cl) in Tamanhint and (K) in Ghadduwah, all other parameters studied in these two places were well within their standard desirable limits. Moderately polluted well waters were in Azzighan (WQI: 61.06). They require suitable treatments such as filtration, chlorination, alum treatment, aeration, neutralization, softening, and chemical precipitation to minimize contamination and make them fit for drinking. To achieve this, water reservoirs can be built in the areas where the wells are located, and water from the wells can be pumped into these reservoirs for suitable treatments before releasing them for human consumption. The well water of Samno (class D) (WQI: 45.77). However, it was excessively polluted and Sabha (WQI: 38.86). Severely polluted (class E) and was not potable. The water was much degraded and unsafe for public health, and it is strongly recommended that people not be allowed to drink water from these wells as a precautionary measure.

Impact on Human Lives

Libya is almost totally reliant on groundwater, accounting for nearly all of the water used for agricultural, industrial, and home reasons. The influence of contaminated groundwater wells on human life was not investigated in this study. On the other hand, the findings are consistent with the conclusions of numerous other research studies, which suggest that the water delivered to residential areas, including schools, is unsafe to drink. UNICEF conducted a nationwide assessment of water and sanitation infrastructure in 140 schools in Libya's west, east, and south in 2018. The study was conducted in collaboration with Libya's National Centre for Disease Control, part of the Ministry of Health. It was discovered that more than half of the schools surveyed lacked adequate and low-quality drinking water and sanitary facilities. Drinking water is scarce in more than two-thirds of the schools (UNICEF 2018).

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UNICEF (2021) is concerned about Libya's deteriorating WASH situation. If immediate solutions are not developed and executed, over 4 million people, including 1.5 million children, may face severe water shortages. The sector is facing major challenges due to the prolonged crisis, which has resulted in a significant drop in services. This is mostly due to a lack of necessary finances to acquire equipment, operational materials, and spare parts for routine maintenance. Suppliers are also having difficulty obtaining hard currency bank credits to import equipment from outside the nation. The repeated attacks on the Manmade River systems knocked down roughly 190 wells (Al-Jafara - Al-Hasawna and Al-Sirir-Tazarbo), threatening to bring this crucial sector to its knees. The water network of the General Company for Water and Wastewater is deteriorating, resulting in enormous amounts of water being lost by up to 50 percent. Only 45 percent of households and institutions are connected to the public sewage network; the rest are connected to cesspits, resulting in groundwater contamination. Moreover, most wastewater is dumped directly into the sea without treatment, causing environmental and marine life harm.

Desalination Plants lack the necessary maintenance and chemicals to keep processes running, reducing their operational efficiency. For example, the Bomba Bay facility has been shut down, leaving nearly 63,000 people without access to safe drinking water in five cities: Al-Tamimi, Bambah, Ras al-Tin, Umm al-Razm, Murtaba, and the eastern shore of Derna. The cost of rehabilitating the plant is expected to be $ 12 million. This is happening against the current liquidity crisis, which has put further strain on families' financial ability to pay purchasing water by truck, hence increasing their financial burden. Furthermore, the remaining seven facilities that supply water to Abu Trabah, Sousa, Derna, Tubrok, Zletin, Alzawya, and Zwara are only running at 28 percent of their intended capacity. They, too, will break down if no action is taken right away. The problem has been made worse by regular power outages and a lack of operational gasoline. All of these factors could lead to a full system failure, cutting off water and sanitation services to low-income households and children (UNICEF 2021).

CONCLUSION

The water quality index (WQI) revealed of well waters of study area as follows,the values revealed that the groundwater quality in the study area was absolutely water (excellent) in 0% of groundwater samples, Thus, there is no water from (class A) in the study area.. the well waters of Tamanhint (WQI: 93.61) and Ghadduwah (WQI:83.76) They were slightly polluted (Class B), were good to drinking. Except (Cl) in Tamanhint and (K) in Ghadduwah all other parameters studied in these two places were well within their standard desirable limits. Moderately polluted well waters (Class C) were located in Azzighan (WQI: 61.06) , they require suitable treatments. The well water of Samno (WQI: 45.77) (class D) however, was excessively polluted, so that it cannot be used for drinking purposes and may be used for agricultural or industrial purposes and Sabha (WQI: 38.86) Severely polluted (class E) and was not potable, or for any other purposes. The water was much degraded and was unsafe for public health and it is strongly recommended that people should not be allowed to drink water from these wells as a precautionary measure. Suitable suggestions were made to improve the quality of groundwater of SW Libya. There is an increasing awareness among the residents of southwest Libya to maintain the well waters at their highest quality and purity levels. It is hoped that the present study may prove to be a valuable tool in maintaining the water at the desired levels for different beneficial uses of the people residing there.

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