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Hydro Chemical Water Quality and its Suitability for Drinking and Irrigation Purpose of the Main Springs Water in the Study Area of Jabal Al-Akhdar-Libya

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Abstract: A number of (14) springs water at various fields in the study area of Jabel Al-Akhder Libya, were selected and analysed at different seasons (summer and winter), this to evaluate and find out the status of water uses and its suitability for drinking water quality and for irrigation purpose.The drinking water quality is evaluated by comparing it with the specifications of TDS and TH set by the world health organization (WHO). According to the WHO specification, TDS amount of up to 500 mg/l is the highest desirable and up to 1500 mg/l is the maximum permissible. Therefore all springs water analyses in the study area at both seasons (summer and winter) falls under fresh types of water (TDS < 1000 mg/l) which is suitable for drinking water according to (WHO). The maximum allowable limit of total hardness (TH) for drinking water is 500 mg/l and the most desirable limit is 100 mg/l as per the (WHO) international standard. Based on this classification in drinking water quality, 86% of water samples belong within the highest desirable category and the remaining samples belong to the moderate up to maximum permissible category as found in the study. It is evident from the whole water samples of the study, that SAR value falls under the category of low sodium hazard. So there is neither salinity nor toxicity problem of irrigation water and hence most of the springs water in the study can safely be used for long term irrigation.Moreover the U.S. salinity diagram, indicate that all water samples in the study fall under (good to moderate) zone. In addition, nearly 29% samples of the study fall under moderate salinity zone EC between (750 - 1000 μmhos/cm) such water should not be used on soils with restricted drainage. The use of USDA classification method for irrigation revealed that all springs water in the study can be commonly classified as type (C2-S1and C3-S1) as explained in the US salinity diagram (Fig 2). In general, the continuous monitoring of traditional water quality in the study area is necessary for both drinking water quality and for irrigation which help appropriate management and sustainable development in relation to the natural resources.

Key words: Drinking water quality · Irrigation water quality · Hydro chemical analyse · springs

INTRODUCTION

Water is an essential bio-resource for all life. The freshwater resources account for less than 1% of all water present on Earth [1, 2]. Therefore, human activities and civilizations were concentrated around these sources of water. Libya is an arid region and is among those countries in North Africa, which are facing serious shortages in water resources, due to the demands of rapid developments within the country [3]. Groundwater is considered a major source of water in Libya and particularly the groundwater within the investigated area [4].

In the study area of Jabel Al-Akhder North East of Libya, the main occupation of the people residing in the region is agricultural and they heavily depend on the groundwater for drinking, domestic, livestock and agricultural purposes [5]. Assessment of water is not only

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used to determine its suitability for human consumption but also in relation to its agricultural, industrial, recreational, commercial uses and its ability to sustain aquatic life.

The periodic monitoring of freshwater resources water quality is necessary to safeguard its long term sustainability [6] and water quality index is an indicator revealing the composite influence of a number of water quality parameters which are significant for specific beneficial uses [7]. However, the rapid increase in agricultural activity in the study area along with environmental factors such as sewage can place stress on the water quality and is likely to worsen over time, which will impact on the health of people [8, 9].

Information on the traditional water resources such as (Springs waters) as represented here in the study is sparse. Therefore existing hydro chemical data in the springs water (Fountains) are highly focus in this work to provide a strong evidence on water quality in relation to water utilized for drinking and its suitability in regards to irrigation purpose in the study area.

MATERIALS AND METHODS

The study area is located in the North-East of Jabel Al-Akhder region, bounded by 32°56"N to 32°34"N latitudes and 22°38"E to 21°50"E longitudes. It occupies an area approximately 2,100 km^2 and the average elevation are vary at different steps level between 100 - 400 m.a.s.l (Fig.1). There are no permanent water bodies in the plain surface except for wadis and springs, which only runs (wadis) or increased during the rainy season particularly for springs water. All springs water discharge in the study area are in average (40 L/S), which is recognized that the quality of springs water is just as important as its quantity. The most important economic activity in the area is agriculture. The average annual rainfall is 400 mm, of which falls during the autumn and winter seasons.

Collection of Water Samples: Water samples were collected from selected 14 fountains (springs) at the study area of Jabel Al-Akhder region during the winter and summer seasons 2017 - 2018. A polyethylene bottles (500 ml) washed by distilled water were used for the sample collection and three replicates were set up at each collection. At the time of sampling, the bottles were thoroughly two to three times rinsed with each spring water to be sampled. These bottles were tightly closed and labelled for chemical and physical analyses.

Method of Analyses: The pH and electrical conductivity (EC) were measured using digital electrical conductivity meters immediately after sampling. Water samples collected in the field were analyzed in the laboratory for the major ions (Ca^{++}, Mg^{++}, Na^{+}, K^{+}, HCO_3^-, CO_3^-, SO_4^{--}, Cl^-, NO_3^-), using the standard methods as suggested by the American Public Health Association [10]. Sodium (Na+) and Potassium (K+) were determined by flame photometer. Total hardness (TH) as $CaCO_3^-$, Calcium (Ca^{++}), carbonate (CO_3^-), bicarbonate (HCO_3^-) and chloride (Cl^-) were analyzed by volumetric methods. Sulfates (SO_4^{--}) were estimated using the colorimetric technique.

Soluble sodium percentage (SSP), residual sodium bicarbonate (RSBC) and sodium adsorption ratio (SAR) were all calculated using the standard equations by [11, 12, 13] respectively. The water quality were also classified based on US salinity diagram [14]. The water quality data was presented in (Tables 1-4).

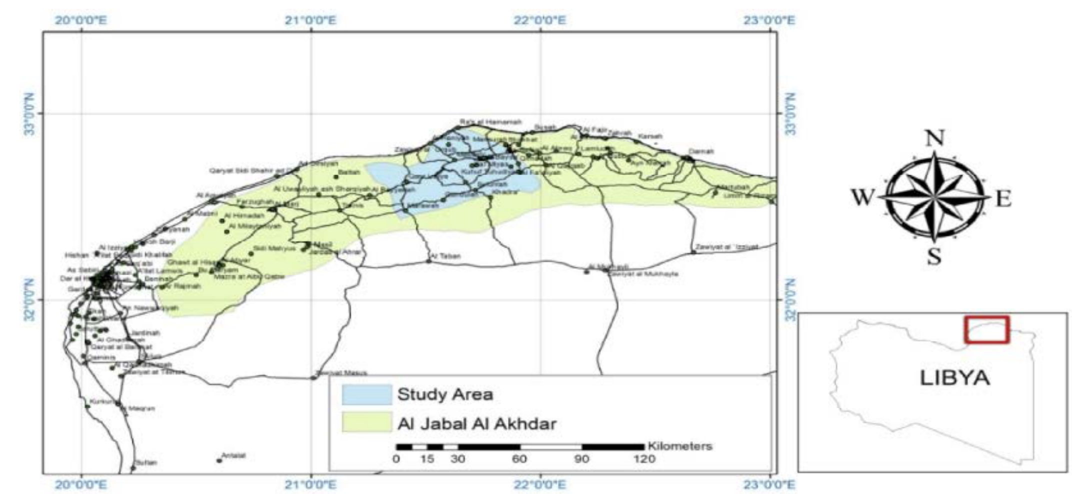

Fig. 1: Index map of the study area

Table 1: Physical and chemical parameters of springs water samples of the study. (Winter season)

No	Spring name	°C	pH	EC µmhos/cm	TDS mg/L	TH mg/L	SSP %	RSBC	SAR
1	El-Belad	18.1	7.10	570	371	176	18.9	0.27	0.55
2	Bo-Mansour	18.0	7.12	654	425	178	14.7	0.25	0.45
3	Karsaa	17.9	7.20	559	368	180	13.2	-0.17	0.39
4	El-Feltro	17.8	7.25	601	375	163	13.4	0.43	0.37
5	Showiab	18.2	7.20	653	392	174	14.1	-0.12	0.41
6	El-Guppa	18.1	7.30	712	446	177	19.2	0.16	0.59
7	Magga	18.1	7.22	543	353	172	14.2	0.31	0.35
8	Dapposia	18.3	7.34	645	401	168	12.2	0.13	0.32
9	Stouwa	17.9	7.26	680	429	166	15.0	-0.11	0.48
10	El-Gaigab	18.2	7.42	750	433	230	15.3	0.00	0.49
11	El-Agdir	18.2	7.40	752	442	223	13.8	0.00	0.45
12	Appolo	17.7	7.35	857	521	236	15.0	0.10	0.48
13	El-Huffra	17.8	7.25	581	351	164	14.4	-0.18	0.42
14	Massah	18.1	7.45	895	536	232	16.5	0.20	0.56
Min Value		17.7	7.10	543	351	163	12.2	-0.18	0.32
Max Value		18.3	7.45	895	536	236	19.2	0.43	0.59

Results in column are mean of three replicates.

Table 2: Physical and chemical parameters of springs water samples of the study. (Winter season)

		mg/L									
No	Spring name	Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCO_3^-	CL^-	CO_3^-	SO_4^-	NO_3^-	D.O
1	El-Belad	52	11	17	3.15	175	36	-	40	19	7.20
2	Bo-Mansour	60	14	15	2.90	198	37	-	53	25	6.10
3	Karsaa	65	10	13	2.54	188	29	-	42	20	9.00
4	El-Feltro	51	17	12	3.10	185	23	-	36	21	9.90
5	Showiab	66	12	14	3.24	194	28	-	40	19	7.00
6	El-Guppa	64	18	21	3.42	205	33	-	54	27	9.40
7	Magga	50	15	13	2.86	172	22	-	36	18	9.20
8	Dapposia	63	16	12	3.00	197	21	-	46	22	7.40
9	Stouwa	70	13	17	2.65	207	32	-	49	29	7.70
10	El-Gaigab	67	14	17	2.75	201	38	-	35	28	9.40
11	El-Agdir	70	15	16	2.70	213	34	-	47	29	9.80
12	Appolo	71	14	17	3.51	220	29	-	50	36	10.10
13	El-Huffra	56	12	13	3.10	160	30	-	38	19	9.70
14	Massah	72	18	21	3.50	232	36	-	57	34	9.20
Min Value		51	10	12	2.54	160	21	-	35	18	6.10
Max Value		72	18	21	3.50	232	38	-	57	36	10.10

Results in column are mean of three replicates.

Table 3: Physical and chemical parameters of springs water samples of the study. (Summer season)

No	Spring name	°C	pH	EC µmhos/cm	TDS mg/L	TH mg/L	SSP %	RSBC	SAR
1	El-Belad	22.5	7.30	742	487	172	19.7	-0.30	0.82
2	Bo-Mansour	22.5	7.25	855	513	170	19.9	-0.30	0.79
3	Karsaa	23.0	7.24	702	426	178	17.6	-0.25	0.57
4	El-Feltro	23.1	7.20	690	413	173	15.6	-0.10	0.48
5	Showiab	22.6	7.22	685	409	169	16.5	-0.02	0.51
6	El-Guppa	22.5	7.28	740	460	180	17.3	0.15	0.57
7	Magga	22.5	7.20	596	358	165	16.0	0.25	0.45
8	Dapposia	23.2	7.26	705	421	176	17.9	-0.04	0.56
9	Stouwa	22.7	7.25	731	436	175	17.0	-0.04	0.53
10	El-Gaigab	23.0	7.26	844	512	223	17.4	0.18	0.60
11	El-Agdir	23.1	7.22	816	493	221	16.0	0.34	0.52
12	Appolo	22.4	7.34	870	521	232	15.8	0.13	0.54
13	El-Huffra	22.8	7.20	720	433	178	16.4	-0.02	0.52
14	Massah	22.7	7.52	905	542	245	16.0	0.02	0.55
Min Value		22.4	7.20	596	358	165	15.6	-0.30	0.45
Max Value		23.2	7.52	905	542	245	19. 9	0.34	0.82

Results in column are mean of three replicates.

Table 4: Physical and chemical parameters of springs water samples of the study (Summer season)

		mg/L									
No	Spring name	Ca^{++}	Mg^{++}	Na^{+}	K^{+}	HCO_3^-	CL^-	CO_3^-	SO_4^-	NO_3^-	D.O
1	El-Belad	73	18	27	3.68	190	57	-	60	19	7.30
2	Bo-Mansour	72	18	30	4.33	201	54	-	58	15	6.60
3	Karsaa	65	12	19	3.62	186	46	-	48	14	7.40
4	El-Feltro	62	14	16	3.90	183	43	-	43	16	6.90
5	Showiab	63	13	17	4.00	178	38	-	40	15	8.70
6	El-Guppa	69	15	20	4.16	220	42	-	46	17	7.10
7	Magga	52	13	14	3.78	174	38	-	40	15	8.00
8	Dapposia	62	14	19	4.06	187	46	-	46	13	7.60
9	Stouwa	67	11	18	3.60	202	43	-	48	10	8.30
10	El-Gaigab	71	17	22	3.52	228	44	-	53	14	7.50
11	El-Agdir	70	18	19	3.50	234	42	-	50	12	8.20
12	Appolo	76	17	20	4.40	240	47	-	48	30	8.10
13	El-Huffra	64	15	18	3.45	194	44	-	45	11	8.00
14	Massah	79	19	21	4.67	241	48	-	58	33	8.40
Min Value		52	11	14	3.45	174	38	-	40	10	6.60
Max Value		79	19	30	4.67	241	57	-	60	33	8.70

Results in column are mean of three replicates.

RESULTS AND DISCUSSION

The highest temperature recorded in summer at Dapposia spring, where was (23.2°C) and the lower degree was found in the Appolo spring (22.4°C). Similar trends were also found in winter season but with less value (Tables 1 and 3). The difference in temperature between all water site of the study is due to the difference in the sampling sites (elevation steps level) and season. Although the drinking water standards are preferably the water be cool on being warm.

Results in the study indicate that pH values, was found in the summer at the highest level (7.52) at Massah spring and the lower value was (7.20) at Feltro spring. While in winter the highest value was (7.45) at Massah spring and the lower value was (7.10) at Belad spring. It is well known that the pH values affected by changes in temperature. However, all the pH value in the water of study area did not exceed the permissible limits in the drinking water (Table A) according to standard specifications of (WHO) World Health Organization (6.5-8.5) [15].

The total dissolved solids (TDS) in the study area in both season were varies between 351 to 542 mg/l. Therefore all springs water analyses in the study area falls under fresh types of water (TDS < 1000 mg/l) according to standard specifications of World Health Organization [15] and *TDS classification* [16] see Table (A and B).

The total hardness (TH) as ($CaCO_3$) ranges from 163 to 245 mg/l. Based on the standard specifications of drinking water on world health organization [15, 16] as shown on (Table A and C). Results obtained (Tables 1 and 3) are within the allowable range for the total hardness value (500 mg/l) estimated in the form of the calcium carbonate.

Electrical Conductivity (EC) in this work were expressed in µmhos/cm. Most of the salts in water are present in their ionic forms and capable of conducting current and conductivity is a good indicator to assess water quality. EC values in all spring samples of the study area were range from 543 - 895 µmohs/cm in winter season. Whereas in the summer season the EC values were slightly increased (Tables 1 and 3). The maximum value of EC was observed in the summer season at Massah spring (905 µmohs/cm) and the minimum were found (596 µmohs/cm) at Magga spring. In general the EC values were good and permissible water are the dominant in the whole of the study area. The quality standard for irrigation water have been specified by (WHO), as described in the permissible limits in water quality [17] see (Tables C and D).

Moreover, results in the study (Tables 2 and 4) shown that concentrations of Na and K in all springs water samples range from 12 to 30 and 2.54 to 4.67 mg/l, respectively for both ions. Although, the concentrations of calcium in the study were range from 51 to 79 mg/l, which is probably derived from calcium rich minerals like feldspars, pyroxenes and amphiboles [18].

The major source of magnesium (Mg) as found in all water samples of the study is might due to ion exchange of minerals in rocks and soils by water. The concentrations of Mg and HCO_3^- ions found in all springs water samples of the study area range from 10 to 19 and 160 to 241 mg/l respectively for both ions and

Table A: World health organization (WHO) standard for drinking water.

Parameters	Maximum allowed (mg / l)	Parameters	Maximum allowed (mg / l)
Color (Unit)	15	Need for chemical oxygen	10
Turbidity (NTU)	5	Vital need for oxygen	6
Taste	Accepted	Hydrogen sulphide	0.1
Smell	Accepted	Total sulphides	0.2
pH	8.5 - 6.5	T.D.S	1000
Cadmium	0.005	Copper	1.0
Cyanide	0.05	Iron	0.3
Mercury	0.001	Magnesium	150
Selenium	0.01	Aluminum	0.2
Lead	0.05	Sodium	200
Chromium	0.05	Potassium	40
Barium	1.00	Fluorides	1.5
Silver	0.05	Manganese	0.1
Alkyl benzene	0.2	Sulfate	400
Arsenic	0.05	Zinc	15
Nitrite	1.0	Calcium	200
Ammonia	0.5	Chlorides	250
Nitrate	45	Total hardness	500 as Ca - carbonate

Source: [WHO].

Table B: Total dissolved solids (TDS) classification.

Class	TDS ppm
Fresh	0-1000
Brackish	1000-10000
Saline	10000-100000
Brine	>100000

Source: [16].

Table C: Classification of Irrigation Water based on electric conductivity.

Water Class	EC (micromohs/cm)	Salinity Significance
Excellent	<250	Water of low salinity is generally composed of higher proportions of calcium, magnesium and bicarbonate ions.
Good	250 - 750	Moderately saline water having varying ionic Concentrations.
Permissible	750 -2250	High saline waters consist mostly of sodium and chloride ions.
Doubtful	>2250	Water containing high concentration of sodium, bicarbonate and carbonate ions has high pH.

Source: (WHO, 2004).

seasons. From the data chloride (Cl^-) recorded in the Tables (2 and 4) show differences between all springs water samples and the highest value found in summer to the concentration of chloride (57 mg/l) at El-Belad spring which close to coastal area of the study, while in the winter the lowest value were (21 mg/l) at Dapposia spring. Results conclude that chloride and sulfate values obtained in the study (Tables 2 and 4) were within the allowable range according to WHO specification standard as shown in (Table A).

Dramatic changes of nitrate (NO_3) concentrations were found in all water analyses of the study. From the data on water analyses contained in the Tables (2 and 4) shown the highest value of NO_3 obtained in the winter at Apollo spring it was (36 mg/l), while the lowest value was record (18 mg/l) at Magga spring. In the summer nitrate (NO_3) values were slightly decreased in all spring samples of the study (Tables 2 and 4), which were at range from (14 - 33 mg/l).

According to the WHO the maximum concentration of nitrates (NO_3) in drinking water is (45 mg/l). Therefore, the concentration of nitrates of all springs water studied here, did not exceed the maximum allowable, except in the Appolo and Massah springs that was close to the maximum acceptable range. However, these results (NO_3) obtained in the study (Tables 2 and 4) are not reassuring for the coming future particularly for those springs contain NO_3 above (30 mg/L). It have attributed the cause of these concentrations in the ratio of nitrate could be due to the leak sewage, the direct flinging of wastes, as well the agricultural activities intensive practice in the specific areas which consequent contamination of these water

Table D: Water quality classification for irrigation.

Category	EC (µs/cm)	RSBC (meq/l)	SAR (meq/l)	SSP %	Sustainability for irrigation
1	< 250	<1.25	<10	<20	Excellent
2	250 -750	1.25 -2.5	10 -18	20 -40	Good
3	770 -2250	>2.5	18 - 26	40 -80	Fair
4	>2250	……..	>26	>80	Poor

Source: [22, 23].

Table E: SAR hazard of irrigation water (meq/l).

None	< 3	No restriction on the use recycled water
Slight to moderate	3 - 9	From 3 to 6 cares should be taken to sensitive crops.
		From 6 to 8 gypsum should be used. Not for sensitive crops.
		Soil should be sampled and tested every 1or 2 years to determined whether the water is causing a sodium increase.
Acute	> 9	Sever damage for crops.

Source: [26].

sources. These interpretations are consistent with the presence of dissolved oxygen as found in the study (Tables 2 and 4), which leads to an anaerobic analyzes of pollutants produced on it the presence of harmful gases in the water such as methane gas and hydrogen sulphide gas as well as reduction of nitrate to nitrite. This result are in agreement with authors [9] of groundwater pollution by nitrates, where attributed the increased concentration of nitrates due to wastewater and nitrogen fertilizers.

In general, the abundance of the natural major ions found in all water analyses in the study is in the following order : Ca >Na > Mg > K and HCO_3 > SO4 >Cl > CO_3. The minimum, maximum and average values of physical and chemical parameters of all springs water samples are presented in Table (1-4). The concentration of dissolved ions in springs water samples are generally governed by lithology, the nature of geochemical reactions and solubility of interaction rocks. The functional sources of dissolved ions can be broadly assessed by plotting the samples, according to the variation in the ratio of)Na+K) / (Na+Ca+K) and Cl/ (Cl+HCO3) as a function of TDS [19].

Salinity and indices such as the soluble sodium percentage (SSP), residual sodium bicarbonate (RSBC), sodium absorption ratio (SAR) and U.S. Salinity laboratory water classification are important parameters for determining the suitability of water for agricultural uses [20]. Electrical conductivity is a good measure of salinity hazard to crops as it reflects the TDS in water.

Soluble sodium percentage (SSP) is used to evaluate sodium hazard. SSP is defined as the ratio of sodium to the total cation. Water with a SSP greater than 60% may result in sodium accumulations that will cause a breakdown in the soil's physical properties [21]. SSP has been calculated by the following equation [22] where, all the ions are expressed in meq/l:

$$SSP\ \% = (Na+K) \times 100 / (Ca+Mg+Na+K).$$

The soluble sodium percentage (SSP) values were found in this study from (12.2% - 19.9%) at El-Dapposia and Bo-Mansour springs respectively in both season. In compression with the previous results of [22, 23] as shown on (Table D), our results in the soluble sodium percentage (SSP) was classified as an excellent type in the whole of the study area for irrigation.

Residual sodium bicarbonate (RSBC) been calculated according to [11] using the following equation, where (RSBC) and the concentration of the constituents are expressed in meq/l:

$$RSBC = (CO_3 + HCO_3) - (Ca + Mg).$$

The residual sodium bi-carbonaite (RSBC) value of the water samples of the study area were found in between (-0.18 meq/l and 0.43 meq/l) at El-Huffra and El-Feltro springs respectively. The positive (RSBC) value indicates that dissolved calcium and magnesium ions less than that of bicarbonate contents as found in the study.

The results of the RSBC in the water of the study was classified according to [22, 23] as an excellent water which are the dominant in the whole the springs water investigated here in the study. Based on this classification on RSBC, the springs water in the study area is suitable for irrigation purposes see (Table D).

SAR is an important parameter for determining the suitability of water in the study area for irrigation because it is a measure of alkali / sodium hazard to crops [24, 25]. In the 1954, U.S. Salinity Laboratory [12] proposed that sodium percentage idea be replaced by a significant ratio termed the sodium adsorption ratio (SAR), because it has a direct relation with the adsorption of sodium by soils.

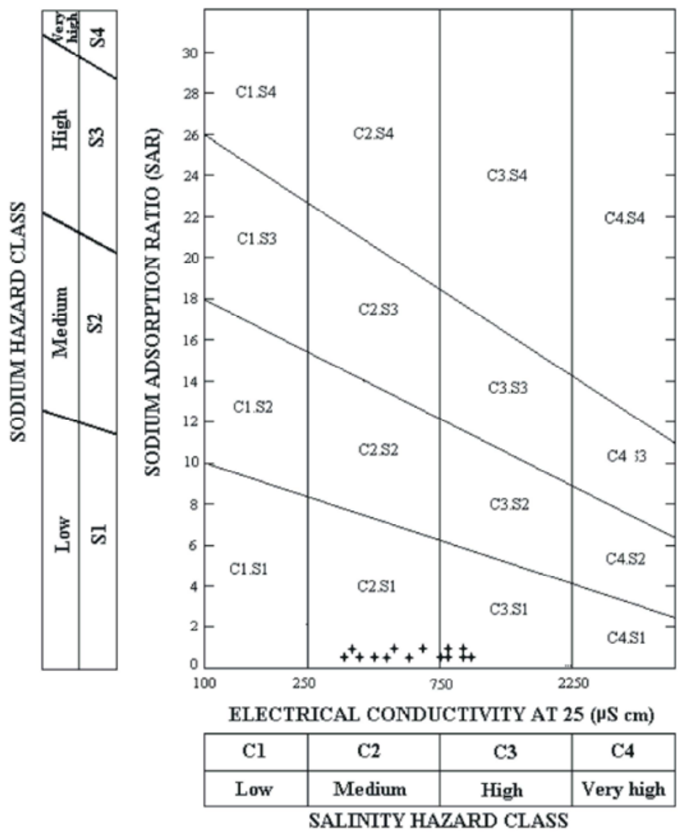

Fig. 2: US salinity diagram

This ratio has been calculated by the following equation which given by Richards (1954) as follow, where, all the ions are expressed in meq/l [12]:

$$SAR = \frac{\left[Na^{+}\right]}{\sqrt{\frac{\left[Ca^{2+}\right]+\left[Mg^{2+}\right]}{2}}}$$

The sodium adsorption ratio (SAR) value of all springs water samples in the study area were found in between (0.32 meq/l - 0.82 meq/l) in both seasons (winter and summer), where none hazard is the dominant in the whole of the study area. It is evident from the whole sample set that the SAR value is classified as an excellent as classified by [26] see (Tables D and E). Hence our finding strongly suggest that all the abstracted springs water samples in the study were suitable for irrigation.

The analytical data plotted on the US salinity diagram conclude that all springs water samples fall under (good to moderate) zone (Figure 2). Therefore, all springs water of study area are suitable for irrigation, in which fall within the field of C2S1 and C3S1 group. In addition only 29% of water sample of the study area fall under slightly high salinity zone (EC> 750µ mhos/cm) which should not be used on soils with restricted drainage. In general, the continuous monitoring of water quality is necessary to help farmers and irrigation authority for making water policy.

Therefore interaction between the rock chemistry and the chemistry of the percolation waters under the subsurface reflect a suitable fresh water for drinking and for irrigation which are the dominant in the whole of fountains (springs) in the study area.

Also water pollution as found in certain springs in the study area should be monitoring regularly which help appropriate management and sustainable development [27].

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REFERENCES

1. Ramadan A.M. Alhendawi, 2010. Problems of World's Fresh Water Scarcity With Particular Reference to Libya. Paper presented at the third academic symposium of Libyan Research study - Universities of UK - Sheffield on 12-06-2010. Abstracts Book, pp: 23.
2. Shiklomanov, I.A., 1993. World Freshwater Resources. In: Water in Crisis. A Guide to the World's Freshwater Resources. Gleick, P.H., (Ed.) New York, Oxford University Press.
3. Helweg, O.J., 2000. Water for a growing population: Water supply and groundwater issues in developing countries. Water International, 25: 33-39.
4. Jaballah, A.M., R.A. Alhendawi, M.G. Nasseem and M.A. Hussin, 2014. Ground water quality and suitability to irrigation -GIS based case study in some regions of Jabel Al-Akhder in Libya.
5. Nasser H. Kaalouh, Fathi B. Lamloum, Mohamed M Yuqob and Ramadan A.M. Alhendawi, 2012. Hydrochemical Water Quality of the Main Traditional Sources of Water in Derna the Current Status and Future. Libyan Agri Research Center Journal Intemationa1, 3(S2): 1362-68.
6. Fathi B. Lamloum, 2008. Hydrochemical Study of Natural Drinking Water of Derna, Libya. Omar AlMukhtar Universty, Unpublished MSc theses.
7. Hounslow, A.W., 1995. Water Quality Data. Analysis and Interpretation. Lewis Publishers. USA, pp: 52.
8. Fathi B. Lamloum, Guma H. Abdalmaula, Emilia Prospero and Ramadan A.M. Alhendawi, 2018. Infants Methemoglobinemia Due to Nitrate Contaminated in Rural Water Supplies in the Region of Jebel Al-Akhdar - Libya.
9. Guma H. Abdalmaula, 2013. Infants Methemoglobinemia: The Drinking Water Quality in Al-Jabal Al-Akhdar Province, Libya with Particular reference to Nitrate. Università Politecnica delle Marche, Italy. PhD Thesis (S.S.D. MED/42).
10. APHA 1995. (The American Public Health Association (APHA), methods for the examination of water and wastewater, 19th Edition, American Public Health Association. Washington, D.C., pp: 1467.
11. Gupta, S.K. and I.C. Gupta, 1987. Mangemente of saline soils and water. Oxford and IBH Publication. Co. New Delhi, India, pp: 399.
12. Richards, A, 1954. Diagnosis and improvement of saline and alkali soils, Agriculture Handbook 60, USDA and IBH Puplishing Co. Ltd. New Delhi, India, pp: 98-99.
13. Todd, D.K., 1980. Ground water Hydrology, John Wiley and Sons.
14. US Salinity Laboratory, 1954. Diagnosis and Improvement of Saline and Alkaline Soils, U.S. Dept. of Agriculture, Hand Book, 60: 160.
15. Guideline to drinking water quality, World Health (WHO), 2011. Organization, Geneva.
16. Bouwer, 1978. Groundwater Hydrology, pp: 490. Tokyou (McGraw-Hill Ltd).
17. WHO, 2004. Guidelines for drinking water quality: training pack. WHO, Geneva.
18. Sawid, F.A. and A.A. Issa, 2015. Assessment of groundwater quality for drinking and irrigation purposes. Transactions on Ecology and The Environment, Vol 196, © 2015 WIT Press doi:10.2495/WRM150271.
19. Gibbs, R.J., 1970. Mechanisms controlling world water chemistry, Science, 17: 1088-1090.
20. Raju, N.J., 2006. Hydrogeochemical parameters for assessment of groundwater quality in the upper Gunjanaeru River basin, Cuddapah District andhara Pradesh, South India, Environmental Geology.
21. Khodapanah, L., W.N.A. Sulaiman and N. KHodapsnah, 2009. Ground water quality assessment for defferent propses in Eshtehard District, Tehran, Iran. European Jornal of Scientific Research, 36(4): 543-553.
22. Ayers, R.S. and D.W. Westcot, 1985. Water quality for agricultuer. FAO irrigation and Drainge paper 29. Rev.1. FAO, Rome, pp: 174.
23. Todd, D.K., 1980. Ground water Hydrology, John Wiley and Sons.
24. Subramani, T., L. Elango and S.R. Damodarasamy, 2005. Groundwater quality and its suitability for drinking and agricultural use in Chithar River Basin, Tamil Nadu, India, Environmental Geology, 47: 1099-1110.
25. Alzway, A., K. Murphy and H. Flowers, 2013. Impact of high salinty of grounwater an irrigated agricultural land A. Case study Alkufra region. International Journal of the Environmental and Water, 2: 1-13.
26. Lenntech, 2008. Water Treatement and erficatuion. Available online URL: http:// www.lenntech.com/ home.htm
27. Ammar, A.A. and M.M. Yacoub, 1999. Evaluation of the Cathment area of the Stuah Karst spring Cyrenica Libya, International Hydrogeological Programme, UNESCO, Paris, IHA, 42: 49-58.