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Evaluation of Ground Water quality and Suitability for Drinking purposes in Alagilat Area, Libya

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ABSTRACT*: Water is valuable natural resources and limiting factor for the life. Fresh water plays vital role to sustain the international economic. The scarcity and pollution of ground water has become serious problem in the arid zones which should be addressed. This study was carried out to assess the suitability of ground water for the human consumption in the rural and urban areas of Alagilat area, Libya. Sixty fife ground water samples were collected from 26 villages during March 2013. The hydro- chemical parameters such as pH, Electrical conductivity (EC), Total dissolved solids (TDS), Total hardiness (TH). Calcium (Ca), Magnesium (Mg), Sodium (Na), Potassium (K), Chloride (Cl), Sulfate (SO_4), Bicarbonate (HCO_3), Fluoride (F), Nitrate (NO_3) and iron (Fe) were analyzed using standard procedures. The results were compared with WHO and Libyan water standards. In this study, the most of the parameters of the water samples were beyond the permissible limits and unsuitable for drinking purposes.*

Keywords*: Alagilat, Drinking water, ground water, Libyan standards, WHO.*

I. INTRODUCTION

Water is a valuable natural resource and essential factor for sustainability. Groundwater resource is one key factor that play important role in sustaining the socio-economic standards in any society. It supports various phases of development, including agriculture and industry. In arid and semi-arid regions, groundwater quality is considered a critical issue that is emphasized strongly in the governments' agendas. The shortage of precipitation, unsustainable human activities and environmental pollution, are few examples of the challenges faced in this region of the globe. The groundwater of the northwestern part of Libya is the major water supply for all daily applications. Specifically, the groundwater in the Jiffarah Plain Basin in this part of the Libyan geography, has been under heavily use over decades by the rapidly expanding development. This development has affected adversely the quality of the groundwater, in terms of chemical, physical and biological aspects.

Characterizing the properties of groundwater for specific application by its industrial or human consumption is considered vital for deciding the feasibility of the resource and its safeness for the public health and the environment. For human consumption, the chemical parameters of ground water should comply with the drinking water needs (WHO 2008). If these parameters exceeded the recommended values, the resource is considered unsafe. In many countries, different studies have been carried out to assess the suitability of ground water for human consumption. For examples, groundwater quality in north east jabal alhasawnah was evaluated for its composition and suitability for drinking (Fathi M. Sanok et al). Nagwa et al (2013) carried out chemical and biological analysis to evaluate ground water quality in Shebna region, Benghazi of Libya. Groundwater quality for human consumption was assessed in Alshati district of Libya (Mansour and Mohammed 2009). Shubhra Singh et al(2012) studied the groundwater quality and its suitability for human consumption in some parts of India. Hydro chemical study was conducted in Birbhnm district, west Bengal to evaluate the suitability of groundwater for drinking purposes (S.K. Nag and Shreya Das 2012). Groundwater quality and its suitability for domestic purposes were assessed in district of Andra Pradesh by (Mushtaq Hussainan and T.V.D Prasad Rao 2008). Statistical methods were implemented to evaluate groundwater quality in Al – gofra Oasis, Libya (Sameh S Ahmed and Mohamed Hashem 2006).

Jumma Arhouma et al (2012) studied the distribution of some chemical elements in groundwater in Derna area, Libya. Chemical and biological properties of groundwater were determined by Mabrouk and Saad (2016). Chemistry of groundwater was assessed for drinking and agricultural purposes in Lahore, Pakistan (M.Amir Khattak et al 2011). H. sakehi and H. Zeinivand (2016) studied the chemical and physical properties of groundwater in Kuhdasht region, Iran. Different elements of cations and anions were measured to assess the groundwater and its suitability for different purposes like, crop irrigation and human consumption in Yinchuan area, China (Lipeiyue et al 2009). However, in Libya, including the Northwestern region, the data similar to such studies are not made on a major scale in the country. Therefore, the present study investigates the hydro-chemical qualities of groundwater in the Northwestern region, particularly Alagilat area for drinking water purposes. The described area is known as an urban and rural area that the society largely depends on its land resource for the human consumption.

II. METHODOLOGY

The study area is situated between the latitude 32^o 45` 25`` and longitude 12$^o$ 22` 34`` in Alagilat area, Libya. It is around 85 km from Tripoli and about 4 meters above the sea level (figure 1). The maximum temperature is about 45^{o}C and minimum 20 ^{o}C with an average annual rainfall of 150mm.It has a dry climate with hot summer and cold winter. Ground water is considered the main source of water supply in the study area. The dominant soils are sandy and sandy loam. The agriculture is considered one of the main activities in the area where barley, wheat, lattice, sparsely, carrots and fodder crops are grown. The current study has been carried out to assess the suitability of ground water quality for the human consumption.

A total of 65 ground water samples were collected during 2013 from 26 villages of Alagilat area, Libya using Global positioning system (GPS). The samples were collected from public wells, private wells, water sources in the health centers, and schools. First, the water was left to run for few minutes from the wells to pump out the standing water before taking the final samples. The samples were collected in pre cleaned sterilized polyethylene plastic bottles of 1L capacity then the samples were placed in clean containers and immediately put in ice boxes. The ice boxes were shipped to Syracuse, Italy where the analyses were done by standard techniques in the laboratories of Ecocontrol Sud Company (Table 1). The ground water samples were analyzed for some hydro- chemical parameters such as Calcium (Ca), Magnesium (Mg), Potassium (K), Sulphate (SO_4), Chloride (Cl), Sodium (Na^+), Bicarbonate(HCO_3) and Nitrate (NO_3). Whereas physical parameters like pH, Electrical conductivity (EC), fluoride (F), Iron (Fe) and dissolved oxygen (DO) were measured in situ using field kit. All chemical parameters are expressed in mg L $^{-1}$ except pH and EC. The results were compared with WHO and Libyan water standards for drinking water`` Table 2``.

III. RESULTS AND DISCUSSION

The summary statistics of the parameters are presented in ″ Table 2″. The (Fig 1 to 15) illustrate the results of this study. The following explanations can be made from the results.

1. The nitrate is found to vary from a minimum of 22.07 mg L^{-1} to a maximum of 239.4 mg L^{-1} with an average of 121.26 mg L^{-1}. The highest concentration was found in well number 45 and the lowest one was noticed in well numbered 57.
2. The concentration of sulphates was ranging between 244 mg L^{-1} and 2893 mg L^{-1} with an average of 1441.91 mg L^{-1}. Over all highest concentration of the sulphates was found in well numbered 49 and the lowest level was found in well numbered 39.
3. Chloride level was found to be varying from 236 to 3443 mg L^{-1} with an average of 786.83 mg L^{-1}. The highest value of chloride was determined in well numbered 19 while the lowest value was in the well number 39.
4. The pH value was found between 6.92 and 7.67 with an average value of 7.36. The highest and the lowest values were found in wells numbered 25 and 19 respectively.
5. The range of the electrical conductivity was found between 1320 and 10680 µs/ cm. The EC values were very high in the all samples in the study area which indicate that the ground water of this area is contains a significant a mounts of salts.
6. The potassium levels in the ground water found to be the highest in well numbered 9 and the lowest in well numbered 22. It varied from 6.3 to 223.6 mg L^{-1} with an average value of 20.38 mg L^{-1}.
7. The highest and the lowest levels of calcium were seen in wells numbered 63 and 19 respectively. It ranged from 80.8 to 944 mg L^{-1} with a n average of 434.32 mg L^{-1}.
8. Sodium concentration ranged from 122.6 to 1678 mg L^{-1}. The highest level was noticed in ground water well numbered 19 and the lowest one was measured in well number 39.
9. The measured levels of magnesium were found to be varying from a minimum of 3.40 mg L^{-1} to a maximum of 3040 mg L^{-1} .The maximum concentration was observed in well numbered 22 and a minimum value in well numbered 39.
10. All samples in the study area contain low concentrations of the dissolved oxygen. It varied between 0.58 mg L^{-1} and 3.77 mg L^{-1} with an average of 1.94 mg L^{-1}. The highest level was detected in well numbered 3 and the lowest value was in well 32.
11. The determined concentration of iron is ranged between 0.02 and 0.58 mg L^{-1} with an average of 0.07 mg L^{-1}.
12. Total hardness was found to be very high in all sampling sites. It is varied from 220.94 to 12734mg L^{-1} with an average of 1945.56 mg L^{-1}

13. The concentration of total dissolved solids obtained in the present study varied from 6835.2 mg L^{-1} to 844.8 mg L^{-1} with an average of 2521.8 mg L^{-1}. The highest value was in well numbered 19 and the lowest one in well numbered 39.
14. The concentration of fluoride varied from 3.2 mg L^{-1} to 0.8 mg L^{-1} with an average of 2.04 mg L^{-1}.The maximum concentration was observed in well numbered 61 and the minimum one in wells numbered 22, 36 and 40.
15. The range of the bicarbonate was found between 766.8 mg L^{-1} and 251.6 with an average of 424.72 mg L^{-1}. The maximum concentration was noticed in well numbered 32 whereas, the minimum was found in well numbered 44.

IV. CONCLUSION AND RECOMMENDATIONS

1. pH values and most of the iron and fluoride concentrations were found to be within the permissible limits recommended by the world health organization and the Libyan standard centre for drinking water quality except in few samples.
2. Percentage of 93.85% of the sampling points exceeded the permissible limits of nitrate except in ground water wells number 13, 27, 43 and 57.
3. Sodium, sulphate, bicarbonate and chloride were higher than the recommended levels set by the world health organization and the Libyan standard centre except in wells numbered 10, 17, 22, and 39.
4. Potassium was beyond the recommended value set by world health organization except in wells number 10,16,17,22 and 39. Whereas, all sampling sites were within the acceptable limit set by the Libyan standard centre except in well numbered 54.
5. Electrical conductivity, Calcium, Magnesium, total dissolved solids and total hardness exceeded the permissible limits set by the World health organization and the Libyan standard centre for the drinking water quality in more than 90 % of the sampling sites.
6. It can be concluded from the results that the ground water of Alagilat area is polluted and unsafe for drinking and cooking purposes.
7. People should use small techniques to purify the water and to minimize the levels of the pollutants
8. People have to be educated environmental awareness camps on health and water quality.

Acknowledgement

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Figures and Tables

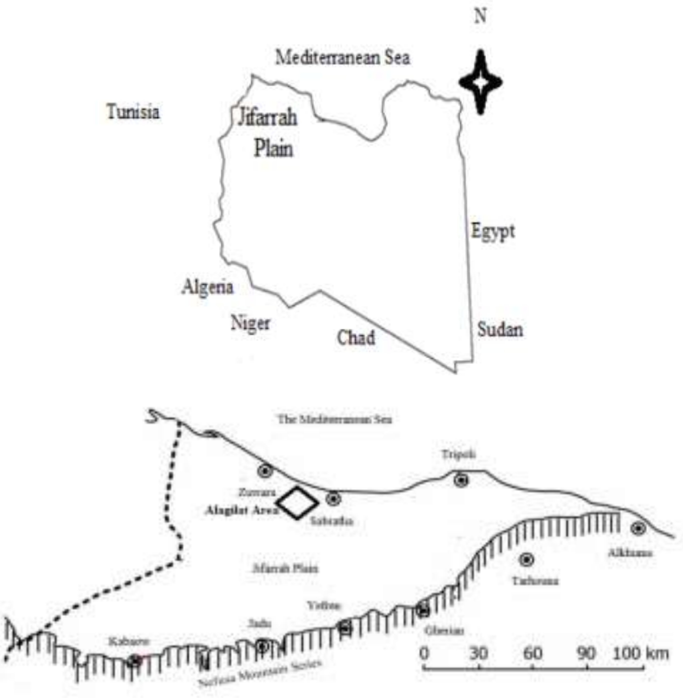

Fig 1. Map of Jifarrah plain showing Alagilat area (study area)

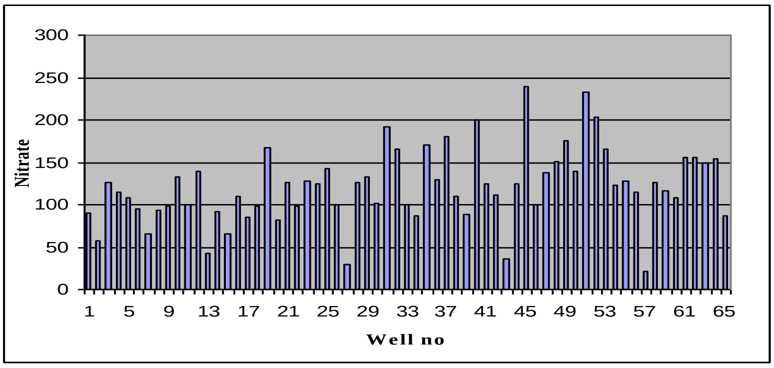

Fig 2. Concentration of Nitrate in the groundwater samples

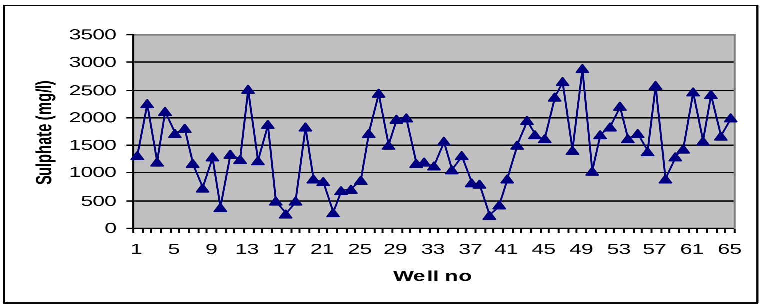

Fig 3. Concentration of sulphate in the groundwater samples

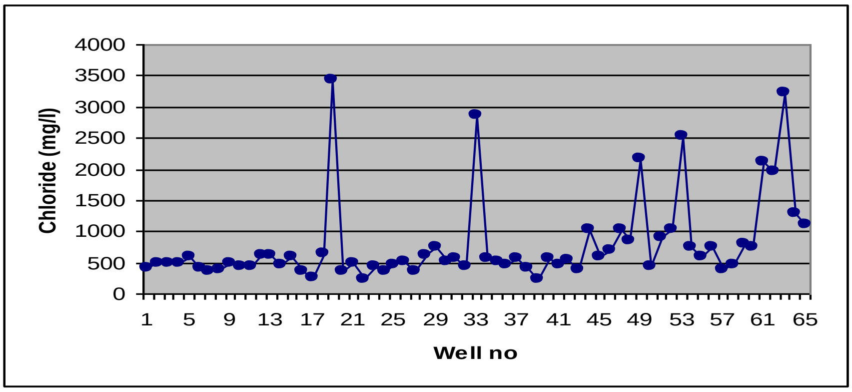

Fig 4. Concentration of chloride in the groundwater samples

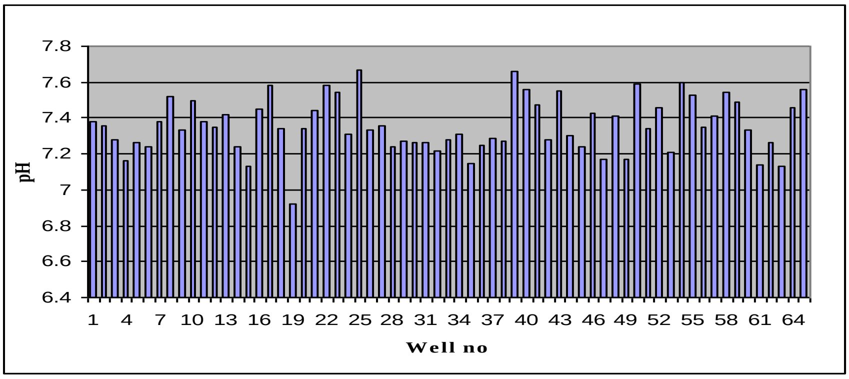

Fig 5. pH in the groundwater samples

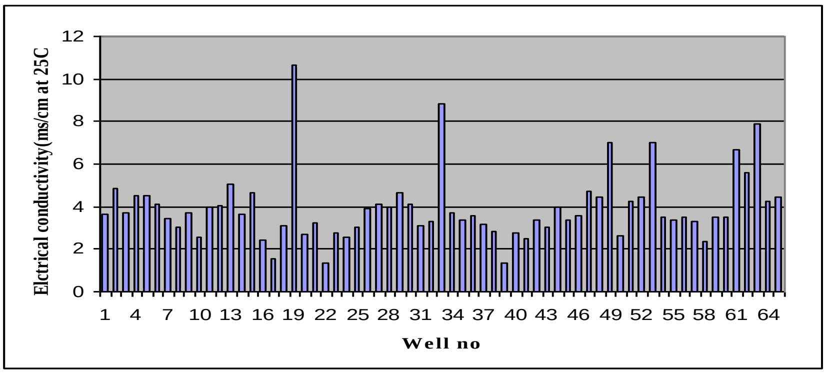

Fig 6. Electrical conductivity in the groundwater samples

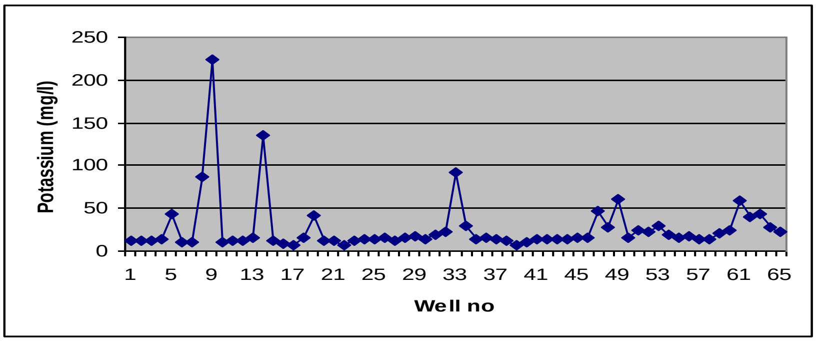

Fig 7. Concentration of potassium in the groundwater samples

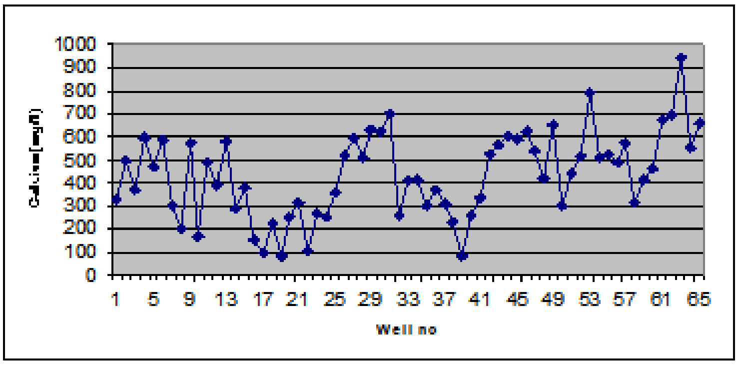

Fig 8. Concentration of calcium in the groundwater samples

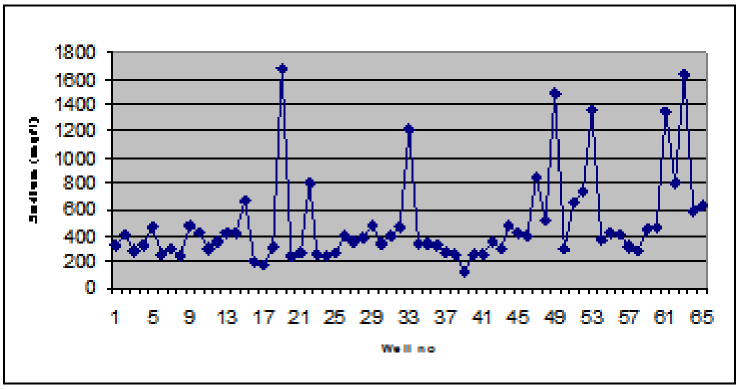

Fig 9. Concentration of sodium in the groundwater samples

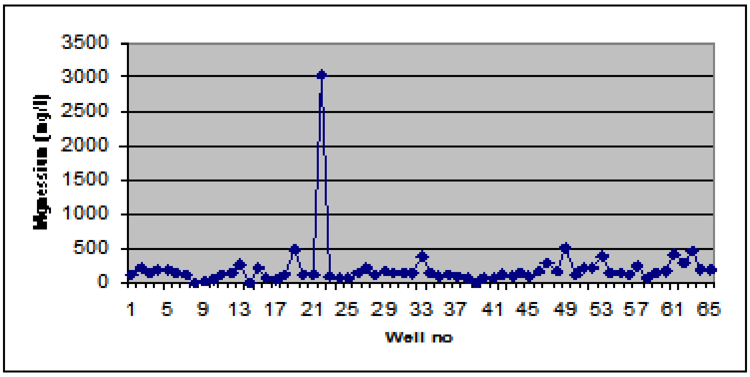

Fig 10. Concentration of Magnesium in the groundwater samples

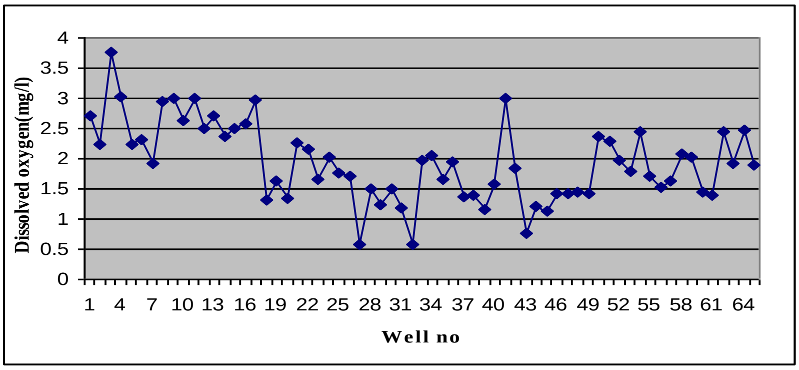

Fig 11. Concentration of dissolved oxygen in the groundwater samples

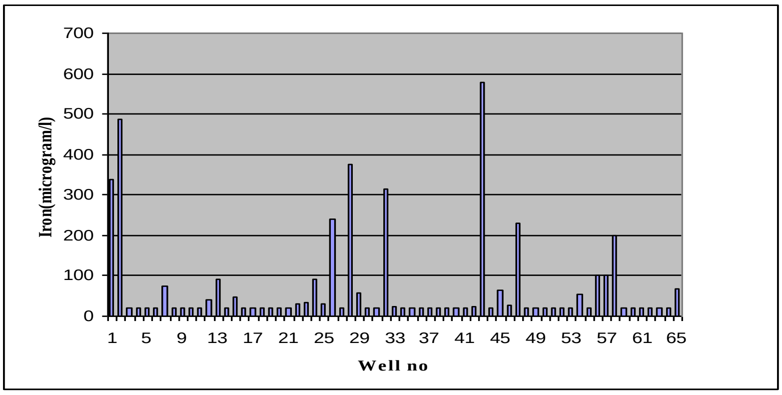

Fig 12. Concentration of iron in the groundwater samples

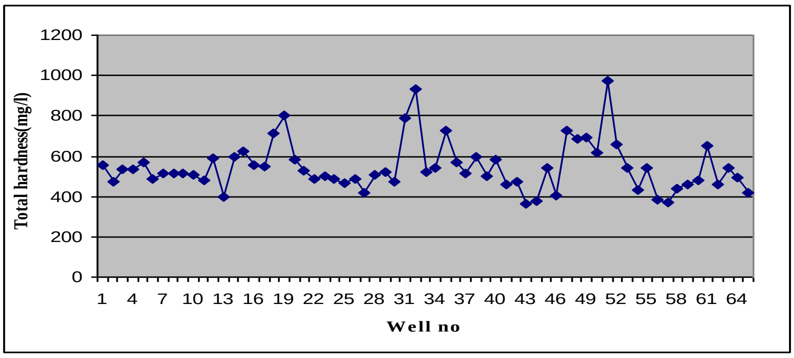

Fig 13. Total hardness in the groundwater samples

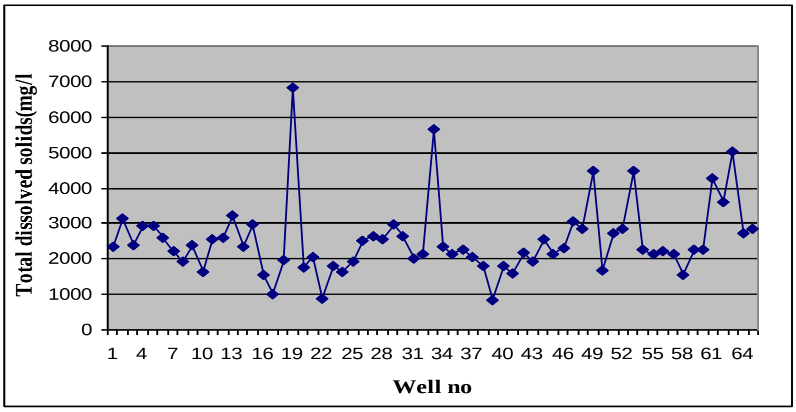

Fig 14. Total dissolved solids in the groundwater samples

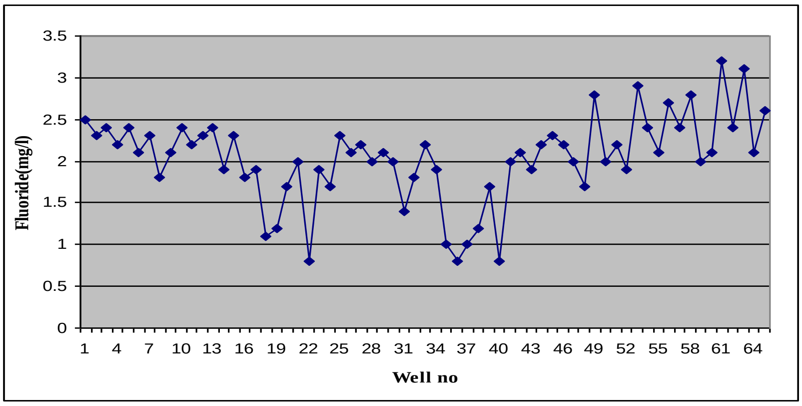

Fig 15. Concentration of fluoride in the groundwater samples

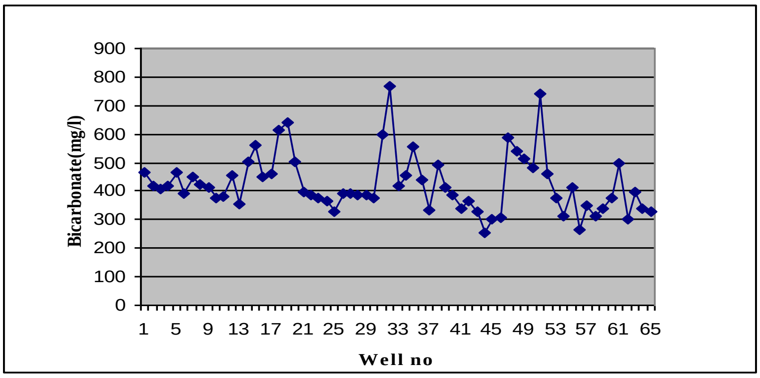

Fig 16. Concentration of Bicarbonate in the groundwater samples

Table 1: Standard Methods and Equipments used to analyze the Parameters

Parameter	Test method	equipment
Ca	EPA 6010C : 2007	ICP-OES
Mg	EPA 6010C : 2007	ICP-OES
K	EPA 6010C : 2007	ICP-OES
Na	EPA 6010C : 2007	ICP-OES
Cl	UNI EN ISO 10304 – 1 : 2009	IC
F	UNI EN ISO 10304 – 1 : 2009	IC
Fe	EPA 6010C :2007	IC
HCO3	APAT CNR IRSA 2010 Man 29 2003	IC
SO_4	UNI EN ISO 10304 – 1 : 2009	IC
DO	---	DO-meter model 970
EC	--	EC-meter model 470
pH	--	pH-meter model 370

Table 2: Range of the chemical parameters in ground water of the study area

Parameter	Min	Aver	Max	SD	WHO	Libyan
NO_3	22.07	121.26	239.40	43.72	45.00	45.00
Ca	8.08	434.32	944.00	183.10	75.00	200.00
K	6.30	26.38	223.60	33.12	10.00	20.00
Mg	3.40	209.70	3040.00	373.79	50.00	150.00
Na	122.60	490.02	1678.00	346.86	100.00	200.00
Cl	236.00	686.83	3443.00	696.73	250.00	250.00
SO_4	244.00	1441.91	2893.00	648.24	200.00	400.00
pH	6.92	7.36	7.67	0.15	6.5 - 8.5	6.5 - 8.5
F	0.80	2.04	3.20	0.52	1.50	1.50
Fe	0.02	0.07	0.58	0.12	0.30	0.30
TH	220.94	1945.56	12734	1568.94	500	500.00
HCO_3	251.6	424.72	766.8	102.38	-	150
EC	1320	3940.31	10680	1607.49	-	-
TDS	844.80	2521.80	6835.2	1028.79	1500	1000.00
DO	0.58	1.94.00	3.77	0.64	8.00	-