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Ground Water Assessment in Tyre Area for Drinking Quality

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Abstract: *A detailed physical, chemical and biological analysis of underground water samples was carried out in different sites among Sour area. Many parameters including pH, turbidity, conductivity, total dissolved solids, calcium, magnesium, total hardness, chloride, acidity, alkalinity, ammonia, nitrite, orthophosphate, sulfate, iron, nitrate, total coliform and E. coli were detected. Overall, the water from all the locations was found to be not safe as drinking water due to presence of bacteria where total coliform exceeded 70 CFU/100 ml and E. coli was above 10 CFU/100ml for most samples. Physical and chemical characteristics varied in between locations and seasons.*

Keywords: *Ground Water Quality, Chemical Analysis, Physical Analysis, Biological Analysis, Libnor Standards, Tyre.*

I. Introduction

The groundwater contained in aquifers is one of the most important sources of water on Earth: About 30 percent of our liquid freshwater is groundwater, according to the National Oceanic and Atmospheric Administration (NOAA).Groundwater constitutes a vital resource in Lebanon. Water quality in Lebanon is influenced by various anthropogenic factors reflecting on domestic, agricultural and industrial activities that expose surface and ground fresh water sources to progressive physical, chemical and microbiological quality degradation. (2) Tyre is situated along the Mediterranean coast, around 80 km to the south of Beirut and 26 km north of the Lebanese southern borders. In fact, Tyre region is sitting on a groundwater basin whose estimated flow might exceed 50 million cubic meters per year. (3)

This study aims to assess and analyze underground water as drinking water in south Lebanon locally in Tyre region. A number of scientific procedures and tools have been developed to assess the water characteristics of underground water in Tyre region. These procedures include the analysis of different parameters such as pH, turbidity, conductivity, calcium, magnesium, total hardness, chloride, sulfate, acidity, alkalinity, iron, total dissolved solids, ammonia, nitrite, nitrate, orthophosphate, total coliform and E. coli. These parameters can affect the drinking water quality, if their values are in higher concentrations than the safe limits set by the World Health Organization (WHO) or EPA and other regulatory bodies. A detailed physical, chemical and bacterial analysis was carried out by taking water samples from different underground water sources in Tyre region during summer 2015/winter 2016. Eight sites were selected for study one of which is a spring and one public well and six private wells. These parameters were compared according to local standards (Libnor). Almost all results of bacterial analysis revealed a serious problem in water quality, and priority to establish wastewater collection and treatment system in studied area. Salinity was detected in one well that is nearby coast due to sea water intrusion, and water was hard in this well too. But in general, physical and chemical properties were acceptable with some fluctuations and exceptions.

II. Methodology

2.1 Study Area

Drinking water samples were collected from 8 sources in Sour area during summer season 2015/2016 and winter/2016 at different regions (table 1). The geographical position of each well was determined with a GPS and indicated on the map (figure 1).

Table 1. Data of sources**.**

Source	1	2(4 wells)	3	4	5	6	7(spring)	8
Level(m)	136	122	107	200	81	384	20	6
Depth(m)	90	(400-600)	103	280	120	400	none	12

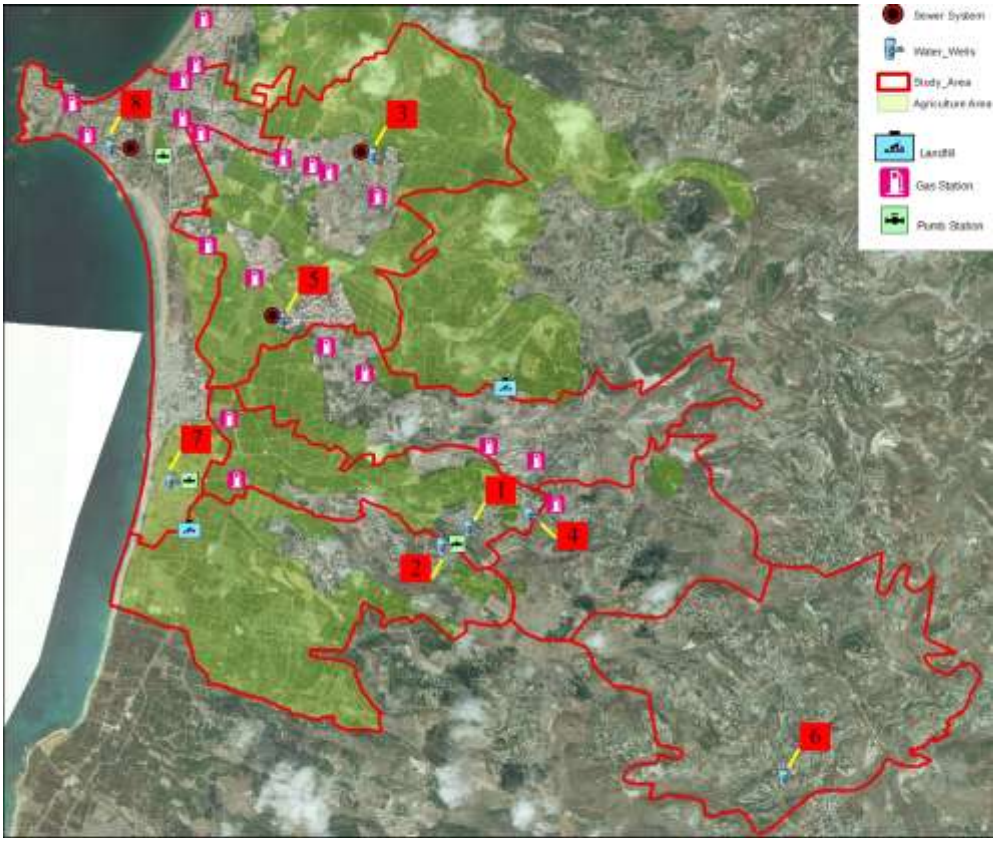

Figure 1. Locations of wells of sampled water on map.

2.2 Experimental procedure

2.2.1 Parameters Measured

The collected data is for the following parameters: turbidity, pH, electrical conductivity, total dissolved solids, calcium, magnesium, total hardness, chloride, acidity, alkalinity, sulfate, iron, orthophosphate, ammonia, nitrite, nitrate, total coliform and E. coli. (4)

2.2.2 Materials and Methods

Polyethylene sampling bottles 1 L were washed with detergent, rinsed with tap water and air-dried for chemical analysis. Samples were kept on ice for bacteriological analysis and transported immediately to the laboratory. Ground water samples were collected after flushing out around 30 L of water before sampling. Culture media used in bacteriological analysis were obtained from Numelab, and chemical products were obtained from Multilab in Lebanon. Analysis was carried out in Sour Lab SLWE. Instruments used in experimental work are: Filtration Systems, Vacuum Connection, Calibration and Adjustment, Benchtop Sterilizers, Incubator, DR 2800, pH meter, Portable turbidity meter, Conductivity meter and Burets set. (5)

2.2.3 Technique for Biological Analysis

The water sample is filtered through a membrane filter of 0.45 µm pore diameter validated according to the ISO Standard 7704:1985. The membrane is then placed on the surface of the Coliform Chromogenic Agar medium. The petri dish with the membrane is incubated for 18-24 hours at 36 ± 2ºC. If in 18 h there is growth of red or colorless colonies, extend the incubation until 24 h. Calculate the concentration of Coliform bacteria and E. coli in 100 mL from the initial volume of water filtered. The results are expressed as Colony Forming Units per milliliter (CFU/mL). (6)

2.2.4 Technique for Chemical Analysis

The following methods were used as a technique for water analysis: Fluoride SPADNS, Nitrate Cadmium Reduction, Iron Total Ferrover Ammonia Nessler, Sulfate SulfaVer, Alkalinity Buret Titration, Nitrite Diazotization, Chloride by Buret, Hardness, Calcium Calver, Hardness, Total Manver 2 Buret titration, Phosphorus, Reactive (Orthophosphate) Phosver 3 and Acidity, Phenolphthalein using Sodium Hydroxide with a Buret.

III. Results and Analysis

Table 2. Average values of physical, chemical and biological parameters of all sources, and shows the data of various physiochemical and biological parameters obtained in study of water from all sources between July/2015 and January /2016.

parameter	Source								Permitted limits
	1	2	3	4	5	6	7	8	
Turbidity	0.74	0.257	2.37	0.446	0.56	0.28	3.03	0.364	10 f TU
pH	7.29	7.39	7.71	7.32	7.26	7.33	7.28	7.33	6.5-8.5
Conductivity	714.2	634.8	924.45	635.4	650.8	644	612.55	2002.8	1500ms/cm
T.D.S	343.6	317.4	462.2	318.65	328.4	324.58	306.27	1001.3	600mg/L
Chloride	53.05	37.3	127.14	39.3	57.55	36.08	23.83	406.5	200mg/l
Calcium	221	196.2	189.82	202.8	221.4	195.66	218	229.2	250mg/l
Magnesium	67.6	102.2	115.45	109	55.2	118.66	82.22	282.6	100mg/l
Total hardness	289.2	298.4	305.45	305.8	267	314.33	300.22	511.8	350mg/l
Acidity	46.2	49	46.36	46.2	48.2	48	50.22	60.2	45mg/l
alkalinity	271.5	260.2	302	279.5	221.78	271.5	277.25	317	350mg/l
Sulfate	13.7	8.1	35.73	10.2	14.1	8.33	17.44	87.8	250mg/l
Iron	0.028	0.025	0.26	0.027	0.034	0.05	0.045	0.033	0.3mg/l
Orthophosphate	0.41	0.367	0.45	0.2518	0.39	0.21	0.381	0.61	0.7mg/l
Ammonia	0.053	0.037	0.11	0.03	0.038	0.046	0.045	0.076	0.5mg/l
Nitrite	0.033	0.02245	0.33	0.01459	0.065	0.021	0.0094	0.079	0.1mg/l
Nitrate	8.8	9.837	2.77	10.408	9.42	12.37	7.72	15.404	45mg/l
Total coliform	>70	3	3.87	62	65	22.33	>70	30	<1
E. Coli	16	0.875	0.25	13	5.11	1.33	4.857	1.87	<1

3.1 Source 1

Table 2 shows the data of various physiochemical and biological parameters obtained in study of water from all sources (S1-S8) between July/2015 and January /2016. The characteristics of water samples from the well were evaluated using Libnor standards. The results for microbiological tests are presented in figure 2. All total coliform columns were greater than 70 CFU/100ml whereas for E. coli it varied between 0 and 70 with an average of 16 CFU/100ml. As known maximum allowed limit set by Libnor Standard is less than 1 CFU/100ml for both total coliform and E. coli.

Figure 2. Bar graph of total coliform and E. coli count versus time of S1.

From a physical point of view, samples from well are good. From a chemical point of view, water from well 1 is drinkable in general with few values above permitted limit due to either dissolution of rocks. From a biological point of view this water is not drinkable and is highly contaminated due to septic tanks in all of the village knowing that site is between the areas of living population. Further disinfection procedure should be taken into consideration before domestic use of this water. Also, it should not be used for irrigation of ground plants such as lettuce, but it can be used for irrigation of fruit trees.

3.2 Source 2

Total coliform ranged between 0 and 6 CFU/100 ml with an average of 3 CFU/100ml. E. coli varied between 0 and 4 CFU/100 ml with an average of 1 CFU/100 ml. Both microbiological parameters in studied water are not compatible with Libnor Standards that set maximum allowed limit less than 1 CFU/100 ml for total coliform and E. coli. Also both EPA and WHO Standards allow no total coliform or E. coli in drinking water.

Figure 3. Bar graph of total coliform and E. coli count versus time of S2.

The history of this well in 2014 is almost of same characteristics. Turbidity is low and conductivity more than 600 ᵐs/cm and less than 700 ᵐs/cm. Also, pH value is within accepted range. Total coliform and E.coli was detected in August 2015 due to lack of recharge of aquifer during summer season while more water is consumed due to high temperature. After discussing all above, we can deduce that water from well 1 is good from physical and chemical point of view except for acidity parameter that decreased after summer because of dilution. Still it is not drinkable because of presence of some bacteria which were total coliform mainly. But, the count was much less than another well found in same village which may be due to depth of excavation of well plus less much less population nearby than the first well. This water is much less harmful to human health since slightly contaminated. However, it still need undergoing a further disinfection method before it is sent for domestic use.

3.3 Source 3

Total coliform was 0 CFU/100 ml till September in which it reached a value of 30 CFU/100ml, and in March total coliform appears no more. E. coli was 0 CFU/100 ml all experimental time except for September 2 CFU/100ml (figure 4). This is because of decrease of ground water source (rain water), and increase of wastewater disposed on the groundwater due to high temperature. No total coliform or E. coli allowed in drinking water according to all Libnor, WHO and EPA Standards.

Figure 4. Bar graph of total coliform and E. coli count versus time of S3.

We conclude that water from this well needs to undergo a treatment method to decrease high concentrations of T.D.S, chloride, acidity calcium and magnesium. However, it is because of aesthetic effect not of health concern. Biological parameters were below maximum allowed limit set by Libnor Standards. Note that this village is of high population but a sewer network is available; this means that groundwater was not polluted by wastewater.

3.4 Source 4

Regarding bacterial analysis, in most of samples total coliform count was equal or more than 70 CFU/100ml (figure 5). E. coli was zero in July, but its presence was detected in August 2015, and it became more than 70 CFU/100ml in January 2016.

Figure 5. Total coliform and E. coli count versus time of S4

Water from this well is not suitable for drinking, and a treatment method should be considered. It is contaminated with bacteria and in deterioration. Note that neither sewer network is available in this village, nor in villages around it. Also, this well is in a planting area where organic pesticides are used. Physical and chemical characters are good except for acidity and magnesium hardness.

3.5 Source 5

Total coliform was detected high more than 70CFU/100 ml for all samples in 2015 as we see in bar graph but it decreased to 25CFU/100 ml in January 2016 due to dilution after rain. The result obtained can be justified due to increase of water amount during winter season. Yet, still this parameter is not acceptable and of health concern since no coliform is allowed in drinking water. No E. coli was detected in September 2015 and January 2016, but E. coli was detected in July and August 2015. Even though E. coli was from 1 to 5 CFU/100 ml it is rejected according to standards that limit allowed E. coli to less than 1CFU/100ml. Note that this area is of high population, and it is mixed where sewer system exist in some of it and doesn't exist in other.

Figure 6. Total coliform and E. coli count versus time of S5.

Then, water from source 5 is not suitable for domestic use because of presence of both total coliform and E. coli. From a physical and chemical point of view, detected parameters are accepted except for acidity. Total coliform and E. coli affects human health, and most common symptoms include nausea, vomiting and diarrhea. This water should be treated by an appropriate disinfection method before being used for drinking purpose.

3.6 Source 6

Total coliform was lowest 7 CFU/100 ml in July and highest 50 CFU /100 ml in February (figure 7). E. coli was 0 CFU/100 ml in July but became 4 CFU/100 ml in February. This may be due to source point pollution. Micro bacterial parameters are not accepted by Libnor Standards that allow no Coliform or E. coli in drinking water. We notice that bacteria concentration is increasing due to lack of recharge of groundwater during this season.

Figure 7. Total coliform and E. coli count versus time of S6.

Then, this water can't be used for drinking due to presence of total coliform and need to be disinfected. It is good from a physical and a chemical point of view.

3.7 Source 7

From figure 7 we can notice that total coliform was high during all sampling period with a value more than 70 CFU/100ml. E. coli was 0 CFU/100 ml in July and increased to 12 CFU/100 ml in September and February. Libnor standards specify maximum allowed limit for both total coliform and E. coli as less than 1 CFU/100ml. Then, all samples are not compatible for drinking. Note that this source is located 1 km far from an open landfill, and no sewer system exist in village too.

Figure 7. Total coliform and E. coli count versus time of S7.

We can say that, water from this source can't be used directly for drinking and need to be treated a responsible action should be taken by government to protect this source from present pollution.

3.8 Source 8

All conductivity values were high and above maximum permitted limit 1500ɱs/cm. Conductivity ranged between 1833 and 2170 ɱs/cm, and average conductivity was 2003 ɱs/cm. These values are not compatible with Libnor Standards. We can interpret this result due to the location of well in urban area near by the sea, and increase of stress on underground water in region.

Figure 8. Conductivity versus time of S8.

Chloride concentrations were very high with an average of 407 mg/l while permitted limit is 200 mg/l. In August chloride reached its maximum concentration 472 mg/l. Then, water is saline and is not suitable to drink. If we consider figure 9 most calcium concentrations were slightly below calcium limit line. Average value of calcium was 229 mg/l which is less than permitted limit 250 mg/l, but calcium was 472 mg/l in September more than permitted limit. Magnesium curve (figure 9) was above magnesium limit line in all sampling period as presented in graph. Magnesium ranged between a maximum of 340 mg/l in August and a minimum of 248 mg/l in March. Average concentration of magnesium was 283 mg/l much more than permitted limit 100 mg/l.

Figure 9. Chloride, calcium and magnesium versus time of S8 with permitted limit line for each parameter.

Total hardness was above permitted limit 350 mg/l with an average of 512 mg/l. Total hardness was maximum in September 560 mg/l and minimum in March 488 mg/l. Water from this well is described to be very hard plus not allowable for drinking. Alkalinity curve (figure 10) was just under alkalinity limit line as we see in graph. Alkalinity ranged between 276 and 340 mg/l with an average equals to 317 mg/l. These values are less than maximum allowed limit 350 mg/l set by Libnor Standards.

Figure 10. Total hardness, alkalinity and T.D.S versus time of S8 with permitted limit line for each parameter.

Total coliform highest value 70 CFU/100 ml was in August and lowest value 0 CFU/100 ml in March as clear in bar graph (figure 11). E. coli appeared in water at end of August 3CFU/100 ml, but no E. coli was detected later in March. It is well known that no total coliform or E. coli is allowed in drinking water. Libnor Standards identify maximum allowed limit for both micro biological parameters less than 1CFU/100ml.

Figure 11. Total coliform and E. coli count versus time of S8.

So, water from this well is not suitable for domestic use because of high conductivity, high T.D. S, total hardness, high chloride, high magnesium, presence of total coliform and E. coli. It is of bad taste and harmful for human health too. Excess chloride leads to hypertension, asthma, irritation in throat and balder cancer for humans, and causes corrosion and scaling in pipes as well. It is recommended to use RO as a treatment in such case to desalinate water. This is due to land scaling by urban expansion and reduced recharge leading to seawater intrusion.

IV. Conclusion

From a physical and chemical point of view, all sources were good except S8 because it has a high conductivity, T.D.S, calcium, chloride concentration all over study period. Total hardness was just under permitted limit in most samples due to limestone nature of rocks in Lebanon. Nitrate concentration exceeded 10 mg/l as an average in most of samples which is of health concern for life time long according to EPA although it is acceptable by WHO and Libnor Standards. Nitrate enters the human body through the use of groundwater for drinking and causes a number of health disorders, namely, gastric cancer, birth malformations and hypertension when present in high concentration in drinking water. (8)

Nitrite, ammonia and orthophosphate were below allowed limit in most samples but some exceptions were observed in specific months as a result of pesticides and agriculture activities.

Most of groundwater was found to be not suitable for drinking due to bacterial contamination and further treatment was necessary due to absence of sewerage networks. Escherichia coli is found in all mammal faeces and it survives in drinking water for between 4 and 12 weeks, depending on environmental conditions which is a serious threat for public health. (9) Bacterial count increased after winter season due to presence of open landfills and excessive use of animal manure in agriculture during fall season.

In conclusion, water from all sources were not suitable for drinking purpose and need to be treated before use. The quality of groundwater is dependent on surface environmental pollution by human activities. Over abstraction and pollution is threating our renewal resources.

References

[1] **Oskin, Becky**. What is Groundwater? livescience. [Online] 2015. http://www.livescience.com/39579-groundwater.html.
[2] Water Supply and Sanitation, [Online] 2013. https://en.wikipedia.org/wiki/Water_supply_and_sanitation_in_Lebanon.
[3] **Nahas, Charbel.***www.charbelnahas.org.* [Online] 2013. www.charbelnahas.org/textes/Amenagement_et_urbanisme/.../F-Tyre_107-140.pdf.
[4] **Organization, World Health.***Guidelines for Drinking-water Quality.* Geneva: WHO Library, 2008. THIRD EDITION.
[5] Scharlau*Microbiology- Technical data sheet reference 01-797 Date 2015.*
[6] *Hach Company U.S.A 2005.*
[7] *Libnore Standards, SLWE main lab saida 2015*
[8] *DeepanjanMajumdar and NavinduGupt, Nitrate pollution of groundwater and associated human health disorders*, Indian journal of environmental health 42(1):28-39-January 2000
[9] S.C. Edberg, E.W. Rice, R.J. Karlin, M.J. Allen , Escherichia coli: the best biological drinking water indicator for public health protection,Journal of Applied Microbiology, Volume 88, Issue SI, December 2000, Pages 106S-116 S