Medicon Engineering Themes
Volume 2 Issue 6 June 2022
Research Paper

Assessment of Groundwater in Al-Lith Region

Sami Goren*, Khalid Albijali, Rayan Alghamdi, Abdul Gaffar Alomari and Meshal Alzahrani

Department of Environmental Engineering, College of Engineering at Al-Lith, Umm Al-Qura University, Saudi Arabia

***Corresponding Author:** Sami Goren, Department of Environmental Engineering, College of Engineering at Al-Lith, Umm Al-Qura University, Saudi Arabia.

Received: May 09, 2022; **Published:** May 18, 2022

DOI: 10.55162/MCET.02.043

Abstract

There are many random wells in the city of Al-Lith, especially in the east of the city of Al-Lith in (the study area). There are no desalination companies in the area, and there are no data showing that the wells are potable & non-potable, and there is no information about the groundwater level in the area. In the beginning, the locations of the targeted wells were determined to conduct the study on, and then the samples were collected from the 20 identified sites in the east of the city of Al-Lith, from 20 wells, and the depth of each well was also determined. According to the results, the aim is to give idea for the water wells whether potable or non-potable.

Keywords: groundwater, water well, water quality, pollution, potable water

Introduction

The earth is covered by water as the form of sea and ocean. The water in the sea and ocean is not suitable to use as the source of potable water unless certain processes are applied. The main water resource for daily life for human is groundwater. On the other hand, groundwater contamination is also caused by human activities and products. Plastic wastes, agricultural fertilizers, pesticides, chemicals, used oil, toxic materials, etc. are the main reason for pollution of soil, water and air. When these pollutants reach to the groundwater, they can easily be spread through aquifer and make it unsuitable for human use. Moreover, this situation affects the eco-system and can stop aquatic and plant life. For this reason, groundwater resources should be kept clean and far from the pollution. To ensure the quality of water, periodic monitoring is necessary for the water resources.

This project was conducted in Al-Lith Governorate of Makkah Al-Mukarramah Region for the purpose of evaluating the quality of groundwater, determining the level of groundwater in the region, and analyse the groundwater and have idea about the water quality.

Al-Lith City is located in the south of the Hejaz Province, which is in the western region of Saudi Arabia. It is bordered to the north by Al-Taif and Al-Bahra, from the east province of Adam and Maysan province, and from the southern province of Al-Qunfudah and the Al- Mkwh province of the Baha region. From the west, there is a sea front stretching about 200 km along the Red Sea coast. The area of the province is estimated at 10.12 thousand km2, which occupies about 7.1% of the area of the region and is ranked fifth among the governorates of the region in terms of area. The population is, as for the year 1435 (2013) about 90.3 thousand people, which represents about 1.14% of the population of the region and comes in eighth place at the level of Makkah [1].

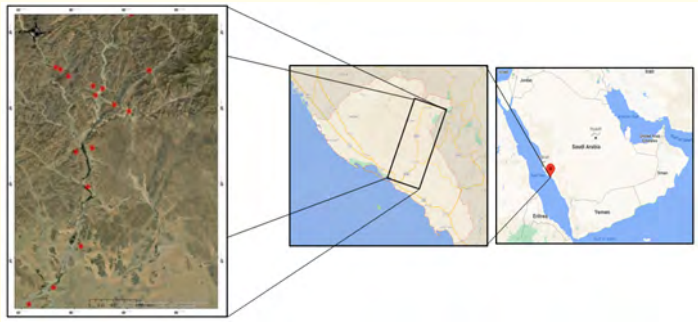


Figure 1: Al-Lith Location (Study Area).

After collecting groundwater samples, they were analysed in the lab with the following parameters: pH, salinity, TDS, DO, conductivity, resistance, iron, copper, aluminium, and compare the results according to the applicable local and international standards and specifications (EPA) for drinking water [2].

The study area is shown at Figure 1. This project was implemented, starting with taking samples and measuring the water level from different wells at the eastern part of Al-Lith City, and determining the wells' locations in which the water level was measured taking samples from them. These samples were transferred to Al-Lith College of Engineering Laboratory, and several analyses were conducted on these samples.

Literaturel Review

The Arabian Plate is one of the tectonic plates that form the earth's crust. It moves north-eastward as a result of the eruption of magmas along the Red Sea rift, which spreads annually at a rate of approximately 15 mm. The basement rocks in Saudi Arabia, or the so-called Arabian Shield, cover about one third of the Kingdom's land area, while the sedimentary rocks, or the so-called Arabian Shelf, cover the rest of the Kingdom. The volcanic flows occupy large areas of western Saudi Arabia, including the holy cities of Mecca and Madina. Geologic structures, such as old and recent surface and subsurface faults and folds are spread throughout the Kingdom, especially in its western parts. Some studies suggest that some internal regional faults may be extensions of some transform faults in the Red Sea [3]. The Arabian Plate is a spectacular active example where both a mantle plume and far-field plate stresses interact to drive continental break-up [4].

Saudi Arabia covers most of the Arabian Peninsula and is characterized by tectonic regimes ranging from Precambrian to Recent [5]. The upper part of its crust consists of crystalline Precambrian basement, Phanerozoic sedimentary cover as much as 10 km thick, and Cenozoic flood basalt (harrat). The distribution of these rocks and variations in elevation across the Plate cause a pronounced geologic and topographic asymmetry, with extensive basement exposures (the Arabian Shield) and elevations of as much as 3000 m in the west, and a Phanerozoic succession (Arabian Platform) that thickens, and a surface that descends to sea level, eastward between the Shield and the northeastern margin of the Plate [6]. The western areas are mostly mountainous with mountains rising up to 3000 m above sea level. The western coastal plain along the Red Sea is low in elevation and fairly narrow. Owing to favorable marine and climatic conditions, coral cultures grew along the coast during recent geological times giving rise to terraces of coralline limestone [7].

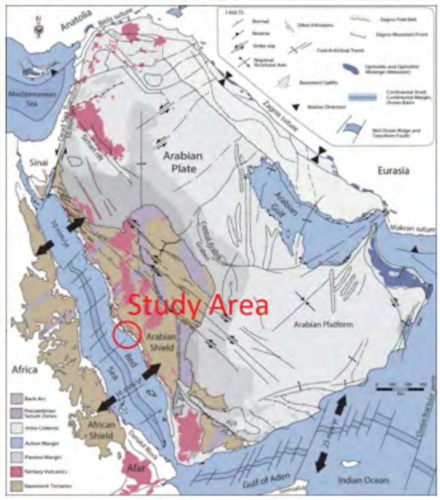


Figure 2: Arabian Shield [4].

Methodology

In order to evaluate the water quality, physical, chemical, and biological properties of water should be examined. The assessment is to classify the water for human use or for recreation and/or breeding, fishery or agricultural use. Conserving the water resources is essential for the health of human and ecosystem.

In this project, some of the physical, chemical properties of water were examined. During the project, all the wells around this area were searched and 43 wells found, and the coordinates were recorded. Among these 43 wells, 20 of them were selected as representative well of the area. Table 1, gives the coordinates of the wells that were selected and used for groundwater sampling.

Sampling Well Locations			
sample number	***sample location***	***sample number***	***sample number***
1	20.16899,40.34212	11	20.56998, 40.48317
2	20.20963, 40.36761	12	20.55403, 40.51531
3	20.23813, 40.4102	13	20.54234, 40.5404
4	20.30981, 40.45752	14	20.58643, 40.47857
5	20.41214, 40.46912	15	20.58202,40.49498
6	20.47277, 40.4489	16	20.61297,40.5756
7	20.47933, 40.47727	17	20.71902, 40.45378
8	20.6029, 40.43614	18	20.70992,40.54438
9	20.61487, 40.42198	19	20.72076,40.55954
10	20.6188, 40.41409	20	20.72781,40.58812

Table 1: Coordinates of the Wells.

The samples are collected and transferred to the laboratory of College of Engineering at Al-Lith, Umm Al-Qura University. The following parameters are chosen due to the lab facilities; pH, TDS, DO, salinity, conductivity, iron, copper, aluminium, resistance.

Lab Experiments

Experiments were conducted at the lab with standard methods. The results are shown in detail as follows. pH, as a concentration of hydrogen ions, in the water shows its acidity or basicness level. Any kind of chemicals or pollutants can affect the pH level of the water, for this reason, it is an important factor that water is changing chemically or not. Excessively high and low pH levels can be dangerous to use. According to the EPA standards, pH level should be from 6.5 to 9 for drinking water. With the results of pH results a graph (Figure 3) is drawn and the min & max values are also plotted at the graph. The groundwater samples are in the acceptable reference according to EPA standards.

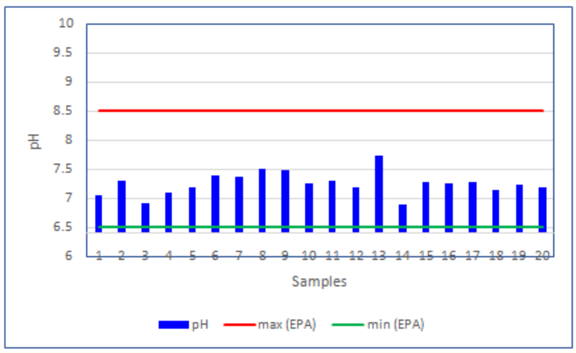


Figure 3: pH results of the samples.

Salinity is explained as the concentration of salts, that means dissolved salts in the water. The environmental facts can affect the salinity level of the groundwater. The salt can naturally exist by weathering effect in the soil if there is no effect of pollution. When there is less rain in the area, the salt level can increase and it is called as dryland salinity. The industrial and agricultural activities can also cause pollution that may lead to salinity. The allowable level of salinity is shown at the Table 2 and the category is show at Table 3.

Salinity (mg/L)	***Quality***
0-600	Good
600-900	Fair
900-1200	Poor
>1200	Unacceptable

Table 2: Salinity Quality Values of Water.

High level of salt cause acidity effect and not suitable for living organisms. The experiments results are plotted as in Figure 4. According to the standards, the groundwater of the selected wells can be accepted as “good” and “fresh”.

Salinity (mg/L)	Category
Up to 1000	Fresh
1000-3000	Fresh to brackish
3000-5000	Brackish
5000-35000	Saline
35000 and above	Hyper-saline

Table 3: The Category of Water according to Salinity.

Figure 4: Salinity Results.

The total dissolved material (TDS) level should be between 50 to 150 ppm to be accepted as the most suitable and acceptable, and if exceed 500 ppm treatment is necessary and in the case of more than 1000 ppm, it doesn't fit for human use [2]. The lab experiment results (Figure 5) show that some of the well number 2, 3, 4, 9, 12 and 14 are not suitable to use.

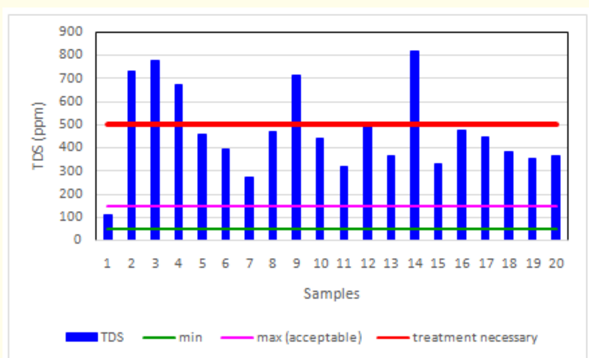


Figure 5: Total Dissolved Material (TDS) Results.

Conductivity for distilled water is in the range of 0.5 to 3 µmhos/cm. The unit of conductivity is micromhos per centimeter (µmhos/cm) or microsiemens per centimeter (µS/cm). The conductivity of fresh water in the rivers generally ranges from 0 to 1500 µS/cm, and ranges from 0 to 800 µS/cm for good drinking water for humans [2]. According to these limits, the groundwater in all the wells as shown at Figure 5, is in the acceptable limit and the values are even close to distilled water.

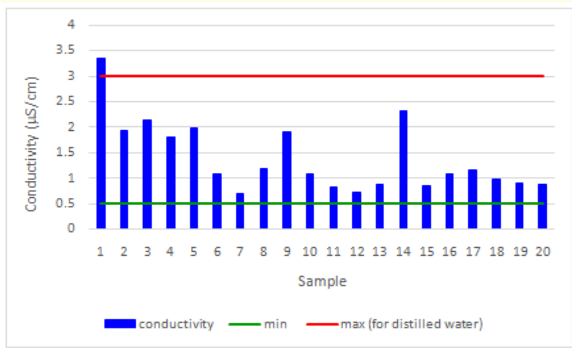


Figure 6: Conductivity Results.

Water can conduct electricity like solid materials. This is caused because of the minerals existing in the water naturally sourced by the different soil and rock types. Conductivity is the indicator of how much salt (minerals) are existing in the water, whether it can easily transport electricity. If the groundwater in the well does not receive additional stream or rainwater, the conductivity increases. It depends also to the temperature; high temperatures cause high conductivity, because evaporation can take only the water away not the salt. Another reason for the high conductivity can be the pollution. Especially, human wastewater has high conductivity. Figure 6 shows the conductivity level at the groundwater samples of the area is very low as much as distilled water.

Iron is known as metal however; it is a natural chemical element that can be found everywhere at the earth's crust. As the water flows on or under the soil, it dissolves the iron and let them seep into the water [8]. If the iron level is high, it can be harmless for the health but also cause nuisance with the bitter taste, colour and odour and also can cause stain at the laundry. Maximum allowable limit for the iron in the drinking water is 0.3 ppm [2]. All the well water samples are analyzed at the laboratory and found that the iron level for all of them are zero. It means that, there is no iron mineral at the area that may cause pollution and leaching problem. The groundwater at the area is safe in terms of iron element.

Copper is a natural occurring metal with a reddish colour in the environment. It is common in soil, water and in air. Even by breathing, we may be exposed to copper. It is also one of the natural elements of our body, but with a limited value. Allowable limit for the copper in drinking water is 1 mg/L, if exceeds this level, treatment of water is necessary [2]. The groundwater samples from all the wells are tested in the laboratory and found no copper amount. All the values are 0 ppm that shows that they are safe in the sense of copper.

Dissolved oxygen (DO) means the concentration of oxygen gas incorporated in water. It shows the molecules of oxygen existing in per million of water. It is not same with the oxygen in water molecules. Oxygen enters water by direct absorption from the atmosphere, which is enhanced by turbulence in the rivers and lakes. For the groundwater in the wells, rainwater and the contact with atmosphere supplies DO and also carried from the source streams and by discharge & infiltration through the soil layers. However, well waters have low DO level compared with surface waters as shown at Figure 7.

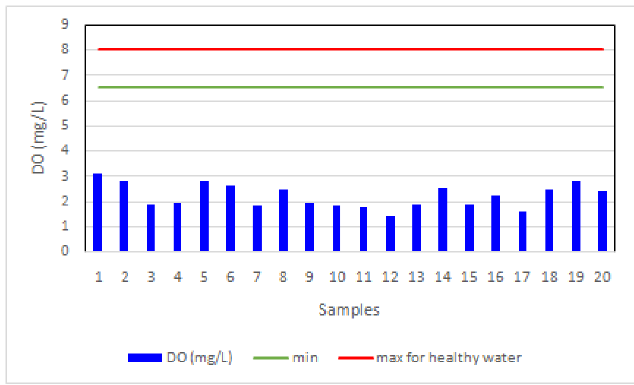


Figure 7: Dissolved Oxygen Results.

In fact, DO is important for aquatic life in water bodies. For drinking water, it is sure that there should be no aquatic or microbial life. However, ideal level of DO gives a better taste to drinking water. Due to the adding taste to water a small amount of DO is desirable at drinking water. If it is more than necessary, it may cause corrosion in the water.

Aluminium is naturally found element in the soil and leach to the groundwater easily if exist in that area. Industrial and agricultural pollution is also effective on the aluminium content in the water. It is extremely dangerous for aquatic life and also can cause toxicity if exists in drinking water. EPA criteria for aluminium is in between 0.05 and 0.2 mg/L. The other parameters of water such as pH, total hardness and dissolved organic carbon can affect the level of aluminium in the water. Figure 8 shows the groundwater samples from the wells ensure the safe level of aluminium.

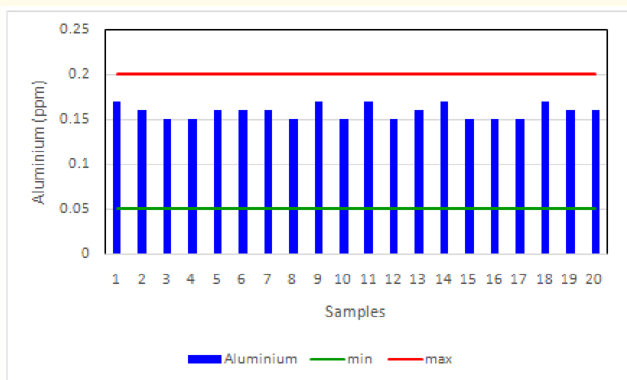


Figure 8: Aluminium Results.

The water's ability of dissolving salt is the indicator for resistance. Its unit is ohm (Ω). 200 ohm is the level for brackish water [2]. The groundwater samples from the wells are shown at Figure 9. According to these results, the groundwater from the wells show the properties of brackish (river) water.

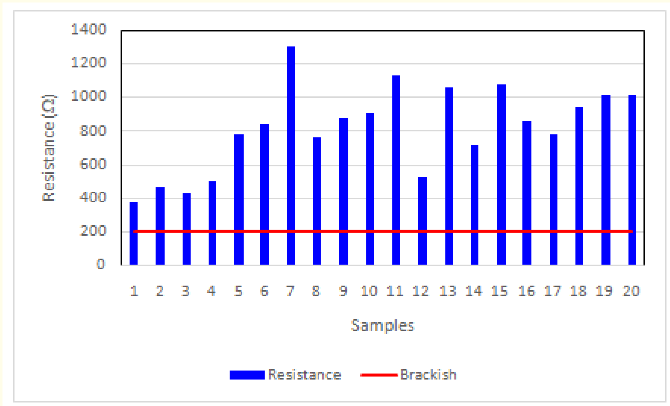
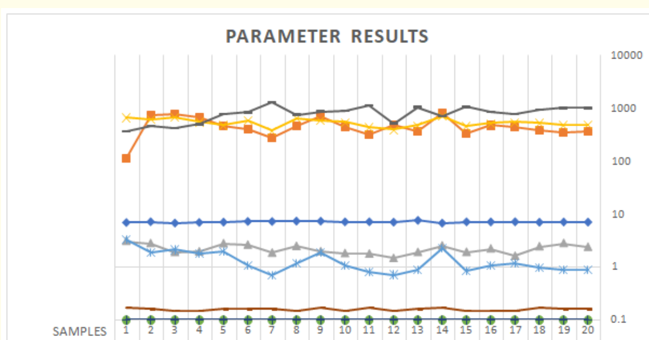


Figure 9: Resistance Results.

Results

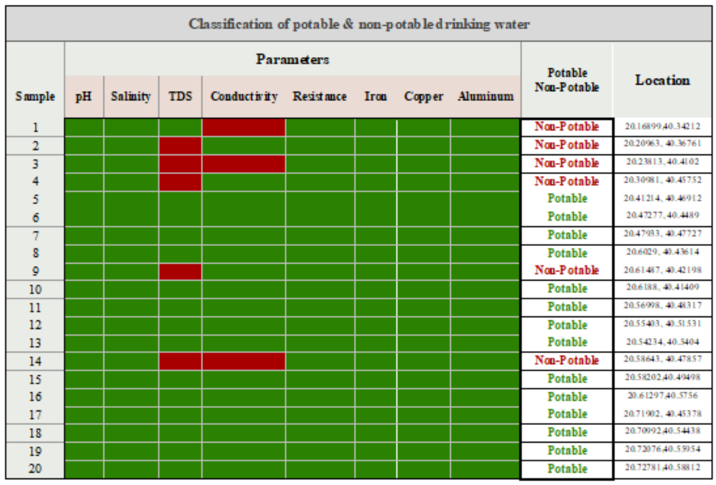
There are many types of contamination threating the groundwater. The contaminants are also different according to the location. In this project, the pollutants are examined according to the local necessities of the people who are living nearby. The wells are mainly used to supply water to the existing trees and for watering the camels. Microbial activities are limited as the temperature is stable throughout the year and there is very less precipitation. There is almost no industrial or radioactive pollution possibility as the area is not an industrial or residential area and human activities are limited. Mostly, the water is used around the well for local necessities and carried by water tank trucks. Groundwater contamination may lead to soil contamination eventually cause degradation in soil quality. If the salinity is high in the groundwater, it can increase the salinity level of the soil. This salinity may contain toxic minerals and metals and may affect the tree and vegetation growth. With this concern, the area for sampling are tried to be enlarged within the bounds of possibility. The results for all the parameters are shown at Figure 10. By the help of the results, a beneficial grasp is tried to be achieved.



SAMPLES	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
pH	7.06	7.3	6.92	7.1	7.19	7.4	7.38	7.5	7.48	7.26	7.3	7.18	7.73	6.9	7.27	7.25	7.29	7.15	7.23	7.19
TDS	113	732	780	672	458	396	273	470	712	442	322	492	364	818	331	477	447	383	354	364
DO	3.1	2.81	1.91	1.96	2.8	2.63	1.86	2.49	1.98	1.82	1.78	1.47	1.91	2.54	1.92	2.23	1.62	2.46	2.82	2.41
Sallinity	658	617.	672.	556.	480.	592.	379.	650.	586.	544.	440.	390.	472.	704.	465.	518.	542.	532.	484.	490.
conductivity	3.35	1.94	2.14	1.81	1.98	1.07	0.70	1.19	1.91	1.07	0.81	0.72	0.87	2.32	0.85	1.07	1.17	0.97	0.90	0.89
Iron	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Copper	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Alininum	0.17	0.16	0.15	0.15	0.16	0.16	0.16	0.15	0.17	0.15	0.17	0.15	0.16	0.17	0.15	0.15	0.15	0.17	0.16	0.16
Resistance	375.	470.	426.	506.	778.	847.	1302	763.	875.	906.	1132	525.	1055	713.	1076	861.	780.	942.	1018	1014

Figure 10: All Parameter Results.

Figure 11 shows the classification of the wells (potable - non-potable) after testing the samples in the laboratory based on international standards.



Classification of potable & non-potable drinking water										
Sample	Parameters								Potable Non-Potable	Location
	pH	Salinity	TDS	Conductivity	Resistance	Iron	Copper	Aluminum		
1									Non-Potable	20.16899,40.34212
2									Non-Potable	20.20963, 40.36761
3									Non-Potable	20.23813, 40.4102
4									Non-Potable	20.30981, 40.45752
5									Potable	20.41214, 40.46912
6									Potable	20.47277, 40.4489
7									Potable	20.47933, 40.47727
8									Potable	20.6029, 40.43614
9									Non-Potable	20.61487, 40.42198
10									Potable	20.6188, 40.41409
11									Potable	20.56998, 40.48317
12									Potable	20.55403, 40.51531
13									Potable	20.54234, 40.5404
14									Non-Potable	20.58643, 40.47857
15									Potable	20.58202,40.49498
16									Potable	20.61297,40.5756
17									Potable	20.71902, 40.45378
18									Potable	20.70992,40.54438
19									Potable	20.72076,40.59954
20									Potable	20.72781,40.58812

Figure 11: Classification of the Wells.

Conclusion and Discussion

Globally, groundwater contamination is a very important problem that may have an appalling effect on human and environment health because it is the main source of fresh water. Especially, in the desert environment, water resources are more important than in anywhere else. It is sure that, there is no water supply network system in the rural area and there is almost no river, as the precipitation is rare. There are very limited water resources and if a well can give water from a convenient height, it is a big advantage for the community. It can be used for agriculture, but the climate is not favourable; due to that, the main usage is daily necessities as drinking water and watering the camels. For that reason, it is indispensable to have a well in the vicinity. However, the water wells are under the threat of pollution for several reasons. First one is based on the soil and rock type that contain minerals in and around the well because earth's crust contains many minerals. The other one is the pollution risk from external sources like agricultural activities (if exists), microplastics, chemicals or sewage may seep into the wells from cesspools. Seawater intrusion is another important factor.

Climatic changes and biological activities (algae and microbial organisms) of the groundwater is also among the major effects for contamination. COVID-19 viruses might have impact on the groundwater as well. As the groundwater is in the subsurface geological strata, if polluted, the remediation is costly and takes long time. For this reason, to monitor and maintain the quality of groundwater is a vital activity for a healthy and sustainable development.

This project has been conducted to monitor the quality of groundwater and determine the level of groundwater for the selected locations. The study started by determining the locations of the wells in the study area. Totally 43 wells were detected and twenty of them were selected to represent the area and water samples were taken and analysed in the laboratory. The results were compared with local (KSA) and international (EPA) standards. By the help of these results, the wells are classified as "potable" and "non-potable". Environmental pollution and water contamination is a leading worldwide problem. Millions of people mostly children die annually due to water related diseases.

In general, the results show that there is no huge amount of pollution however some of them are not suitable for human use. For that reason, it is recommended to the residents of the east of the city of Al-Lith (the study area) to use home water desalination devices to purify the water that comes from the wells and avoid digging new wells near non-potable wells. This study should be extended with periodic samples from the same wells, with increasing parameters. Also, the area should be enlarged to guide more residents to reach healthy water.

References

1 Database of Emirate of Makkah (2021).
2 U.S. Environmental Protection Agency (online).Ground Water and Drinking Water (2022).
3 Movements of the Arabian Plate, Saudi Geological Survey, National Geological Database, Jeddah 21514, KSA (2021).
4 Thamer Z Aldaajani, Khalid A Almalki and Peter G Betts. "Plume Versus Slab-Pull: Example from the Arabian Plate". Front. Earth Sci (2021).
5 Eldosouky AM., et al. "Mapping Main Structures and Related Mineralization of the Arabian Shield (Saudi Arabia) Using Sharp Edge Detector of Transformed Gravity Data". Minerals 12.71 (2022).
6 Robert J Stern and Peter Johnson. "Continental lithosphere of the Arabian Plate: A geologic, petrologic, and geophysical synthesis". Earth-Science Reviews 101.1-2 (2010): 29-67.
7 Al-Refeai, T., Al-Ghamdy, D. "Geological and geotechnical aspects of Saudi Arabia". Geotech GeolEng 12 (1994): 253-276.
8 Lemley A, Schwartz JJ and Wagenet L. "Iron and Manganese in Household Drinking Water". Water Treatment Notes. Fact Sheet n.6. Cornell Cooperative Extension, New York State College of Human Ecology (1999).

Volume 2 Issue 6 June 2022