ARID Journals

ARID International Journal for Science and Technology (AIJST)
ISSN: 2662-009X

Journal home page: http://arid.my/j/aijst

مَجلةُ أُريد الدَّوليةُ للعُلومِ والتِّكنولوجيا

المجلد 7 ، العدد 13 ،حزيران 2024 م

Sustainability in

Evaluation of Some Drinking Water Qualities in Some Villages in Gezira Sudan State

Wigdan Karamalla

Faculty of Agriculture, Khartoum University, Sudan

تقييم خواص مياه الشرب في بعض قرى ولاية الجزيرة السودان

وجدان كرم الله أحمد الريح

كلية الزراعة - معهد الدراسات البيئية - جامعة الخرطوم

السودان

Wigdan.karmalla@brightriders.ae
https://doi.org/10.36772/arid.aijst.2024.7131

ARTICLE INFO

Article history:
Received 04-11-2023
Received in revised form 22-03-2024
Accepted 17-05-2024
Available online 15-06-2024
https://doi.org/10.36772/arid.aijst.2024.7131

ABSTRACT

Safe and potable water is the basic need for human. In Gezira State groundwater is the main source of domestic water. While most villages in Gezira State traditionally use pit latrines, septic tanks and injection wells have been introduced recently. The aim of this study is to investigate the effect of latrine system in some villages in North Gezira State on some physical, chemical, and microbiological parameters of groundwater. Water samples were collected from sixteen villages (Wadalmahna, Alkamlin Abdalab, Umdagarsey, Wadalmajedi, Abu usher, Altalbab, Alshawarab, Genib, Albataheen, Abufroa, Alsadaga, Alhassaheisa, Alsalama, Addaid Abu usher, Altakla Hamed, and Altakla Gobara) and analyzed for various physico-chemical and microbiological parameters. Physico-chemical parameter includes pH, electrical conductivity, turbidity, total dissolved solids, total hardness, calcium, magnesium, sodium, chloride, and some heavy metals. The microbiologic test includes a total count of coli form and fecal coli form E. coli, which is an indicator of fecal contamination of water. Standard laboratory methods for analysis were used. These parameters were compared with World Health Organization (WHO) and Sudanese Standards and Metrology Organization (SSMO) to assess the suitability of groundwater for domestic purpose. The results show that most of the Physio-chemical parameters are within the acceptable ranges for WHO and SSMO, except water salinity in three villages (Alshawarab, 1935 µmhoscm-1; Albataheen, 1885 µmhoscm-1 and Abufroa, 1780 µmhoscm-1) is higher than the acceptable level (1500 µmhoscm-1). For microbiological tests, total coli form bacteria were detected in all water samples. E. coli was not detected in villages where traditional pit latrine is used. In village where septic tank and injection well is common E. coli was detected in all the samples. The study concludes that the groundwater used for drinking in North Gezira State is polluted, and there is contamination with E. coli in areas where traditional pit latrines are not the sanitation system.

Keywords: drinking water, latrine system, Villages in Gezira State, Physical, chemical, groundwater, WHO, microbiological

الملخص

تعتبر المياه الصالحة للشرب من الاحتياجات الأساسية للإنسان. حيث إن المياه الجوفية هي المصدر الرئيسي للمياه المستخدمة في المنازل في ولاية الجزيرة. تستخدم معظم قرى ولاية الجزيرة المراحيض التقليدية، ولكن مؤخرًا استخدمت خزانات الصرف الصحي وبئر الحقن. تهدف الدراسة إلى معرفة تأثير نظام المراحيض في بعض قرى ولاية شمال الجزيرة على بعض المعايير الفيزيائية والكيميائية والميكروبيولوجية للمياه الجوفية. تم جمع عينات المياه من ست عشرة قرية (ودالمحنة، الكاملين عبدالبلاب، أم دقرسي، ودالماجدي، أبو عشر، الطالباب، الشاوارب، قنب، البطاحين، أبوفروع، الصداقة، الحصاحيصا، السلمة، عديد أبو عشر، التكلة حمد، والتكلة جبارة). وتحليلها لمختلف المعايير الفيزيائية والكيميائية والميكروبيولوجية. تتضمن المعايير الفيزيائية والكيميائية: الرقم الهيدروجيني، والتوصيل الكهربائي، والعكارة، والمواد الصلبة الذائبة الكلية، والصلابة الكلية، وتركيز العناصر مثل الكالسيوم، والمغنيسيوم، والصوديوم، والكلوريد، وبعض المعادن الثقيلة. يشتمل الاختبار الميكروبيولوجي على العدد الإجمالي للبكتيريا القولونية والبرازية القولونية، وهو مؤشر على تلوث المياه بالمخلفات البشرية. تم استخدام طرق معملية قياسية للتحليل. تمت مقارنة هذه المعايير مع معايير منظمة الصحة العالمية (WHO) ومنظمة المواصفات والمقاييس السودانية (SSMO) لتقييم مدى ملاءمة المياه الجوفية للأغراض المنزلية. أظهرت النتائج أن معظم المعايير الفيزيوكيميائية تقع ضمن االمدى المقبول من WHO و SSMO ، باستثناء ملوحة المياه في ثلاث قرى (الشاوراب ، 1935 ميكرومتر سم$^{-1}$ ؛ البطاحين ، 1885 ميكرومتر سم ^{1} وأبوفروع ، 1780 ميكرومتر سم$^{-1}$) و كانت أعلى من المستوى المقبول (1500 ميكرومتر سم$^{-1}$). بالنسبة للاختبارات الميكروبيولوجية ، تم الكشف عن بكتيريا القولونية الكلية في جميع عينات المياه و لم يتم الكشف عن الإشريكية القولونية في القرى التي تستخدم فيها المراحيض التقليدية. في القري التي ينتشر فيها خزان الصرف الصحي وبئر الحقن، تم الكشف عن الإشريكية القولونية في جميع العينات. وخلصت الدراسة إلى وجود تلوث بيئي في المياه الجوفية المستخدمة للشرب في ولاية شمال الجزيرة وتلوث بالإشريكية القولونية عندما لا يكون المرحاض التقليدي هو نظام الصرف الصحي.

الكلمات المفتاحية : مياه الشرب، نظام الحمامات (المراحيض)، قرى ولاية الجزيرة، الخواص الفيزيائية والكيميائية والميكروبيولوجية والمياه الجوفية، منظمة الصحة العالمية.

I. Introduction

Groundwater is an important source of water in Sudan and approximately 80% of the citizen used ground water for daily activities, at most times of the year [1]. Ground water resource plays an important role in supporting people live in arid and semi-arid regions and scientists have estimated that about 22.6 million cubic kilometers of groundwater are found in the upper layers of the earth's surface. Groundwater is characterized as water free of disease-causing organisms, so there is no need to purify it before using it, unless it is exposed to chemical or biological pollution.

Groundwater resources represent a large potential for drinking water in Gezira State, while most of the villages and towns depend on groundwater and water from Blue and White Nile for drinking and other domestic uses [2]. Most of the inhabitants are farmers and the area is considered as rural area. However, recently some features of urbanization are observed specially in big villages [1] reported that urbanization and industrial enterprises are main source of the contamination of groundwater. Uncontrolled and excessive use of nitrogen fertilizers is other potential source of contamination [1] .

Safe water is essential for man health. Contamination of water with fecal material is common in areas with poor hygienic standard and lack of sanitation facilities. Such conditions usually lead to prevalence of water borne diseases. Improvement of both drinking water quality and sanitation services represents a powerful mean of prevention of health problems related to water. In Sudan human wastes are disposed on site; either in traditional pit latrine as in most villages or as recently in some big villages in septic tank + injection well. About 55% of population in Sudan used pit latrine for sanitation. However, recently some people start to use injection well for disposing their waste. Disposal of human waste by these methods may lead to leakage of bacteriological

contamination and other pollutants to the groundwater. Contamination is likely to happen since most of the injections well are constructed over shallow unconfined or semi-confined aquifers [1] Assessing the water quality of Tigris river for drinking purpose using water quality index approach has been studied in which all the stations showed unsuitable quality of water for drinking [3].

The effect of Sunlight Exposure on Physicochemical Properties of Plastic Bottled Water at Al-Mogran Station in Khartoum State, Sudan has been reported [4]. Inductively Coupled Plasma Emission Spectroscopy Technique has been used in the study

The Effect of heat and Storage Duration on Physicochemical Properties of Plastic Bottled Water at Sharq El Nile Locality in Khartoum State, Sudan, has been reported [5].

In this paper the microbiological aspect of groundwater in some villages in North of Jazira state in central of Sudan, has been discussed and the rest of the study discusses the physical and chemical properties of drinking water in the villages of Gezira State and will be published elsewhere [6- 7].

2 Study Problem

Drinking water in some areas of Gezira State are suffering from the change in the characters of drinking water as the result of mixing of groundwater with sanitation system.

1.3 Objective

To evaluate the effect of septic tank, injection well and traditional pit latrine on drinking water in some villages of Northern Gezira State.

1.4 Study Area General Description

The study area is within Gezira state, which is located in the central part of Sudan. The state is surrounded by the White Nile River in the west and Dinder and Rahad Rivers in the east and traversed by the Blue Nile River. It lies between by latitudes 14.8860° N, 33.4384° E. The total

area of Gezira is 23.3X10^3 km^2 and the population is 4.65 million approximately. The majority of the population is agro-pastoralists and fewer are urban population (Figure 1).

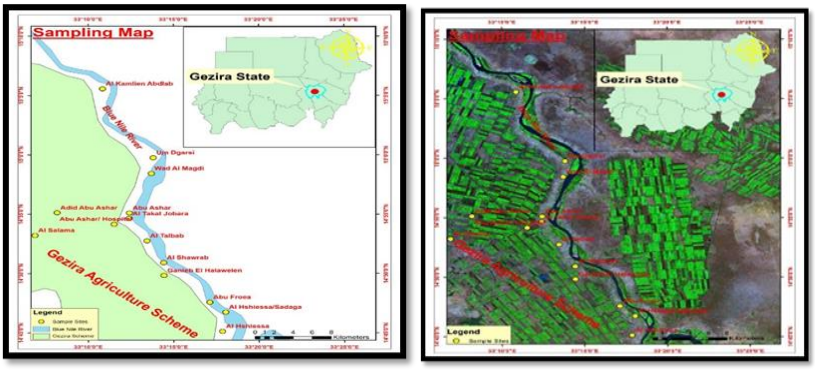

Figure (1): The study Area

2. Materials and Methods

2.1 Bacteriological analysis

2.1.1 Total Counts Bacteria (Colony Count)

Total viable count was carried out using the pour plate technique according to the method described by [9]. Ten ml of each sample was transferred to90 ml of sterile diluents, as a first dilution 10^{-1}, serial dilutions were made up to 10^{-6}. Then one ml from each dilution was transferred aseptically in duplicate into sterile Petri dishes which contain 15 ml of melted plate count agar (45ºC). The Dishes were then thoroughly mixed to facilitate distribution of the sample throughout the medium, the medium was allowed to solidify and plates were incubated at 37 ºC for 48 hours. Colony counter (Labtech) and hand-tally were used for the determination of the total bacterial counts in terms of colony forming units per ml (c.f.u. /ml).

2.1.2 Fecal coliform bacteria and E. *coli*

Method used to determine fecal coliforms in drinking water sample it was the Most Probable Number (MPN) Serial dilutions of (1:10, 1:100, 1:1000etc.) were prepared we picked 1ml of the

sample into 9 ml sterilized distilled water. One milliliter aliquots from each of the dilutions were inoculated into 5ml of MacConkey broth (Nutrient medium) with inverted Durham tubes and incubated at 35ºC for total coli forms tubes showing color change from purple to yellow and gas collected in the Durham tubes after 24 hours were identified as positive for total coli forms. Gas positive tubes were subjected to further analysis with E. C broth and incubated at 44 ºC for 24 hours. EC positive tubes were confirmed presence of *E. coli* was counted

2.2 Suitability of water for drinking

The suitability of groundwater for domestic purposes was evaluated by comparing the values of different water quality parameters with those of the Guidelines for drinking-water quality [8] and Sudanese Standards and Metrology Organization (SSMO) guidelines values for drinking water.

3. Results and Discussions

3.1 Microbiological Quality of Water Samples

Total coliform bacteria, fecal coliform, and *E. coli* are all indicators of drinking water quality. The total coliform group is a large collection of different kinds of bacteria. Fecal coliforms are types of total coliform that mostly exist in feces. *E. coli* is a sub-group of fecal coliform. Detection of total coliform, *E. coli* and fecal Streptococci in these samples was an indication that water was exposed to contamination from human or animal feces.

3.2 Escherichia coli (E.coli)

E. coli is a sub-group of fecal coliform. Fecal coliforms are types of total coliform that mostly exist in feces. Result from Table 1, shows that only eight water resources (25%) recorded zero level of *E. coli* in conformity with the WHO guideline. For water to be considered no risk to human health the *E. coli* in water sample should be zero. Contamination of water with *E. coli* has been reported in study for water quality in Gezira [10] . In all villages which have simple pit latrine (no

Siphon) *E. coli* was not detected except in village N0 23 (Abufroa). In this village the water samples were collected from two water sources. In some part of the village siphon latrine was used (Appendix). This result may indicate there is a possibility that siphon or sanitation system with septic tank and injection well is source of contamination with *E. coli*

3.3 Total coliform (T.C)

Coliform bacteria are organisms that are present in the environment and in the feces of all warm-blooded animals and humans. Coliform bacteria will not likely cause illness. However, their presence in drinking water indicates that disease-causing organisms (pathogens) could be in the water system. Most pathogens that can contaminate water supplies come from the feces of humans or animals. Total coliform bacteria were detected in all samples investigated (Appendix). The highest count was uncountable in three location and the minimum is 600cfu/100ml .

This result in table 1 is in agreement with result reported for ground water examined in Khartoum North [11]; Al Gedarif [12] and Northern Sudan [13]

Table (1): Concentration of *Escherichia coli* and Total coliform in some villages in North Gezira groundwater samples (c.f.u. /ml) and their respective WHO guidelines for drinking water.

	T. Coli	*E. coli*
Mean	17385.6	
Median	5500	
Maximum	Uncountable	23 (+)
Minimum	600	8 (-)
WHO	Shall not be detectable in any 100 ml sample	Shall not be detectable in any 100 ml sample
SSMO	Shall not be detectable in any 100 ml sample	Shall not be detectable in any 100 ml sample
Standard deviation	29698.4	

T.coli = Total coliform; E. Coli = *Escherichia coli* -= Negative; + = Positive

4. Conclusion and Recommendations

Ground water quality in most of the villages in the study area is safe and potable.

Most of the studies physiochemical parameters studies are within the recommended limits of the local, regional and international standards of drinking water. However, in in three villages (Alshawarab, Albataheen, and Abufroa,) the salinity of the ground water is higher than the acceptable concentration.

The ground water in all the villages were contaminated with coli form bacteria Moreover, in villages were septic tank and injection well is common, the ground water is contaminated with E. coli.

This study recommends further research on microbial contamination of ground water and detail studies on the effect of septic tank and injection well on water quality. Establishment of sewage net in different towns of Gazira state, and encouragement of house hold to replace their latrines and septic system by establishing and connecting their system to the general sewage net.

List of Abbreviations

c.f.u. /ml : colony forming units per ml

WHO: World Health Organization

SSMO: Sudanese Standards and Metrology Organization

References

[1] G. Abdo, "Status of Groundwater Quality and Pollution Risk in Sudan", Groundwater Protection Network in the Arab Region IHP, Conference: Technical Documents in Hydrology, Unesco IHO, Unesco Cairo Office At: Unesco Cairo Office publication,14 (2003) Conference paper.

[2] E. A. Farah, Groundwater geology of the northern part of Khartoum Basin (central Sudan) M.Sc. thesis. Dept. of geology, University of Khartoum, Sudan. (1994).

[3] Ibrahim Abdulrazak Al-Ani, Tamara Sidek. 1 Ibrahim Abdulrazak Al-Ani, Tamara Sidek "Assessing the water quality of Tigris river for drinking purpose using water quality index approach, ARID International Journal for Science and Technology (AIJST) 2, No 3 (2019)32-44

[4] Mohammed Awad Elaamerri and Sawsan Ahmed Elhouri Ahmed "Effect of Sunlight Exposure on Physicochemical Properties of Plastic Bottled Water at Al-Mogran Station in Khartoum State, Sudan," ARID International Journal for Science and Technology (AIJST)5, NO.10, (2022)106-143

[5] Mohammed Awad Elaamerri , "The Effect of heat and Storage Duration on Physicochemical Properties of Plastic Bottled Water at Sharq El Nile Locality in Khartoum State, Sudan", AIJST, 6, No. 12(2023) 54-66

[6] W.K. Ahmed" Evaluation of some Drinking Water Qualities in some Villages in Gezira State "(central Sudan), M.Sc. thesis. in Environment Sciences, Institute of Environmental Studies Khartoum University, January (2023).

[7] W.K. Ahmed", Sustainability and trends used to address drinking water challenges. scientific paper, 13th International Scientific Forum, ARID Platform, 30 Oct-03 Nov 2023, Malaysia.

[8] World Health Organization (WHO), Guidelines for drinking- water quality [electronic resource]: incorporating 1st and 2nd addenda, Vol.1, Recommendations. – 3rd ed. 1. Potable water – standards. 2. Water – standards. 3. Water quality – standards. 4. Guidelines. I. World Health Organization. ISBN 978 92 4 154761 1 (WEB version) (NLM classification: WA 675. (2008)

[9] W. F. Harrigan and Margaret F. McCance (Editors), Laboratory Methods in Food and Dairy Microbiology (Revised Edition). 452 S., 24 Abb. London-New York-San Francisco 1976.

[10] A.M. Ell-Amin, A.M.E. Sulieman, and E.A. El-Khalifa, " Quality characteristics of drinking water in Khartoum state and Wad-Medani District", *Sudan. Int.: 14th international water technology conference*, IWTC 14 (2010), Cairo, Egypt. pp 863–876

[11] H.M, Abdel-Magid Abdellah, A.M, Abbkar, S.M. and F.A, Adam, "Assessment of Well drinking Water Quality in Samrab, Dardog ,and Hattab Communities, Khartoum North", *Sudan Journal of Applied Chemistry* , 10(01) (, 2017)32-37 ,DOI:1001023237-5736/10.9790

[12] Zeinab J. Abdel daim, Awad M. Abdel-Rahim, Ali Ahmed Abdulwahab, "Enumeration of Coliform Bacteria and E. coli Contaminating the Drinking Water of Al Gedarif City", Gezira Journal of Engineering and Applied Sciences, (5) No.1(2010)

[13] H. G. Musa, P. Shears S. Karl and S. K. Elsabay, "Water quality and public health in northern Sudan: a study of rural and peri-urban communities", *J. Appl. Microbiol*. 87 (1999) 676–682.

Appendix

Concentration of Total coliform *and Escherichia coli*, in some villages in North Gezira groundwater samples (c.f.u. /ml)

No	Village	High way		Total Coliform	E. colli	Sanitation system
1	ود المحنة	E		1.45×10^4	-Ve	-
2	الكاملين عبد الاب	W		1.5×10^3	-Ve	-
3	الكاملين عبد الاب	W		4.1×10^3	-Ve	-
4	ام دقرسي	E		8.9×10^4	+Ve	+
5	ام دقرسي	E		3.9×10^3	+Ve	+
6	ام دقرسي	E		5.9×10^3	+Ve	+
7	ود الماجدي	E		3.36×10^4	+Ve	+
8	ود الماجدي	E		1.85×10^3	+Ve	+
9	ابوعشر	E		7.25×10^4	+Ve	+
10	الطالباب	E		3.1×10^3	+Ve	+
11	الطالباب	E		5.35×10^4	+Ve	+
12	الطالباب	E		Uncountable	+Ve	+
13	الشاوراب	E		Uncountable	+Ve	+
14	قنب الحلاوين	W		7.5×10^2	+Ve	+
15	الحصاحيصا	W		1.05×10^3	+Ve	+
16	البطاحين	E		1.1×10^3	-Ve	-
17	ابوفروع	E		1.4×10^3	-Ve	+
18	ابوفروع	E		5.5×10^2	+Ve	+
19	ابوعشر المستشفى	W		6.25×10^3	+Ve	+
20	الحصاحيصا	W		1.15×10^5	+Ve	+
21	ابوعشر الري	W		6×10^2	+Ve	+
22	السلمه	W		17×10^2	-Ve	-

23	عديد ابوعشر	W		5.6×10^3	+Ve	+
24	التكله حمد	W		5.3×10^3	-Ve	-
25	الحصاحيصا الصداقة	W		8.3×10^3	+Ve	+
26	ابوعشر التكله جباره	W		9.6×10^3	-Ve	-
27	ابوعشر	E		1.01×10^3	+Ve	+
28	ابوعشر	E		1.26×10^4	+Ve	+
29	ابوعشر	E		Uncountable	+Ve	+
30		E				

E= East & W= West