Volume (2) Issue (2)

20 June 2026

Rawafed Journal of Scientific Studies and Research

Assessment of Groundwater Quality in Eastern Province of Khartoum State, Khartoum, Sudan

Eathar Suliman Osman

(Msc student graduate school,college of water resource engineering, Sudan university of Science and Technology)

Abdelatif Mokhtar Ahmed

(Associate Prof. Department of Geology, College of Science, Sudan university of Science and Technology)

https://doi.org/10.65723/RMSP1951

Abstract:

This work has been carried out in the eastern province of Khartoum state, Sudan.Sixteen bore holes had been used for this study. Physical and chemical analysis had been used to identify the quality of groundwater in the study area.

Physical and chemical analysis results showed that the groundwater is fit for consumption and drinking. Certain groundwater samples in few localities showed high values of TDS (Total Dissolved Solids) such as AlsheqAlameen Om Katara, Alsheq Mustafa Alfadny, Albayada and Alsheq Mustafa Alameenno. 3. Also, Turbidity is high at boreholes no1 (Alsalheen), borehole no3 (AlsheqAlameen Om Katara), borehole no5 (Hay Alhuda) and borehole no6(Ed Alqenaabnorth). For chemical analysis results Albayada and Alsheq Mustafa Alameen 3 showed high values of (chloride).

From Physical and chemical analysis, it is concluded that the groundwater in the study area is fit for drinking and human consumption except at few localities.

Keywords: groundwater quality, physical and chemical analysis

Introduction:

Ground water is water in the zone of saturation where all the voids within a geologic stratum are permanently filled with water (Chapman,1996, Amah, Esu, and Kanu, 2008). Access to safe drinking-water is essential to health, a basic human right and a component of effective policy for health protection (WHO,2008). A person requires about three liters of potable water per day to maintain the essential fluids of the body (Fetter,2007). Groundwater is crucial for the livelihoods and food security of over 1 billion rural households in the poorer regions of Africa and Asia, and for domestic supplies of a large part of the population elsewhere in the world. During the past 50 years, the global groundwater abstraction rate has at least tripled, significantly boosting food production and rural development. It is now a major source of water for human consumption, supplying nearly half of all drinking water in the world.

Groundwater also plays an important role on fault movement, generation and prediction of earthquakes, the development of geothermal system, the thermodynamics of plutons, and the genesis of economic minerals deposits. At depth, groundwater flow system, control the migration and accumulation of petroleum, nearer to the service it plays a major role in such geomorphologic process such as karst formation, natural slope development, stream bed erosion (freeze, and cherry,1997).

Saline water is the most common pollutant in fresh groundwater. Intrusion of saline water occurs where saline water displaces or mixes with freshwater in an aquifer. The phenomenon can occur in deep aquifers with the upward advance of saline waters of geologic origin, in shallow aquifers from surface waste discharges, and in coastal aquifers from an invasion of sea water. The interrelations of two miscible fluids in porous media have been studied extensively both theoretically and under field conditions. (David Keith Todd,1960).

According to the 2012 estimate, it was found that the population of study area is about (956,030) inhabitants. Some of the tribes scattered along the study area are:AL_Shukaria, AL_Hassania, AL_Mughrabia, AL_Mahs, AL_Ja'alin, AL_Danakla, etc. The governorate of study area consists of (Northern country side, Eastern country side and Southern country side). There are many neighborhoods in the study area such as: _ Nasr district, Fayha district, Ed AL_Qunayab North etc.

Water pollution is thus a cosmopolitan problem that needs urgent attention and prevention (Ali, soltan,1996, and Osman,2007). It resulted from many sources, e.g. accidental spillage of chemical wastes, discharge of industrial or sewerage effluents, agricultural drainage, domestic wastewater and gasoline from fishery boots (Handy,1994, Ali and Soltan,1996)

The main objectives of this study are to evaluate the physical and chemical characteristics of well water samples collected from diverse drinking water sources in the study area and to compare the results obtained with the local, regional and international standards and guidelines.

LOCATION AND GEOLOGY:

The area under study is located in the central Sudan and extends from the east bank of the Blue Nile to the east bank of the Nile River and is bordered to the north by the Nile River state and to the east by the states of Gedaref and Kassala (East of the Nile Local). The area under investigation (Fig1), entirely lies in the eastern part of Khartoum state, mainly occupies vast areas of eastern Nile province. The area is bounded between latitudes 15.42° and 15.78°N and longitudes 32.93°E.The area is bounded by the River Nile and Blue Nile from its western side, and is about 400 square kilometers in area (Abdel Latif,1992).

The General geology of the region consist of:1) recent sediments: it is a thin layer of newly formed sediment, formed by crumbed rocks eroded from the substances by erosion.2) Nubiansandstone: it consists of layers of clay and concrete formations with high permeability and porosity which makes it the main water source in the region, and the depths of this layer ranges between (100-150) meters and there are remnants of it scattered on different sides of the mountain range along the area covering the valley of slit to the east, these remnants have been exposed to erosion.3) BasementRocks: they are a group of crystalline rocks or sedimentary origin and represent the non-porous upon which modern sedimentation is based, sediments are hard rocks that do not carry ground water except in some special cases represented by fault lines and erosion areas, where these reservoirs are secondary subterranean specific composition and its water is mostly salty because of the friction of the basement rocks. (East of the Nile local).

The study area is entirely confined to the Nubian sandstone formation. Due to the lack of index fossils, the exact age of the Nubian sandstone is not known. Butpaleontological and stratigraphical evidence collected from elsewhere in the Sudan suggest an upper cretaceous age. The Nubian formation is overlain unconformably by alluvial deposits of the Blue and Main Niles. These deposits occur as a narrow belt fringing the Nile having a maximum width of 8km and a variable thickness of 5-20 km. They consist of ill-sorted clays and silts with sandy and gravelly lenses. The deposits can't be differentiated into distinct stratigraphic units because they lack fossils of definite age. In general, they are considered to be quaternary in age (Whiteman,1971).

In few places the alluvial deposits and the Nubian formation are covered by wind-blown sands and the recent Nile silts. Over the area ground water occurs mainly in the Nubian sandstone formation and the alluvial deposits of the Niles and water is transmitted by intergranular flow (Haggaz and khairalla, 1988). Aquifers of the alluvial deposits and the Nubian formation are believed to be hydraulically interconnected (Khairalla,1966).

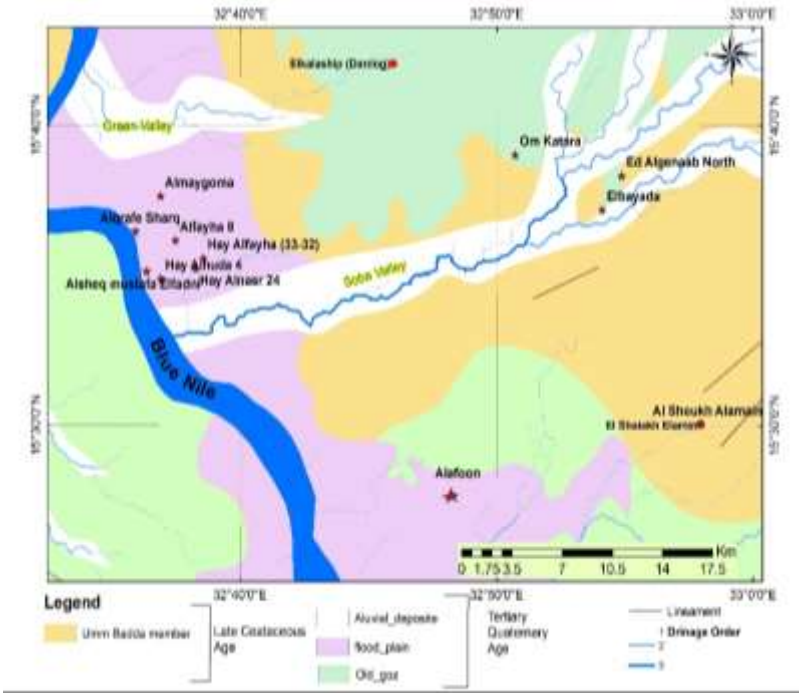

Fig (1): Location of the study area

Materials and Methods:

1)Sampling Techniques

8 bore holes 9 ,GW and 1 HDW within the study area were chosen to carry out this study.

-Standard methods used for sampling

Water samples were collected aseptically in sterile bottles. The opening of the tap was cleaned and sterilized by alcohol and flaming. The tap was opened and first stream was discarded, after two minutes the target sample‘ s location. The bottle was tightly closed and immediately transported to laboratory for chemical and physical analysis.

There are 10 physiochemical analyses for samples were at (Ministry of Water Resources and Electricity) (General Directorate of Groundwater and Wadis P.O. BOX15006 Khartoum). And there are 8 physiochemical analyses for samples were at (Khartoum State Water Corporation (Centeral Laboratory)).

2) Data collection:

There are 8 hydrogeological samples were collected mainly from the (Khartoum state water corporation central laboratory. Chemical and physical analysis of water). And there is other 10 hydrogeological data was collected from (Ministry of water resources and electricity) (General directorate of groundwater and Wadis P.O. BOX15006 Khartoum).

This work depend mainly on the hydrochemical interpretation of the results of chemical analysis of the collection water samples quality in the study area and its suitability for irrigation. This beside investigation of the chemical characteristics and quality of the groundwater.

Results and Discussion:

1) Presentation of Results:

Water quality assessment of the sixteen water samples collected from wells was carried out in order to define the water quality of the individual water sources. Results obtained from the analysis were compared with the World Health Organization (WHO) standard for drinking water, guidelines for Sudanese Standards and Metrology Organization – ISO(SSMO)maximum permissible limits in order to determine the suitability or otherwise of the water sources sampled. According to the World Health Organization (WHO,1984) the quality of water whether used for drinking, domestic purpose, food production or recreational purpose has an important impact on health as poor quality water can cause disease outbreak. The sixteen samples were assessed to determine their Physical and Chemical Characteristics.

2) Discussion of the Results:

A) Discussion of the physical parameters:

Table no 1 provide detailed measurements obtained in the laboratory for the physical parameters such as Turbidity: in Table no. 1 the values of turbidity in the study area are far above WHO standards for drinking water (5NTU), except at three localities (Alfayha square 4(2.22NTU), Alfayha field no (33-32) (2.9NTU) and (Algrafesharqsarhan)(2.37NTU). Hardness also indicates that all the hardness values are far below the WHO guide lines (1984) (500mg/l), except at well no (14) (Alsheq Alameen3) (636mg/l). pHA look at table (1) indicates that all the hardness values are far below the WHO guidelines (1984) (6.5-8.5). E.conductivity: For E.conductivity values in the study area, high values were observed at well no 11 (Albayada) (6700ms/cm) which are far above the standard of WHO (1984) (1400ms/cm), also high

values were observed at well no14 (Alsheq Alameen3) (4910ms/cm) and (Om Katara) (1812ms/cm) at well no 3. TDS: For TDS values in the study area high values were observed at well no 11(Albayada) (4690mg/l) which are far above the standards of WHO (1984) (1000mg/l). Also, high values were observed at (AlsheqAlameen 2) (739.2mg/l) and (Alsheq Mustafa Alfadny) (968.1mg/l) also (Om Katara) at well no 3 (964 mg/l), although they are below standards of who but considered high value

Table 1. Physical composition of Ground water in the study area:

NO	**UNIT**	**NTU**	**TCV**			**Mg/I**	**Mg/I**	**C°**	**IIS/CM**
	Locality	Turbidity	Color	Odor	Ph	TDS	hardness	Temperature	E. conductivity
1	ALsalheen	11.7	-	-	7.7	173	140	31.6	288
2	Hay alrahma-Almaygoma	5.7	-	NIL	7.5	272	200	28.0	495
3	ALsheqALameen Om Katara	11.9	-	NIL	7.3	964	182	23.3	1812
4	ALfayha field no (33-32)	2.9	-	NIL	7.6	195	140	28.9	324
5	Hay ALhuda field no (4)	16.9	-	NIL	7.6	165	128	29.7	300
6	Ed ALgenaab North	21.9	-	NIL	6.5	558	230	30.4	1027
7	ALgrafeSharq Sarhan well	2.37	-	NIL	**7.7**	261	217	27.4	434
8	ALfayha well, no (8)	2.22	-	NIL	7.9	160.8	136	26.6	268
9	ALsheqALameen (2)	-	-	-	7.1	739.2	154	-	1056
10	ALsheq Mustafa ALfadny	-	-	-	8.2	968.1	224	-	1383
11	ALbayada	-	-	-	-	4690	84	-	6700
12	ALalafoon bore hole (1)	-	-	-	-	242.9	152	-	343
13	ALalafoon bore hole (2)	-	-	-	-	287.7	166	-	411
14	ALsheqALameen (3)	-	-	-	8	343.7	636	-	4910
15	ALgrafesharq	-	-	-	-	257.6	198	-	668
16	ALfayha (1)	-	-	-	-	235.9	136	-	337

NO	Unit		Mg/l	Mg/l	Mg/l	Mg/l
	Locality	Appearance	T.S. S	T. Alkalinity	Ph.ph Alkalinity	Phosphate
1	ALsalheen	Turbid	-	146	NIL	0.13
2	Hay alrahma-Almaygoma	Turbid	-	182	NIL	0.13
3	ALsheqALameen Om Katara	Turbid	-	218	NIL	-
4	ALfayha field no (33-32)	Clear	-	164	NIL	0.68
5	Hay ALhuda field no (4)	Turbid	-	114	NIL	0.69
6	Ed ALgenaab North	Turbid	-	204	NIL	-
7	ALgrafeSharqSarhan well	Clear	-	220	NIL	0.13
8	ALfayhawell no (8)	Clear	-	132	NIL	-
9	ALsheqALameen (2)	-	-	378.2	NIL	-
10	ALsheq Mustafa ALfadny	-	-	341.6	NIL	-
11	ALbayada	-	-	488	NIL	-
12	ALalafoon bore hole (1)	-	-	207.4	NIL	-
13	ALalafoon bore hole (2)	-	-	219.6	NIL	-
14	ALsheqALameen (3)	-	-	402.6	NIL	-
15	ALgrafesharq	-	-	274.4	NIL	-
16	ALfayha (1)	-	-	176.8		-

B) Discussion of the Chemical Parameters: -

Table no 2 provide detailed measurements obtained in the laboratory for the chemicalParameters such as Chloride (CL) values in the study area high values were observed at well no 11 (Albayada) (1525.79mg/l) and well no 14 (Alsheq Alameen3) (745.5mg/l) which are far above the standard of WHO (1984) (250mg/l). F (Floride)in Table no 2 the values of Fluoride in the study area are below WHO standards for drinking water (1.5mg/l), except at well no 11 (Albayada) (1.58mg/l). Fe (Iron)in Table no 2 all the values of Iron in the study area are below WHO standards for drinking water (1984) (0.3mg/l). Mn For Manganese values in the study area high values were observed at well no 2 (Hayalrahma-Almaygoma) (0.237mg/l) and well no 7 (Algrafsharg –BerSarhan) (0.166 mg/l) which are far above the standard of WHO (1984) (0.1mg/l).NO3 in table no. 2 all the values of Nitrate in the study area are below WHO standards for drinking water (45mg/l).NO2in table no 2 all the values of Nitrite in the study area are below SSMO standards for drinking water (2mg/l).Ca All the values of Calcium in the study area are below WHO standards for drinking water (100mg/l) except at well no 14(AlsheqAlameen 3) (137.6mg/l).Mg All the values of Magnesium in the study area are below WHO standards for drinking water (50mg/l) except at well no. 14(AlsheqAlameen 3) (70.956 mg/l).NaFor Sodium the values in the study area high values were observed at well no 11 (Albayada) (1680.72mg/l), well no 14 (Alsheq Alameen3) (821.761 mg/l), well no 10 (AlseqAlfadny) (233.327 mg/l) and well no 3 (Om Ktara) (210 mg/l) which are far above the standard of WHO (1984) (200mg/l).

Table (2): Chemical composition of Groundwater in the study area:

NO	UNIT	Mg/I	Mg/I	Mg/I	Mg/I	Mg/I
	Locality	Cl	F	SO_4	NH_3	NO_2
1	ALsalheen	4	0.28	NIL	0.06	0.037
2	Hay alrahma-Almaygoma	20	0.02	30	0.08	0.018
3	ALsheqALameen Om Katara	210	1.44	124	0.04	0.019
4	ALfayha field no (33-32)	5	0.4	NIL	0.32	0.031
5	Hay ALhuda field no 4	11	0.49	11	0.17	0.049
6	Ed ALgenaab North	90	0.08	88	0.27	0.083
7	ALgrafeSharqSarhan well	6	0.21	5	0.34	0.033
8	ALfayhawell no (8)	5	0.09	2	0.31	0.036
9	ALsheqALameen (2)	16.898	1.01	90	0	0.0363
10	ALsheq Mustafa ALfadny	176.932	1.14	215	0	0.0495
11	ALbayada	1525.79	1.58	760	0	0.0099
12	ALalafoon bore hole (1)	23.856	0.13	15	0	0.02673
13	ALalafoon bore hole (2)	23.856	0.12	26	0	0.01155
14	ALsheqALameen (3)	745.5	0.89	1000	0.0244	0.0066
15	ALgrafesharq	12.922	0.01	5	0.183	0.099
16	ALfayha (1)	19.88	0.4	15	0.0244	0.0594

NO	UNIT	Mg/I	Mg/I	Mg/I	Mg/I	Mg/I	Mg/I	Mg/I
	Locality	NO_3	Fe	Ca	Mg	Na	k	Mn
1	ALsalheen	1.7	0.04	32	14.4	8.7	2.1	0.075
2	Hay alrahma-Almaygoma	3.7	0.02	44	21.6	18.9	3.7	0.237
3	ALsheqALameen Om Katara	4.8	0.11	33.6	23.52	210	18	-
4	ALfayha field no (33-32)	3.9	0.18	31.2	14.88	13.6	1.2	0.085
5	Hay ALhuda field no (4)	7.4	0.15	31.2	12	10.6	2.2	0.06
6	Ed ALgenaab North	9.5	NIL	57.6	20.64	79	12.6	0.033
7	ALgrafeSharqSarhan well	1.8	0.05	52.8	20.4	9.9	2.6	0.166
8	ALfayhawell no (8)	9.9	26.6	34.4	12	7.5	1.4	-
9	ALsheqALameen (2)	4.4	-	33.6	17.01	171.156	-	-
10	ALsheq Mustafa ALfadny	8.36	-	42.4	28.674	233.327	-	-
11	ALbayada	14.96	-	20	8.262	1680.72	-	-
12	ALalafoon bore hole (1)	3.52	-	32	17.496	41.328	-	-

13	ALalafoon bore hole (2)	7.92	-	32.8	20.412	34.433	-	-
14	ALsheqALameen (3)	6.6	-	137.6	70.956	821.761	-	-
15	ALgrafesharq	4.84	-	26.4	32.076	20.961	-	-
16	ALfayha (1)	8.8	-	30.4	14.58	19.23	-	-

Conclusions and Recommendations:

1) Conclusion: -

The increasing availability of water resources and increasing water demand make the assessment of water resources extremely important for sustainable development. The area under study is located in the central Sudan and extends from the east bank of the Blue Nile to the east bank of the Nile River and is bordered to the north by the Nile River state and to the east by the states of Gedaref and Kassala. General geology of the region include: Recent sediments, Gezira Formation, Nubian sandstone, Basement Rocks. The Global Positioning System (GPS) was used to determine the locations, coordinates, and elevations of the wells. The Surfer (13) is used for display spatial data, analyze it and prepare the maps as base maps, geologic maps, and maps showing the locations of boreholes, and groundwater samples. According to the physical and chemical results of the groundwater in the study area the results showed that the water is fit for human consumption and domestic uses. Some of the groundwater wells show high values of TDS (Total Dissolved Solid) such as well no 3 (AlsheqAlameen Om Katara), well no 10 (Alsheq Mustafa Alfadny), well no 11(Albayada), and well no 14 (Alsheq Mustafa Alameen 3). Hardness of the water in the study area is suitable except at well no14(Alsheq Mustafa Alameen 3). Generally, all groundwater wells are fit for human uses except at certain localities such as well no 10) Alsheq Mustafa Alfadny), well no 11(Albayada), and well no 14 (Alsheq Mustafa Alameen 3).

2) Recommendation: -

- To improve the lifestyle in the study area, the main recommendation is to avoid drinking water of low quality. There are some recommendations for future groundwater studies in the study area.
- The geophysical well logging should be carried for the boreholes to demarcate the water saturated layers and their water quality
- To obtain more accurate and reliable results, advance technology and the latest software for groundwater research are recommended. (Groundwater modelling technique).
- It is recommended that the water at certain wells such as well no10 (Alsheq Mustafa Alfadny), 11(Albayada), and well no 14 (Alsheq Mustafa Alameen 3) should be treated to be fit for human uses.
-Further research should be carried out for the treatment of removal of high TDS (Total Dissolved Solid). Also, for presence of Na (Sodium) for removal at well no11 (Albayada).

References:

Ahmed, A. M. (1992). Some Aspects of ground water Quality in Eastern Khartoum Area. M.Sc. thesis, University of Khartoum.

Ahmed, A. M., Sulaiman, W. N., Osman, M. M., Saeed, E. M. and Mohamed, Y. A. (2000). Groundwater Quality in Khartoum State, Sudan. *The Electronic Journal of the International Association for Environmental Hydrology,* **8**: 1-7.

Amah, E. A. and Agbebia, M. A. (2015). Determination of Groundwater Flow Direction in Ekintae Limestone Quarry Near Mfamosig, South Eastern, Nigeria. *International Journal of geology, Agriculture and Environmental Sciences,* **3**: 1-5.

Osman, A. G. and Kloas, W. (2010). Water Quality and Heavy Metal Monitoring in Water, Sediments, and Tissues of the African catfish clarias gariepinus (Burchell, 1822) from the River Nile, Egypt. *Journal of Environmental Protection*, **1**: 389-400.

Todd, D. K. (1980). Ground Water Hydrology. NewYork, John Wiley. Pp.11.

WHO (2008). Guidelines for drinking water quality, World Health Organization, Geneva.