QUALITY ASSESSMENT OF RAISING GROUNDWATER IN WATER LOGGING AREAS IN ASWAN CITY

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ABSTRACT

Aswan is considered one of the important Egyptian Governorates as it represents the southern gate to Egypt. Moreover, the existences of Aswan High Dam which represent a strategic element of the Egyptian country give this city high importance. The present study deals with the quality assessing the rising groundwater the aquifer into the logged areas in Aswan city using Water Quality Index approach and gives a recommendation for using water for drinking. Eight water samples are collected between December 2016 to June 2017 Physio-chemical parameter are estimated and processed according to Standard Methods for the Examination of Water and Wastewater (21st edition – SMWW). According to the international standards of assessing water quality for drinking and irrigation uses and national laws and rules for using and discharge of groundwater and drainage water into the River Nile or irrigation Canal. TDS in the rising groundwater is relatively high; it ranged from 235 to 6794 mg/l. It also has a highly polluting effect on water quality. It has nitrate concentration ranges from 0.2,82 to 204.59 mg/l. Samples of Alnubalaa graveyard, Kima leakage, and Leakage behind Spanish bazar samples show characters showed WQI of 71.2, 79.1, and 57.2 respectively, that resemble to be river Nile water or irrigated water and cannot be used for drinking. Groundwater sample was collected from Alshallal well has 86.9 WQI. It can be used as drinking water after some disinfection treatment with chlorine. other sites have WQI (drinking water- raw water) {Al Hasaya House (23.8-31.1), Aldamas Leakage House (38.5-45), Alsail House (16-27.1) and Khor awada House (24.3-26)} have WQI for (drinking water- raw water),

show bad criteria compared to drinking water standards and raw water standards and can be recommended doing some treatment before discharging to River Nile or using in irrigation.
Key words: and Phrases: Water Quality, groundwater, Water Quality Index, drinking water, River Nile, raised groundwater in logged areas, deep well.

INTRODUCTION

Environmental pollution problems are one of the most serious national problems which require great efforts at all levels; either, national and international. This is especially true with respect to pollution of rivers because they serve as the recipient of urban and rural wastewater. Water quality issues have become of major concern to all agencies dealing with water resources management and planning. This requires data collection, analysis, and interpretation. One major goal of surface water quality data collection may be the estimation of the magnitude of changes in the concentration of various constituents (Yehia and Sabae., 2011).

Human activities mainly impact surface water and groundwater quality through effluent discharges, using agricultural chemicals, in addition to the increased exploitation of water resources. Many rivers in the developing countries are heavily polluted due to anthropogenic activities (Jonnalagadda and Mgere 2011).

Over the last few years, a steady rise in groundwater levels has been observed in several parts of Aswan City. This reflect environmental problems existing in many areas of the city, where it creates swamps, logged areas and ponds and affects the foundation of many buildings as it appears in El-Seil, Khor Awada, Phantomic graves, El-Aqad buildings, Blood Bank, Military building, El Shallal and KIMA Factory area. Rising groundwater levels in

water logged areas are expected to be a chronic problem and will likely be a major issue for residential areas of Aswan city (Selim *et al*., 2014).

Water quality index (WQI) is considered as one of the most effective tools which can be used to evaluate the water quality status for drinking using a single value indicating the overall quality of water that describes the status of water quality to the public as well as decision and policy makers. It is based on the ensemble of the records of physical, chemical and biological parameters of the water body using specific methods (Elshemy *et al.*, 2016).

The present study deals with the following:

1. The status of the rising groundwater in logged areas resources in Aswan city.
2. Assessing the quality of the groundwater for drinking in Aswan City using Water Quality Index approach.
3. Providing a recommendation for the treatment of water resources environmental pollution.

MATERIAL AND METHODS

Water quality assessment is carried out through sampling 8 water samples collected three times between December 2016 and June 2017 and running physiochemical analyses. These samples are distributed along the study area and representing different water types (Rising groundwater in logged areas and Deep groundwater in wells. Rising groundwater (Samples in logged areas) samples were collected from 8 sites (Figure1). These sites are Al Hasaya House, Alsail House, Khor awada House, Berket Aldamas

Leakage House, Alnubalaa graveyard, Kima Leakage, Well 5 Alshallal water plant and Leakage behind Spanish bazar.

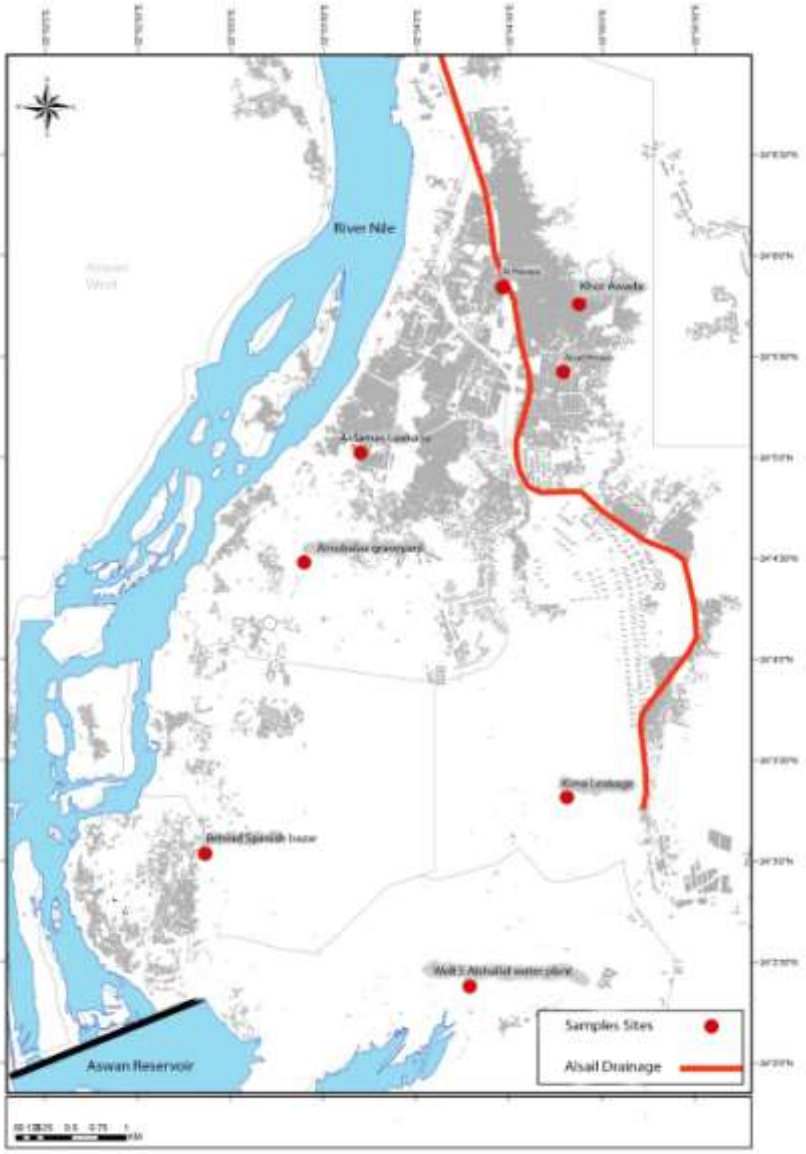


Figure (1): sampling points and water logging areas

Sampling and onsite field measurements are done according to the international standards. Eight samples are collected from waterlogged areas (rising groundwater). Before measuring the field parameters for water quality (pH, E.C., Temp, O2 and residual chlorine) the site is pumped subjected to pumping to reach the steady state for measurements of EC and temperature.

Samples are collected and analysed according to Standard Methods for the Examination of Water and Wastewater 21st edition - SMWW. (Eaton *et al*, 1998) As well as the Canadian Water Quality Index (WQI) from Canadian Council of Ministers of the Environment (CCME) by using equation to indicate water quality according to several standards including drinking water standard, aquifers standard and river raw water standard. (CCME, 2017)

WQI Calculation of the CCME: The water quality index (WQI) were developed by the CCME and employs the combination of three essential measures of variance such as scope, frequency, and amplitude. Detailed calculation procedures and classification are explained in Canadian Water Quality Index 1.0 – Technical report as follows [10].

Scope (F_1) represents the extent of water quality guideline non-compliance over the time period of interest. F1 is expressed as indicated in Equation 01.

$$F_1 = \frac{Number\ of\ failed\ variables}{Total\ number\ of\ variables} \times 100 \qquad \text{Equation 01}$$

Frequency (F_2) represents the percentage of individual tests that do not meet the guidelines called “failed tests” as expressed in Equation 02.

$$F_2 = \frac{Number\ of\ failed\ tests}{Total\ number\ of\ tests} \times 100 \qquad \text{Equation 02}$$

Amplitude (F_3) represents the amount by which failed test values do not meet their guidelines. Amplitude is calculated in three steps.

i. The number of times by which an individual concentration is greater than (or less than, when the guideline is a minimum) the objective is termed an "excursion" and is expressed as follows. When the test value must not exceed the objective (Equation 03)

$$excursion_i = \frac{Failed\ test\ value\ i}{Objective\ /guideline\ i} - 1 \qquad \text{Equation 03}$$

For the cases in which the test value must not fall below the objective (Equation 04)

$$excursioni = \frac{Objective\ /guideline\ i}{Failed\ test\ value\ i} - 1 \qquad \text{Equation 04}$$

ii. The collective amount by which individual tests are out of compliance is calculated by summing the excursions of individual tests from their objectives and dividing by the total number of tests (both those meeting objectives and those not meeting objectives). This variable referred to as the normalized sum of excursions, (nse) is calculated as Equation 05.

$$nse = \frac{\sum_{i=1}^{n} excursion\ i}{Number\ of\ tests} \qquad \text{Equation 05}$$

iii. The amplitude F3 is calculated by an asymptotic function that scales the normalized sum of the excursions from objectives (nse) to yield a range between 0 and 100. Mathematically, F3 is expressed as indicated in Equation 06.

$$F_3 = \frac{nse}{0.01nse + 0.01} \qquad \text{Equation 06}$$

The CCME WQI is then calculated as,

$$CCME\ WQI = 100 - \frac{\sqrt{f1^2 + f2^2 + f3^2}}{1.732}$$ Equation 07

CCME WQI value has been determined, water quality can be ranked by relating it to one of the following categories

CCME WQI guide line				
Poor	**Marginal**	**Fair**	**Good**	**Excellent**
(CCME WQI Value 0-44) – water quality is almost always threatened or impaired; conditions usually depart from natural or desirable levels.	(CCME WQI Value 45-64) – water quality is frequently threatened or impaired; conditions often depart from natural or desirable levels.	(CCME WQI Value 65-79) – water quality is usually protected but occasionally threatened or impaired; conditions sometimes depart from natural or desirable levels.	(CCME WQI Value 80-94) – water quality is protected with only a minor degree of threat or impairment; conditions rarely depart from natural or desirable levels.	(CCME WQI Value 95-100) – water quality is protected with a virtual absence of threat or impairment; conditions very close to natural or pristine levels. These index values can only be obtained if all measurements are within objectives virtually all of the time.

RESULTS

Results for water quality analyses including both physico-chemical and microbiological parameters are shown in Tables (1,2 and 3) during the period from December 2016 to June 2017. There is a significant difference between water quality of rising groundwater in the logged areas and that from deep

groundwater (wells) which has fresh groundwater with a TDS average 258 mg/l. The water TDS in the leakage is relatively high; it ranged from 235 to 6794 mg/l. It is highly polluted; the nitrate concentration ranges from 0.2.82 to 204.59 mg/l.

Table (1): Physico-chemical and microbiological characteristics of rising groundwater samples in some area of Aswan city

Sampling date		**12/2016**							
Sampling Location		**Al Hasaya House**	**Alsail House**	**Khor awada House**	**Aldamas Leakage House**	**Alnubalaa graveyard**	**Kima Leakage**	**Well 5 Alshallal water plant**	**Leakage behind spanish bazar**
Parameter	Unit								
pH	-	8.4	8.1	8.1	8.5	7.8	6.9	7.1	6.4
Electrical Conductivity	µS/cm	10020	2690	3700	1094	344	557	434	1108
TDS	mg/L	6015	1610	2220	660	210	335	262	665
T. Hardness	mg/L	260	483	235	91	100	132	157	71
Sodium	mg/L	2196	340	701	187	27	53	20	231
Potassium	mg/L	85	23	19	33	4	6	4	2
Chloride	mg/L	1511	425	531	75	11	33	7	48
Sulfate	mg/L	3340	487	860	121	19	43	15	117
Iron	mg/L	0.145	0.325	<0.05	0.075	0.218	<0.05	0.064	0.355
Manganese	mg/L	<0.025	<0.025	<0.025	<0.025	<0.025	0.042	0.107	<0.025
Nitrate	mg/L	2.8	187.1	168.9	24.7	4.2	2.5	0.73	0.71
Nitrite	mg/L	ND	0.29	0.29	0.1	0.07	0.07	0.15	0.06
Fluoride	mg/L	0.83	0.35	0.62	0.59	0.46	0.4	0.32	3
Ammonia	mg/L	0.61	0.83	0.88	0.61	0.53	0.58	0.69	ND
Total Bacterial Counts	CFU/ mL	11540	25080	13250	26790	6560	25370	40	27220

Table (2): Physico-chemical and microbiological characteristics of rising groundwater samples in some area of Aswan city

Sampling date		**03/2017**							
Sampling Location		**Al Hasaya House**	**Alsail House**	**Khor awada House**	**Aldamas Leakage House**	**Alnubalaa graveyard**	**Kima Leakage**	**Well 5 Alshallal water plant**	**Leakage behind spanish bazar**
Parameter	**Unit**								
pH	-	8	8.1	8.2	8.4	7.3	7	7.2	6.3
Electrical Conductivity	µS/cm	11301	3040	4181	1236	389	629	422	1252
TDS	mg/L	6781	1824	2509	742	233	378	253	751
T. Hardness	mg/L	286	546	261	103	114	139	155	79
Sodium	mg/L	2471	376	784	211	33	57	20	259
Potassium	mg/L	91	27	22	37	6	8	5	51
Chloride	mg/L	1705	481	605	85	12	35	8	55
Sulfate	mg/L	3770	541	981	137	23	49	14	134
Iron	mg/L	0.164	0.690	<0.05	0.085	0.239	<0.05	0.061	0.405
Manganese	mg/L	<0.025	<0.025	<0.025	<0.025	<0.025	0.06	0.11	<0.025
Nitrate	mg/L	3.13	201.36	188.92	27.91	4.61	2.81	0.71	0.81
Nitrite	mg/L	ND	0.31	0.31	0.11	0.07	0.09	0.16	0.08
Fluoride	mg/L	0.91	0.39	0.68	0.67	0.50	0.43	0.33	3.41
Ammonia	mg/L	0.66	0.88	0.91	0.69	0.59	0.61	0.68	ND
Total Bacterial Counts	CFU/ mL	11430	24320	12980	27450	6140	26510	33	27670

Table (3): Physico-chemical and microbiological characteristics of rising groundwater samples in some area of Aswan city

Sampling date		**06/2017**							
Sampling Location		**Al Hasaya House**	**Alsail House**	**Khor awada House**	**Aldamas Leakage House**	**Almubalaa graveyard**	**Kima Leakage**	**Alshallal water plant**	**Well 5 bazar**	**Leakage behind spanish**
Parameter	**Unit**								
pH	-	8.1	8	8.1	8.4	7.5	7.1	7	6.2
Electrical Conductivity	µS/cm	12645.82	3401.42	4678.54	1383.33	434.98	704.31	429.0	1401.03
TDS	mg/L	7587	2041	2807	830	261	423	257	841
T. Hardness	mg/L	320	611	292	115	128	156	154	88
Sodium	mg/L	2765	421	877	236	37	64	21	290
Potassium	mg/L	102	30	25	42	7	9	4	57
Chloride	mg/L	1908	538	677	95	13	39	7	62
Sulfate	mg/L	4219	605	1098	153	26	54	16	150
Iron	mg/L	0.18	0.77	<0.05	0.09	0.27	<0.05	0.07	0.45
Manganese	mg/L	<0.025	<0.025	<0.025	<0.025	<0.025	0.07	0.13	<0.025
Nitrate	mg/L	3.50	225.32	211.40	31.23	5.16	3.14	0.74	0.91
Nitrite	mg/L	ND	0.35	0.35	0.13	0.08	0.10	0.17	0.09
Fluoride	mg/L	1.02	0.44	0.76	0.75	0.56	0.48	0.35	3.82
Ammonia	mg/L	0.74	0.98	1.02	0.77	0.66	0.68	0.76	ND
Total Bacterial Counts	CFU/mL	12790	27214	14525	30717	6871	29665	37	30963

Table (4): Physico-chemical and microbiological characteristics of rising groundwater samples in water logged areas in Aswan city (Average of three samples ±SD) SD = Standard Deviation

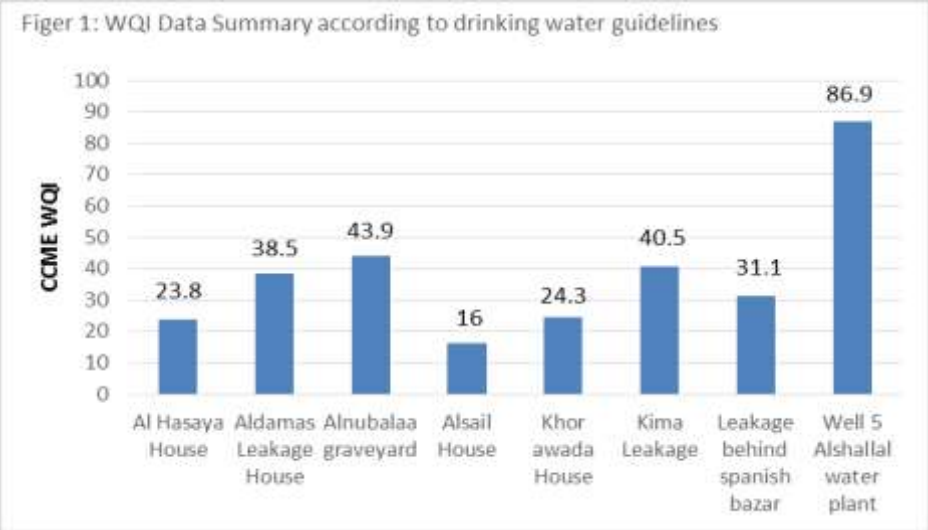
Sampling Location		Al Hasaya House	Alsail House	Khor awada House	Aldamas Leakage House	Alnubalaa graveyard	Kima Leakage	Well 5 Alshallal water plant	Leakage behind spanish bazar
Parameter	**Unit**								
pH	-	8.2	8.1	8.1	8.4	7.5	7.0	7.1	6.3
E.C.	µS/cm	11322	3044	4187	1238	389	630	428	1254
TDS	mg/L	6794	1825	2512	744	235	378	258	752
T. Hardness	mg/L	289	547	263	103	114	142	155	79
Sodium	mg/L	2477	379	787	212	32	58	20	260
Potassium	mg/L	93	27	22	37	6	8	4	37
Chloride	mg/L	1708	481	604	85	12	36	7	55
Sulfate	mg/L	3776	544	980	137	23	49	15	134
Iron	mg/L	0.164	0.596	<0.05	0.085	0.241	<0.05	0.064	0.404
Manganese	mg/L	<0.025	<0.025	<0.025	<0.025	<0.025	0.06	0.11	<0.025
Nitrate	mg/L	3.14	204.59	189.74	27.95	4.66	2.82	0.73	0.81
Nitrite	mg/L	ND	0.315	0.316	0.113	0.073	0.087	0.16	0.077
Fluoride	mg/L	0.92	0.39	0.69	0.67	0.51	0.44	0.33	3.41
Ammonia	mg/L	0.67	0.90	0.94	0.69	0.59	0.62	0.71	ND
Total Bacterial Counts	CFU/mL	11920	25538	13585	28319	6524	27182	37	28618

Table (5): Statistical Calculation of parameters (in ppm)

	Minimum	Maximum	Mean	Median	STD
pH	6.3	8.4	7.6	7.8	0.739
Electrical Conductivity	389.2	11322.3	2811.5	1245.8	3695.282
TDS	234.7	6794.4	1687.3	748.1	2217.225
T. Hardness	79.5	546.5	211.5	148.8	154.695
Sodium	20.3	2477.3	528.2	235.8	826.859
Potassium	4.333	92.610	29.101	24.305	28.893
Chloride	7.333	1708.0	373.6	69.9	586.677
Sulfate	14.9	3776.2	707.1	135.3	1284.822
Iron	0.064	0.596	0.259	0.203	0.206
Manganese	0.056	0.114	0.085	0.085	0.041
Nitrate	0.727	204.594	54.305	3.900	88.713
Nitrite	0.073	0.316	0.163	0.113	0.108
Fluoride	0.333	3.409	0.919	0.587	1.024
Ammonia	0.593	0.936	0.732	0.690	0.133
Total Bacterial Counts	37	28618	17715	19561	11152

Table (6): WQI Data Summary according to drinking water guidelines

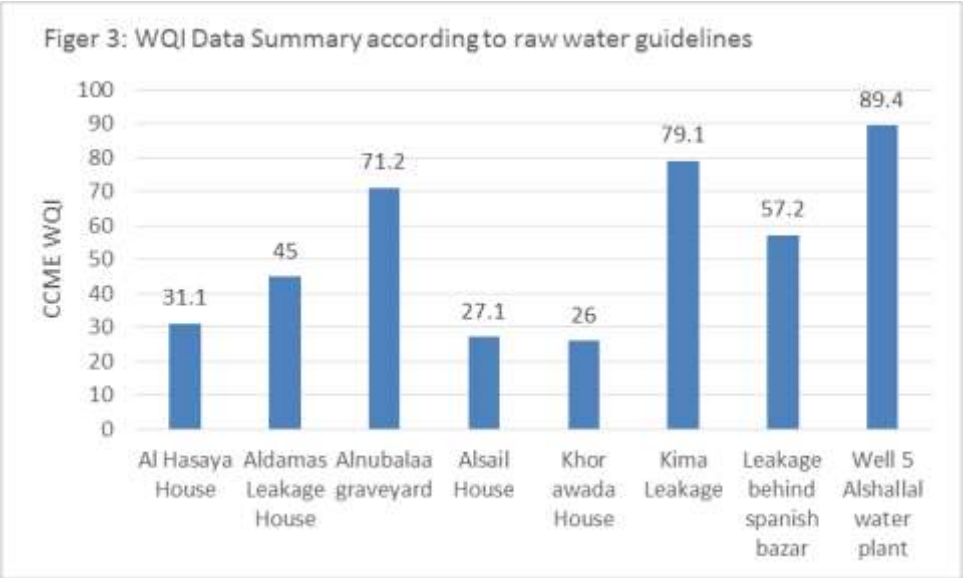
Station	Index Period	CCME WQI	WQI Category
Al Hasaya House	2016-2017	23.8	POOR
Aldamas Leakage House	2016-2017	38.5	POOR
Alnubalaa graveyard	2016-2017	43.9	POOR
Alsail House	2016-2017	16	POOR
Khor awada House	2016-2017	24.3	POOR
Kima Leakage	2016-2017	40.5	POOR
Leakage behind spanish bazar	2016-2017	31.1	POOR
Well 5 Alshallal water plant	2016-2017	86.9	Good



From the water quality index calculation in (Table 3 and Figure 1) all water in the logged areasare poor to drinking water criteria all raised location (Al Hasaya House, Aldamas Leakage House, Alnubalaa graveyard, Alsail House, Khor awada House, Kima Leakage, Leakage behind and Spanish bazar failed in nitrate, ammonia and total bacterial count but the sample from well 5 groundwater show good criteria to drinking water.

Table (7): WQI Data Summary according to raw water guidelines

Station	Index Period	CCME WQI	WQI Category
Al Hasaya House	2016-2017	31.1	POOR
Aldamas Leakage House	2016-2017	45	MARGINAL
Alnubalaa graveyard	2016-2017	71.2	FAIR
Alsail House	2016-2017	27.1	POOR
Khor awada House	2016-2017	26	POOR
Kima Leakage	2016-2017	79.1	FAIR
Leakage behind spanish bazar	2016-2017	57.2	MARGINAL
Well 5 Alshallal water plant	2016-2017	89.4	GOOD



Depending on raw water criteria and data from WQI calculation (table 4) it was found that Alnubalaa graveyard, Kima leakage and well 5 in Alshallal water plant are good for discharge into the river or use in irrigation. Leakage behind Spanish bazar is marginal because it is low in pH and has value in TDS and fluoride exceeds the standard value.

CONCLUSION

8 Water samples are collected from the different location, in logged areas in Aswan City three times between Decembers 2016 and June 2017 they are assesssed, using Canadian Water Quality Index (CCME) equations to indicate water quality according to drinking water standard and river raw water standard. The water samples were collected from houses Alnubalaa graveyard, Kima leakage, and Leakage behind Spanish bazar have chemical and bacteriological characters near to be river Nile water but it cannot use for drinking.

According to the international standards of assessing water quality for drinking and irrigation uses and national laws and rules for using and discharge of groundwater and drainage water into the River Nile or irrigation Canal.

The Water samples collected from groundwater in the quantity aquifers can be used for drinking water after some disinfection treatment with chlorine.

Other sites of logged areas such as Al Hasaya House, Aldamas Leakage House Alsail House, and Khor awada House the collected water samples bad criteria comparing to drinking water standard and raw water standers and they need for treatment before discharging it to River Nile or using for irrigation.

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قانون رقم ٤٨ لسنة ١٩٨٢ للصرف على الخزانات الجوفية وفروع وروافد النيل والمجري الرئيسي لنهر النيل والمصارف البلدية والصنعية.

قرار وزارى رقم ٩٢ لسنة ٢٠١٣ بشأن تعديل اللائحة التنفيذية لقانون ٤٨ لسنة ١٩٨٢ فى شأن حماية نهر النيل والمجارى المائية

قرار رقم ٤٥٨ لسنة ٢٠٠٧ الحدود القصوي للمعايير والمواصفات الواجب توافرها في المياه الصالحة للشرب والاستخدام المنزلي

تقييم جودة المياه الجوفية المرتفعة في بعض المناطق بمدينة أسوان

[١]

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المستخلص

تعتبر أسوان واحدة من أهم محافظات مصر لأنها تمثل البوابة الجنوبية لمصر. علاوة على ذلك، فإن وجود سد أسوان العالي الذي يمثل عنصرا استراتيجيا للدولة المصرية يعطي أهمية كبيرة لهذه المدينة. يهدف تقييم جودة المياه الجوفية المتصاعدة في مدينة أسوان إلى دراسة وتقييم جودة موارد المياه الجوفية في مدينة أسوان باستخدام مؤشر جودة المياه وإعطاء توصيات حول هذه المشكلة. تم جمع ثمان عينات من المياه خلال الفترة من ديسمبر ٢٠١٦ إلى يونيو ٢٠١٧، وإجراء تحاليل فيزيائية–كيميائية وفقًا لـ (الطرق القياسية لفحص المياه والصرف الصحي، الطبعة ٢١ – SMWW). أظهرت النتائج الفرق بين جودة المياه في المياه الجوفية المتصاعدة ارتفاعًا نسبيًا في الأملاح الكلية الذائبة تراوحت من ٢٣٥ إلى ٦٧٩٤ ملغ / لتر وجودة المياه في آبار المياه الجوفية العميقة التي تحتوي على نسبة املاح كلية ذائبة 258 ملغم / لتر، حيث أن لها تأثيرًا كبيرًا على جودة المياه، ويرتفع تركيز بعض الملوثات مثل النترات من ٠,٢,٨٢ إلى ٢٠٤,٥٩ مليجرام في اللتر. المياه التي تم تجميعها من مقبرة النبلاء وبركة مصنع كيما وخلف البازار الإسباني تظهر مؤشر جودة 71.2 و ٧٩,١ و ٥٧,٢ تظهر صفات قريبة من مياه النيل او المياه التي تستخدم للزراعة ولا يمكن استخدامها للشرب ، العينات التي تم جمعها من آبار محطة الشلال أعطت مؤشر جودة ٨٦,٩ أي يمكن استخدامها للشرب مباشرة بعد التطهير بالكلور ، المواقع الأخرى لديها مؤشر جودة (مياه الشرب – المياه الخام) علي التوالي {منزل بمنطقة الحصايا (31.1–23.8)، منزل بمنطقة الدماس–38.5) (45، منزل بمنطقة السيل (١٦–٢٧,١) منزل بمنطقة خور عواضة (٢٤–٣–٢٦)} ، ويظهران معايير سيئة مقارنة بالمواصفات القياسية لمياه الشرب ومعايير الصرف علي المجاري المائية، حيث يوصي بالقيام ببعض المعالجة قبل الصرف إلى نهر النيل أو أي جري مائي أو الاستخدام في الري.

كلمات دالة: جودة المياه – مؤشر جودة المياه – مياه الشرب – نهر النيل – ارتفاع المياه الجوفية – الخزان الجوفي – الآبار العميقة.