DIFFERENT POLLUTANT MONITORING IN QARUN LAKE

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ABSTRACT

The presence of pollutants in the lakes considers the most common problem facing consumers. So, the aim of this study was to monitor the physiochemical, bacteriological properties of Qarun lake. It is a closed saline lake in the northern part of El-Fayoum Depression (Middle Egypt) at the margin of the Great Western Desert. During the 20th century, lake water salinity has increased strongly as a result of high evaporation rate. Also fish productivity decreased strongly. It receives agricultural and domestic non-treated drainage waters, which are also used for aquaculture in Qarun area. The study aimed to know the state of the lake and monitored the effect of agricultural drainages and domestic on the concentration of pollutants. The Physiochemical, bacteriological and some heavy metals monitored during the summer of 2017 to compare it with the previous results of the lake.

The study proved that the lake suffering pollution by heavy metals as Cd (0.0034mg/l), Zn (1.091mg/l) at Al-Bats drain, NH_3 (0.58 mg/l), PO_4^{-3}(1.38mg/l), COD (292mg/l) and BOD (71mg/l) at Al-Wadi drain. Therefore, it is necessary to put an environmental policy to control this pollution.

Keywords: Qarun, Heavy metals, Water, Physiochemical, Bacteriological, lakes.

INTRODUCTION

Lake Qarun is one of the oldest lakes in Egypt and was known to the ancient Egyptians by the Sea of Morris (the Great Lake). The third largest lake in Egypt, located in Fayoum on the edge of the Western Desert about 90 km south of Cairo. Fayoum is not far from the Nile Valley, it is one of the most important natural monuments in Egypt and a resource that has helped to support human culture for 8000 years. (Fathi and Flower, 2005)

It works as a store for agricultural water and sewage in Fayoum governorate. It receives agricultural drainage water constantly, controlling the area and volume. (Abu-Salama, 2007)

The lake receives sewage and agricultural water through a system of twelve banks. Most of the wastewater reaches the lake through two main banks, El-Batts and El-Wadi, while there are small drains pouring sewage in the lake by hydraulic pumps but small amounts. (Dardir and Wali, 2009)

The main water sources in the lake are also from agricultural drainage and domestic wastewater (Abdel-Satar *et al.*, 2010). Therefore, increases salinity gradually which greatly affects living organisms in the lake, in addition to aggravation enrich the lake water caused by it load of nutrients from agricultural wastewater. (Ibrahim and Ramzy, 2013)

Lake Qarun receiving about 450 million cubic meters annually of agricultural drainage water, which is almost reserves of lost lake water per year evaporation, leading to a gradual increase in salinity and adverse effects on the lake environment, for example, it animals and plants (Hassan, 2015). The lake received about 226.3 and 100.84 million cubic meters of sewage from Al-Wadi and Al-Batts drainages, respectively. (El-Sherif *et al.*, 2016)

Lake Qarun is one of the most important aquatic lives. As well as its importance as natural drainage Fayoum Governorate, the lake is an important place to Fisheries, salt production, tourism and migratory birds Seasons of autumn and winter (Barakat *et al.*, 2017). So it was the Qarun area Nature reserve declared in accordance with the provisions Law No. 102 of 1983, by Presidential Decree No. 943/1989. (El Naby *et al.*, 2018)

Monitoring the concentration of heavy metals and assessing their levels of pollution in the sediments of Lake Qarun critical and critical issues to ensure a sustainable ecosystem that works well in the future (Williams, 2018). The aim of this work is to assess the physiochemical, bacteriological and some heavy metals in water from different sampling points to assess the degree of pollution.

MATERIALS AND METHODS

Study area: Lake Qarun is a long closed salt basin located between longitudes 30° 24 & 30° 49 E. and Latitudes are 29 °24 and 29 °33 N. at the bottom of the Fayoum depression, about 80 km Southwest of Cairo (Abdel Wahed, 2015). It has irregular shape about 40 km long About 6 km average width, with about average area 240 km^2 and the volume of 924 million cubic meters. The lake is shallow, with an average depth of 4.2 meters, and about 20% of the lake is between 5 and 8 meters deep. Water level fluctuation of the lake is between 43 and 45 meters below sea level. (Embabi, 2017)

Chemicals: The reagents and synthetic solutions used in this study were all prepared using analytical grade chemicals, which were HR- COD Reagent (0-1500 ppm), BOD nutrient, Lithium hydroxide (for BOD testing), Nesslaer reagent, mineral stabilizer, poly vinyl alcohol (for Ammonia testing) and Phosver (Phosphate Reagent) from HACH-Co.

Instruments:

1. Inductively Coupled Plasma-Emission Spectrometry (ICP-ES) (Perkin Elmer optima 3000, USA) for heavy metals analysis.
2. PH meter (ORION model 7l0A).
3. Digital Thermometer, HANNA, model: Checktemp - HI98501.
4. Conductivity Meter / TDS Meter, HANNA, model HI993310.
5. Dissolve Oxygen Metter, HACH, model HQ3OD.
6. Spectrophotmeter, HACH, model DR5000.

Sampling Points: Samples were collected from the places, where direction to north and distances which mentioned in Figure (1).

Figure (1): Sampling Points

RESULTS AND DISCUSSIONS

Physiochemical characteristics of lake water quality:

Electrical Conductivity (EC): The distributions of the most physical parameters of water quality e.g. Electrical Conductivity (EC) at 150 m distance ranged between (39200 - 52890 µs/cm) and at 300 m distance ranged between (41910 - 54480 µs/cm) as shown in (Tables 1, 2). Upon comparing these results with the previous studies, the EC was higher than the study conducted by (Abo El-Gheit *et al.*, 2012), where the EC ranged between (21900 - 43400 µs/cm).

Total Dissolved Solids (TDS): At 150 m distance ranged between (25088 - 36982 mg/l) and at 300 m distance ranged between (26822 - 38365 mg/l) as shown in (tables1, 2). Upon comparing these results with the previous studies, the TDS was higher than the study conducted by (Abo El-Gheit *et al.*, 2012), where the TDS ranged between (15200 – 31940 mg/l).

Total Suspended Solids (TSS): At 150 m distance ranged between (214 - 272 mg/l) and at from 300 m distance ranged between (180 - 243 mg/l) as shown in (Tables 1, 2). Upon comparing these results with the previous studies, the TSS was lower than the study conducted by (Abo El-Gheit *et al.*, 2012), where the TSS ranged between (3216 – 4100 mg/l).

Dissolved Oxygen (DO) and (pH): The decrease in Dissolved Oxygen (DO) concentration reaching 5 mg/l may be due to phytoplankton blooming (Konsowa, 2007). During algal and blooming Phenomenon, the DO concentration decrease and CO_2 increase, leading to decrease in pH (6.84). This returns to the intrusion of drainage and agricultural water together with modifications observed in environment and climate (Edwards and Withers, 2008). Nutrients increase with runoff from agricultural lands (especially intensively cultivated lands with large inputs of synthetic fertilizers) and urban waste water, creating eutrophication (Liu *et al.*, 2009), upon comparing these results with the previous studies, the dissolved oxygen ratio was relatively lower than the study conducted by (Hussein *et al.*, 2008), where the concentration of dissolved oxygen ranged between (5.6-15 mg/l) and pH ranged between (7 - 8.9) in Al-Bats drainage.

Ammonia (NH_3): The present results declared that ammonia accounted for the major proportion of total soluble inorganic nitrogen. The ammonia concentrations ranged between (0.52 – 0.84 mg/l) at 150m distance and ranged between (0.31 – 0.61mg/L) at 300 m distance as shown in (Tables 1, 2). Results were found higher than the permissible limits. Upon comparing these results with the previous studies, NH_3 ratio was lower than the study conducted by (Abo El-Gheit *et al.*, 2012), where the concentration of NH_3 ranged between (0.85 - 1.45mg/l).

Phosphate (PO_4^{-3}): Phosphorus that enters the aquatic system through anthropogenic sources, e.g. fertilizer-runoff, potentially could be incorporated into either inorganic or organic fraction. Phosphate concentrations ranged between (0.60 - 1.64 mg/l) at 150 m distance and at 300 m distance, phosphate concentrations ranged between (0.44 - 1.09 mg/l) where results were found higher than the permissible limits as shown in (Tables 1, 2). Upon comparing these results with the previous studies, PO_4^{-3} ratio was higher than the study conducted by (Abo El-Gheit *et al.*, 2012), where the concentration of PO_4^{-3} ranged between (0.101 - 0.168 mg/l).

BOD and COD: All the results of (BOD) and (COD) were found higher than the permissible limits of law as shown in (Tables 1, 2).

The maximum limits which mentioned in the tables were in accordance with Article 68 of Law 48 of 1982 and amended by the Minister of Irrigation Decree No. 402 of 2009 on the standards and specifications of non-freshwater bodies.

Samples from the sampling points on 150 m distance:

Table (1): Samples from the sampling points on 150 m distance

Name of Drain	Sampling point	pH	Cond. (μs/cm)	TDS (mg/l)	TSS (mg/l)	Do (mg/l)	BOD (mg/l)	COD (mg/l)	NO_3^- (mg/l)	PO_4^{-3} (mg/l)	NH_3^+ (mg/l)
Al-Bats	1	6.84	40100	25664	238	5.10	33	279	3.79	1.64	0.66
AlSheeah	3	7.33	42350	27104	272	5.80	72	170	4.13	0.60	0.54
Raheel	5	7.44	39200	25088	214	6.40	65	159	3.92	0.87	0.52
Al-Wadi	7	6.87	44660	28582	232	5.10	71	292	3.35	1.38	0.58
Kahk	9	7.62	52890	33850	229	5.00	104	89	3.01	1.18	0.84
Breesh	11	7.33	52160	36982	246	5.60	63	179	3.48	1.19	0.82
	Average	7.24	45227	29545	239	5.50	67.85	195	3.61	1.14	0.66
	Min	6.84	39200	25088	214	5.00	32.66	89	3.01	0.60	0.52
	Max	7.62	52890	36982	272	6.40	103.7	292	4.13	1.64	0.84
	SD	0.32	5967	4809	20	0.54	22.68	77	0.41	0.37	0.14
	Maximum limits / law 402 of 2009	7 – 8.5	--	--	--	--	5	10	15	0.50	0.50

The results showed that the maximum polluted sample with COD from point (7), source Al-Wadi drain. While the maximum polluted sample with BOD and NH_3 from point (9), source Kahk drainage station. From other side the maximum polluted sample with PO_4^{-3} from point (1), source Al-Bats drain station. Also, the results showed that the water is acidic in samples from points (1, 7), source Al-Bats drain and Al-Wadi drain station respectively as shown in Table (2).

Samples from the sampling points on 300 m distance:

Table (2): Samples from the sampling points on 300 m distance

Name of Drain	Sampling point	pH	Conducti. (µs/cm)	TDS (mg/l)	TSS (mg/l)	Do (mg/l)	BOD (mg/l)	COD (mg/l)	NO_3^- (mg/l)	PO_4^{-3} (mg/l)	NH_3^+ (mg/l)
Al-Bats	2	7.22	43540	27866	216	5.30	31	287	3.66	1.09	0.49
Al-Sheeah	4	7.79	44120	28237	223	6.20	65	162	3.70	0.48	0.36
Raheel	6	7.63	41910	26822	180	6.30	61	148	3.84	0.44	0.31
Al-Wadi	8	7.18	49730	31827	227	5.50	61	275	3.16	1.02	0.40
Kahk	10	7.51	54480	34867	183	6.60	74	68	3.36	1.07	0.61
Breesh	12	7.26	54320	38365	243	5.80	53	152	3.16	1.02	0.61
	Average	7.43	48017	31331	212	5.95	58	182	3.48	0.85	0.46
	Min	7.18	41910	26822	180	5.30	31	68	3.16	0.44	0.31
	Max	7.79	54480	38365	243	6.60	74	287	3.84	1.09	0.61
	SD	0.25	5603	4564	25	0.50	15	84	0.29	0.30	0.13
	Maximum limits / law 402 of 2009	7 – 8.5	–	–	–	–	*	10	15.00	0.50	0.50

The results showed that the maximum polluted sample with COD and PO_4^{-3} from point (2), source Al-Bats drain station. While the maximum polluted sample with BOD and NH_3 from point (10), source Kahk drainage station. From other side the maximum polluted sample with NH_3 from point (10, 12), source Kahk drainage station respectively as shown in Table (3).

Effect of distance on pollutant concentration: The average of all samples collected after 150 m and 300 m from the source showed that the concentration of pollutant decreased with the increasing the distance away from the source.

Bacteriological properties: Also the microbiological properties have been studied, the results proved that the potential count of coliform bacteria in the lake is between 35 and 750 CFU/100 ml in sampling period, the result exceed the limits mentioned in Law 48 of 1982 for non-fresh water bodies.

Heavy metal properties: Some heavy metals properties such as Cu, Fe, Zn, Cd have been studied for the samples from 150 m distance and 300 m distance.

Cd: Cadmium concentrations ranged between (0.0001 - 0.0034 mg/l) as shown in (Table 3, 4), thus exceed the maximum limits mentioned in the law as shown in (Table 3) in points near Al-Bats and Al-Wadi drainages. Upon comparing these results with the previous studies, the Cadmium ratio was relatively higher than the study conducted by (Hussein *et al.*, 2008), where the concentration of cadmium less than (0.0001mg/l) in Al-Bats drainage.

Zn: Zinc concentrations ranged between (0.018 - 1.091 mg/l) and ranged between (0.022 - 1.008) as shown in (Table 3, 4), the results did not exceed the permissible limits except the near points of Al-Bats drainage, thus exceed the maximum limit mentioned in the law. Upon comparing these results with the previous results, the zinc ratio was relatively lower than the study conducted by (Hussein *et al.*, 2008), where the concentration of zinc in Al-Bats drainage (1.4 mg).

Fe: The obtained results of the concentration levels of (Fe) exceed (1 mg/l) in points near Al-Bats drainage, Al-Sheeah lifting station and Al-Wadi drainage as shown in (Table3, 4) higher than the permissible limits of law. Upon comparing these results with the previous studies, the Iron ratio was higher than the study conducted by (Sabae and Mohamed, 2015), where the concentration of Iron ranged between (0.138-0.175 mg/l) in Al-Bats drainage.

Cu: The obtained results of the concentration levels of (Cu) exceed (1 mg/l) in points near Al-Bats drainage and Al-Wadi drainage higher than the permissible limits of law. Upon comparing these results with the previous studies, the Copper ratio was higher than the study conducted by (Hussein *et al.*, 2008), where the concentration of Copper ranged between (0.026 - 0.093 mg/l) in Al-Bats drainage.

Heavy metals on Samples from a 150 m distance: Also some heavy metals ions properties such as Cu^{+2}, Fe^{+2}, Zn^{+2}, Cd^{+2} has been studied for the samples from a 150 m distance, the results proved that points (1, 7) the most polluted with heavy metals as shown in Table (3).

Table (3): Heavy metals on Samples from a 150 m distance

Sampling point	Cd^{+2} (mg/L)	Zn^{+2} (mg/L)	Fe^{+2} (mg/L)	Cu^{+2} (mg/L)
1	0.0034	1.091	1.042	1.0057
3	0.0009	0.837	1.008	0.0043
5	0.0005	0.02	0.614	0.0039
7	0.0033	0.018	1.215	1.0123
9	0.0019	0.053	0.057	0.0021
11	0.0002	0.019	0.001	0.0016
Average	0.002	0.340	0.656	0.338
Min.	0.000	0.018	0.001	0.002
Max.	0.003	1.091	1.215	1.012
SD	0.001	0.490	0.524	0.520
Maximum limits*	0.00	1	1	1

Heavy metals on Samples from a 300 m distance:

Also some heavy metals properties such as Cu, Fe, Zn, Cd have been studied for the samples from a 300 m distance, the results proved that points (2, 8), source Al-Bats drain and Al-Wadi drain station respectively are the most polluted with heavy metals as shown in Table (4).

Table (4): Heavy metals on Samples from a 300 m distance

Sampling point	Cd^{+2} (mg/L)	Zn^{+2} (mg/L)	Fe^{+2} (mg/L)	Cu^{+2} (mg/L)
2	0.0023	1.008	1.007	1.0018
4	0.0006	0.337	1.003	0.0023
6	0.0003	0.038	0.504	0.0024
8	0.0022	0.027	1.113	1.0136
10	0.0015	0.022	0.041	0.0019
12	0.0001	0.047	0.003	0.0008
Average	0.001	0.286	0.734	0.404
Min	0.000	0.022	0.041	0.002
Max	0.002	1.008	1.113	1.014
SD	0.001	0.425	0.454	0.551
Maximum limits*	0.003	1	1	1

* Maximum limits in accordance with Article 68 of Law 48 of 1982 and amended by the Minister of Irrigation Decree No. 402 of 2009 on the standards and specifications of non-freshwater bodies.

CONCLUSION

From the present study, it can be clear that the problems of heavy metal and chemicals contamination in the studied area were serious as reflected by the relatively high mineral concentrations recorded in the collected water samples. However, due to the high heavy metal concentrations which may soon reach a dangerous level, which may affect the lake's use in fish production and may also contaminate groundwater in nearby springs and pass through food. A series of wildlife in the surrounding area. In addition, salinity is the main factor responsible for the deterioration of the environmental status of Lake Qarun and its low saltiness for future decades unless certain treatment is carried out by removing the confirmed quantities of salinity for high salinity modification. From the lake to the desired level it is suitable for fish to serve. In general, the study found that the quality of water in Lake Qarun is polluted and this pollution promotes the accumulation of heavy elements in the lake water through discharges that carry large quantities of pollutants such as contaminants of agricultural drainage, industrial and untreated sewage, although salted during the twentieth century.

RECOMMENDATION

From the discussion and the previous conclusion, we recommend, Lake Qarun need to coordinate various efforts to save them from these serious environmental problems. At present, these problems can be overcome by the use of appropriate management, specialized scientific research and the strict implementation of the recommended solutions.

REFERENCES

Abdel Wahed, M. S. (2015): Geochemistry and water quality of Lake Qarun, Egypt. Acta Universitatis Lappeenrantaensis, 21: 31-57.

Abdel Satar, A. M.; Goher, M. E. and Sayed, M. F. (2010): Recent environmental changes in water and sediment quality of Lake Qarun, Egypt. Journal of Fisheries and Aquatic Science, 5(2), 56 - 69.

Abo El-Gheit, E. N.; Abdo, M. H. and Mahmoud, S. A. (2012): Impact of Blooming Phenomenon on Water Quality and Fishes in Qarun Lake, Egypt, International J. of Environmental Science and Engineering (IJESE), 3: 11 - 23.

Abo Salama, M. S. M. (2007): Spatial and temporal consolidation of drainage water quality monitoring networks (Doctoral dissertation, Ph.D. dissertation, Universität Lüneburg, Fakultät III, Umwelt und Technik, Germany).

Barakat, A. O.; Khairy, M. and Aukaily, I. (2017): Bioaccumulation of organochlorine contaminants in fish species from Lake Qarun, a protected area of Egypt. Toxicological & Environmental Chemistry, 99(1), 117-133.

Dardir, A. A. and Wali, A. M. A. (2009): Extraction of salts from lake Quaroun, Egypt: Environmental and economic impacts. Global Nest J, 11(1), 106-113.

Edwards, A. C. and Withers, P. J. A. (2008): Transport and delivery of suspended solids, nitrogen and phosphorus from various sources to fresh water in the UK. J. Hydrol., 350: 144 – 153.

Embabi, N. S. (2017): Landscapes and Landforms of Egypt: Landforms and Evolution. Springer.

El Naby, A. A.; Al Menoufy, S. and Gad, A. (2018): Benthic foraminiferal assemblages as bio-indicators of metals contamination in sediments, Qarun Lake as a case study, Egypt. Journal of African Earth Sciences, 139, 96-112.

El-Sherif, S. A. E. H. and El-Ghafour, S. A. (2016): Investigation of the quality properties and nutritional values of four fish species from Lake Qaroun, Egypt. International Journal of ChemTech Research, 9(4), 16-26.

Fathi, A. A. and Flower, R. J. (2005): Water quality and phytoplankton communities in Lake Qarun (Egypt). Aquatic Sciences, 67(3), 350-362.

Hussein, H.; Amer, R.; Gaballah, A.; Refaat, Y. and Abdel Wahab, A. (2008): Pollution Monitoring for Lake Qarun: Adv. Environ. Biol., 2(2): 70-80.

Hassan, R. M. (2015): Ecosystem Restoration Using Maintenance Dredging In Lake Qarun, Egypt. Journal of American Science, 11(12), 55 - 65.

Ibrahim, L. A. and Ramzy, E. M. (2013): Water quality and its impact on Tilapia zilli (case study) Qarun lake-Egypt. International Water Technology Journal, 3(4), 170-191.

Konsowa, A. H. (2007): Ecological studies on fish farms of El-Fayoum depression (Egypt). Egypt J. Aquat Res, 33:290 – 300.

Liu, T.; Wang, H.; Yang, H.; Ma, Y. and Cai, O. (2009): Detection of phosphorus species in sediments of artificial landscape lake in China by fractionation and phosphorus-31 nuclear magnetic resonance spectroscopy. Environ. Pollut., 157:49 - 56.

Sabae, S. Z. and Mohamed, F. A. S. (2015): Effect of Environmental Pollution on the Health of Tilapia spp. from Lake Qarun: Global Veterinaria 14 (3): 304-328.

Williams, G. (2018): How convincing is the evidence that changing agricultural land cover has affected water salinity in Lake Qarun? Meliora: International Journal of Student Sustainability Research, 1(2).

مراقبة الملوثات المختلفة ببحيرة قارون

[٢]

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المستخلص

يعتبر وجود الملوثات في البحيرات المشكلة الأكثر شيوعًا التي يواجهها المستهلكون. لذا كان الهدف من هذه الدراسة هو مراقبة الخصائص الفيزيائية، الكيميائية والبكتريولوجية لبحيرة قارون. لأن هذه البحيرة هي بحيرة ملحية مغلقة في الجزء الشمالي من منخفض الفيوم (مصر الوسطى) على حافة الصحراء الغربية الكبرى. وكانت تستخدم هذه البحيرة لاستيعاب كميات كبيرة من الفيضان من نهر النيل. وخلال القرن العشرين، ارتفعت ملوحة مياه البحيرة بنسبة كبيرة نتيجة مياه الصرف التى تدخل الى البحيرة وكذلك نتيجة كمية البخر التى تخرج من البحيرة. وتمت مراقبة الخواص الفيزيوكيميائية والبكتريولوجية وبعض المعادن الثقيلة خلال صيف عام ٢٠١٧ لمقارنتها بالمعايير والقوانين التى وضعتها وزارة البيئة فتم سحب عينات من البحيرة في أماكن صب المصارف بها علي بعد ١٥٠م و٣٠٠م من الشاطئ.

أثبتت الدراسة أن البحيرة تعاني من التلوث ببعض المعادن الثقيلة، الأمونيا، الفوسفات بالإضافة لمتطلب كبير من الأكسجين الحيوي والكيميائي خصوصا في الأماكن القريبة من منطقة صب

المصارف بالبحيرة. لذلك توصي الدراسة بضرورة وضع سياسة بيئية للحد من هذا التلوث مع استمرارية الرصد البيئي للبحيرة.

الكلمات الدالة: بحيرة قارون، التلوث، تحاليل المياه، المعادن الثقيلة، سياسة بيئية، مراقبة بيئية.