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Water Quality Characteristics of the River Nile at Delta Barrage with Special Reference to Rosetta Branch

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Abstract: Eighteen water samples were collected during the seasons of the year 2003, from 9 stations which represented 2 bifurcated branches and 4 canals of the River Nile at most of Delta Barrage. More than 5 x 10^8 m^3 daily effluents which include domestic and agricultural wastes are discharged from El-Rahawy drain into Rosetta branch. The drain lies 30 km north to Cairo at El-Kanater El-Khyria, Egypt. The impacts of this effluents was found to be exist to about 2 km in high concentration as recorded for suspended and dissolved solids, COD, BOD, HCO_3^-, CO_3^{--}, Cl^-, SO_4^{--}, S^{--}, NO_2^-, NO_3^-, NH_3^-, SiO_2, TP and PO_4^{3-} With the exception of the above, mentioned area the water of the River Nile at Delta Barrage showed good water quality without any harmful risk as shown by its safe human usage.

Key words: Water pollution · River Nile · Water quality · Delta Barrage

INTRODUCTION

The River Nile is an old river, whose basin is the dominant feature of the northern quarter of the continent of Africa with extent length about 6740 km. It follows from the south at Ethiopia plateau to Egypt. According to El-Dib [1], the River Nile constitutes over 98% of the fresh water resources available to Egypt, represent 55.5 million m^3 per year coming from the south according to the international agreement for the distribution of water resources of River Nile between countries of Nile basin. Moreover, other 8.5 million m^3 can be supplied from ground water and 3.7 million m^3 reused drainage water. Such quantities will not surely satisfy the increasing demand of water in the different activities.

At, the North of Cairo at Delta Barrage, the River Nile bifurcates into two branches namely Damietta and Rosetta and four Rayahs (canals) namely El-Nassery, El-Behery, El-Menofy and El-Toufeky [2-4].

Concerning the Rosetta branch, it is worthy to attention that, El-Rahawy drain is the principle source of pollution which potentially affect and deteriorate the water quality of this branch.

The aim of the present work is to pay attention and follow up the changes in the River Nile water quality, at Delta Barrage especially at an important area; Rosetta branch, which received great amount of pollution from El-Rahawy Drain.

MATERIALS AND METHODS

The area of study included the River Nile region after bifurcation at Delta Barrage (Fig. 1). Different sampling sites are selected to cover the area of investigation (Table 1). During 2003 eighteen water samples were collected seasonally from subsurface and near bottom water from different localities (Table 1). Ruttner water sampler of 2 L capacity was used for collection of samples and these samples were kept in well stoppered polyethylene bottles. The determinations of the chemical parameters were undertaken according to standard methods of APHA [5].

Statistical Analyses: Principal component analysis (PCA), a multivariate technique, was used to summarize the general trend and changes in chemical components using correlation analysis. PCA was performed using CANOCO V. 4.0 [6].

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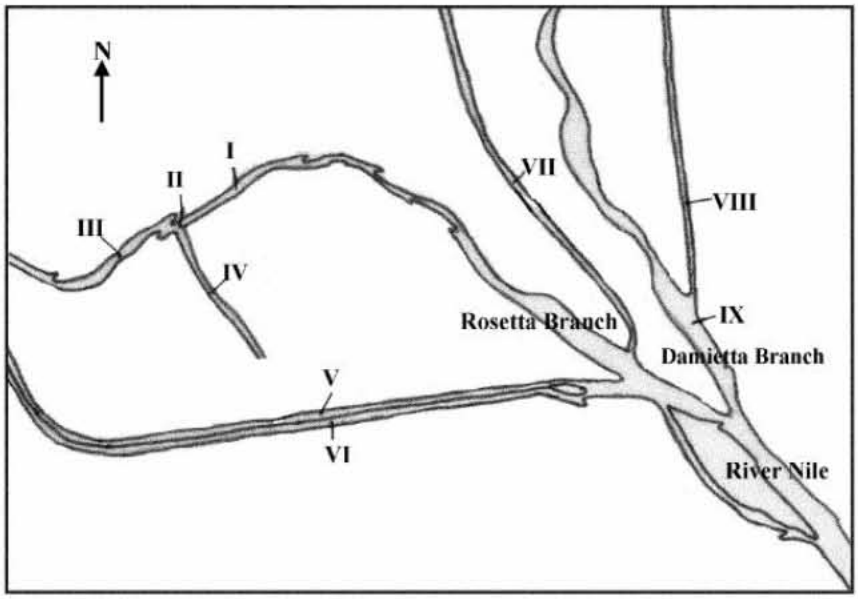

Fig. 1: Map showing the selected stations at El-Kanater El-Khyria region

Table 1: Features of the sampling stations

Stations	Code	Features of station
Station 1	I	500 meter in Rosetta branch upstream of the drain
Station 2	II	Mixed point infront of El-Rahway drain
Station 3	III	500 meter in Rosetta branch downstream of the drain
Station 4	IV	El-Rahway Drain
Station 5	V	Rayah El-Behary
Station 6	VI	Rayah El-Nassery
Station 7	VII	Rayah El-Menofy
Station 8	VIII	Rayah El-Towfeky
Station 9	IX	Damietta branch

RESULTS

Total Solids: As mentioned in Table 2, the present results revealed that the suspended, dissolved and total solids have the same trends along different sites. The higher values were found in the Rosetta branch in the area include the effluents of El-Rahawy drain as compared to other localities. The suspended solids (mg l^{-1}) show the range of 76-372 at Rosetta branch as compared with 60-94 in the other sites. Also, the dissolved solids show the ranges of 302-690 and 241-388 and 378-1060 and 313-485 for the total solids, respectively in the above regions.

Chemical and Biological Oxygen Demand (COD and BOD): The present results showed high values for COD (11.4-17.6 mg l^{-1}) measured at the area of El-Rahawy drain and low values (0.8-1.8 mg l^{-1}) recorded at the other sites (Table 3). However, BOD for the above mentioned areas showed zero values and (0.4-3.8 mg l^{-1}) for Rosetta branch and other sites, respectively.

Carbonate, Bicarbonate and Chloride: Carbonate variations in the area of study are limited and fluctuated in the range of 0-10 mg l^{-1} with depletion at station IV for carbonate as compared with the maximum value at station IX. On the other side, higher values of bicarbonate were measured at the area of stations II, III and IV with the range of 280-596 mg l^{-1} as compared with the lowest value of 133 mg l^{-1} at station X (Table 4). Again the higher values of chloride (104.2-124.1 mg l^{-1}) were measured in the same area of stations II, III and IV and the minimum value of 4.9 mg l^{-1} recorded at station VII (Table 4).

Table 2: Suspended, dissolved and total solids (mg l^{-1}) in the River Nile at Delta Barrage during 2003

	Suspended solids		Dissolved Solids		Total solids	
Stations	Range	Average	Range	Average	Range	Average
I	64-97	76	257-388	304	321-485	380
II	203-372	270	377-690	500	579-1060	769
III	76-343	162	302-637	465	378-980	637
IV	167-348	265	494-667	580	760-994	845
V	60-80	69	241-321	277	302- 402	347
VI	62-85	75	250-339	299	312-424	374
VII	63-85	73	251-342	293	313-427	366
VIII	66-93	76	266-371	305	332-464	382
IX	72-94	81	290-376	323	362-470	404

Table 3: Biological and chemical oxygen demand (mg l^{-1}) in the River Nile at Delta Barrage during 2003

	B.O.D.		C.O.D.		BOD/COD
Stations	Range	Average	Range	Average	Range
I	2.8-3.680	3.27	1.8-4.20	3.00	1.72-3.52
II	0.0-4.000	1.79	1.4-11.4	8.20	0.66-0.90
III	1.6-5.200	3.46	3.2-17.6	9.95	0.35-0.52
IV	0.0-0.500	0.25	6.6-11.0	9.20	0.02-0.06
V	2.96-4.25	3.67	3.4-7.00	5.40	0.68-1.09
VI	0.8-3.800	1.88	2.0-10.0	5.55	0.25-0.91
VII	2.32-3.60	2.97	1.0-2.80	3.10	0.9-3.530
VIII	1.84-2.40	2.08	0.8-6.00	3.95	0.94-1.11
IX	0.4-2.250	1.12	0.8-6.00	3.70	0.55-0.77

Table 4: Carbonate, bicarbonate and chloride (mg l^{-1}) in the River Nile at Delta Barrage during 2003

	Carbonate		Bicarbonate		Chloride	
Stations	Range	Average	Range	Average	Range	Average
I	4-6	5.0	151-337	270.5	6.9-34.70	19.1
II	0-4	1.0	288-454	364.0	9.9-124.1	54.6
III	0-2	0.7	280-421	340.3	10.9-104.2	45.1
IV	0	0.0	292-596	436.3	11.9-116.1	65.8
V	4-10	6.0	133-324	212.8	4.9-33.70	21.3
VI	4	4.0	159-347	261.5	5.9-33.90	19.8
VII	2-6	4.0	160-324	257.3	4.9-33.70	19.1
VIII	4-8	6.0	144-330	262.8	9.9-32.70	20.3
IX	2-10	6.1	165-340	278.5	9.9-34.70	18.4

Sulphate, Sulphide and Silicate: As given in Table 5, sulphate, sulphide and silicate varied in the same trend with the higher values recorded in the area of Rosetta branch (stations II, III and IV) and the other sites showed lower values. Thus, sulphate concentration fluctuated in the ranges of 15.9-108 and 15.8-58.7 mg l^{-1} for the above regions, respectively. The same trend for sulphide (0.76-2.32 and 0.24-1.68 mg l^{-1}) and for silicate (1.45-11.56 and 0.97-4.35 mg l^{-1}) were recorded for the above mentioned two regions, respectively.

Nitrate, Nitrite and Ammonia: The area of the Rosetta branch contained nitrate in the ranges of 25.85-41.16 μg l^{-1}, while, it was 16.81-111.45 μg l^{-1} in the other

Table 6: Nitrate, Nitrite (μg l^{-1}) and Ammonia (mg l^{-1}) in the River Nile at Delta Barrage during 2003

	Nitrate		Nitrite		Ammonia	
Stations	range	Average	range	Average	range	Average
I	33.13-81.73	56.58	1.52-7.400	3.84	0.22-0.660	0.37
II	35.39-39.15	36.83	8.28-22.66	15.82	9.92-19.00	13.96
III	25.85-37.65	32.32	8.76-23.09	15.31	0.37-21.33	15.20
IV	37.9-41.160	39.03	14.16-21.67	18.87	17.47-29.00	21.74
V	16.81-82.33	49.99	2.39-4.030	3.13	0.16-0.520	0.32
VI	22.34-87.10	50.89	1.85-6.860	4.08	0.21-0.320	0.25
VII	17.06-74.82	40.54	1.74-4.030	2.53	0.17-0.240	0.21
VIII	24.1-111.45	58.63	1.52-5.010	2.78	0.25-0.320	0.28
IX	20.83-44.68	30.50	1.3-5.3400	3.87	0.21-0.260	0.23

Table 7: Orthophosphate and total phosphorus (μg l^{-1}) in the River Nile at Delta Barrage during 2003

	Orthophosphate		Total phosphorus	
Stations	range	Average	Range	Average
I	32.7-84.700	63.5	120.6-536.4	258.20
II	602.9-1887.2	1385.9	1000.8-1946.7	1561.0
III	75.6-1615.5	1121.1	664.7-1562.1	1278.0
IV	1278.3-1851.5	1542.5	1580.8-2611.4	2104.6
V	37.8-69.500	56.2	138.4-312.7	213.00
VI	37.3-72.500	56.8	120.6-319.4	258.60
VII	37.8-102.20	67.7	149.7-335.7	248.20
VIII	36.3-178.80	87.1	186.0-394.9	295.30
IX	17.9-168.60	70.3	239-236.5	250.70

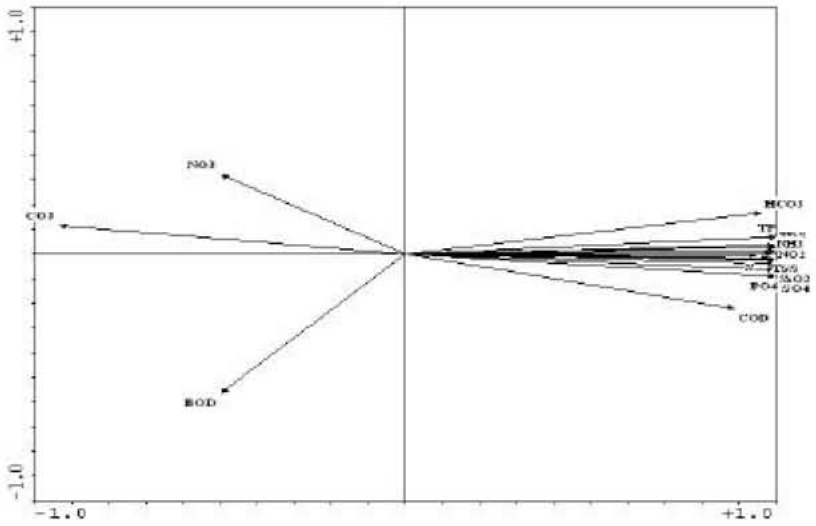

Fig. 2: Principal component analysis (PCA) ordination of sampling stations based on studied parameters

localities (Table 6). On the other hand, nitrite concentration showed the maximum value of 23.09 μg l^{-1} at station III as compared with the minimum value of 1.3 μg l^{-1} at station IX. Also, ammonia concentration varied in the ranges of 0.15-29 mg l^{-1} with minimum value at station V and maximum value at station IV.

Orthophosphate and Total Phosphorus: As shown in Table 7 orthophosphate and total phosphorus were fluctuated in the same trend whereas, the maximum values were measured in the areas include stations II, III and IV with the ranges of 75.6-1887.2 and 664.7-2611.4 μg l^{-1}, respectively. On the other side the lowest values were

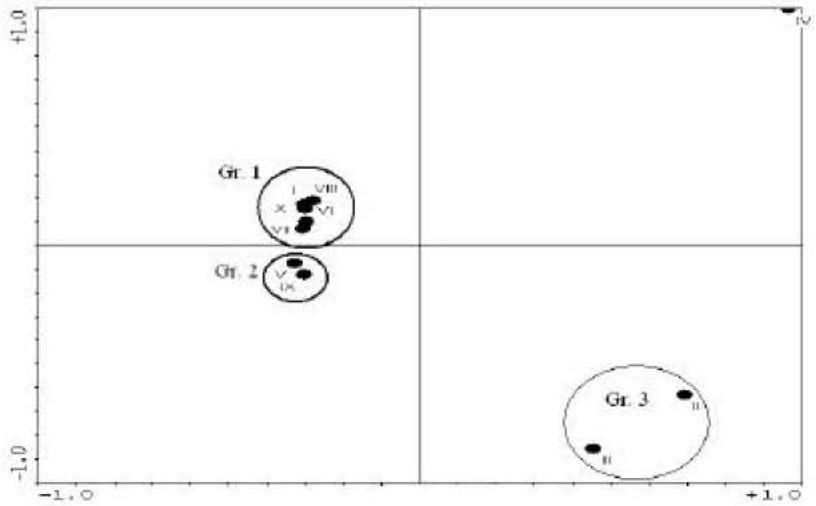

Fig. 3: Principal component analysis (PCA) ordination of sampling stations based on sampling locations

measured at the other areas with the ranges of 17.9-178.8 and 120.6-536.4 μg l^{-1} for orthophosphate and total phosphorus, respectively.

DISCUSSION

Before the construction of Aswan High Dam, the Nile flood have high concentrations of suspended matters and low concentrations of dissolved solids. However, recently, the river conditions down stream from Aswan High Dam showed low levels of suspended matters and relatively high levels of dissolved solids [7, 8]. Thus, the suspended matter sedimented in most areas at the southern of Lake Nasser and the water flow free from silt down stream from High Dam.

Concerning the biodegradability condition of the aquatic body; the COD/BOD ratio in the present work was taken into consideration. Therefore, the present results revealed that all values for the above mentioned ratio were found to be less than one at stations II, III and IV indicating that the water of these stations reached to degradation level, which mean that the water of Rosetta branch in the area of EL-Rahawy drain effluents may be biodegradable. However, the results of the same ratio compared with the stations I, V, VII and VIII showed a higher values than 1. This may lead to the conclusion that the water at these stations was considered to be clear and not reached to the degradation level [9]. On the other hand, the depletion of carbonate contents at stations II, III and IV during the seasons of high temperature may be attributed to the precipitation of $CaCO_3$ or may be due to the conversion to HCO_3^- [10]; consequently the area of Rosetta branch showed higher values of bicarbonate, sulphate and sulphide which represent mixed point in front of El-Rahawy drain. Thus, the introduction of excess of the effluents of this drain may results in the depletion of dissolved oxygen [11, 12]. On the other hand, ammonia was enriched the area of Rosetta branch in which the water is polluted by domestic wastes from the effluents, this lead to the toxicity and death of fish and other microorganisms. The high concentration of ammonia (>1 mg l^{-1})has been given as an indicator of organic pollution and it is toxic in concentration over 2.5 mg l^{-1} to aquatic organisms [13]. Again, the present results revealed that the orthophosphate, silicate and total phosphorus were fluctuated in the same trend, with the maximum values measured in the area of Rosetta branch polluted by effluents of domestic wastes of El-Rahawy drain. This effluents also include fertilizers, pesticides, herbicides and detergent enriched by phosphorus and organic compounds [14-17].

Concerning the principal component analysis for the present results, in which the polluted water in the area of investigation is represented on the X axis, while the pure Nile water is represented on Y axis (Fig 3). The obtained values lead to the following remarks:, Group 1 (sites I, VI, VII and VIII), are characterized by high content of nitrate depending on phytoplankton exist, there was no effect of El-Rahawy drain as these sites are far from the drain. However group 2 (sites V and IX) are not affected by El-Rahawy drain, as these sites are far from Rosetta branch. Last group 3 (sites II and III) which represent the mixed point in front of El-Rahawy drain and 500 meter down stream Rosetta branch, respectively are affected

positively or negatively by El-Rahawy drain depending on the intrusion of the drain.

In conclusion, River Nile at Rosetta branch remains threatened by the increasing of human activities in the long term which affect the water quality characteristics. El-Rahawy drain is the main source of pollution at the area of investigation due to huge amount of domestic and agricultural wastes inflow into Rosetta branch.

REFERENCES

1. El-Dib, M.A., 2004. Impact of Nile River water quality on drinking water treatment. States of Biodiversity of River Nile. Workshop hold at British Council, Cairo, Egypt. 9 December, pp: 80.
2. Saad, M.A.H. and R.H. Goma, 1994. Effect of the High Dam and Aswan Catract on the chemical composition of the Nile water. I. Major Anions. Verh. Internat. Verein. Limnol., 25: 1812-1815, Stuttgart.
3. Daifullah, A.A.M., A.A. Elewa, M.B. Shehata and M.H. Abdo, 2003. Evaluation of some heavy metals in water, sediment and fish samples from Rver Nile (Kafr El-Zyat City), Egypt: A treatment approach. African J. Environ. Assess. Managem., 6(1): 16-31.
4. Abdel Aziz, G.S., 2005. Study on the water quality of the River Nile with relation to the environmental condition at El-Kanater El-Khyria region. M.S. Thesis. Fac. Sci. (Girls) Al-Azher Univ. Cairo, Egypt pp: 186.
5. American Public Health Association (APHA), 1995. Standard methods of the examination of water and waste water. 16th Edn. New York.
6. Ter Braak, C.F., 1987. CANOCO-a FORTRAN program for canonical community ordination by partial detrended canonical correspondence analysis, principle component analysis and redundancy analysis (Version 3.1) Agriculture Mathematics Group, Wageningen.
7. Beadle, L.C., 1981. The inland waters of tropical Afric. An Introduction to tropical limnology. 2nd Edn. Longman, London and New York, pp: 475.
8. Sayed, M.F., 2003. Chemical studies of pollution in Rosetta branch of River Nile between Kafr El-Zayat and Rosetta outlet. PhD. Thesis Fac. Sci., Cairo Univ. Egypt, pp: 403.
9. WHO, 1992. World Health Organization for inorganic constituents of health significance and European Economic Community Standard for parameters and Goals, New York, pp: 1271.
10. Spotte, S., 1979. Seawater aquarium: the captive environment. John Wiley and Sons, N.Y., pp: 413.
11. Maria Adelaide, Ruveado, ArnoHdeolivera, Gilles Revel, Guypinte, SophieAroult and Pierr Toulhoat 2000. Study of water and sediment interaction in the Dasvelas River Berazil-major and trace elements. ISSN 0378-4738=water SA. Vol. 26 No 2 pp: 255-274.
12. Badr, M.H., A.A. Elewa, M.B. Shehata, L.F. Mohamed and G.S. Abdel-Aziz, 2006. Studies on the effect of El-Rahawy drain on River Nile water Pollution by trace metals and major cations at EL-Kanater El-Khyria area under the effect of seasonal variation. Ass. Univ. Bull. Environ. Res., 9: 35-53.
13. Reid, K.G., 1961. Ecology of inland waters and estuaries. Textbook UNR, New York, pp: 375.
14. Ali, M.H.H., 2008. Assessment of some water quality characteristics and determination of some heavy metals in Lake Manzalah, Egypt. J. Aquat. Biol. Fish., Vol. 12, No 2: 133-154.
15. Marsden, M.W., 1989. Lake restoration by reducing external loading: the influence of sediment phosphorus. Freshwater Biol., 21: 139-162.
16. Masoud, M.S. A.A. Elewa, A.E. Ali and E.A. Mohamed, 2005. Distribution of some metal concentrations in water and sediment of Lake Edku, Egypt Bull. Chem. Technol. Macedonia, 24: 21-34.
17. Abdo, M.H., 2002. Environmental studies on Rosetta branch and some chemical application in the area extended from El-Kanater El-Khyria to Kafr El-Zayat city. Ph.D. Thesis, Fac. Sci. Ain. Shams Univ., Cairo, Egypt.