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THE CURRENT STATE OF WATER QUALITY IN THE DAMIETTA NILE BRANCH - EGYPT

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Abstract: Hydrochemical parameters and heavy metal concentrations in water samples were measured in eighteen stations selected from the Damietta Nile Branch; beginning from Samanoud to Mit Alkholy Abdalla villages. Average concentrations of pH, DO, BOD, COD, TN and TP were compared with the permissible limits of Egypt laws (2007) and WHO (2011). Noticeable local variations of these parameters have been recorded. High concentrations of BOD and COD in the Nile water are due to the pollutions from Elnasriyah drain, fish farming, domestic sewage, agricultural and industrial wastes, which constitute serious deterioration of the water quality. It was found that the average of total nitrogen varied from 8.78 mg/l in the Damietta Nile Branch to 16.57 mg/l in Elnasriyah drain. The average of total phosphorus equals 0.22 mg/l in the Damietta Nile Branch and 0.41 mg/l in Elnasriyah drain; both of the two values are less than 1.0 mg/l (permissible limits of Egypt laws, 2007). The average concentrations of Pb and Cd in the Nile water recorded higher contents than the permissible limits given by Egypt laws (2007) and WHO (2011) for drinking water. Also, the average concentrations of Co and Cd in Elnasriyah drain are higher than the permissible limits of FAO (1985, 1994); implying potential adverse impacts in the aquatic environment. This study proved that Elnasriyah drain at Samanoud is considered as one of the main sources for pollution in the area.

keywords: Hydrochemical parameters – heavy metals - pollution - Damietta Nile Branch - Elnasriyah drain

1.Introduction

The Damietta Nile Branch is about 230 km long with variable widths of 300 and 500 m. This branch is characterized by variable depths with an average of about 8 m. The Nile River has been exposed to variant sources of contamination; agriculture, domestic sewage and industrial effluents represent a true threat to the Nile River (1). The Nile River receives considerable amounts of untreated effluents rich in organic matter; however, it has an intense self-purification capacity as indicated by investigation of Biochemical Oxygen Demand (BOD) (2). High concentrations of metals like Cu and Fe are present in domestic wastewater (3). The physico-chemical properties of the Nile River water have been rather widely monitored (4) and (5). Marked regional variations of many physical and chemical parameters in sub-deltaic and deltaic regions of the Nile River were attributed to the effect of pollution point sources. The sharp increase in the concentration of Fe, Cu, Zn and conductivity at 40 km upstream Cairo were directly related to the industrial effluents (6). While concentration of phosphorus, nitrogen, total dissolved salts, biological oxygen demand, copper, lead, zinc and iron are increased significantly from up to down-stream sites related to intense human activities. The aim of this research is to evaluate the extent of pollution of the Damietta Nile Branch's water (Fig.1) and to determine its sources

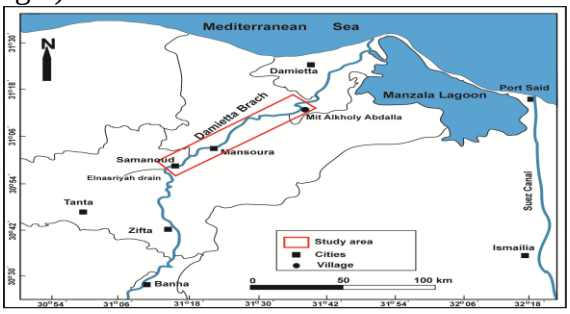


Fig. 1 Location map showing the studied area of Damietta Nile Branch . (begin from Samanoud city to Mit Alkholy Abdalla village).

2. Material and methods

Twenty one water samples were collected from 18 stations distributed along the Damietta Nile Branch from Samanoud to Mit Alkholy Abdalla village during 2015/2016 (Fig. 2). Water samples were taken below one meter depth from the water surface of the River using plastic bottles; where it is kept in dark polyethylene bottles. The water samples were transferred to the laboratory for storage in the refrigerator at 4°C until analysis.

Hydrogen-ion concentration (pH) was determined in water samples using pH meter. Dissolved Oxygen (DO) concentration was measured by using the modified Winkler method according to Standard Method 4500 (7). Biochemical Oxygen Demand (BOD) was measured by using the 5 days method (8). Chemical Oxygen Demand (COD) was determined by using the potassium dichromate (9). Total nitrogen (TN) was measured by using Kjeldahl method (10). Total phosphorus (TP) was determined by using ascorbic acid molybdate method (11). Heavy metal concentrations (Fe, Zn, Mn, Cu, Ni, Co, Pb and Cd) were determined by the extracting method (7). Atomic absorption spectrophotometer was used to measure the heavy metals in ppm. Statistical analysis was carried out by using the SPSS software package (SPSS Ver.16)

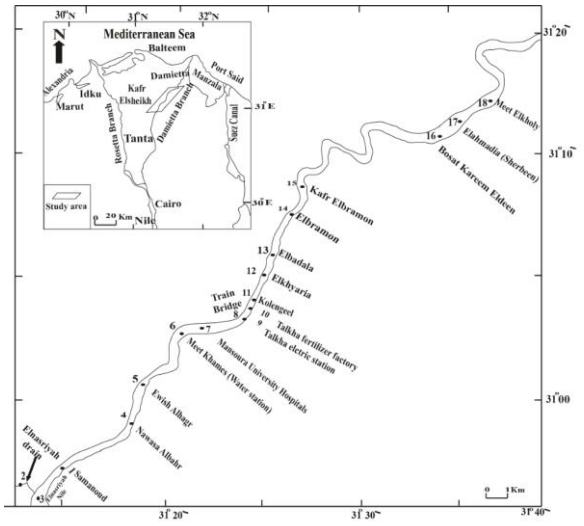


Fig. 1: Location map showing stations of collecting water samples from the Damietta Nile branch. (●)

Results and discussion

The results of physico-chemical parameters determined in the Damietta Nile branch water samples and Elnasriyah drain water are listed in Table (1) and illustrated in Figs. (2 to 6). Significances of these parameters are discussed and interpreted.

pH values ranged between 7.60 and 9.00 with an average of 8.46 in the Damietta Nile Branch water and varied from 8.20 to 9.00 with an average of 8.57 in Elnasriyah drain water indicating slightly alkaline to alkaline water. Therefore, the average pH value of the Damietta Nile Branch falls within the permissible limits of (12) and (13) for drinking water. On the other hand, in Elnasriyah drain the average value of pH lies above the permissible limits of (14(, which should not exceed 8.5. Total nitrogen (TN) ranged between 2.80 and 29.40 mg/l with average value of 8.78 ppm in the Damietta Nile Branch, and varied from 8.40 to 21.00 mg/l with average value 16.57 mg/l in Elnasriyah drain. Values of TN in Elnasriyah drain water appear higher than in the Damietta Nile Branch. Total phosphorus (TP) has concentration varied from 0.06 to 0.68 mg/l with an average of 0.22 mg/l in the Damietta Nile Branch, and fluctuated from 0.20 to 0.59 mg/l with an average of 0.41 mg/l in Elnasriyah drain. Both average values are less than the permissible limits of (11) (not exceed 1.0 mg/l). Total phosphorus (TP) concentration is mainly related to agricultural drainage water enriched with fertilizers, which agree with that assumption of (15.(

Dissolved oxygen (DO) fluctuated between 3.80 and 11.80 mg/l with average 7.28 mg/l in the Damietta Nile branch, while it varied from 0.44 to 4.75 mg/l with average 1.93 mg/l in Elnasriyah drain; being lower than that of the Damietta branch (Table 1 and Fig. 4). The high DO content is related to the decrease of the temperature (16). The low DO value (3.8 mg/l) which is recorded at station No. 19 (Bosat Kareem Eldin) in the Damietta branch was probably related to the microbial decomposition of the organic matter accumulated due to fish farm wasting. The average concentration of DO in the Damietta branch exceeded the permissible limits of (11) (6 mg/l) while in the Elnasriyah drain was less than the permissible limits of (11.(

On the other hand, biological oxygen demand (BOD) exhibits values varied from 6.00 to 517.50 mg/l with average 99.99 mg/l in

the Damietta branch and ranged between 6.40 and 54.40 mg/l with average 24.53 mg/l in Elnasriyah drain water (Table 1). The highest BOD was observed at station No. 20 (Mit Elkholy Abdalla) and at station No. 3 (Elnasriyah) (Fig. 5) indicating excessive export of biodegradable organic matter which increases the de-oxygenation of water and agree with the assumption of (17). The high BOD values may be related to photosynthesis activity at the water surface. It was observed that the average values of BOD in both of the Damietta Nile and Elnasriyah drain are higher than the permissible limits of (11) (not exceed 3 mg/l.(

Chemical oxygen demand (COD) occurred between 40.00 and 149.60 mg/l with average 97.42 mg/l in the Damietta Nile branch and varied from 27.20 to 125.80 mg/l with average 78.20 mg/l in Elnasriyah drain (Table 1, Fig. 6). The maximum COD concentration in the Damietta Nile is recorded at station No. 8 (Meet Khames Water Station) while the lowest COD concentration is recorded at station No. 19 (Bosat Kareem Eldin), probably due to the abundance of phytoplankton (14, 18 and 19). However, high COD values was recorded at station No. 4 (Elnasriyah drain) due to the high decomposition rate of organic matter as result of low DO content in summer. Estimation of BOD/COD ratio (Table 1) indicates that Mit Alkholy Abdalla and Elnasriyah drain waters are the most polluted stations.The average values of COD in both Damietta Nile and Elnasriyah drain have higher values than the permissible limits given by (11) (not exceed 10 mg/l).

Table 1: Results of chemical parameters determined in Damietta Nile branch and Elnasriyah drain waters. (Data given in mg/l).

S. No. .	Stations	pH	TN ppm	TP	DO	BOD	COD	BOD/COD
1	Samanoud	7.80	5.60	0.37	-	-	-	-
2	Elnasriyah drain (front)	8.50	21.00	0.59	0.60	6.40	81.60	0.078
3	Elnasriyah drain (middle)	9.00	20.30	0.44	0.44	54.40	27.20	2
4	Elnasriyah drain down stream	8.20	8.40	0.20	4.75	12.80	125.80	0.101
5	Elnasriyah Nile	7.60	7.00	0.68	7.70	83.20	68.00	1.2
6	Nawasa Albahr	8.00	14.00	0.14	-	-	-	-
7	Ewish Alhagr	8.20	11.60	0.16	-	-	-	-
8	Water station (Meet Khames)	8.50	9.10	0.17	8.30	35.20	149.60	0.235
9	Mansoura hospital	8.70	11.20	0.14	11.80	12.80	122.40	0.104
10	Mansoura train bridge	8.70	5.60	0.11	-	-	-	-
11	Talkha electric station	8.40	14.00	0.14	7.10	13.20	122.40	0.107
12	Talkha fertilizer factory	9.00	4.90	0.18	6.30	16.00	122.40	0.130
13	Kolengeel	8.80	4.20	0.40	-	-	-	-
14	Elkhyariya	9.00	2.80	0.25	-	-	-	-
15	El badala	8.90	2.80	0.16	-	-	-	-
16	Elbramon	8.06	5.60	0.08	-	-	-	-
17	Kafr Elbramon	7.92	10.50	0.16	-	-	-	-
18	Elahmadia-Sherbin	8.90	4.90	0.20	4.00	6.00	140.00	0.042
19	Bosat Kareem Eldin	8.90	29.40	0.17	3.80	51.00	40.00	1.275
20	Mit Alkholy Abdalla	8.36	7.00	0.06	10.00	517.50	80.00	6.468
21	Mit Alkholy Abdalla farm)	8.56	7.80	0.30	6.50	165.00	100.00	1.650
	Average in Damietta Nile Branch	8.46	8.78	0.22	7.28	99.99	97.42	1.026
	Average in Elnasriyah drain	8.57	16.57	0.41	1.93	24.53	78.20	0.313

not determined

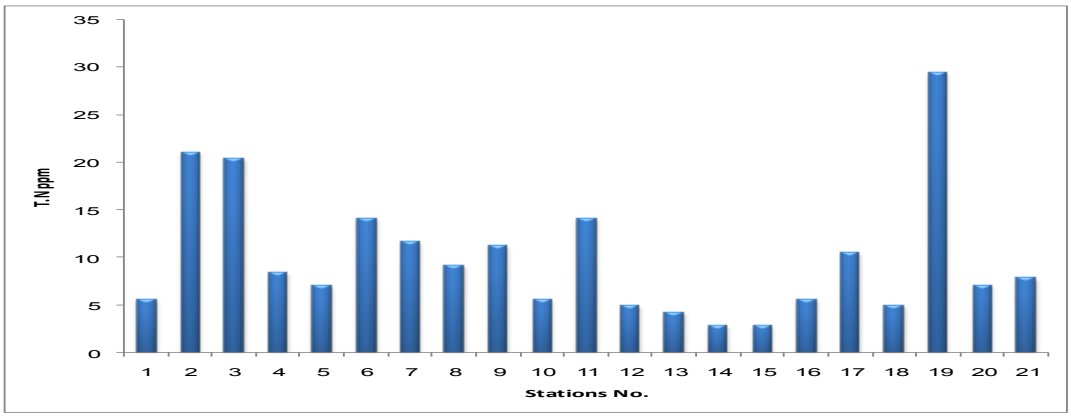


Fig. 2: Bar graph distribution for Total Nitrogen (TN) concentrations in the Damietta Nile Branch and drain waters.

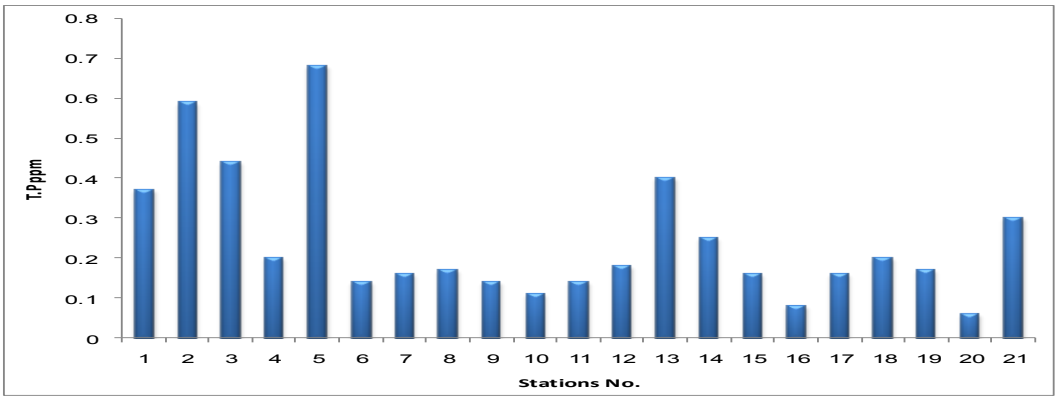


Fig. 3: Bar graph distribution for Total Phosphorus (TP) concentrations in the Damietta Nile Branch and drain waters.

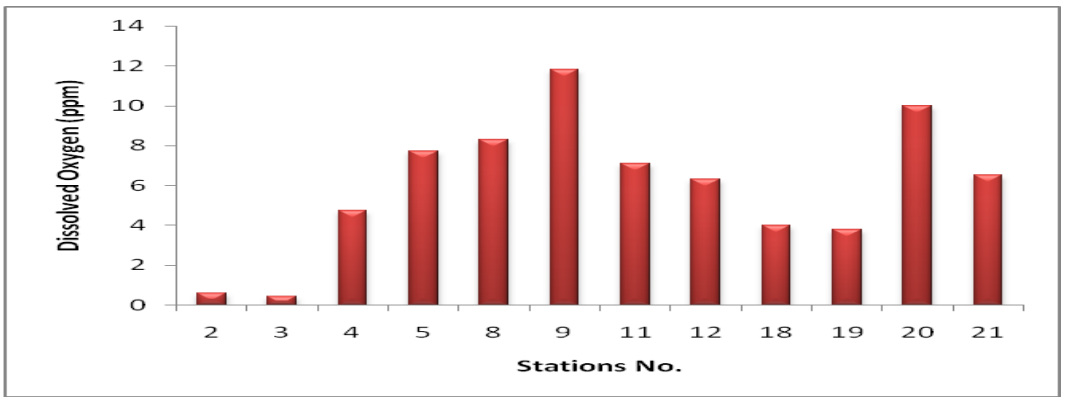


Fig. 4: Bar graph distribution for DO concentrations in the Damietta Nile Branch and drain waters.

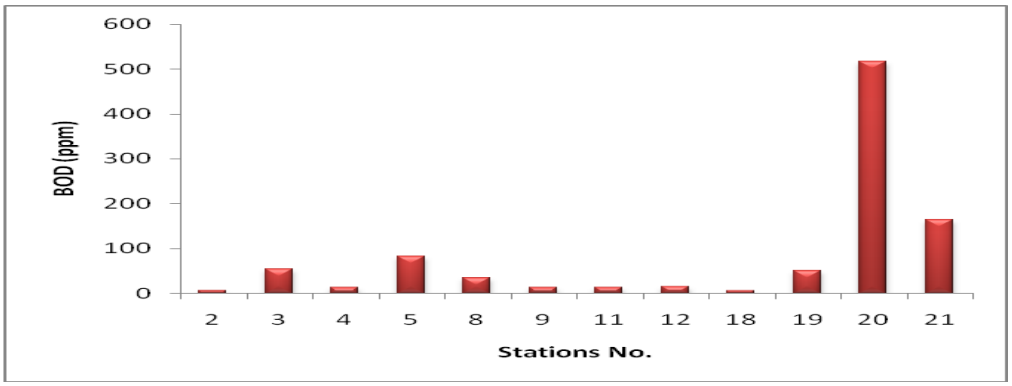


Fig. 5: Bar graph distribution for BOD concentrations in the Damietta Nile Branch and drain waters

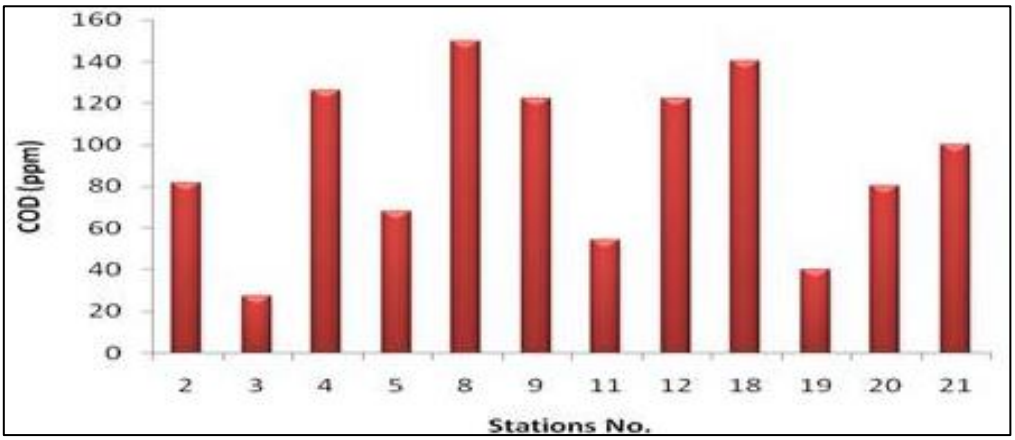


Fig. 6: Bar graph distribution for COD concentrations in the Damietta Nile Branch and drain waters.

Heavy Metals Concentration

Heavy metals are introduced into the water in the forms of particulate and dissolved phases (20). Increased concentration of heavy metals can be based on pH values, high concentration of salt, changes in redox conditions and increasing presence of organic and inorganic legends (21). High levels of Cd, Ni, Pb and Zn can be explained by their high mobility in the environment where they are known to be toxins (22). Heavy metals pollution is important because of its toxicity for the environment and human beings (23, 24 and 25). Metals can accumulate in the human body and are non-degradable, causing danger to nervous system and internal organs (26 and 27). Urbanization and industrialization lead to increasing the metal pollution of aquatic ecosystems (28 and 29).

Distribution and Sources of Heavy Metal Pollution

Heavy metal concentrations in the Damietta Nile branch and Elnasriyah drain waters are summarized in Table (2) and illustrated in Fig. (7).

Iron (Fe): Average concentration of Fe equals 0.113 mg/l and 0.161 mg/l in the Damietta Nile and in Elnasriyah drain water respectively. Highest Fe content is recorded at station No. 20 (Meet Alkholy Abdalla, Fig.7) probably related to occurrence of the fish farms in the river. (30) related ferrous compounds in the aquatic environments to the precipitation of Fe in alkaline and oxidizing conditions. Fe has positive correlation coefficient with Zn (r = 0.540, Table 4). Average value of Fe was lower than the permissible limits given by (12 and 13).

Zinc (Zn): Average value of Zn equals 0.028 mg/l in the Damietta Nile branch and 0.022 mg/l in Elnasriyah drain. Maximum Zn content was recorded in station No. 19 (Bosat Kareem Eldin, Fig.7). The highest Zn value was occurred in Elnasriyah drain water. The main sources of zinc are domestic wastes and atmospheric deposition (31). Average concentration of zinc in the Damietta Nile branch is lower than the permissible limits of (12) for drinking water.

Manganese (Mn): The maximum value of Mn was noticed at station No. 15 (Elbadala) and also in Elnasriyah drain due to discharge of domestic wastes (point source) of pollution and industrial wastes. (32) reported that the burning discharge of diesel fuel in the motor cars is the major sources for manganese in air and water. A positive correlation exists between concentration of manganese and cobalt (r =0.513, Table 4). Average Mn values given in Table (2) fall within the permissible limits of both (12 and 13) for drinking water.

Copper (Cu): Highest Cu concentration was recorded at station No. 1 (Samanoud) and is related to the effect of industrial pollution discharged into the Damietta branch (Table 2, Fig.7). Cu occurred in low amounts in most stations with averages equal 0.008 mg/l in Damietta branch and 0.006 mg/l in Elnasriyah drain; the two values appear less than the permissible limits of (12 and 13) for drinking water and (33).

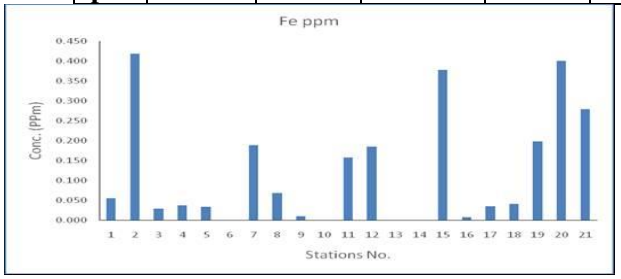
Table.2: Heavy metals concentration in Damietta Nile Branch and Elnasriyah drain. (Data given in mg/l).

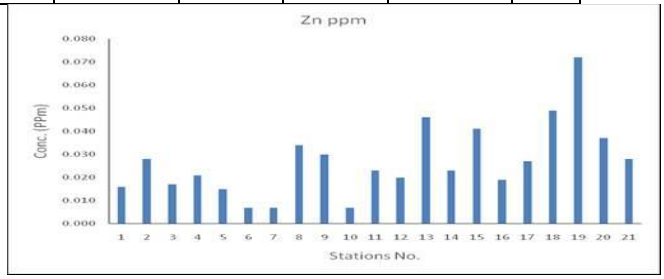
St. No.	Location	Fe	Zn	Mn	Cu	Ni	Co	Pb	Cd
1	Samanoud	0.055	0.016	0.069	0.060	0.001	0.132	0.048	0.012
2	Elnasriyah drain upper	0.418	0.028	0.070	0.007	0.002	0.078	0.000	0.001
3	Elnasriyah drain Middle	0.029	0.017	0.052	0.005	0.002	0.134	0.002	0.014
4	Elnasriyah drain down	0.037	0.021	0.094	0.005	0.003	0.096	0.000	0.020
5	Elnasriyah Nile	0.033	0.015	0.082	0.004	0.004	0.028	0.004	0.050
6	Nawasa Albahr	0.000	0.007	0.069	0.002	0.000	0.206	0.015	0.025
7	Ewish Alhagr	0.188	0.007	0.067	0.000	0.000	0.214	0.006	0.060
8	Mit Khames Water St.	0.068	0.034	0.094	0.004	0.001	0.116	0.013	0.024
9	Mansoura hospital	0.010	0.030	0.032	0.003	0.001	0.082	0.010	0.009
10	Mansoura train bridge	0.000	0.007	0.153	0.023	0.008	0.123	0.014	0.010
11	Talkha electric station	0.157	0.023	0.080	0.004	0.003	0.013	0.013	0.014
12	Talkha fertilizer factory	0.185	0.020	0.263	0.005	0.002	0.037	0.002	0.028
13	kolengeel	0.000	0.046	0.113	0.002	0.002	0.019	0.001	0.010
14	Elkhyariya	0.000	0.023	0.056	0.001	0.005	0.017	0.027	0.164
15	Elbadala	0.377	0.041	0.356	0.002	0.005	0.038	0.006	0.015
16	Elbramon	0.007	0.019	0.064	0.003	0.028	0.153	0.012	0.029
17	Kafr Elbramon	0.035	0.027	0.072	0.028	0.041	0.157	0.006	0.020
18	ElAhmadia- Sherbin	0.041	0.049	0.015	0.003	0.002	0.037	0.006	0.009
19	Bosat Kareem Eldin	0.198	0.072	0.109	0.001	0.001	0.040	0.005	0.059
20	Mit Alkholy Abdalla	0.400	0.037	0.098	0.000	0.005	0.063	0.000	0.028
21	Mit Alkholy Abdalla	0.278	0.028	0.010	0.000	0.004	0.157	0.003	0.017
	Average in Damietta B	0.113	0.028	0.100	0.008	0.006	0.090	0.011	0.032
	Average in Elnasriyah D	0.161	0.022	0.072	0.006	0.002	0.103	0.001	0.012
	P. L. Egypt (2007)	0.3	3.0	0.1	2.0	0.020	0.4	0.010	0.003
	P. L. WHO (2011)	0.3		0.1	2.0	0.070	-	0.010	0.003
	P. L. FAO (1994)	5.0	2.0	0.2	0.2	0.2	-	5.0	0.010

Not available P. L. Permissible limits

Table 3: Correlation coefficients of metal concentrations in the analyzed water samples.

	Fe	Zn	Mn	Cu	Ni	Co	Pb	Cd	TP	pH
Fe	**1**									
Zn	**0.540***	**1**								
Mn	**-0.730**	**-0.317**	**1**							
Cu	**0.213**	**-0.155**	**-0.231**	**1**						
Ni	**0.169**	**-0.245**	**-0.327**	**-0.01**	**1**					
Co	**-0.811**	**-0.479**	**0.513***	**-0.058**	**-0.045**	**1**				
Pb	**0.279**	**0.232**	**-0.37**	**-0.208**	**0.291**	**-0.268**	**1**			
Cd	**-0.009**	**-0.393**	**-0.198**	**0.011**	**0.162**	**0.094**	**0.07**	**1**		
TP	**-0.769**	**-0.419**	**0.479***	**-0.082**	**-0.229**	**0.840****	**-0.387**	**-0.005**	**1**	
pH	**-0.874**	**-0.44**	**0.624****	**-0.191**	**-0.202**	**0.942****	**-0.293**	**0.056**	**0.901****	**1**





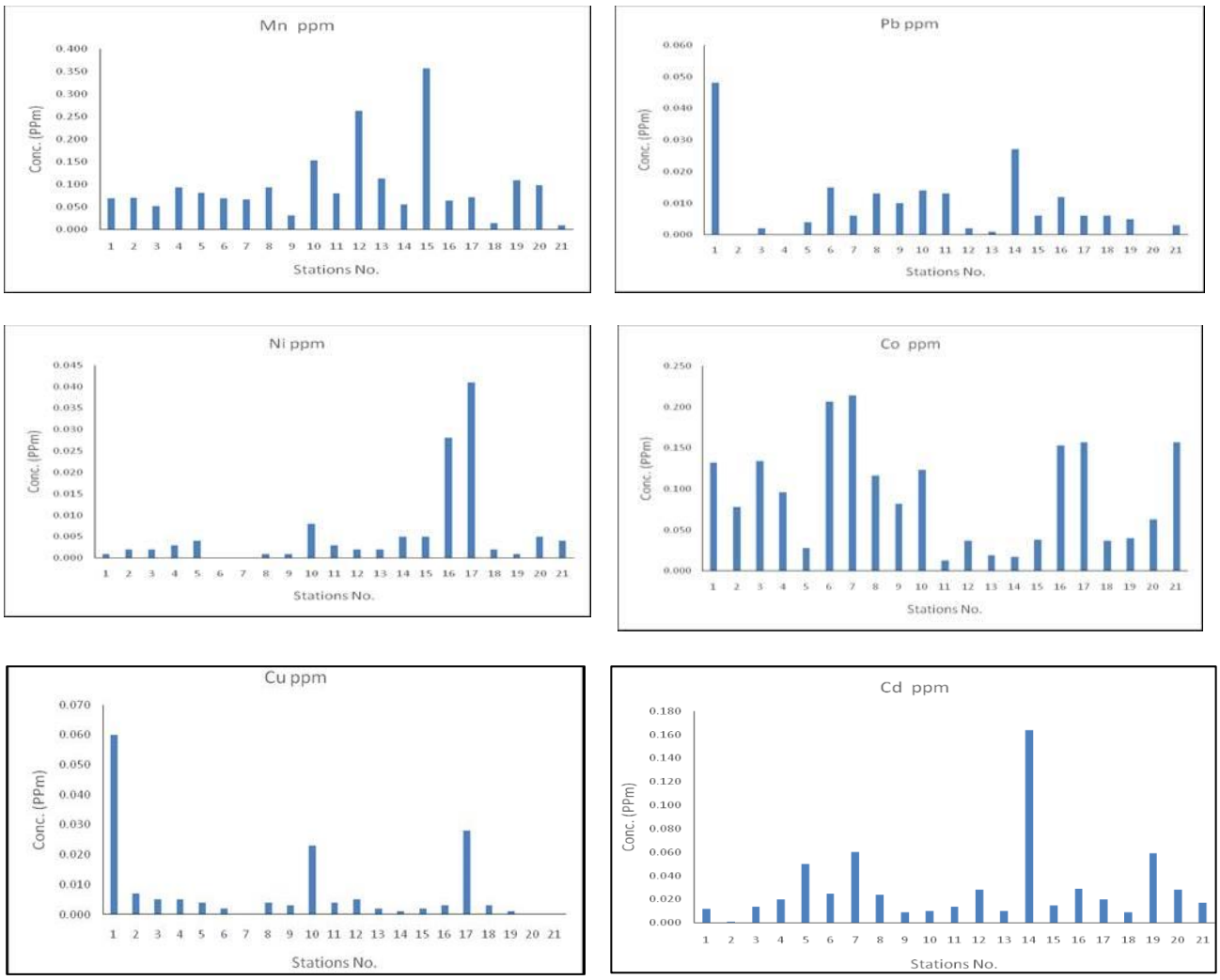


Fig.7: Distribution of heavy metal contents in the analyzed water samples from Damietta Nile Branch and Elnasriyah drain.

Nickel (Ni): The distribution of Ni values are listed in Fig. (7). The highest Ni content recorded in station No.17 (Kafr Elbramon) was probably due to domestic waste discharged directly into the Nile water. It was found that the average concentration of Ni in the Damietta branch and Elnasriyah drain waters are lower than the permissible limits of (12 and 13) for drinking water (not exceed 0.070 and 0.020 mg/l) and (33) (not exceed 0.2 mg/l).

Cobalt (Co): Co concentration has erratic distribution (Fig. 7); the highest Co content was found at stations No. 6&7. The average Co content in the Damietta branch is lower than the permissible limits of (12) for drinking water (not exceed 0.4 mg/l). Co has strong positive correlation with TP (r = 0.840). Average Co in Elnasriyah drain was higher than the permissible limits of (14) (not exceed 0.05 mg/l). During the periods of reducing conditions at low depths in the Nile water, Mn, Fe and Co are mobilized from the bottom sediments (34).

Lead (Pb): The distribution of Pb concentrations is shown in Fig. (7). The highest Pb value is recorded from station No. 1 (Samanoud) which is related to industrial pollution. Higher levels of Pb often occur in water bodies beside highways due to high combustion of gasoline (35). Average Pb concentration (0.011 mg/l) in the Damietta Nile branch is higher than the permissible limits given by (12 and 13) for drinking water (not exceed 0.010 mg/l).

Cadmium (Cd): Cd has values ranged between 0.009 and 0.164 mg/l with average 0.032 mg/l in the Damietta branch. Cd content has fluctuated between 0.001 and 0.020 mg/l with average 0.012 mg/l in Elnasriyah drain. (36) believed that the relatively high levels of

Cd, Zn and Ni are mainly attributed to fuel exhaust and abrasion of rubber tires. Distribution of Cd concentrations shown in Fig. (7) indicates that the highest Cd concentration recorded at station No. 14 (Elkhyariya) was probably due to the discharge of hazardous waste from Talkha fertilizer factory. Average value of Cd (0.012 mg/l) in Elnasriyah drain was higher than the permissible limits of (33) (not exceed 0.010 mg/l). On the other hand, average Cd (0.032 mg/l) in the Damietta branch was also higher than the permissible limits given by (12 and 13) (not exceed 0.003 mg/l).

Generally, heavy metal concentrations in the Damietta Nile Branch water follow the order: Fe > Mn > Co > Cd > Zn > Pb > Cu > Ni, while in Elnasriyah drain the order was: Fe > Co > Mn > Zn > Cd > Cu > Ni > Pb.

Environmental Assessment of Water Quality

This study offered comprehensive water quality information of Damietta Nile Branch. Noteworthy, Nile water in the area studied has vital importance for the Egyptian industry and agriculture; these waters are the major source for drinking water supply in Egypt. Comparison of the present study with some international quality criteria of surface fresh-water intended for domestic water supply has been established. Both average concentrations in the Damietta Nile branch and the maximum values suggested by European Communities and U.S. Environmental Protection Agency EPA for portable water are summarized in Table (5). It is evident that the average concentrations of most heavy metals in the Damietta Nile Branch are lower than those given by (13 and 14) except for Co and Cd.

Water quality in the vicinity of pollution sources has negative effects. The sharp increase in the concentrations of Fe, Zn, Cd and Pb were directly related to the industrial effluents. The atmospheric pollution caused by industrial plants has severe local impacts. Water quality deterioration due to point source pollution is pronounced at Samanoud district where stations 1, 2, 3 and 4 are located

Table 5: Comparison of average heavy metal concentrations in Nile waters with those given by others (concentration in mg/l).

Reference ------ Metal	Damietta Branch (P. Study)	Nile River(6)	Rosetta& Damietta(5)	Rosetta Branch(17)	(37)	(4)
Fe	0.113	0.163	0.340	0.088	0.12	5
Mn	0.100	-	0.073	0.103	0.100	0.2
Cu	0.008	0.035	0.002	0.011	0.002	0.2
Zn	0.028	0.012	0.024	0.049	0.12	2
Ni	0.006	-	0.017	0.007	-	0.2
Co	0.090	-	-	0.005	10.40	0.05
Pb	0.011	0.007	0.007	0.012	0.0015	5
Cd	0.032	0.001	0.002	0.002	0.0001	0.005

Not available

It has been assumed that the water quality of the Nile River in the delta region is essentially influenced by agricultural discharge that changes the chemical composition of the water. However, combination of many factors; industrial, domestic and flow of agricultural drainage water make the composition of the Nile water unstable. However, the effect of industrial and domestic wastes tend to disappear few kilometers downstream with decreasing the BOD values supporting the suggestion assumed that the Nile River has high self-purification capacity according to (2).

The data obtained from this study has indicated that the Damietta Nile branch has received considerable high amounts of untreated sewage rich in organic matter and industrial and agricultural effluents. Elnasriyah drain (named as Omar Bek) has highly turbid water with extreme BOD, COD values and very rich in P. In the front of Elansriyah drain, Damietta Nile water has sharp decrease in pH, DO, and increase in BOD, P and total dissolved salts. This finding fully confirmed the negative impacts of industrial pollution on the Nile water. The BOD attained maximum values at stations no. 20 and no. 21 at Mit Alkholy Abdalla which mainly attributed to the fish farms and domestic wastes effluent rich with organic matter.

In an attempt to evaluate the suitability of water for domestic uses, the obtained data were compared with the international quality standards of surface fresh waters intended for domestic water supply; the background values are most desirable and serve as guidelines for water quality control and as indicators of the extent and possible consequences of contamination when exceeds. Most of the data from this study was obtained from large inland waters. Results of this study (Table 6) appear fortunately below the upper limits suggested by European Communities Directives (38) and U.S. Environmental Protection Agency (39) for potable water supply. The self-purification capacity of the Nile River is supposed to be high. The chemical water quality is in general tolerable for domestic uses. When compared with some major rivers in Europe and USA, the Nile River can be considered mostly as a moderately clean river but with localized severe pollution problems.

Table 6: Comparison of average heavy metal concentrations in inland waters, soils and the present study (concentration in mg/l).

Metal	Background (40)	MississipiRiver (41)	Damietta Branch (P. study)	(42)
Fe	-	-	0.113	-
Mn	-	-	0.100	-
Zn	10	10	0.028	5
Cu	1	2	0.008	0.05
Ni	0.3	1.5	0.006	-
Co	0.05	-	0.090	0.05
Pb	0.2	0.2	0.011	0.1
Cd	0.07	0.1	0.032	0.01

No guideline available

Conclusions

Distribution and concentrations of chemical parameters and heavy metals in the Damietta Nile branch and Elnasriyah drain have been investigated in twenty one water samples from Samanoud to Mit Alkholy Abdalla. The biological oxygen demand (BOD) and chemical oxygen demand (COD) concentrations in the Damietta Nile Branch are higher than in Elnasriyah drain however, both of them are higher than the permissible limits of (12) (not exceed 3.0 mg/l and 10 mg/l, respectively). Average total nitrogen (TN) in Elnasriyah drain water is higher than in Damietta Nile Branch due to the high nitrate concentrations. The average total phosphorous (TP) in the Damietta Nile branch and Elnasriyah drain is higher than the permissible limits of (12) (not exceed 1.0 mg/l). Dissolved oxygen (DO) in the Damietta Nile Branch has average value 7.28 mg/l exceeding the permissible limits of (12) and indicating better water quality than Elnasriyah drain water where DO values equal 1.93 mg/l being lower than the permissible limits of (12). Urbanization influences are mostly reflected by elevated contents of lead, cadmium and zinc. Average concentrations of Pb and Cd are higher than the permissible limits of both (12 and 13) for drinking water. Leaching of heavy metals from trash and solid waste dumps together with the fish farms in the Damietta Nile Branch play considerable rules in the pollution of the water in this area.

Recommendations

1) Aregular and continuous monitoring through laboratory facilities for the hydrochemical parameters, heavy metal concentrations and E. coli at annual levels to identify changes occurring in the Damietta Nile Branch and quality control for water use.

2) The environmental law should be enforced to prevent the discharge of wastewater (industrial, agricultural, domestic) to Nile River.

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