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Environmental Study on some Pollutants of Shoubra El-Kheima Power Plant in Nile River

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Summary: Shoubra El-Keima is considered as one of the most polluted regions in Egypt. The effluent of wastewater and cooling water from Sboubra El-Kheima power plant to the Nile River water was examined. The changes in physico-chemical characteristics of Nile River water at Shoubra El-Kheima power plant area have been studied. The study included the physical parameters such as temperature, electric conductivity, TDS, TSS,TS, turbidity and color. The chemical parameters included DO, BOD_5, COD, pH and oil and grease content; major anions included carbonate, bicarbonate, chloride, sulphide and sulphate; whereas, nutrient salts included nitrite, nitrate, ammonia, orthophosphate, total phosphate and silica were determined using standard methods of analysis. On the other hand, some trace metal ions including Ni^{2+}, Fe^{3+}, Zr^{4+} and Cr^{6+} besides, Mn^{2+} and Zn^{2+} ions were determined with the developed and standard spectrophotometric methods. The water and sediment samples were taken in front, 500 M before and 500 M after the power plant from surface and/or bottom, respectively.

Introduction

The use of water resources is not only determined by the quantity needed for given purposes, but also by the requirements for a certain quality of the water. Such quality is generally described through a set of variables relate to the physico-chemical and biological properties of the water. Accordingly, the wastewater effluent must be treated to a sufficient degree to render it safe and keep with the 48/82 law(1). The physico-chemical characteristics of water in Ismailia Canal showed monthly variations of all parameters. The canal water which is bicarbonate stream, can be characterized by slight basicity, moderate organic content, low turbidity and moderate hardness(2). Whereas the Nubia Lake showed that, the stratification and DO profiles along the lake were relatively higher values of HCO_3^-, CO_3^{2-} and SO_4^{2-} ions measured during the flood period due to the washing of the DS through the Nile tributaries after sedimentation of the suspended particles. The decrease in the concentration of Ca^{2+}, Mg^{2+} and Na^+ ions is mostly due to deposition through the electrical double layer on the surface of the fine suspended particles(3). The analysis of water along the Rosetta Branch especially El-Rahawy drain from El-Kanater to Kafr El-Zayat city during low flow condition was studied. A sharp increase in electric conductivity, ammonia, BOD_5, COD, TDS and great depletion in DO is directly affect on the water quality of Rosetta Branch, which is seriously deteriorating the area locating down stream the drain[4]. On the other hand, water quality index and water quality model Duflow has been calculated for the water abstracted from the Rosetta Branch at the water intakes locations using the data obtained from a source assessment survey. After inspecting the overall water quality index, the BOD_5 and the ammonia are the most contributing factors in increasing the water quality index calculated. It was obvious that, the Rahawy drain was the most polluted source affecting Rosetta Branch and water quality of drinking water intakes[5].

The Nile River water at El-Kanater El-Khyria region have been affected by many substances drained from soap plant[6]. The increases in the nutrient salts especially at the area which receive the main drain of the soap plant accompanied by low water productivity, may be attributed to the organic matter decomposition and oxygen depletion. The toxicity of them contaminate the aquatic environment and accumulate on the bottom and poison it. Whereas, the concentrations of anions and cations of the Nile River water at El-Kanater El-Khyria region showed that, the area opposite to the soap factory is more affected by direct exposure to the drainage and the reflux of water used for cooling[7]. This led to exerting drastic changes in the concentrations of the major anions and cations.

El-Gohary et al.[8] conducted the wastewater management of an industrial complex which produces different products, i.e. soap, perfume extract, macaroni, jam and juices. A continuous monitoring program for final effluents was carried out for almost 3 months. The composite wastewater from both soap and food processing plants is highly contaminated with organic compounds as indicated by COD and BOD_5. Biological treatment of the composite wastewater removed the organic contaminants in the waste-water. The average residual of BOD_5, COD, oil and grease values were 30, 92 and 8.3 mg/l, respectively. Based on the laboratory results, a final process design was developed.

The analysis of sediments of the Nile River indicated that, the concentrations of the trace metals varied from south to north direction (Aswan to Helwan). Sediments are the major compartment for many materials of toxic or nutrient concentration in aquatic environments[9]. The level for all metal ions in the sediments of the river is found below the permissible limits set by the Environmental Protection Agency (EPA) as harmless to the aquatic life. On the other hand, the ability of bed sediments of Rosetta and Damietta Branches of the Nile River to store the heavy metal pollutants from different pollution sources has been studied[10]. The results of grain size distribution showed that, the bottom sediment of Rosetta Branch characterized by high percentage of sand with low organic matter content while, the bottom sediment of Damietta Branch characterized by high percentage of silt, clay and organic matter. Moreover, in order to assess the impact of pollution sources on the bed sediments of the two branches, different sediment pollution indicators were applied. The results of the assessment showed that, the reach of Damietta Branch located downsream El-Serw drain could be considered unpolluted to moderately polluted by heavy metals whereas, the reach of the Rosetta branch downstream El-Rahawy drain could be considered moderately to strongly polluted.

The use of coagulation as a tertiary treatment of secondary effluent in the water reuse process for industrial application has been carried out at the biological treatment by denitrification-nitrification processes(11). The study was conducted using alum, ferrous sulphate, lime, alum combined with lime and ferrous sulphate combined with different lime doses. The best effectiveness of orthophosphorous removal was found for alum, 96.2% and ferrous sulphate combined with lime, 84.2%. The best results of permanganate COD removal were reached for ferrous sulphate, 52.5% and ferrous sulphate combined with lime, 51.3%. On the other hand, jar tests involving coagulation with alum, flocculation, settling and filtration conducted on secondary effluent samples, indicated the occurrence of two distinct coagulation mechanisms, charge neutralization and sweep coagulation at different alum dosages and pH conditions has been studied(12). An optimum alum dosages ranged from 55 to 60 mg/l and pH from 6.0 to 6.5 in this range. The BOD_5, TOC, turbidity, TP and PO_4^{3-} levels of the secondary effluent were reduced by 73%, 57%, 98% and 99%, respectively after tertiary filtration. It was found that, the primary chemical treatment by alum or lime, removed more than 90% of TSS, phosphate, BOD_5, oil and grease content whereas, organic nitrogen removal were 70%.

Many of the criteria developed for fresh water fish are based on the food and agriculture organization (FAO). Dissolved oxygen is a common factor in any aquatic community. In the absence of the irrigation water pricing and efficiency measures are the main focus to investigate the relation between variables involved in water conversation and how to interact with each other. Fayoum governorate represents the country problems at a small scale(13). A system analysis approach was used for the identification and characterization of the relationship between social and environment aspects of water scarcity and water conservation issues.

The water parameters of the Vistula River was studied. The major sources of pollution are located in the heavily industrialized areas, where the river flow is comparatively low which makes the situation worse throughout the Sile Sian industrial region. Some water parameters determined in Vistula River were BOD_5 15000 mg/l, COD

60 mg/l, TSS 100 mg/l and chloride 1500 mg/l. The study showed that, about 60% of the river water along its length is not acceptable for any use because of its poor quality[14].

This paper represents the stages of wastewater treatment in Shoubra El-Kheima power plant and its final disposal to the Nile River water. Industrial wastewater from the power plant is collected in the retention basin after separating the oil and grease. The water is treated before disposal into the river. The sewage system is treated with aeration and chlorination before discharging to the river water. The sludge of waste water and sewage are flocpressed with polymer and get rid of outside the plant. The cooling water flows through the tubes of condenser and the steam flows outside the tubes before entering the water-steam cycle. Heat exchange is an industrial wastes discharged into the river water which alter the ecology of a stream by lowering the solubility of oxygen in the water and reducing the amount of DO whereas, metabolic activity of aquatic species increases the BOD_5 content. The impurities present in a water supply to power plant are divided into suspended and dissolved solids. The suspended solids such as mud, clay and silt are removed by clarification and filtration processes whereas, the dissolved solids removed by demineralization process.

Experimental

1. Area of Investigation and Sampling Points

The water sampling in Nile River was selected at drainage area in Shoubra El-Kheima power plant were collected in the period from November 2001 to September 2002. The sampling points I, II and III are sitting at 500 m south power plant, in front of power plant and at 500 m north power plant, respectively.

2. Water sampling

The water samples were collected in a duplicates from the surface and bottom layers in two liter well stoppered polyethylene bottles and transported to the laboratory in ice tanks within few hours from collection. The preservation of samples was done according to the standard method for measuring the parameters such as pH, EC, CO_3^{2-}, HCO_3^-, NH_3, NO_2^-, NO_3^-, PO_4^{3-}, DO, BOD, Ca^{2+}, Mg^{2+}, Na^+, K^+, Cl^- and SO_4^{2-} where the water used without any preserved material but for the measuring of the organic nitrogen , the concentrated H_2SO_4 was added to water sample before measurement. Heavy metals such as Fe^{3+}, Mn^{2+}, Zn^{2+}, Cu^{2+}, $Ni^{2+}$and Cr^{6+} were determined using spectrophotometric methods. The samples were preserved immediately after collection by acidification with concentrated HNO_3 to pH<2. Use 5.0 ml nitric acid for one liter sample, then store in refrigerator at 4 ºC to prevent change in volume due to evaporation. To extract trace elements from water samples, nitric acid digestion method was used[15].

3. Sediment sampling

Sediment sample such as Zr (IV) was collected using hand corer sampler below the sites of water samples and stored in polyethylene bags and then transported to the laboratory in ice tanks within few hours from collection.

4. Apparatus

Spectrophotometer, Bausch and Lomb model Spectronic 2000. pH meter, model Orion 420 A. BOD meter, model Orion 890. DO meter, model, WTW Oxi-597. Conductivity meter, YSI model 35. Turbidity meter, model Chemitrex, type 12. Flame photometry, Perkin Elmer model Coleman. Fluorimeter, Perkin Elmer, model LS 50 B with transparent cell 1-cm path length. Atomic Absorption Spectrometer, Varian model Spectra AA 20 plus.

Results and Discussion

I. Physical Parameters

Temperature: Is a key parameter which influences physical, chemical and biological transformations in the aquatic environment. Before establishing the power plant in 1984, water temperature was found to be 18.2 and 28.3 ºC during winter and summer seasons whereas after establishing the plant, the temperature raised to 36.3 ºC due to the use of river water in cooling processes which led to thermal pollution.

Electrical Conductivity (EC): Conductivity is the result of ionizable solids in solution. The lowest value of EC was reached to 305 μ mhos before power plant whereas, the highest value reached to 622 μ mhos in front of power plant due to the waste water flow into the river and the thermal pollution which help on release of chemical salts from sediments to the upper water.

Total Dissolved Solids (TDS): The experimental data showed that, the maximum TDS value was observed after power plant due to the waste containing large amounts of DS.

Total Suspended Solids (TSS): The TSS content before power plant was 47 mg/l whereas, in front of power plant was 843 mg/l during summer season which contain a great amount of TSS flows into the river water.

Total Solids (TS): The Nile water entering Egypt carried annually about 100 million tons of suspended sediments consisting of 30% sand, 40% silt and 30% clay. The flood water was uncontrolled and left to drain in the sea. After constructing the High Dam, causes an increase in DS of Nile water because evaporation of the stored water in Nasser Lake. The highest value of TS in front of power plant was 1142 mg/l, not reached to a harmful level of 2000 mg/l and the water is not biodegradable. Total solids are the sum of total dissolved and suspended solids and determined gravimetrically.

Turbidity: The suspended matter in water such as clay, silt, finely divided organic and inorganic matter and micro-organisms causes the turbidity. The highest value of turbidity during autumn was 12 NTU, whereas the lowest value during summer was 5 NTU.

Color: The limit of transparency of water was measuring using properly calibrated glass color disks. The lower values of transparency in front of power plant due to the effect of turbid water bearing mud as well as the abundance of micro-organisms populations(16).

Odor: Taste and odor are affected with atmospheric conditions such as impurity, temperature and humidity. Chlorine, algae and phenols can intensify certain odors. The organic content of the Nile River water is relatively high throughout the year included impurities which will impart taste and odor to the water. The test for odor has no scientific mean and not accurate. Table 1, summarizes the seasonal variations of physical properties at power plant area where the RSD ranged between 0.002 and 0.025.

II. Chemical Parameters

Dissolved Oxygen (DO): The maximum value of DO before power plant was 7.2 mg/l whereas, the minimum value in front of power plant was 6.7 mg/l due to the increase of water temperature led to reduction in the diffusion rate of atmospheric oxygen to water and the effect of disposal water. The surface water obtained their oxygen from atmosphere and photosynthesis of aquatic flora whereas, the bottom water can be supplied from the surface water by diffusion and oxidation of organic carbon by biological processes(17).

Biochemical Oxygen Demand (BOD): The BOD is a measure of the amount of oxygen required by bacteria to oxidize the waste aerobically to carbon dioxide and water(18). The highest value of BOD was 4.6 mg/l in front of power plant during summer season, may be attributed to thermal pollution. Whereas, the lowest value of BOD was 2.9 mg/l during spring season at the same point, may be due to the presence of industrial wastes.

Table 1
Seasonal Variations of Physical Properties at Shoubra El-Kheima Power Plant

Seasons / S.P.	Summer A/S	Summer B	Autumn A/S	Autumn B	Winter A/S	Winter B	Spring A/S	Spring B	Regional Av. A/S	Regional Av. B
1. Temperature, ºC										
I	28.3	30.3	24.3	26.7	18.2	19.2	21.8	22.7	**23.1**	**24.7**
II	36.3	29.8	36.7	26.8	31.7	19.3	32.1	22.7	**34.2**	**24.6**
III	28.5	30.7	25.2	26.7	23.7	19.2	23.7	22.7	**24.1**	**24.8**
Mean	31.1	30.3	28.7	26.7	23.0	19.2	25.9	22.7	**26.8**	**24.7**
2. TDS, mg/l										
I	161.8	165.6	269.4	239.3	252.2	236.4	222,8	231.0	**266.6**	**218.1**
II	303.0	158.5	321.8	237.7	663.0	312.8	888.0	262.5	**543.9**	**242.9**
III	158.2	172.3	249.5	254.9	266.3	304.5	217.3	230.6	**222.8**	**240.6**
Mean	207.7	162.5	280.2	244.0	393.3	284.6	442.7	241.4	**331.0**	**240.6**
3. TSS, mg/l										
I	45.8	31.5	62.8	46.2	97.6	179.0	35.5	43.3	**60.4**	**72.7**
II	843	59.3	191.7	258	107.5	294.2	55.8	87.4	**299.5**	**174.7**
III	65.2	73.4	59.1	68.5	52.3	184.9	39.6	39.8	**54.0**	**91.6**
Mean	318	54.7	104.5	124.2	58.8	219.4	42.6	53.8	**137.7**	**113.0**
4. TS, mg/l										
I	206.2	195.0	232.0	236.2	298.8	415.3	258.6	266.2	**273.9**	**303.2**
II	1142.8	218	512.8	594.8	770.0	605.6	944.7	350.5	**842.6**	**442.3**
III	223.6	245.6	325.2	310.4	319.2	488.7	258.2	270.4	**277.9**	**332.5**
Mean	245.2	219.8	385.0	418.8	462.7	470.2	365.4	295.6	**464.8**	**359.3**
5. EC, m mohs										
I	305.4		412.9		351.4		347		**354.1**	
II	532		622.1		582.8		457.3		**348.5**	
III	317.2		432.7		384.6		330.5		**366.2**	
Mean	348.9		489.2		439.5		225.9		**384.9**	
6. Color, units										
I	89		79		88		85		**85.2**	
II	59.5		56		56.5		50		**55.2**	
III	76.5		78		80.5		75		**77.5**	
Mean	**75**		**71**		**75**		**70**		**72.7**	

Where: SP is sampling point; A is air sample, S is surface sample and B is bottom sample.

Chemical Oxygen Demand (COD): The COD was used to determine the amount of oxidizable organic material in water. The highest value of COD during autumn due to lack of organic matter, whereas the lowest value during spring season. The oxidizable organic matter affects on aquatic ecosystem by interacting with inorganic matter forming complexes contains heavy metals.

BOD/COD Ratio: The 1:1 BOD/COD ratio is specific to the purified water according to national standard and the ratios 2:1 up to 4:1 for domestic sewage. The BOD/COD ratio in power plant area is 0.32 indicates that, this water not reached to the biodegradation level.

Pollution load: The pollution load in the aquatic environment calculate the amount of biotic oxygen consumption (BOC) through the oxidation of organic matter and oxidation of ammonia, this gives indication of oxygen consumption by mineralization of organic substance as given in the formula, BOC = $\frac{BOD}{DO}\times 100$ [19]. The BOC values were 47.9, 35.8, 46.4 and 54.1% during autumn, winter, spring and summer, respectively. The aquatic body of river water is loaded by organic pollution during summer and autumn whereas, the lowest load were in the spring and winter seasons.

pH Value: The carbonate system which included CO_2, H_2CO_3, HCO_3^- and CO_3^{2-} is the principle system for regulating the pH of the water. The rise in the temperature rate decreased the pH values of the water and activated the photosynthesis process. The thermal pollution in the river water at the area opposite to power plant led to decomposition of organic matter with liberation of CO_2 and decrease in the pH values.

Oil and Grease: The oil content is considered one of the most pollutants in aquatic life. The minimum value of oil content in river water before power plant was 2.0 mg/l during winter season whereas, the maximum value during summer season in front of power plant was 4.1 mg/l. The oil content is high at point II due to the disposal waste of power plant. Table 2, summarizes the seasonal variations of chemical properties at power plant area.

III. Major Anions

Carbonate alkalinity: The minimum CO_3^{2-} ion concentration in the river water was 0.8 mg/l may be attributed to the relatively high temperature in the surface water and CO_2 gas escaped to the atmosphere. In addition to the turbulence which promoting the escaped CO_2 and led to decrease in the carbonate content and precipitation of $CaCO_3$ on bottom[20]. The maximum value of carbonate during autumn was 11.5 mg/l may be due to the increase in amount of an aquatic plants which decayed with raising temperature led to CO_2 liberation.

Bicarbonate alkalinity: The relative increase in bicarbonate content in the Nile River water during summer and autumn seasons may be attributed to the reaction between CO_2 and OH^- and the combination of CO_3^{2-} with H^+[21]. The minimum value of bicarbonate content in the river water during spring was 111 mg/l, may be due to the thermal effects caused by the power plant which dissociate HCO_3^- ions into CO_2 and OH^-.

Chloride: The Cl^- ion is an essential element for the photosynthesis of water to release oxygen for ATP formation and for certain phosphorylation reactions. The relative decrease in the Cl^- ions during summer may be due its consumption by micro-organisms during the biological assimilations. The increase in Cl^- ions during autumn and winter seasons may be attributed to the drought period and decaying most of micro-organisms. Also, discharge of industrial waste and sewage water led to an increase in Cl^- ions in Nile River water opposite to power plant.

Table 2
Seasonal Variations of Chemical Properties at Shoubra El-Kheima Power Plant

Seasons / S.P.	Summer S	Summer B	Autumn S	Autumn B	Winter S	Winter B	Spring S	Spring B	Regional Av. S	Regional Av. B
1. DO, mg/l										
I	7.2	7.4	8.5	8.6	8.4	8.7	6.8	6.7	**7.7**	**7.8**
II	6.8	6.9	8.1	8.5	8.3	8.4	6.7	6.8	**7.5**	**7.6**
III	6.4	7.0	8.3	8.6	8.2	8.7	6.7	6.6	**7.4**	**7.7**
Mean	6.8	7.1	8.3	8.6	8.3	8.6	6.7	6.7	**7.5**	**7.7**
2. BOD, mg/l										
I	3.6	3.3	3.9	3.6	2.8	3.1	3.4	3.3	**3.3**	**3.3**
II	4.6	3.9	4.5	4.4	2.4	2.9	2.9	2.8	**3.6**	**3.5**
III	3.2	3.9	4.5	3.3	2.9	4.1	3.1	3.2	**3.4**	**3.6**
Mean	3.8	3.7	4.3	3.8	2.7	3.4	3.1	3.1	**3.5**	**3.5**
3. COD, mg/l										
I	10.9	10.7	11.9	10.0	6.2	6.5	13.3	14.5	**10.6**	**10.3**
II	12.3	11.4	16.9	15.5	8.2	9.1	14.7	14.1	**13.0**	**12.4**
III	11.2	10.0	10.7	10.4	8.1	9.7	13.1	12.3	**10.8**	**10.6**
Mean	11.5	10.7	13.2	11.8	13.1	12.3	13.7	13.6	**11.5**	**11.1**
4. BOD/COD ratio										
I	0.32		0.34		0.46		0.23		**0.34**	
II	0.36		0.28		0.31		0.20		**0.29**	
III	0.32		0.37		0.39		0.25		**0.33**	
Mean	0.33		0.36		0.38		0.23		**0.32**	
5. pH										
I	7.45	7.52	7.95	8.0	7.92	7.95	7.77	7.85	**7.77**	**7.83**
II	7.31	7.46	7.71	7.72	6.35	7.58	7.30	7.68	**7.30**	**7.68**
III	7.45	7.48	7.88	7.99	7.80	7.85	7.76	7.82	**7.76**	**7.82**
Mean	7.40	7.49	7.85	7.90	7.30	7.76	7.61	7.78	**7.61**	**7.78**
6. Oil and Grease, mg/l										
I	3.8		3.0		2.0		2.9		**2.9**	
II	4.1		3.1		2.2		3.4		**3.2**	
III	3.7		2.9		2.1		3.2		**3.0**	
Mean	**3.9**		**3.0**		**2.1**		**3.2**		**3.0**	

Where: S.P. is sampling points; S is surface sample and B is bottom sample.

Sulphate: The increase in SO_4^{2-} ions in front of power plant may be attributed to the bacterial oxidation effect and also, from washing steps in the regeneration of the demineralizer system. The decrease in SO_4^{2-} ions on the bottom during spring may be due to the reduction of SO_4^{2-} into S^{2-} ions caused by bacterial activity and COD, whereas H_2S gas was released to overlay water leading to the precipitation of insoluble sulphide[(22)].

Sulphide: The decrease in S^{2-} ions during autumn and spring seasons may be due to the oxidation of S^{2-} ion into the most stable form SO_4^{2-} ion. Sulphur is very important for protein structure and affect on the growth of the aquatic biota due to the abundance of S^{2-} ion into SO_4^{2-} ion. Table 3, summarizes the seasonal variations of the major anions at power plant area.

Table 3
Seasonal Variations of Major Anions at Shoubra El-Kheima Power Plant

Seasons / S.P.	Summer S	Summer B	Autumn S	Autumn B	Winter S	Winter B	Spring S	Spring B	Regional Av. S	Regional Av. B
1. CO_3^{2-}, mg/l										
I	6.8	8.2	11.8	10.2	6.4	6.5	6.8	5.6	**7.9**	**7.6**
II	0.8	5.2	4.2	5.3	3.3	7.6	3.3	4.9	**2.9**	**5.7**
III	5.9	8.5	8.3	10.4	5.0	7.2	5.5	6.0	**6.2**	**8.0**
Mean	4.5	7.3	8.1	10.6	7.1	4.9	5.2	5.5	**5.7**	**7.1**
2. HCO_3^-, mg/l										
I	247.9	240.0	291.6	288.9	273.8	284.0	250.6	256.3	**266.0**	**267.5**
II	153.9	141.7	257.9	271.2	268.2	270.4	110.7	235.0	**197.7**	**231.1**
III	240.3	233.6	275.3	293.1	289.0	274.2	253.5	258.7	**264.5**	**264.9**
Mean	214.0	250.1	274.9	286.3	277.1	276.2	204.9	250.0	**242.7**	**254.4**
3. Cl^-, mg/l										
I	22.8	22.0	28.6	27.5	36.5	35.2	28.6	27.6	**29.2**	**28.1**
II	24.1	22.7	28.3	28.7	41.6	35.9	36.4	26.2	**32.6**	**28.4**
III	22.1	21.9	27.5	26.9	36.2	33.3	26.7	25.7	**28.1**	**26.9**
Mean	23.0	22.2	28.2	27.7	38.1	34.8	27.3	26.5	**29.1**	**27.8**
4. SO_4^{2-}, mg/l										
I	9.9	10.8	26.9	28.0	22.0	27.1	25.2	35.2	**21.7**	**25.3**
II	183.7	13.0	138.6	98.5	258.0	8.6	209.5	57.8	**197.4**	**44.5**
III	12.2	10.2	28.4	25.4	27.3	25.2	19.1	24.9	**21.7**	**21.4**
Mean	53.3	11.3	65.5	50.6	102.4	20.3	84.6	39.3	**101.9**	**40.5**
5. S_2^{2-}, mg/l										
I	273.8	226.7	356.0	404.0	285.0	285.0	238.5	261.0	**288.3**	**294.2**
II	321.2	274.3	452.5	428.0	285.0	260.0	214.3	219.6	**318.2**	**295.5**
III	202.0	345.0	380.5	380.4	285.0	285.0	328.0	252.0	**298.9**	**315.6**
Mean	**265.7**	**282.0**	**396.3**	**404.0**	**285.0**	**276.7**	**260.2**	**244.2**	**301.8**	**301.7**

Where: S.P. is sampling points; S is surface sample and B is bottom sample.

IV. Major Cations

Sodium: The relative increase of Na^+ ions in winter season may be attributed to the drought period and decaying of most phytoplankton and dead of micro-organisms which are decomposed, leading to the liberation of different anions and cations. Whereas, the relative decrease in Na^+ ions during summer and autumn seasons may be attributed to the effect of flood dilution and the increase in the rate of flourishing of the phytoplankton and biological assimilation which consumed great amounts of Na^+ ions.

Potassium: K^+ ion is an essential element in growth of phytoplankton, aquatic animals and plants. There is no variations in K^+ content during different seasons. The decrease in K^+ ion in the river water may be due to the precipitation of K^+ ions as carbonate salts[23].

Calcium: The relative decrease in the Ca^{2+} ion in the surface water may be attributed to the precipitation of $CaCO_3$ during day light via raising water temperature that lowered solubility of $CaCO_3$. The slight decrease in Ca^{2+} ions on bottom water, may be attributed by its uptake by aquatic plants, micro-organisms and fishes. The decrease in $CaCO_3$ solubility as a result of increases in temperature and loss of CO_2. The thermal pollution resulting from cooling system may be help on the precipitation of Ca^{2+} ion as $CaCO_3$[24].

Magnesium: Mg^{2+} ion in plants serves as the metal at the heart of the active center in the chlorophyll molecule and its enzymatic reaction involved in the synthesis of nucleic acids and plays an important role in the photosynthesis[25]. The increase in Mg^{2+} ions concentration on the bottom water may be due to its release from sediments to overlying water. On the other hand, the relative decrease in Mg^{2+} ions during spring season may be due to its uptake by micro-organisms and phytoplankton whereas, the relative decrease in the Mg^{2+} ions during summer season may be due to flood dilution effect. Table 4, summarizes the seasonal variations of the major cations at power plant area.

V. Nutrient Salts

The nutrient salts are considered an essential components for the living organisms in natural water. Nitrogen, phosphorus and silica compounds are the most interesting nutrients. The problems caused by these nutrients are caused by human activities.

Nitrite: The nitrite is considered as intermediate stage in the oxidation of nitrogen and can arise directly from biological disruption of organic matter via ammonia compounds or by the reduction of nitrate. The maximum value of NO_2^- ion was found in front of power plant due to the drainage which causes a thermal pollution effected on the phytoplankton.

Nitrate: The nitrate considered as an important source of pollution of the rivers water due to excessive use of fertilizers as urea and ammonium nitrate. The increase in the NO_3^- ions during autumn and winter seasons may be due to the increase in the rate of oxidation of NH_3 and NO_2^- ion into NO_3^- ions. The results show that, the decrease in NO_3^- ions during summer season may be attributed to its uptake by micro-organisms and water flood whereas, the slight increase in the NO_3^- ions on the bottom water may be due to the nitrification of NH_3 and NO_2^- by the biochemical decomposition of dead planktons[26].

Table 4
Seasonal variations of Major Cations at Shoubra El-Kheima Power Plant

Seasons / S.P.	Summer S	Summer B	Autumn S	Autumn B	Winter S	Winter B	Spring S	Spring B	Regional Av. S	Regional Av. B
1. Na^+, mg/l										
I	25.4	26.3	24.4	23.0	31.2	30.8	28.1	28.7	**27.3**	**27.2**
II	27.2	50.3	46.9	43.6	73.4	39.5	64.8	41.2	**58.8**	**37.9**
III	26.6	27.5	25.3	24.3	29.7	30.8	29.0	29.5	**27.6**	**28.0**
Mean	34.1	27.0	32.2	30.3	44.8	33.7	40.6	33.1	**37.9**	**28.5**
2. K^+, mg/l										
I	4.9	5.2	5.8	4.8	5.7	5.6	5.3	5.4	**5.4**	**5.2**
II	3.3	4.9	6.2	5.4	5.7	5.8	4.2	5.2	**4.8**	**5.3**
III	5.0	5.3	6.3	6.1	5.6	5.8	5.6	5.6	**5.6**	**5.7**
Mean	4.4	5.1	6.1	5.4	5.7	5.7	5.0	5.4	**5.3**	**5.4**
3. Ca^{2+}, mg/l										
I	28.9	29.8	37.4	34.2	39.0	38.2	32.6	33.9	**35.4**	**34.0**
II	22.7	28.3	32.6	33.1	41.7	37.6	31.8	33.2	**32.2**	**33.0**
III	30.0	30.1	36.3	35.3	37.7	38.5	33.1	33.1	**34.3**	**34.2**
Mean	27.2	29.4	35.4	34.2	39.5	38.1	32.5	33.4	**33.6**	**33.8**
4. Mg^{2+}, mg/l										
I	8.2	8.0	12.5	16.0	11.4	11.9	12.6	12.1	**11.2**	**12.0**
II	8.7	9.1	15.0	13.2	13.3	14.3	9.4	12.5	**11.6**	**12.3**
III	8.3	7.5	13.3	16.6	12.2	10.7	11.9	12.0	**11.4**	**11.7**
Mean	**8.4**	**8.2**	**13.6**	**15.3**	**12.3**	**12.3**	**11.3**	**12.2**	**11.4**	**12.0**

Where: S.P. is sampling points; S is surface sample and B is bottom sample.

Ammonia: The ammonia present in the river water as NH_4^+ ion or NH_3 depending on the NH_3 concentration. The increase in the NH_3 led to toxic and death of fishes and aquatic organisms whereas, NH_4^+ ions have no effect. The increase in NH_3 depending on the reduction of NO_2^- and NO_3^- ions into NH_3 and the pH medium. On the other hand, the maximum values of NH_3 were observed in front of power plant may be due to the industrial wastes and thermal pollution.

Orthophosphate: Phosphorus is an essential element for the growth of algae and micro-organisms and occurs in plankton in the soft tissues as well as in skeletons. It is extracted by phytoplankton and become concentrated in fish scales[27]. The increase in PO_4^{3-} ions in the bottom water inversely proportional with the amount of DO. The variation in PO_4^{3-} ions in front of power plant may be attributed to the wastes and thermal pollution .

Total Phosphate: The increase of TP in the river water during summer season due to the release of phosphate from sediments to upper layer whereas, the relative increase in the TP during winter season due to the effect of drought period which arise from phytoplankton and other organisms. On the other hand, the relative decrease in TP during autumn and spring seasons, may be due to its uptake by aquatic plants during photosynthesis process. The maximum TP values in front of power plant due to thermal pollution which led to decomposition and decaying of the phytoplankton and other aquatic plants[(28)].

Silica: The decrease in SiO_2 content observed in front of power plant, may be attributed to the thermal pollution and industrial wastes which is responsible for the precipitation of soluble silicate on the bottom. The changes in silicate concentration may be caused by biological effect and upwelling of bottom water due to the effect of water movements, turbulent, temperature, pH and salinity during flood period. Silica causes scale in the boilers and cooling water systems in the power plant and removed by highly basic anion exchanger in conjunction with demineralization and distillation. Table 5, summarizes the seasonal variations of the nutrient salts in power plant area.

VI. Trace Metals

The water flow along the surface of the earth governs all animal and plant life. Some of the metal ions are classified biochemically as essential elements. They are present in trace quantities in the bodies of living organisms.

Iron: It is play an important role in the geo- and biochemical cycle in the Nile River water. The relative decrease in iron ions on the surface water may be due to its uptake by phytoplankton and other aquatic plants whereas, the relative increase in iron may be attributed to its releasing from bottom sediments to the surface water. The highest values of iron in front of power plant may be due to the effect of the wastes and thermal pollution which led to phytoplankton and aquatic plants to decay followed by an increase in iron concentration. Iron was determined spectrophotometrically with quercetin and PVP[(29)].

Manganese: Both Mn^{2+} and Fe^{3+} ions are considered an essential elements in the growth of plankton. Manganese frequently occurs in association with iron but in lesser amount in the river water. The maximum values of Mn^{2+} ion in front of power plant due to the effect of drainage and thermal pollution whereas, the relative decrease in Mn^{2+} ion on the surface water may be attributed to its uptake by phytoplankton but the relative decrease in Mn^{2+} ion on the bottom water may be related to the adsorption of Mn^{2+} ions on suspended matters as a sediment. Mn^{2+} ion was determined with ammonium persulphate [(15)].

Table 5
Seasonal Variations of Nutrient Salts at Shoubra El-Kheima Power Plant

Seasons / S.P.	Summer S	Summer B	Autumn S	Autumn B	Winter S	Winter B	Spring S	Spring B	Regional Av. S	Regional Av. B
1. NO_2^-, mg/l										
I	1.9	1.8	3.1	7.5	2.9	4.3	2.2	1.9	**2.5**	**3.9**
II	210	5.4	61.4	42.0	95.2	24.2	1.36	29.4	**125.6**	**25.2**
III	2.6	3.0	2.9	3.3	3.4	4.5	2.2	2.0	**2.8**	**3.2**
Mean	71.5	3.4	22.5	17.6	33.8	11.0	46.8	11.1	**43.6**	**1.8**
2. NO_3^-, mg/l										
I	26.9	15.7	42.5	84.2	36.3	40.6	32.4	23.0	**34.5**	**40.9**
II	63.8	42.2	397.7	195.5	412.3	193.8	411.4	84.5	**619.8**	**128.9**
III	30.8	37.9	57.2	80.8	38.1	35.1	46.5	25.1	**43.1**	**44.7**
Mean	231.9	31.9	165.8	120.0	162.2	89.8	163.4	44.2	**180.8**	**71.5**
3. NH_3, mg/l										
I	0.40	0.40	0.20	0.22	0.34	0.44	0.35	0.36	**0.32**	**0.35**
II	9.52	0.61	5.32	3.98	4.32	4.32	2.5	13.82	**5.97**	**2.85**
III	0.42	0.52	0.34	0.32	0.36	0.36	0.48	0.5	**0.4**	**0.42**
Mean	0.50	0.50	1.9	1.5	1.7	1.3	4.9	1.1	**3.0**	**1.1**
4. PO_4^{3-}, mg/l										
I	60.8	70.4	52.4	55.1	34.3	47.7	28.6	28.0	**44.0**	**49.2**
II	80.9	78.8	51.5	55.1	88.5	63.5	65.9	36.4	**71.7**	**58.4**
III	79.7	46.4	36.8	40.0	45.3	65.6	26.8	31.2	**49.4**	**45.8**
Mean	73.8	65.2	46.9	48.9	59.0	55.8	38.4	23.9	**59.5**	**48.4**
5. TP, mg/l										
I	297.0	294.2	77.8	115.0	92.2	240.0	96.5	100.5	**140.9**	**187.4**
II	431.5	655.6	92.7	101.8	150.5	175.4	140.0	124.7	**203.7**	**264.4**
III	285.5	344.8	62.3	64.6	183.6	145.3	97.4	104.2	**157.3**	**164.7**
Mean	338.0	431.5	77.6	93.8	142.1	186.9	111.3	109.8	**167.2**	**205.5**
6. SiO_2, mg/l										
I	4.9	5.2	3.7	3.6	1.4	1.5	2.8	3.3	**3.3**	**3.2**
II	3.6	4.8	3.6	3.5	1.3	1.4	3.0	3.4	**2.9**	**3.3**
III	4.7	4.4	3.8	3.6	1.3	1.3	3.2	3.2	**3.2**	**3.1**
Mean	**4.6**	**4.7**	**3.7**	**3.6**	**1.3**	**1.4**	**3.0**	**3.3**	**3.1**	**3.2**

Where: S.P. is sampling points; S is surface sample and B is bottom sample.

Zinc: It is an essential trace element in living organisms being involved in the nucleic acid synthesis and occurring in many enzymes. The decrease in Zn^{2+} ion on the surface layer may be due to its uptake by phytoplankton and micro-organisms and the increase in Zn^{2+} ion on the bottom may be attributed to its release from sediments to the water. Zn^{2+} ion was determined spectrophotometrically with dithizon[(15)].

Copper: It is a trace element essential to life processes and not occur in natural water and arises from the use of copper pipes. The relative increase in Cu^{2+} ions during summer and spring seasons may be attributed to the chelation of the copper by aquatic organisms

which is deposited on the bottom of river. The maximum concentration of Cu^{2+} ions was observed in front of power plant may be attributed to the effect of wastes and thermal pollution. Cu^{2+} ion was determined spectrophotometrically with neocuproine[(15)].
area.

Table 6
Seasonal Variations of Trace Metals at Shoubra El-Kheima Power Plant

Seasons / S.P.	Summer S	Summer B	Autumn S	Autumn B	Winter S	Winter B	Spring S	Spring B	Regional Av. S	Regional Av. B
1. Fe(III) , mg/l										
I	3.7	1.7	1.9	4.0	0.8	0.3	1.0	1.7	**1.8**	**1.9**
II	13.8	2.6	3.5	3.9	1.7	9.6	2.8	1.5	**5.4**	**4.4**
III	2.0	3.5	10.2	11.9	1.4	1.5	1.4	2.8	**3.7**	**4.9**
Mean	6.5	2.6	5.2	6.6	1.3	3.8	1.7	2.0	**3.7**	**5.0**
2. Mn(II) , mg/l										
I	105.5	164.2	215.6	547.0	51.4	72.6	48.6	45.4	**105.3**	**207.3**
II	770.0	140.7	326.2	465.3	79.0	435.5	132.3	327.0	**326.8**	**342.1**
III	47.8	45.6	494.5	384.6	44.2	44.8	810.0	118.2	**349.1**	**198.3**
Mean	307.8	116.8	345.3	532.3	58.2	184.3	330.4	163.5	**260.4**	**249.2**
3. Ni(II) , mg/l										
I	13.2	12.8	21.3	22.7	14.6	15.3	14.1	14.0	**15.8**	**16.2**
II	76.5	19.6	48.5	51.0	62.9	63.2	58.7	60.6	**61.6**	**48.6**
III	12.7	12.4	44.5	40.6	11.4	16.7	16.3	16.9	**21.2**	**21.6**
Mean	34.1	14.9	38.1	38.2	31.7	18.6	29.7	30.5	**30.1**	**28.8**
4. Zn(II) , mg/l										
I	30.0	28.8	28.2	45.6	20.5	30.0	30.0	37.6	**39.6**	**35.5**
II	667.4	34.5	40.5	106.0	10.8	37.4	65.5	30.4	**196.0**	**52.1**
III	1.3	15.0	192.0	116.0	6.3	71.0	58.4	72.5	**64.5**	**68.6**
Mean	232.9	26.1	90.2	89.2	12.5	51.3	51.3	46.8	**96.7**	**52.0**
5. Zr(IV) , mg/l*										
I	26.4		29.4		24.8		25.6		**26.5**	
II	27.2		31.0		26.3		26.5		**27.7**	
III	25.3		29.6		24.5		25.0		**26.1**	
Mean	26.3		30.0		25.2		25.7		**26.8**	
5. Cr(VI) , mg/l										
I	14.8	14.5	24.7	24.8	18.6	19.0	12.4	12.1	**17.6**	**17.7**
II	56.4	30.9	51.9	52.2	53.5	53.9	48.4	48.7	**52.5**	**46.4**
III	15.3	15.2	28.4	26.0	17.3	18.6	14.6	14.9	**18.9**	**18.7**
Mean	**28.8**	**20.2**	**35.0**	**34.3**	**29.8**	**30.5**	**25.1**	**25.2**	29.7	27.6

Where: S.P. is sampling point; S and B are surface and bottom samples; * in sediments.

Chromium: The chromate compounds are added to cooling water for corrosion control. Chromium exists in water supplies mainly as Cr(VI) and was determined spectro - photometrically with quercetin and PVP[(30)].

Nickel: Ni^{2+} ion rarely exists in the river water but it has been arise from industrial waste water processes such as electroplating baths, lines and reservoirs through cleaning out. Ni^{2+} ion was determined specrophotometrically with DPC and Triton X-100[31].

Zirconium: Zr(IV) rarely exist in the river water and has been exist in clays during water flood as sediments annually. Zr(IV) was determined spectrophotometrically with morin and PVP[32]. Table 6, summarizes the seasonal variations of trace metals at power plant

Conclusion

1. The results obtained showed that, the industrial wastes from the power plant led to an increase of physico-chemical parameters.

2. The concentrations of chemical and physical parameters are affected by the climatic conditions and biological activity of micro-organisms in water.

3. The thermal pollution in front of the power plant is very high and alter the ecology of a stream lowering the solubility of oxygen in the water, because gas solubility in water is inversely proportional to the temperature and thereby reducing the amount of DO. To control the danger of the pollutants in the river water, the law 48/82 has been applied for protection of the Nile River and aquatic environment of fresh water in Egypt.

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