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ENVIRONMENTAL ASSESSMENT OF SURFACE WATER QUALITY OF THE RIVER NILE SURROUNDING THE PROJECT OF THE NEW ASSUIT BARRAGE AND ITS HYDROPOWER PLANT, EGYPT

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ABSTRACT:

Owing to the great pressure experienced on the developing countries due to increasing of population and widens industrialization; developing countries have to diverse sources of energy to produce electricity, control irrigation systems and transportation means. At the beginning of 2012, the new Assiut barrage and its hydropower plant was initiated in the River Nile at Assiut city in Egypt. The chemistry of physico-chemical parameters and biological characteristics play a discriminative role for assessment of water quality in the vicinity of the hydropower plant area. About 190 water samples were collected around the project in the period of 2012- 2014, for the analysis of physicochemical properties such as pH , TDS, DO, COD, BOD, NO3 in mg / l and temperature in OCand Turbidity(NTU). Their mean values are 8.09, 206.25, 7.15, 9.80, 5.11, 0.55 mg/l and 23.20 OC and 5.95 NTU respectively. The obtained values were compared with allowable levels stated by WHO and Egyptian laws 48/1982 for the River Nile protection from pollution. The overall water quality index is 75.50 falls in the second class (70- 90) of water quality categorization of good water quality. Biological species of water environment such as zooplankton, benthos and concentration of the heavy metals in fish were assessed in water samples and sediment around the industrial area. The study showed that surface water quality is suitable for industrial projects, but needs some purification for drinking water. Recommendation to protect surface water quality from environmental pollution was suggested.

Key words: *hydropower plant, water quality index, physicochemical parameters, zooplankton, fish, heavy metals, River Nile, Assiut, Egypt*

INTRODUCTION:

Hydroelectric energy is produced by the force of falling water. The capacity to produce this energy is dependent on both the available flow and the height from which it falls. Building up behind a high dam, water accumulates potential energy.

This is transformed into mechanical energy when the water rushes down the sluice and strikes the rotary blades of turbine. The turbine's rotation spins electromagnets which generate current in stationary coils of wire. Finally, the current is put through a transformer where the voltage is increased for long distance transmission over power lines.

Electricity from hydro-energy is a major part of the present electrical systems, being the most efficient renewable energy source. The hydropower plants convert almost 90% of the

available potential. They are more efficient than the fossil fueled power plants due to the loose of 50% content of their fuel as waste heat and gases contributing to the phenomena of global warming and acid rains. In comparison to the development of other alternative energy sources such as wind, solar, tidal, the hydro-energy is the best ecological solution for the stability of the electric system (Batisha, 2007; Bhatt et al., 2011). Hydropower plants, from environmental concern, are green resources of energy due to none emissions of greenhouse gases (Bucur et al., 2010).

The water quality is a control parameter of the environmental quality of hydroelectric power plants (Bucur et al., 2010). Water plays the most important role of human survival and is used for producing his welfare through producing electricity. Hence, maintaining the quality of the hydro-sources is a main concern from ecological, economical and sustainable development reasons for life. Physico-chemical parameters such as pH, DO, BOD, COD, EC, TDS, TSS, NO3, Turbidity and temperature of water are the basic characteristics of water quality (Ogedengbe and Akinbile (2004).

Water quality index (WQI) provides a simple number that expresses overall water quality at a certain location and time, based on several water quality parameters (Al- Janabi et al., 2012). The objective of water quality index is to turn complex water quality data into information that understandable and used by the public. A water quality index based on some very important parameters introduces a single indicator of water quality. In general, water quality indices incorporate data from multiple water quality parameters into a mathematical equation that rates the health of a water system with number (CCME, 2001; Alobeidy et al. 2010). Physicochemical properties of water in any aquatic ecosystem are largely governed by the existing meteorological conditions and are essential for determining the structural and functional status of natural water (Yisa and Jimoh, 2010).

Control structures such as weirs and barrages constructed on the river Nile will change the hydraulic regime of that river by increasing water depths and reducing velocities in the zones of developed backwater curves (Tandale and Mujawar, 2014). This modified hydraulic regime impacts water quality due to changes in the transport and decay processes of pollutants along the rivers [12]. The modified hydraulic regime also impacts the thermal regime and fish habitat in the river (Jena et al.2013).

Zooplankton communities are highly sensitive to environmental variation. As a result, changes in their abundance, species diversity, or community composition can provide important indication of environmental change or disturbance [Brett, 1989]. Zooplankton communities often respond quickly to environmental change because most

species have short generation times. Zooplankton communities respond to a wide variety of disturbances including nutrient loading (Cuker, 1992), acidification, contaminants, fish densities (Husien, 1972; Obuid-Alla, 2000) and sediment inputs (Obuid- Alla, 2000). Benthic invertebrates are organisms that live on the bottom of a water body. The abundance, diversity, biomass and species composition of benthic invertebrates can be used as indicators of changing environmental conditions (McCauley and Kalff, 1981; Yan et al., 1996).

1.1 Aim of the Work

The study aims to analyze the physicochemical and biological characteristics to assess the surface water quality of the River Nil in the vicinity of the New Assiut Barrage and its Hydropower Plantand the data produced can be taken as a baseline for future environmental impact assessment of the project.

2. Materials and Methods

2.1 Site description

The government of Egypt is replacing the existing Assuit barrage in Upper Egypt with a new structure incorporating a power plant.

The old barrage was constructed in the year of 1900 to divert water for irrigation of farmland in the region.

Over the years the riverbed has degraded, especially after commissioning of the Aswan High Dam, and the stability of the barrage may eventually be threatened during low flow periods.

This lead to the decision to construct a new barrage and is making use of the water energy with a power plant. The location (27○ 12′ 19" N, 31° 11′ 26″ E) is at the river approximately400km downstream of the old barrage in North-east of Assuit city. Figure (1) shows a geographical map of the New Assuit Barrage and the Hydropower Plant.

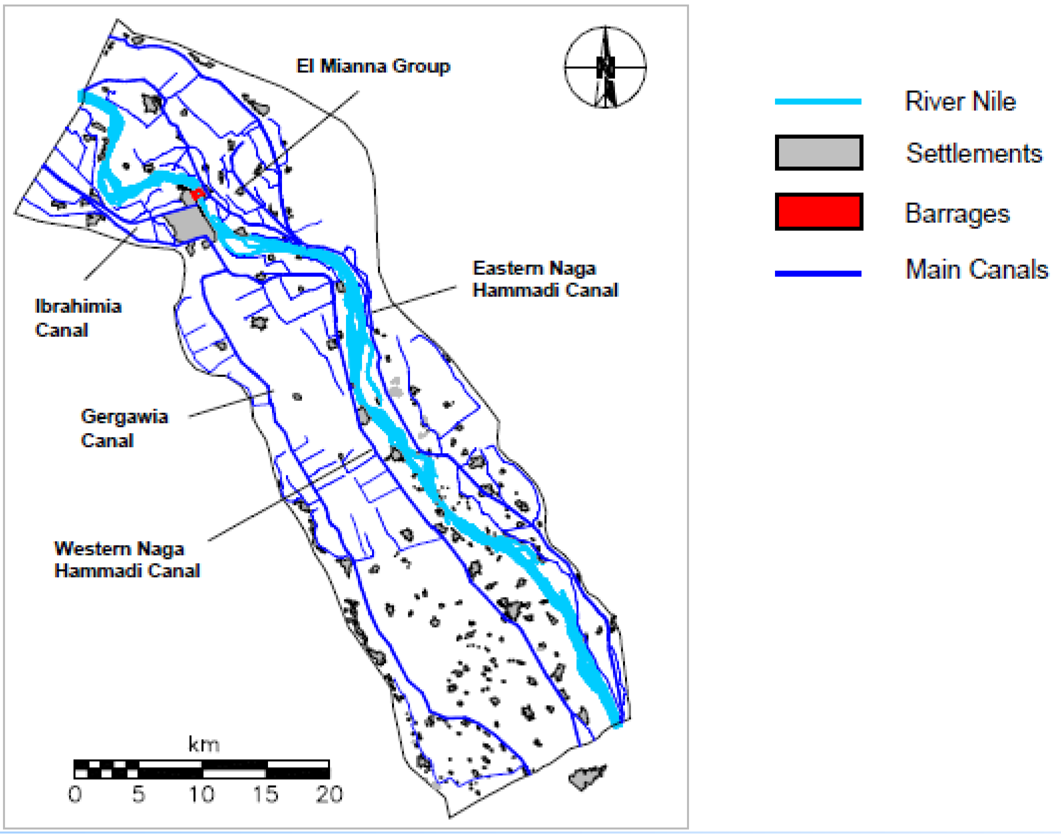

Figure (1): Geographical map showing the site of the New Assuit Barrage and its Hydro power Plant

In order to facilitate the construction of the multipurpose barrage within the area of the course of the river, a sealing element comprising a plastic concrete cut off wall with a depth of up to 60 m was constructed all around the site area. The wall toe is embedded into a silt / clay layer and provides an excellent impervious apron against water inflow. This enables the excavation up to a depth of approximately 30 m inside the pit for the foundation of the concrete structures. The construction of the surrounding cutoff wall is completed and concrete structures are presently being built inside the pit. The cutoff wall is approximately 1800 m long and confines a large area of 4200 square meters.Figure 2 shows the proposed project.

Figure (2): The proposed project (under licence of ANDRITZ Hydro)

Some construction works for the New Assuit barrage are expected to increase temporarily the solid load and consequently the turbidity of the Nile downstream to the construction site. These essentially: the diversion canal, the foundation of the powerhouse and the sluice way, the navigation lock and the removal of the cofferdams at the end of construction.

The construction of the foundation of the powerhouse, the sluiceway, and the navigation lock will require excavation in the riverbed, the construction of two cofferdams respectively upstream and downstream from the new barrage, the establishment of an approximately 1 m wide and 60 m deep bentonite cutoff wall included with cofferdams and the riverbanks. Excavation works and final removal of some temporary increase of concentration in Total Suspended Solids TSS in the river downstream of the construction site. Although it's anticipated that the sand and silt fraction composing the suspended load will be settled again within short distance from the working site, the finest clay-sized particles may remain in suspension for several kilometers downstream of the new barrage site (Akinbile et al., 2013). Similarly, the use of bentonite substantially a clay material could possibly slightly contribute to increase the turbidity of the Nile downstream during the construction of the cutoff wall. Water extracted from pit dewatering the construction of the building foundation is expected to be free of turbidity and will be discharged into the river downstream of the work site.

2.2 Collection of water samples

Figure (3): Project site and sampling locations

Water quality parameters like temperature, pH, total dissolved solids (TDS), total suspended solids (TSS), dissolved oxygen (DO), and conductivity were measured in the water samples taken from the sites around the project, using a thermometer, pH meter, conductivity-meter and TDS meter respectively (Mahananda et al., 2010).

For dissolved oxygen (DO), samples were collected into 300 ml plain glass bottles and the DO fixed using the azide modification of the Winkler's method (Chindeu et al., 2011). Samples for micro-organisms analysis were collected into sterilized plain glass bottles. All samples were stored in icebox and transported to the National Research Center (Water Pollution Research Unit Laboratories).

The methods used for water quality test are presented below in the Table (1).

The results obtained were also compared against the threshold values of basic procedures based on WHO guidelines (2004), National drinking water quality (NDWQS 2062 B.S.) and guidelines set by the European Union (EU) (Abhineet and Dohare., 2014). Descriptive statistics of the data set are presented in Table (2) and were carried out to simplify its interpretation and to define the parameters responsible for the main variability in water quality variance (Ali et al., 2014; Verma et al., 2012)). Also correlation factors for water quality parameters were determined to reveal much more about the combination of any parameters that are more

affective on water quality. Mean values of different physicochemical and biological characteristics (Mean ± SD and range) are shown in Table (3).

Table (1): Water quality test methods and test units

Parameters	Test unit	Method
PH*	-	Thermometer
Temperature*	°C	Electrometric
Turbidity	NTU	Spectrophotometric
Electrical conductivity*	µS/cm	Electrometric
Total dissolved solids*	mg/l	Electrometric
Total suspended solids	mg/l	Filteration
Total alkalinity	mg/l as $CaCO_3$	Titration & Electrometric
Total hardness	mg/l as $CaCO_3$	Titration, Na EDTA
Total Nitrogen	mg/l	Kjeldabl method
Lead (Pb)	mg/l	Atomic absorption Spectrophotometric
Dissolved oxygen(DO)	mg/l	Titration and Electrophotometric
Chemical oxygen demand (COD)	mg/l	$K_2Cr_2O_7$ Digestion
Biological oxygen demand (BOD)	mg/l	5 days incubation
Total Coli- form	CFU/100 ml	Membrane filter
Fecal Coli- form	CFU/100 ml	Membrane filter

***These parameters are tested both on field and in laboratory**

The available data related to the concentration of water quality variables were standardized to make them compatible to standardize the concentration of the water quality pollutant such as TDS; the measured concentration was divided by the corresponding standard value. For some water quality variables such as DO, which a higher concentration shows a better water quality condition, the observed concentration is standardized by dividing the measured concentration by the related standard (Yazdian et al., 2014).

2. 3 Application of the (WQI)

This study attempted to evaluate the historical changes in water quality in the period of the construction of the hydropower plant in the River Nile. For this purpose, 11 water quality parameters have been selected which are: pH, Dissolved Oxygen, Turbidity, Conductivity, TSS, TDS, COD, Biochemical Oxygen Demand BOD, Nitrates and temperature of water. The values used for each parameter are the mean value of the all values taken under this investigation.

In the formulation of WQI, the importance of various parameters depends on the intended use of water; here water quality parameters are studied from the point of view of suitability for the initiation of a hydropower

plant in the construction phase. The standards (permissible values of various parameters) for the drinking water used in this study are those recommended by WHO (2004) and when the WHO standards were not available, the Egyptian drinking water standards are applied. The calculation and formulation of the WQI involved the following steps:

a). In the first step, each of the ten parameters has been assigned a weight (AW) ranging from 1 to 4 depending on the collective expert opinions taken from different previous studies. The mean values for the weights of each parameter along with the references used are shown in table 3. However, a relative weight of 1 was considered as the least significant and 4 as the most significant (Parmar and Parmar, 2010).

b). in the second step, the relative weight (RW) was calculated by using the following equation (Tandale and Mujawar, 2014; CCME, 2001):

$$RW = \frac{AWi}{\sum_{i=1}^{n} AWi}$$

Where RW= the relative weight, AW= the assigned weight of each parameter, n= the number of parameters. The calculated relative weight (RW) values of each parameter are given in Table 3.

C). in the third step, a quality rating scale(QI) for all the parameter except pH and DO was assigned by dividing its concentration in each water sample by its respective standard according to the drinking water guideline recommended by the Egyptian drinking water standards, the result was then multiplied by 100 (Alobeidy et al.2010).

……………………… (2) $$Qi = \left[\frac{Ci}{Si}\right] * 100$$

While the quantity rating for pH or DO (QPH , DO) was calculated on the basis of:

$$Q\ (pH, DO) = \left[\frac{Ci-Vi}{Si-Vi}\right] * 100$$

Table (3): Shows Water Quality Factors and Weights (www.water-research.net/)

Factor	Weight
Dissolved oxygen	0.17
Fecal coliform	0.16
pH	0.11
Biochemical oxygen demand	0.11
Temperature change	0.10
Total phosphate	0.10
Nitrates	0.10
Turbidity	0.08
Total solids	0.07

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Where Qi= the quantity rating, Ci= value of the water quality parameter obtained from the laboratory analysis, Si= value of the water quality parameter obtained from recommended WHO or Egyptian standard of the corresponding parameter, Vi= the ideal value which is considered as7.0 for pH and 14.6 for DO. Equation (2) and (3) ensures that Qi=0 when a pollutant is totally absent in the sample and Qi = 100 when the value of this parameter is just equal to its permissible value. Thus the higher the value of Qi is, more polluted in the water (Mustapha and Aris, 2011).

d). finally, for computing the WQI, the sub-indices (SI) were first calculated for each . parameter, and then used to compute the WQI as in the following equations:

SI = RW*Qi…………………………………………………. (4)

$$WQI = \sum_{i=1}^{n} SIi \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

The computed WQI values could be classified into five classes as has been shown in Table 4.

Table (4): Water Quality Index Legend (www.water-research.net/)

Range	Quality
90-100	Excellent
70-90	Good
50-70	Medium
25-50	Bad
0-25	Very bad

2.4 Statistical analysis

The obtained data were processed statistically using the software SPSS. 16. Standard Deviation SD, the mean, the minimum, the maximum and the range values were determined.

2. 5 Biological Factors

Eight stations were chosen for samples of plankton and benthos on basis of 4 sites located upstream and the other four sites located downstream of the existing barrage of the River Nile and around the project site. Global Position System (GPS) device (Garmin 62s) was used to define the coordinates of these sites as shown in Table (2)

Table (2): shows the sampling locations and GPS coordinates

Long. E	Lat. N	Location	No.
31° 11′ 34″	27° 11′ 21″	1.5 km upstream of existing barrage In the east side of the river	S_1
31° 11′ 42″	27° 11′ 25″	1.5 upstream of existing barrage in West side of the river	S_2
31° 11′ 28″	27° 11′ 34″	1 km upstream of existing barrage In the east side of the river	S_3
31° 11′ 35″	27° 11′ 40″	1km upstream of existing barrage In the west side of the river Nile	S_4
31° 11′ 32″	27° 12′ 58″	1.6 km downstream of Assuit new barrage, in the west side	S_5
31° 9′ 53″	27° 12′ 58″	3 km downstream of Assuit new barrage	S_6
31° 10′ 34″	27° 12′ 35″	1.4 km downstream of Assuit barrage, west side	S_7
31° 10′ 51″	27 ° 12′ 28″	1 km downstream of new Assuit barrage, east side	S_8

2.5.1 Sampling of plankton and benthos

Quantitative and qualitative samples of plankton were collected using plankton net (Figure 4) (mesh size ~ 100 µm and radius ~ 6.5 cm). Samples were identified in the laboratory using various taxonomic keys and references. The abundance of zooplankton species was calculated as the number of individuals per cubic metre. For quantitative purposes of benthos, three random samples were taken from each site using an Ekman dredge with an opening area equivalent to 250 cm2. Samples were separated and identified in the lab. All recorded invertebrate species were divided into constancy classes according to the system adopted Brett (1989), Hussein (1972) and Obuid-Allah (2000) as follows: Predominant taxa: Present in more than 50% of the samples and Accidental taxa:Present in less than 25 % of the samples (Obuid-Alla et al., 2014) .

Figure (4): Method of Zooplankton Collection by Planktonic Network

2.5.2 Fish collection and preparation for the study

Specimens of the Nile Tilapia Oreochromisniloticus were collected from the Nile River upstream and downstream of the old barrage on 7 May 2014 and transported in plastic tanks to the Laboratory of Fish Biology in the Zoology Department, Faculty of Science, Assiut University. The fish were immediately used for blood smear preparations.

2.5.3 Micronucleus test and erythrocyte alterations for detecting effects of pollution

Blood smears were obtained by caudal incision on clean grease-free microscopic slides. The smears were fixed in absolute methanol for 10 min. after drying at room temperature. Slides were stained with haematoxylin and eosin. This was followed by dehydration in ascending grades of alcohol (30, 50, 70, and 90%, absolute). Finally the slides were cleared in xylene and permanently mounted by DPX (Cuker, 1992; McCauley and Kalff, 1995). Many slides were selected on the basis of staining quality, then coded, randomized and scored blindly. In each group 10,000 cells (a minimum of 1,000 per slide) were examined (Al-Sabti and Metcalfe 1995) at 40× objective and 10× eyepiece for micro-nucleated and morphologically altered erythrocytes in separate studies. The established criteria for identifying micronuclei (MN) (Schmidt 1975) were strictly followed to ensure authentic scoring.

2.5.4 Samples for heavy metals analysis

Heavy metals like lead (Pb), cadmium (Cd), cupper (Cu), Iron (Fe), zinc (Zn) and mercury (Hg) were measured at analysis laboratory using Atomic absorption Spectroscopy (AAS). Heavy metals were measured in the water, sediment and in the serum and muscles of the fish Tilapia (OreochromisNilocticus). Heavy metals concentration was compared with allowable

levels stated by WHO & FEBA (Saeed and Shaker, 2008; Obuid-Alla et al., 2014).

3. Results and Discussions

3.1 Analysis physicochemical properties

The pH values ranged from 6.77 to 8.80 with a mean value of 8.09 (Table5). The pH falls within the range of desirable for municipal uses which are between 6.5 and 8.5. Below this range, the water would be considered acidic and may not be fit for domestic uses, and above this range it might be considered basic, containing some elements of pollution. This range would permit existence of aquatic life. The tolerable pH limit for fish and other aquatic animals is 9.0, above which the BOD and DO would be reduced thereby endangering aquatic life. The values of DO ranged between 4.00 and 9.90 mg/l with a mean value of 7.15 mg/l (Table 4). The maximum range of DO values was between 5 and 45mg/l below which aquatic life is endangered (Wahaab and Badway, 2004). Low DO values recorded at some points during measurement might be due to reduced photoperiod and photosynthesis activities of aquatic plants and similar observations were recorded by (El- Ayouti and Abo- Ali, 2013). Some higher amount of DO may be due to higher river water dilution and its reduction depended on the biodegraded quantity of organic and inorganic materials within the dilution capacity which agreed with the findings of (Abowei, 2010). This means that minor purification would be needed for public water supply uses. However for recreational purposes, the water was suited for all types of water sports and for irrigation purposes.

The value of BOD for the River Nile samples ranged between 2.50 and 15.00 mg/l while the mean value was 5.11 mg/l(Table 4). The observed lowest value may be attributed to the infiltration of pollutants into the river from the nearby industrial wastewater discharged into the river and private residences and also result in the death of aquatic animals caused by the oxygen depletion at that point. This is similar to the findings of (Choudhary et al., 2014) and (Debels et al., 2005). Based on the National River Nile Water Quality stated by the law 48/1982 and BOD ranged from 2.50 and 15.00, in these some highly measured sites, this show slightly polluted and requires intensive treatment in order to serve public water supply purposes, as for industrial and recreational purposes water has become polluted but it is still falls within acceptable limits for water sports which are dependent on the bacteria count in water. At this stage, fish farming is doubtful for some sensitive fishes

Table (5): Statistical values for the physicochemical parameters

Limit	Mean ±SD	Max	Min	Parameter
8.50	8.09±0.42	8.80	6.77	P H
-	0.32±0.04	0.45	0.23	EC
6.00	7.15±1.22	9.90	4.00	DO
-	5.95±2.73	18.00	1.50	TUR.
-	23.20±3.86	29.70	15.80	T°
6.00	5.11±1.48	15.00	2.50	BOD
10.00	9.80±2.93	28.00	4.00	COD
2.00	0.55±0.27	1.70	0.057	NO3- N
500.00	206.25±26.03	298.00	142.70	TDS
-	14.51±6.47	52.00	4.00	TSS
0.10	0.11±0.04	0.30	0.016	Oil & Grease

For COD the highest value was 28mg/l and the lowest value is 4.00mg/l as shown in Table 4. Higher COD values indicated the ability of water to consume more oxygen during decomposition, and the level of organic pollutants was also high since more decomposition occurred. As turbidity is taken as a scale for clarity of water, measurements recorded high values due to construction and civil works that proceeded in initiation of cover dam of the project. Increasing of turbidity may depress the photosynthesis of aquatic plants, decreasing of COD, hiders light to go through water resulting in decreasing the self-purification of the river and less of dissolved Oxygen required by aquatic organisms. Tss ranged from 4.00 to 52.00 mg/l, this enhances turbidity in the surface water and affect the aquatic life of many aquatic organisms. The heavy granules of construction works are precipitated at small distances of the working site, this may result in erosion in the bed of the river, but small particles travel downstream for long distances causing deterioration of river's water. Also TDS contribute in turbidity and affect the surface water of the river taken for drinking or for industrial purposes. Finally physicochemical properties plays vital role in assessment of water quality where it contributes to decide the availability of water to be used in industrial or in domestic uses (Fadael and Gafari, 2014).

Calculations of water quality index WQI showed that the values of physicochemical parameters in surface water of the river Nile around the new Assuit barrage and hydropower plant reached the values of 10.75, 17.17, 12.60, 19.37, and 3.71 for pH , DO, BOD, TDS and NO3 – N respectively. The

overall water quality index is 75.50 falls in the second class (70- 90) of water quality categorization of good water quality.

3.2 Biological characteristics

3. 2.1 Zooplankton and benthos

Zooplankton and benthos in the investigated area (upstream and downstream) indicated that 43 taxa were recorded. 35 taxa were recorded upstream while 29 taxa were recorded downstream. The richness of taxa upstream is expected and may be due to the effects of the existing old barrage because it is well known that barrages and dams make the conditions of the upstream looking like lake conditions. Thus true association of zooplankton occurs, leading to the increase of zooplankton. Also, passing of water carrying zooplankton through the gates of the barrages leads to destruction of some tiny taxa. This may account for the decreasing number of taxa downstream of the barrages especially in zooplankton. Another cause for zooplankton decrease is attributed to the increasing turbidity resulting from falling of water bearing high density of debris that affects digestive tract of zooplankton causing their death. It is clear from Table (6) that there is partially decreased due to dredging effect in this side.

3.2.2 Erythrocyte alterations as an indicator of pollution

As shown in Table (8), an altered erythrocyte percentage appears in all samples collected from upstream and downstream of the old barrage at Assiut. It is clear that this percentage is abnormal compared with data reported by (Mekkawyet al. (2011) in another Nile species (catfish, Clariasgariepinus where they reported that the percentage of altered erythrocytes was 0.7 ± 0.48 in the control fishes and this percentage was increased after exposure to a chemical pollutant (4-Nonylphenol) to be 12 ± 3.26 in moderate doses and 42 ± 15.98 in higher doses).

Table (6): Invertebrate taxa recorded upstream at the four investigated sites and their frequencies of occurrence

Taxa	Frequency of occurrence	%
1.Zooplankton		
Cladocera		
1.Bosminal longirostris	4	100
2.Alona bukobensis	3	75
3.Chydrus	4	100
4.Oxyurella sp	2	50
5.Simocephalus expinosus	1	25
6. Leydigia	1	25
7.Daphnia longispina	2	50
Copepoda		
8.Thermocyclops consimilis	1	25
9. Eucycyclopsagilis	1	25
10. Mesocyclopsgunnus	1	25
11. Microcyclopsalidus	1	25
12. Nauplius larva	4	100
Ostracoda		
13. Cypridopsisvidua	1	25
14. Potamocypris variegate	2	50
15. Hemicyprisdentatomarginata	1	25
16. Limnocythereinopinata	1	25
17. Ilyocyprbiplicata	1	25
Rotifera		
18. Asplanchna sp.	1	25
19. Keratellaquadrata	1	25
20. Keratellacochlearis	4	100
21. Nothalcasquamala	1	25
22. Trichocrcasimilis	2	50
23. Polyarthra sp.	1	25
2- Benthos		
24. Bellamya unicolor	1	25
25. Lanistescarinatus	1	25
26. Melanoidestuberculata	2	50
27. Cleopatra bulimoides	2	50
28. Theodoxusniloticus	1	25
29. Lymnaeatruncatula	1	25
30. Caelaturaaegyptiaca	1	25
31. Corbiculafluminea	3	75
32. Corbiculafluminalis	1	25
33. Unioteretiusculus	1	25
3. Isects		
34. Chironomid larvae	1	25
35. Water mites	1	25

Figure (5) and Figure (6) show the blood smears of fish collected and represent the structure of blood of the Nile Tilapia Oreochromisniloticus. The blood of normal fish is composed of nucleated erythrocytes (Er), rounded with a centrally located rounded nucleus. The major alterations of red blood cells (RBCs) are echinocytes or crenated cells (Cr) where the red blood cells develop an irregular cell surface with numerous projections; acanthocytes (Ac), crenate cells with fewer projections from the surface; tear-drop like cells (Tr), with a shape like a tear with pointed apices; and

Table (7): Invertebrate taxa recorded downstream at the four investigated sites and their frequencies of occurrence

Taxa	Frequency of occurrence	%
1. Zooplankton		
Cladocers		
1.Bosmina longiroostris	4	100
2.Alona bukobensis	1	25
3. ChydrusCfsphaericus	2	50
4. Oxyurella sp.	1	25
5. Pleuroxus sp.	1	25
6. Diaphanosomabirgei	1	25
7. Daphnia longispina	1	25
Copepoda		
8. Schizoperanilotica	1	25
9. Afrocyclopsgibsoni	1	25
10. Mesocyclopsogunnus	1	25
11. Microcyclopsvaricans	1	25
12. Nauplius larvae	4	100
Ostracoda		
13. Cypridopsisvidua	2	50
14. Potamocyprisvariegata	1	25
15. Hemicyprisdentatomarginata	1	25
16. Ilyocyprisgibba	1	25
Rotifera		
17. Keratellavidua	1	25
18. Keratellacochlearis	3	75
19. Branchionuscalyciflorus	2	50
20. Nothalcasquamala	2	50
21. Kelicottia sp.	1	25
22. Trichocrcasimilis	3	75
2. Benthos		
23. Bellamya unicolor	1	25
24. Ceopatrabulimoides	2	50
25. Lymnaeabulimoides	1	25
26. Caelaturaaegyptiaca	1	25
27. Corbiculafluminea	1	25
28. Unioteretiuscukus	3	75
3. Insects		
29. Chironomid larvae	1	25

sickle cells (Sk) which vary in shape between ellipsoidal, boat-shaped and genuine sickle.One may conclude that the percentage of altered erythrocytes was increased in comparison with the last monitoring report, indicating some effect from pollution. Also the percentage of altered erythrocytes was high in comparison with both the first and second reports; this may be due to the accumulation of pollutants during implementation of the project (Obuid-Alla et al. 2014).

According to the established criteria of Al-Sabti and Metcalfe (1995), we could not detect any micronuclei in red blood cells in fish collected from both upstream and downstream of the old barrage at Assiut.

Table (8): Altered erythrocytes % (mean ± SE) in OreochromisNiloticusupstream and downstream of the old barrage in Assiut

07 May 2014 LOCATION	Sample 1		Sample 2		Sample 3	
	Range	Mean± SE	Range	Mean ±SE	Range	Mean ± SE
Upstream	1-5	3.8± 0.14[a]	1-4	3.2± 0.33[b]	1-6	4.1 ± 0.64[b]
Downstream	1-5	3.2±0.6[a]	2-7	2.9±0.74[a]	1-8	4.6±1.22[a]

(Similar letters mean that there is no significant difference at $p<0.05$)

3.2.3 Investigating fish around the industrial area

Referring to Table (8), one can conclude that sampling of fish from upstream and downstream of the barrage indicated that only one species was caught namely: OreochromisNiloticus. The quantity of different species collected based on the effort of catchment is shown in Table (8). The present data indicate that the catch per unit effort (CPUE) in upstream of the old barrage of Assuit was 13.666 less than less than that of downstream 19.166. This may be due to the CPUE depends on the behavior of fishes, environmental factors, age and size of fishes [7- 9], but the important part of studying fisheries is to stand with heavy metals that may present in their tissues.

Table (9): Shows fish species collected from upstream and downstream of Assuit barrage

Fish species	Net size	Catch time	Catch date		Place		CPUE
Oreochromis	1.5 cm	12pm:16am (6 hrs)	27/02/2013		Upstream (About 500 m far from The old barrage		
	Frequency	Wt (gm)	TL (cm)	HL(cm)	SL(cm)	BW(cm)	
Upstream	1	25	11	3	9.5	4	
	2	30	11.5	3	9	3.5	
	24	45	12	3	10	4	
	8	50	12.5	3	10.5	4	
	10	80	15.5	4	13	5	
	25	70	14	4	12	4.5	
	8	40	12	3.5	9.5	4	82/6=13.66
	4	35	12	3	10	3.5	
Fish species	Net size	Catch time	Catch date				CPUE
	1.5 cm	6pm:12am (6hrs)	1/05/2013		Downstream (Just beside the old and new Barrage)		
	Frequency	Wt (gm)	TL (cm)	HL (cm)	SL(cm)	BW(cm)	
Downstream	12	45	12	3	9.5	4	
	10	50	12	3.5	6.5	4	
	14	30	13	3	7	4.5	
	8	50	13	4	8	5	
	4	10	9	2.2	5	3	
	6	45	11	3	7	4.5	
	11	15	11	3	6	4	115/6=19.16
	50	30	12	3.5	7	4	

3.2.4 Heavy metals concentration in the fish tissues

Table (9) shows the heavy metals concentration measured in both the serum and muscle of fish species, OreochromisNiloticus collected from upstream and downstream of the barrage. According to [28]) accumulation of heavy metals in fish depends on metal concentration, time of exposure, way of metal uptake, environmental conditions (water temperature, pH, hardness, salinity), and intrinsic factors (fish age, feeding habits).

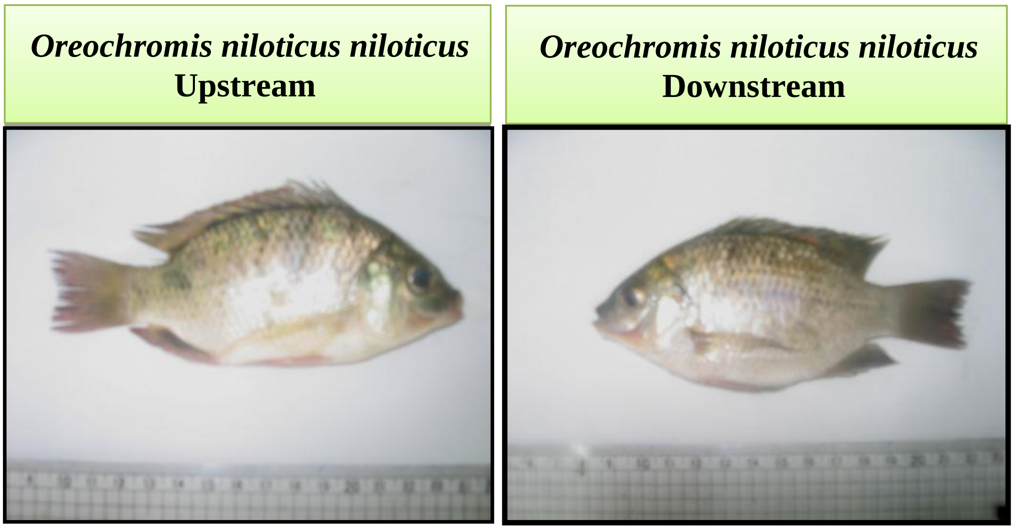

Figure (4): Fish sampled upstream and downstream of the old barrage

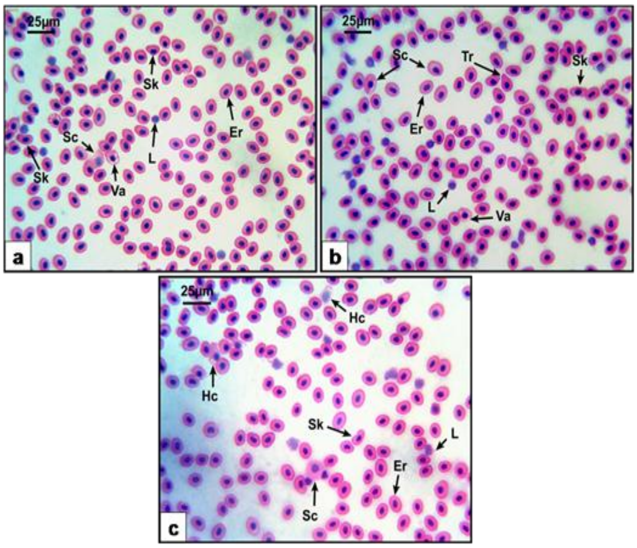

Figure 5 (a, b, c): Blood film of Monosex tilapia OreochromisNiloticusfrom three samples upstream showing normal erythrocytes (Er) and leucocytes (L) with the presence of swelled cells (Sc), sickle cells (Sk), teardrop-like cells (Tr), haemolysed cells (Hc) and cells with prominent vacuoles (Va) (H&E, x400)

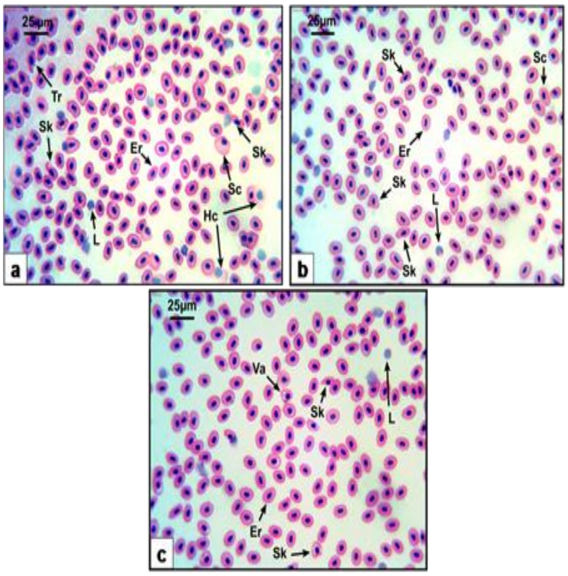

Figure 6 (a, b, c): Blood film of Monosex Tilapia OreochromisNiloticusfrom three samples downstream showing normal erythrocytes (Er) and leucocytes (L) with the presence of swelled cells (Sc), sickle cells (Sk), teardrop-like cells (Tr), haemolysed cells (Hc) and cells with prominent vacuoles (Va) (H&E, x400)

Table (10): Heavy metal concentration in the serum and muscles of Oerochromisniloticus from upstream and downstream of old barrage of Assuit

	Heavy metals	Serum		Muscle		Permissible limit For fish (WHO and FEBA)
		Range	Mean ±SD	Range	Mean ±SD	
Downstream	Fe	1384.2-1521.5	1441.9±41.1	2.2- 4.1	2.9±0.6	0.5mg/kg
	Cu	ND	ND	0.2- 1.0	0.5±0.3	3.0mg/kg
	Zn	1.6- 3.9	2.6±0.6	0.5-1.8	1.04±0.4	----
	Cd	0- 0.01	0.003±0.003	0.002-0.01	0.005±0.003	0.005ppm(WHO)
	Pb	0.3-0.9	0.6±0.2	0.1-0.2	0.17±0.03	2.0 mg/kg
	Hg	0.05-0.07	0.06±0.006	ND	---	----
Upstream	Fe	1280- 1380	1342±31.3	4.8- 7.1	5.9±0.7	0.5mg/kg
	Cu	ND	ND	0.6-0.8	0.7±0.05	3.0 mg/kg
	Zn	2.0-4.3	2.9±0.7	1.3- 2.0	1.8±0.2	----
	Cd	0-0.006	0.002±0.002	0.009-0.01	0.012±0.002	0.005 mg/kg
	Pb	0.2-0.5	0.3±0.08	0.2-0.3	0.23±0.03	2.0 mg/kg
	Hg	0.06-0.25	0.13±0.06	0.14-2.5	0.93±0.8	---

Analysis of water samples for heavy metal concentration indicated that the concentration of heavy metals were in accord with allowable levels stated by WHO except for Fe of concentration 0.731 mg/kg and 0,897 mg/kg in samples S1, S2 respectively , exceeding the WHO limit of 0.3mg/kg. Also Pb reached 0.211mg/kg for S1 and 0.224mg/kg for S2, exceeding the permissible level of 0.01 mg/kg.

Table (11): Heavy metal concentrations in the water upstream and downstream of the existing barrage at the river Nile and the permissible levels

Elements	Heavy metals concentration in water mg/l					
	Pb (ppm)	Cd(ppm)	Zn(ppm)	Cu(ppm)	Fe(ppm)	Hg(ppm)
Sample location	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD	Mean±SD	Mean ± SD
WQ1 27° 11′ 21" N 31° 11′ 34" E	0.211± 0.026	0.002±0.0004	0.002±0.001	0.001±0.0	0.731±0.009	ND
WQ5 27° 12′ 58" N 31° 10′ 51" E	0.224±0.024	0.002±0.000	0.005±0.001	0.001±0.001	0.897±0.004	ND
Permissible* Limits mg/l	0.01	0.001	0.01	0.01	0.3	0.001

*** Egyptian law48/1982 for River Nile protection from pollution**

Table (12): Heavy metal concentrations in the sediment upstream and downstream of the existing barrage at the River Nile

Elements	Heavy metals concentration in sediment (downstream) mg/kg					
	Pb (ppm)	Cd(ppm)	Zn(ppm)	Cu(ppm)	Fe(ppm)	Hg(ppm)
Sample location	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD	Mean ± SD
WQ1 27° 11′ 21" N 31° 11′ 34" E	1.021±0.006	0.059±0.020	0.032±0.002	23.129±0.260	22.780±0.012	ND
WQ7 27° 12′ 35" N 31° 10′ 34" E	3.018±0.011	0.405±0.007	0.039±0.002	23.699±0.498	25.346±0.363	ND
WQ8 27° 12′ 35″ N 31° 10′ 51″ E	3.023±0.012	0.511±0.010	0.037±0.004	23.627±0.418	25.342±0.457	ND
Permissible Limits mg/ kg	35	0.6	123	35.7	-	0.17

For all levels of heavy metals concentration measured in sediment samples, it was found that they were under allowable levels stated by WHO. This may due to the mobile ions of these heavy metals in the river waters.

Conclusion

Thephysico-chemical parameters and biological characteristics were used to assess the quality of water in the River Nile around the newAssiut barrage and its hydroelectric station. The following points were obtained:

1. **The physico- chemical parameters measured of the surface water upstream and downstream of the barrages lie within the permissible limits according to the Article (49) of decree No. 92/ 2013 of law 48 of 1982 on the protection of the River Nile from pollution.**
2. **In some points of the investigated area observed that the clarity of water has impaired due to turbidity, TDS, and TSS resulting from project construction works. This situation is lasted through settlement of debris and dilution of the river but for the suspended particles it may travel to long distances downstream across the river.**
3. **No significant difference in the abundance of invertebrate taxa measured upstream and downstream.**
4. **No micronuclei red blood cells observed in both fish collected from upstream and downstream which means no genotoxicity.**
5. **The concentration of heavy metals Pb, Cd and Fe in the water of upstream and downstream are outside the permissible limits while Zn, Cu and Hg lie within the permissible limits.**
6. **The concentration of heavy metals in the muscles of fish (upstream and downstream) lies within the permissible limits established by WHO and FEBA except downstream. In case of Cd it is slightly higher than the permissible limit in upstream specimens.**

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الملخص العربي

التقييم البيئى لجودة المياه السطحية لنهر النيل حول كوبرى اسيوط الجديد ومحطته الكهرومائية - مصر (Andritz Hydro –Hideleco)

☆ ثابت على محمد طه

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ايماءا الى الضغوط المتزايدة نتيجة الزيادة السكانية والتوسع الصناعى فى الدول النامية فانها تسعى الى تنويع مصادر الطاقة المختلفة ، ققى مايو ٢٠١٢ تم البدء فى انشاء كوبرى اسيوط الجديد ومحطته الكهرومائية فى مدينة اسيوط بمصرلانتاج الطاقة الكهربية والتحكم فى الرى وطرق المواصلات ، ولما كانت العوامل الفيزوكيمائية والبيولوجية تلعب دورا بالغا فى تقييم جودة المياه حول منطقة المحطة الكهرومائية ، ففى سبيل ذلك تم تجميع ١٩٠ عينة من المياه حول المشروع فى الفترة من ٢٠١٢ وحتى نهاية ٢٠١٤ وقد تم تحليل هذه العينات بالمركز القومى للبحوث بالقاهرة ومعامل كلية العلوم جامعة اسيوط وذلك للوقوف على تركيز هذه العوامل مثل: الاس الهيدروجينى ، كمية المواد الصلبة المذابة، الاوكسيجين المذاب ، كمية الاوكسجين الكميائى، النترات ودرجة الحرارة والعكارة ، وكان متوسط قيم هذه العوامل على الترتيب : ٨.٠٩ ، ٢٠٦.٢٥ ، ٧.١٥ ، ٩.٨٠ ، ٥.١١ ، ٠.٥٥ مجم/لتر ودرجة الحرارة٢٣.٢٠ درجة مئوية ،٥.٩٥ وحدة نفلو، وقد تم مقارنة هذه القيم بالنسب المسموح بها طبقا لمنظمة الصحة العالمية (WHO) ، وقانون ٤٨/١٩٨٢ الخاص بحماية نهر النيل من التلوث ، كذلك وقد تم حساب معدلات الجودة للمياه السطحية لنهر النيل ووجد انها مطابقة للمواصفات وتقع تحت التصنيف الجيد للمياه (٧٠ –٩٠) ، وقد تم دراسة العوامل البيولوجية مثل : البلانكتون والبنتوزيس وتركيز المعادن الثقيلة فى اسماك مياه النهر وفى المياه فى منطقة الدراسة ، وفد بينت الدراسة ان المياه صالحة للمشروعات الصناعية بينما يلزمها المعالجة لمشروعات مياه الشرب وتم وضع الاقتراحات للمحافظة على مياه نهر النيل من التلوث البيئى .