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Total and Bio-Available Phosphorus in Sediments and Its Contribution to Lake Nasser Eutrophication, Egypt

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ABSTRACT

Phosphorus has negatively influences on the ecosystem and causes eutrophication. To assess the degree of eutrophication it is necessary to know not only the total P content in the sediments, but also its bio-available forms. The main objectives of this study are to assess the distribution of total phosphorus in bed sediment along Lake Nasser, to characterize the phosphorus bioavailable forms in surface sediments, to examine the relationship between phosphorus concentration and other sediment properties and to assess the potential contribution of bioavailable phosphorus in eutrophication. To achieve these objectives, superficial sediment and water samples were collected along Lake Nasser during May 2016. The sediment samples were analyzed for total phosphorus, water soluble phosphorus, plant available phosphorus and grain size distribution. For water, dissolved oxygen, total phosphorus, Chlorophyll-a and transparency are analyzed. The results showed that, the total phosphorus in sediment samples ranged from 550 to 704 mg/kg and showed a temporal variation comparing with the data recorded during May 2009 (P= 0.046). Water soluble-phosphorus (WSP) and plant available phosphorus ranged from 1 to 3.25 mg/kg and 13.8 to 26.9 mg/kg, respectively, which represented 0.15 % - 0.46% and 2.06% - 4.59% of the total sedimentary phosphorus. The total phosphorus, transparency and chlorophyll-a in water ranged from 40 to 60 µg/l, from 1.3 to 2.8 m and from 2.4 to 32 µg/l respectively. The total phosphorus concentration in bottom layer of water column recorded higher values than that in the surface layer and ranged from 55 to 100 µg/l. The results also show that, the depletion of dissolved oxygen concentration near the bottom layer (2.15 mg/l) may enhance the release of P from the sediments. The high positive correlation was found between total phosphorus in sediment and WSP in sediment, clay and TP in water. However, total phosphorus in sediment has strong negative correlation with sand. It's worth mentioning that, WSP in sediment has a positive correlation with total phosphorus in water, indicated that WSP fraction can release phosphorus easily and increasing the total phosphorus in water. Based on Trophic State Index Calculation (TSI), Lake Nasser ranged from mesotrophic to light eutrophic state. It is recommended that dredging the surface sediments from the sedimentation zone have a positive effect in improving water quality where, dredging removes substantial amount of P stored in sediments.

INTRODUCTION

Among other elements, phosphorus (P) is usually considered the limiting nutrient for primary producers in fresh water. External load is the factor directly increasing the nutrients of any water bodies; however, various pollutants may be adsorbed to the sediments accumulated on the bottom of the lakes. These sediments may accumulate over long periods and can act as new pollutant sources to the overlying water after the water quality has improved (**Søndergaard *et. al.*, 1996**).

Eutrophication can result in significant deterioration in water quality due to the increased growth of undesirable algae and aquatic weeds followed by oxygen depletion due to biomass death and decomposition (**Xie, *et. al.*, 2007 and Abell, *et. al.*, 2010**). Excessive concentrations of phosphorus is the most common cause of eutrophication in freshwater lakes, reservoirs, streams, and in the headwaters of estuarine systems **(Wang, *et. al*., 2012)**. The amount of phosphorus presented in a water body depends on both the external phosphorus load and its release and retention in the sediments. Sediments act as a sink where P can be stored, and also as a source of P for the overlying water (**Wang *et. al.*, 2014**). Recycling of P from sediments enriched by years of high nutrient inputs causes lakes to remain eutrophic even after external inputs of phosphorus are decreased (**Abrams and Jarrell, 1995**). Concern regarding the eutrophication of lakes has grown in recent years, leading to implementation of P reduction measures (**Carvalho *et. al.*; 2008, Xing *et. al.*, 2013 and Han *et. al.*, 2014**).To assess the risk of eutrophication in aquatic systems it is necessary to know not only the total P content in the sediments but also its fraction distribution among the different sediment phases. At present, eutrophication of surface waters is a serious problem in many parts of the world. Decreasing the external nutrient load is one of the most implemented measures to combat eutrophication. However, reduction of the external phosphorus load does not always lead to a satisfactory reduction of phosphate levels in the water layer (**Cullen & Forsberg, 1988; Redshaw *et. al.*, 1990; Boers 1991**). Owing to the internal loading of phosphorus from the sediment, the phosphorus concentration of the water layer frequently remains higher than is to be expected following the reduction of the external load. If the phosphorus release from the sediment is sufficiently high to maintain an unacceptable degree of eutrophication of the water layer, additional measures are required. Dredging of lake sediments, for instance, is usually highly successful (**Bjork 1988; Roelofs *et. al.*, 1996**) but is costly, also because at present most sediment has (technically) to be considered as chemical waste. Alternatively, precipitation and immobilization of phosphorus by the addition of iron salts to the sediment may be a valuable technique (**Boers 1991; Smolders *et. al.*, 1995**).

The High Dam Lake is one of the largest man-made lakes in Africa. The current length at 180 m over mean sea level is about 500 km, of which 350 km are within the Egyptian territory and are known as Lake Nasser (between 22°00′–23°58′ N and 31°19′–33°15′ E). The 150 km stretch which lies in the northern part of Sudan is known as Lake Nubia (between 20°27′–22°00′ N and 30°07′–31°19′ E) (**Abou El Ella and El Samman, 2010).**

Lake Nasser water is a major source used for different purposes in Egypt. This study examines data from lakebed sediment and water column obtained in 24 sampling sites along Lake Nasser. Accordingly, this study aims to assess the distribution of total phosphorus (TP) in bed sediment along Lake Nasser, to characterize the phosphorus forms in surface sediments, to examine the relationship between phosphorus concentration and other sediment properties and to assess the potential contribution of bioavailable P in Lake Nasser eutrophication.

MATRIALS AND METHODS

Study Area and Sampling Sites

The study area started from Km 130 (El-Madeek) to Km 333 (Arkeen) upstream Aswan High Dam, in Lake Nasser as shown in (Tab. 1 & Fig. 1). This area was chosen as an example of a significant sedimentation zone (area). Superficial sediment samples and water samples were collected from 8 sampling monitored sites (three samples from each site; East, Middle and West) along Lake Nasser during May 2016.

Table (1): Coordinates of the Sampling Sites along Lake Nasser

Sampling Sites	Km	N	E
El Madeek	130	22° 54' 61.6"	32° 36' 00.7"
Ebreem	228	22° 39' 47.0"	31° 59' 03.8"
Masmas	237	22° 35' 98.8"	31° 54' 11"
Toushka	247	22° 26' 66.5"	31° 49' 11.6"
Abu-Simble	281	22° 19' 39.2"	31° 37' 51.9"
Adendan	307	22° 12' 06.2"	31° 28' 91.5"
Sara	325	22° 04' 73.4"	31° 22' 15.7"
Arkeen	333	22° 01' 73.4"	31° 21' 23.7"

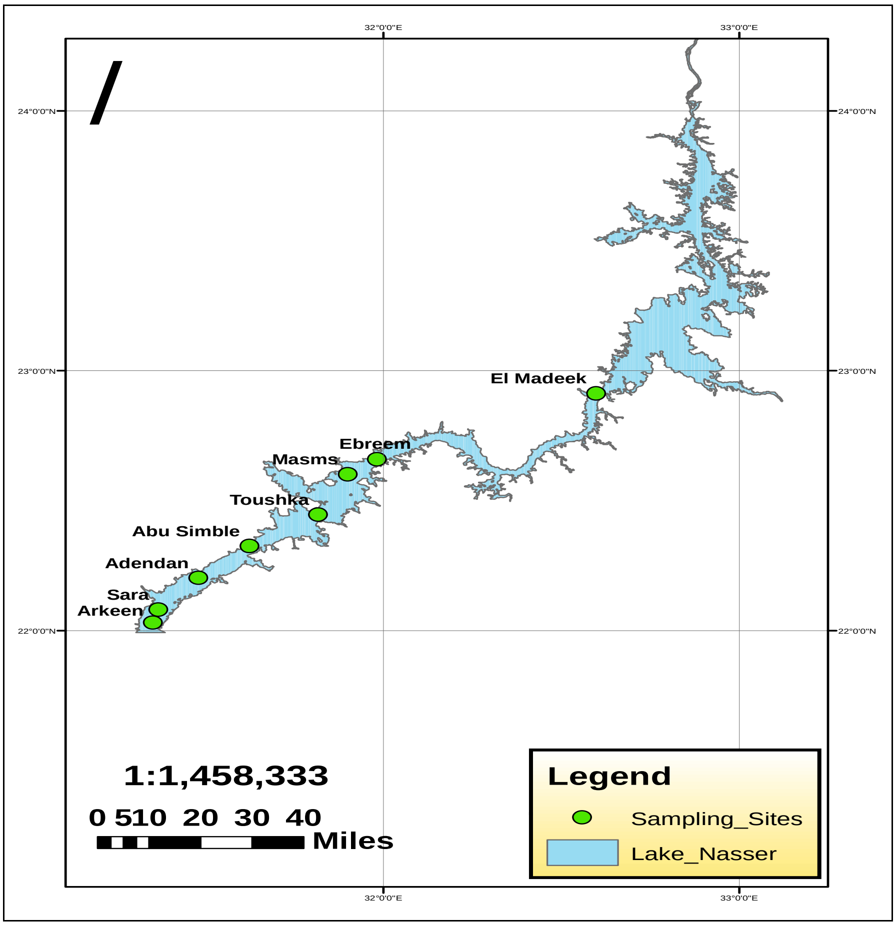

Fig. (1): Map of sampling sites along Lake Nasser.

Analyzed Parameters:

The sediment samples were transferred into labeled polyethylene bags and stored in the laboratory into a freezer until the time of analysis. The analyzed parameters are:

- Available Phosphorus: Water-soluble and plant available phosphorus are analyzed based on the **Tiessen and Moir (1993)** method.
- Total Phosphorus: Total phosphorus in bed sediment was analyzed based on the standard procedure (**APHA, 1989**) by using acid persulfate method.
- Grain Size Distribution: Sediment samples used for particle-size distribution were pretreated with H_2O_2 and HCl, dispersed over-night in Na-hexa-metaphosphate, and then evaluated by the pipette method (**Day, 1965**). Moreover, the water samples were analyzed for dissolved oxygen DO, TP, chlorophyll *a* and transparency according to standard methods (**APHA, 1989**).

Statistical analysis:

Correlation matrix and ANOVA one way were applied using Minitab 16 Software.

Trophic State Index Calculation (TSI)

The formulas for calculating the TSI values for Secchi disk, TP, and chlorophyll *a* are as follows:

Secchi disk: TSI (SD) = 60 - 14.41 ln secchi depth (m)

Total phosphorus: TSI (TP) = 14.42 ln total Phosphorus (µg/l) + 4.15

Chlorophyll *a*: TSI (CHL) = 9.81 ln Chlorophyll-a (µg/l) + 30.6

Where ln = natural log (**Carlson, 1977).** These equations are considered as a general formula used for different water bodies.

RESULTS AND DISCUSSION

Phosphorus Characteristics of Bed Sediments

Water- Soluble Phosphorus (WSP):

This fraction is usually considered to represent the most labile P in the sediments (**Yaobing *et. al.*, 1999**). The WSP content along the area under study showed that, there is no significant differences between East, Middle and west of the Lake ($p>0.05$) samples as illustrated in (Fig. 2). The WSP contents in the collected sediments samples ranged between 1.08 mg/kg and 3.25 mg/kg at the eastern bank while, it ranged from 1 mg/kg to 2.38 mg/kg at the middle along the study area. However, the WSP ranged between 1.08 mg/k and 2.78 mg/kg at the western bank (Fig. 3). Water soluble-phosphorus represents a very low percent of the total phosphorus less than 1%as shown in (Tab. 2), where it ranged from 0.2% to 0.46% at the eastern bank, from 0.15% to 0.34% in the middle, and from 0.17% to 0.40% in western bank. Water soluble- phosphorus gives an indication of potential soluble-phosphorus movement with leaching and sometimes used as a measure of labile- P (**Nishimoto *et. al.*, 1977**). The water-soluble phosphorus representing the loosely adsorbed and labile P in sediments (**Zhou *et. al.*, 2001**), which considered the most available form but it was low in the sediments compared with total sedimentary phosphorus.

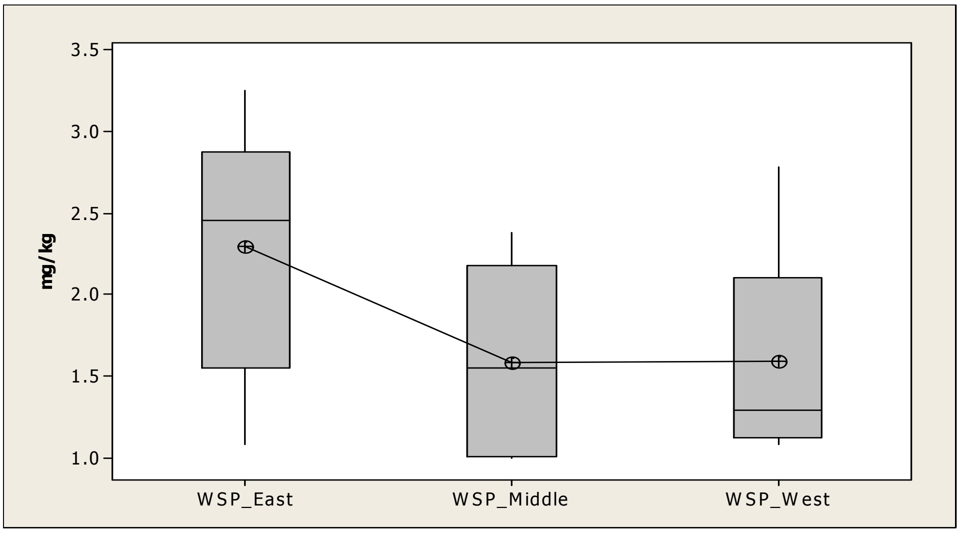

Fig. (2): Boxplot of water soluble phosphorus in bed sediments

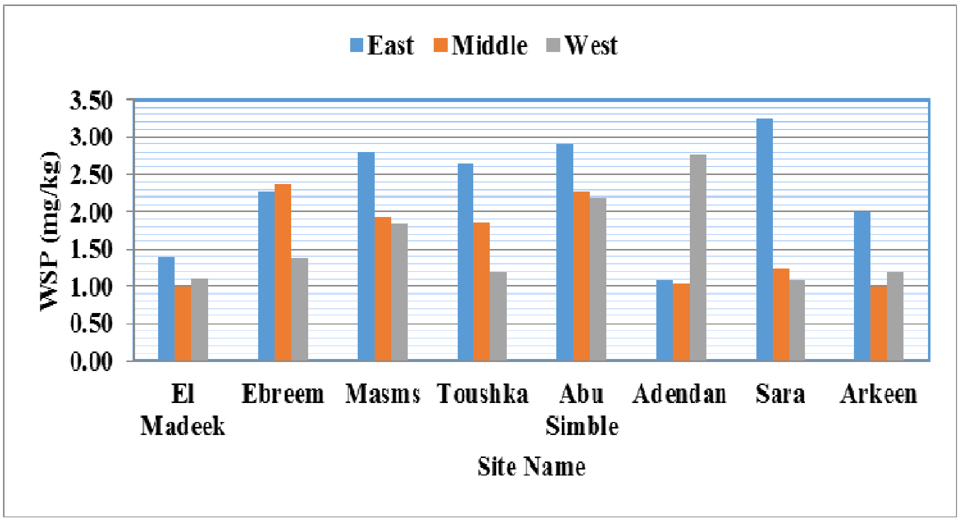

Fig. (3): Water soluble phosphorus in bed sediments along Lake Nasser

Table (2): Water soluble phosphorus percentage in bed sediments along Lake Nasser

Site Name	East	Middle	West
	%WSP	%WSP	%WSP
El Madeek	0.22	0.17	0.17
Ebreem	0.33	0.34	0.24
Masms	0.44	0.32	0.29
Toushka	0.39	0.28	0.18
Abu Simble	0.41	0.33	0.33
Adendan	0.20	0.15	0.40
Sara	0.46	0.18	0.17
Arkeen	0.29	0.16	0.18

Plant Available – Phosphorus (PA-P):

The plant available-P was found to be highly correlated with P uptake by plants (**Menon *et. al.*, 1989 and Sharpley, 1991**) and assumed to be plant available (**Cross and Schlesinger, 1995**). The PA-P content along the area under study showed that, there is no significant differences (P>0.05) between East, Middle and West samples as indicated in (Fig. 4). The PA-P contents in the collected sediments samples ranged between 15.3 mg/kg and 26.9 mg/kg at the eastern bank while, it ranged from 16.11 mg/kg to 26.7 mg/kg at the middle. However, it is ranged between 13.8 mg/k and 26.3 mg/kg at the western bank (Figure 5). The PA-P with respect to the total p, recorded small fractions, where it ranged from 2.37% to 3.88% at the eastern bank, from 2.3% to 4.59% in the middle, and from 2.06% to 3.95% in the western bank (Tab. 3).

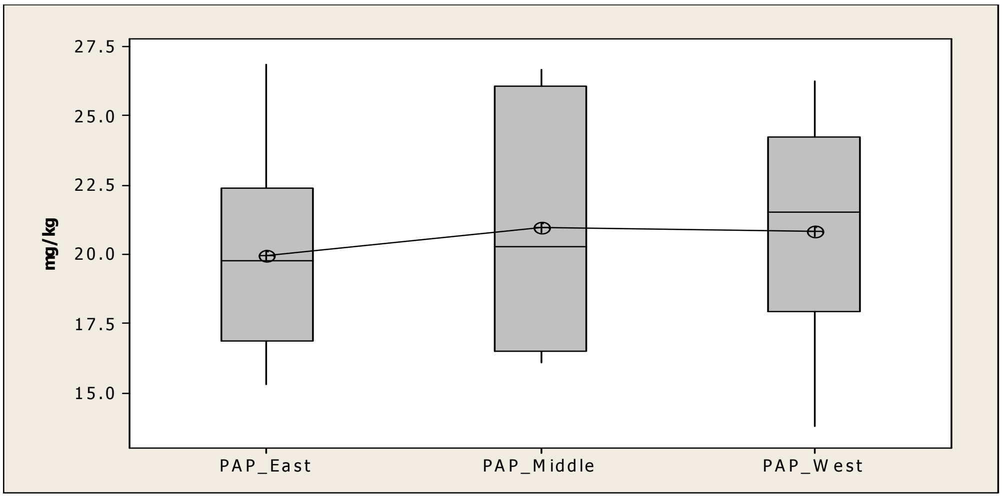

Fig. (4): Boxplot of plant available phosphorus in bed sediments

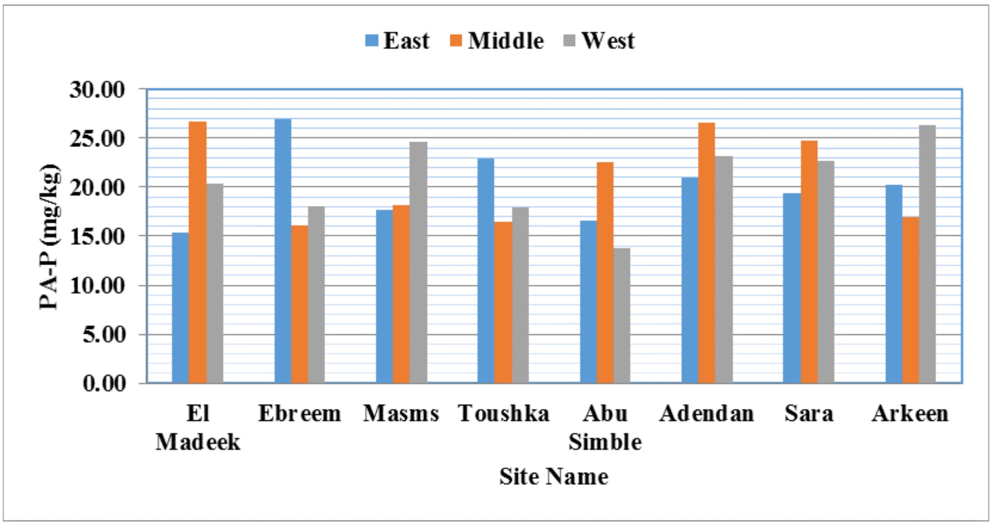

Fig. (5): Plant available phosphorus in bed sediments along Lake Nasser

Table (3): Plant available phosphorus percentage (%) in bed sediments along Lake Nasser

Site Name	East	Middle	West
	%PA-P	%PA-P	%PA-P
El Madeek	2.39	4.59	3.22
Ebreem	3.88	2.30	3.08
Masms	2.81	3.02	3.90
Toushka	3.36	2.45	2.71
Abu Simble	2.37	3.29	2.06
Adendan	3.80	3.91	3.31
Sara	2.75	3.58	3.49
Arkeen	2.89	2.68	3.95

It's worth mentioning that, this extracting solution removes dissolved and adsorbed Phosphorus on calcium carbonate and Fe-oxide surfaces (**Olsen *et. al.*,**

1954), which give an indication of how much sediment P will become available to plants and considered as Plant Available Phosphorus.

The concentration of bioavailable P reflects the degree of pollution and the endogenous release ability. Bioavailable P can be transformed into active P through chemical and biological reactions and in turn influence the overlying water quality (**Bridgeman *et. al.*, 2012**). Several studies have shown that higher amounts of bioavailable P in sediments result in greater release of P (**Abdallah, 2011**; **Bridgeman *et. al.*, 2012 and Liu *et. al.*, 2012)**. Based on research by Rydin (**2000**), approximately 50–60% of organic phosphorus in sediments can be degraded or hydrolyzed into bioavailable P. In this study, both the concentration and the proportion of bioavailable P were considerable, indicating that the potential availability and release risk to the overlying water were high and contributed for lake eutrophication.

The loosely sorbed phosphorus (WSP) represented <1% of the sedimentary total phosphorus, while the plant available phosphorus (PA–P) ranged between 2.06 and 4.59%.

Bioavailable Phosphorus is the part of the Phosphorus that is readily available and released during certain environmental conditions, like low redox potential and changes in pH.

Internal loading occurs under conditions like high pH, high temperatures, depletion of dissolved oxygen (DO) (**Bostrom, 1988**). Under certain environmental conditions, the sediments may become a potential Phosphorus source that will support the elevated trophic status of Lake. Stratification and water mixing during summer and winter respectively play an important role in this phenomenon. Stratification lead to anoxic conditions, lowered pH and accumulation of nutrients in the near bottom layers of water column (**Carpenter, 2005**) and sedimentary P may be re-suspended. This fraction can be released for the growth of phytoplankton when anoxic conditions prevail at the bottom layer of water (**Ting and Appan, 1996**). In that study, the DO concentration at the bottom water layer was found less than that recorded at the surface layer of the water as shown in (Table 4) and this may be considered as one of the most important factor that affect the release of phosphorus from the bed sediments.

Total Phosphors Concentration (TP)

Total phosphorus in bed sediment showed no significant differences (P>0.05) between East, Middle and West samples (Fig. 6). It also gives an indication of the natural source of phosphate in bed sediment. It is ranged between 550 mg/kg and 704 mg/kg at the eastern site samples, while it ranged from 582 to 700 mg/kg at the middle site. However, TP ranged between 586 and 700 mg/kg at the western samples as illustrated in (Fig. 7). Although the bed sediment along Lake Nasser has high concentrations of TP, the available phosphorus represented very low values comparing with the total sedimentary phosphorus concentration. This may be due to, that most of the phosphorus are found in the apatite mineral (HCl – P) and in residual forms which consider as inert form (**Kaiserli *et. al*., 2002)**.

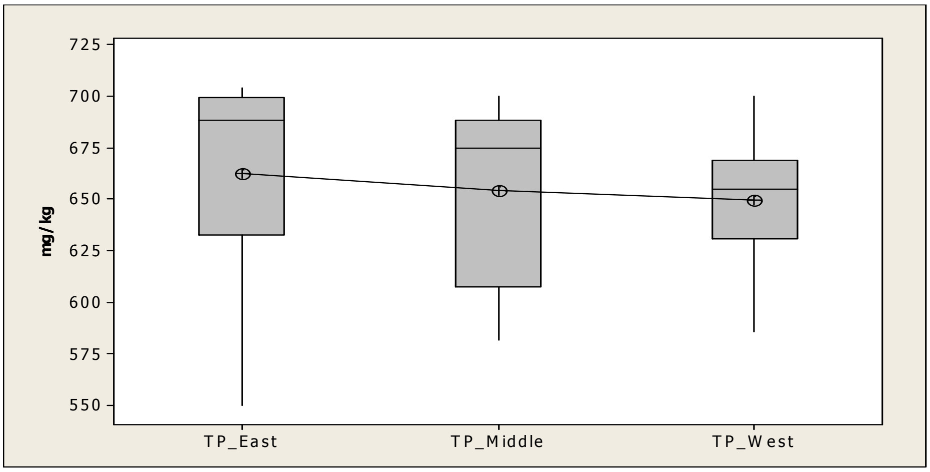

Fig. (6): Boxplot of total phosphorus in bed sediments

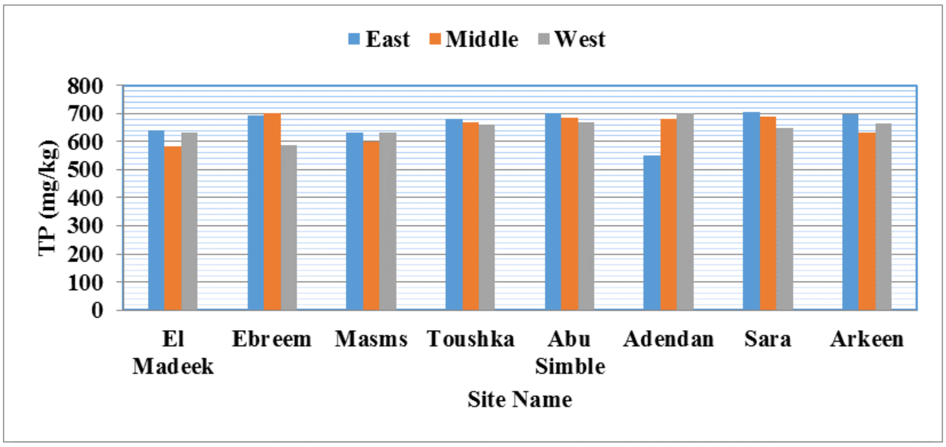

Fig. (7): Total phosphorus in bed sediments along Lake Nasser

Comparing the results of total phosphorus concentration in bed sediments recorded during May 2016 with that recorded during May 2009 we found that, there is a temporal variation in phosphorus concentration (P = 0.046). The temporal variation of total P content may be related to different factors including water temperature, pH, dissolved oxygen and sediment-water exchange processes (**Wang *et. al.*, 2012**). More P was released under alkaline conditions than acidic conditions, but the least amount of P was released under neutral pH. Desorption of phosphate from ferric hydroxide at high pH is a distinct possibility **(Mokhtar *et. al.*, 1995)**

The texture of the studied sediments differed from fine to medium sand to silty clay and clay percentage ranged from 9.08 % to 76.53% as shown in (Fig. 8).

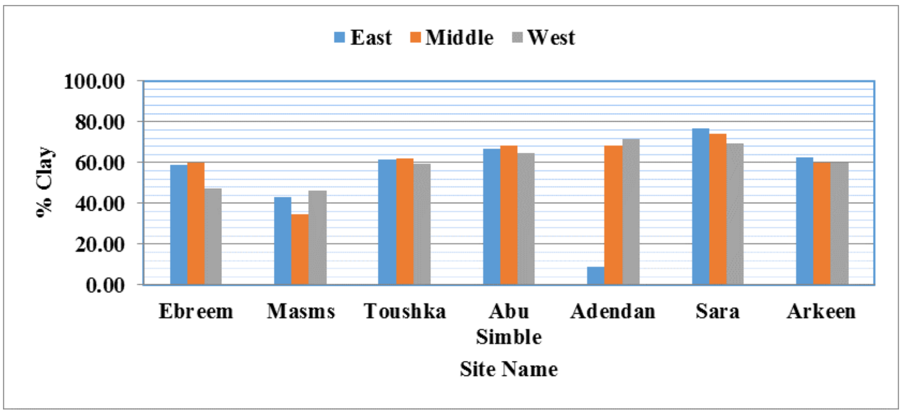

Fig. (8): Percentage (%) of clay in bed sediments along Lake Nasser

The relationships between different forms of phosphorus and total phosphorus in water were analyzed using person's correlation (Tab. 4). The concentration of TP in sediment was positively correlated with a number of variables like WSP in sediment, clay and TP in water. However, TP in sediment has strong negative correlation with sand. WSP in sediment has a positive correlation with TP in water, which suggests that the WSP from sediment might be exchanging with P in water column. The results of this study could help better understanding the P dynamics at the sediment-water interface in Lake Nasser.

Table (4): Correlations matrix between TP, WSP in sediments, sand, silt, clay & TP in water samples

	TP Sediment	*WSP Sediment*	*Sand*	*Silt*	*Clay*	*TP Water*
TP Sediment						
WSP Sediment	0.548					
Sand	-0.705	-0.212				
Silt	-0.103	-0.015	-0.487			
Clay	0.869	0.252	-0.835	-0.075		
TP Water	0.277	0.423	-0.029	0.032	0.013	

Contribution of Bioavailable Phosphorus to Lake Nasser Eutrophication

Lakes are commonly classified according to their trophic state, a term that describes how "green" the lake is as measured by the amount of algae biomass in the water. Three trophic state categories are used to describe lakes as they grow progressively greener: oligotrophic, mesotrophic, and eutrophic. Along Lake Nasser the available phosphors in bed sediment may be led to increase the concentration of phosphate in water column, which is considered the limiting factor for Lakes eutrophication. The subsequent release of surface-bound phosphate from suspended and re-suspended sediment in the Lake may provide a significant concentration of phosphate in the water column. The environmental conditions under which phosphorus could be released depend upon the geochemical phase of phosphorus. The exchangeable phosphate can be released to water if replaced by another anion such as hydroxide ion (**Jensen *et. al.*, 1992**). Table (5) shows the concentration of total phosphorus in the surface and the bottom layers of water column, Secchi depth and chlorophyll a in water along Lake Nasser.

Table (5): Water Quality Variables in Water along Lake Nasser

Sites	DO Surface (mg/l)	DO Bottom (mg/l)	TP surface (µg/l)	TP bottom (µg/l)	Secchi Depth (m)	Chlorophyll-a (µg/l)
El Madeek	7.63	3.32	40	55	2.8	2.4
Ebreem	7.60	3.90	50	55	2.8	7.1
Masmas	7.50	2.20	55	60	2.5	3.5
Toushka	7.55	4.16	55	70	2.0	4.8
Abu Simble	8.27	2.15	60	80	2.3	7.0
Adendan	6.78	6.68	50	80	2.0	8.5
Sara	6.78	6.25	60	70	1.5	25.0
Arkeen	6.94	2.70	40	100	1.3	32.0

The total P concentration in bottom layer of water column was recorded higher values than that in the surface layer and ranged from 55 to 100µg/l. There is a considerable potential for release P from the sediment into the overlying water and sediment P could be the dominant factor determining the trophic status of the lake if the external load is reduced. lake managers can classify the lake based on typical ranges for phosphorus, nitrogen, chlorophyll *a* and Secchi depth values reported in the lifecycle adapted from **Vollenweider and Kerekes, 1980** (Table 6).

Table (6): Mean values of variables associated with trophic level in Lakes

Water Quality Variable	Oligotrophic	Mesotrophic	Eutrophic
TP (µg/l)	8	27	84
Chl a (µg/l)	1.7	4.7	14
Secchi Depth (m)	9.9	4.2	2.4

From tables 5 and 6 and based on the values of TP, Chl-a and SD measured in Lake Nasser, the Lake was ranged from mesotrophic to lightly eutrophic state.

Carlson Trophic State Index (TSI)

A popular method for examining algal biomass as it relates to trophic state is through the use of the Trophic State Index (TSI) developed by **Carlson (1977)**. A watershed manager can use measurements of three variables - chlorophyll *a*, TP, and Secchi depth.

The TSI ranges from zero to 100 and can be used to assign trophic state "grade" to a lake. When classifying lakes, priority is often given to the TSI value associated with chlorophyll a, since it is the most accurate of the three parameters for predicting algal biomass. Any of the three variables, however, can theoretically be used to classify a lake (**Devi Prasad and Siddaraju 2012)**.

Figures (9 to 11) show TSI values and corresponding measurements of the three parameters in the lake. Ranges of TSI values can by grouped into the traditional trophic state categories. Lakes with TSI values less than 40 are usually classified as oligotrophic. TSI values greater than 50 are generally defined as eutrophic lakes. Mesotrophic lakes have TSI values between 40 and 50.

Lake Nasser is commonly classified according to their trophic state as Mesotrophic and lightly Eutrophic Lake based on TSI (Chl a), TSI (SD) and TSI (TP) calculations (**Devi Prasad and Siddaraju 2012)**.

In that study the **TSI (TP) > TSI (CHL) = TSI (SD**) as mentioned before, this give an indication of there are some factors other than phosphorus limits algal biomass **Carlson (1977)**. Phosphorus in water is not considered to be directly toxic to humans and animals (**Amdur *et. al.,* 1991**). For this reason, there is no drinking water standards have been established for P. Any toxicity caused by P in freshwaters is indirect. The probable cause is toxic algal blooms or anoxic conditions activated by P pollution. It is worth to mention that, the flourishing of algal blooms give an indication of high phosphorus contents in water.

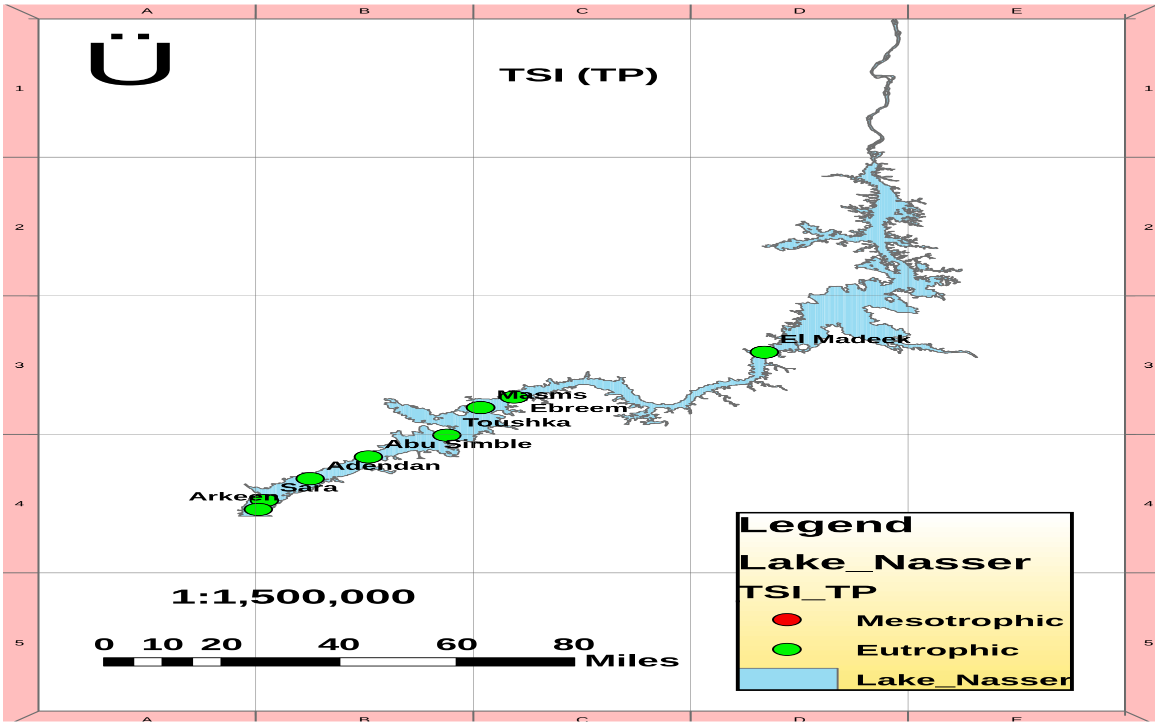

Fig. (9): TSI graduation based on TP concentrations

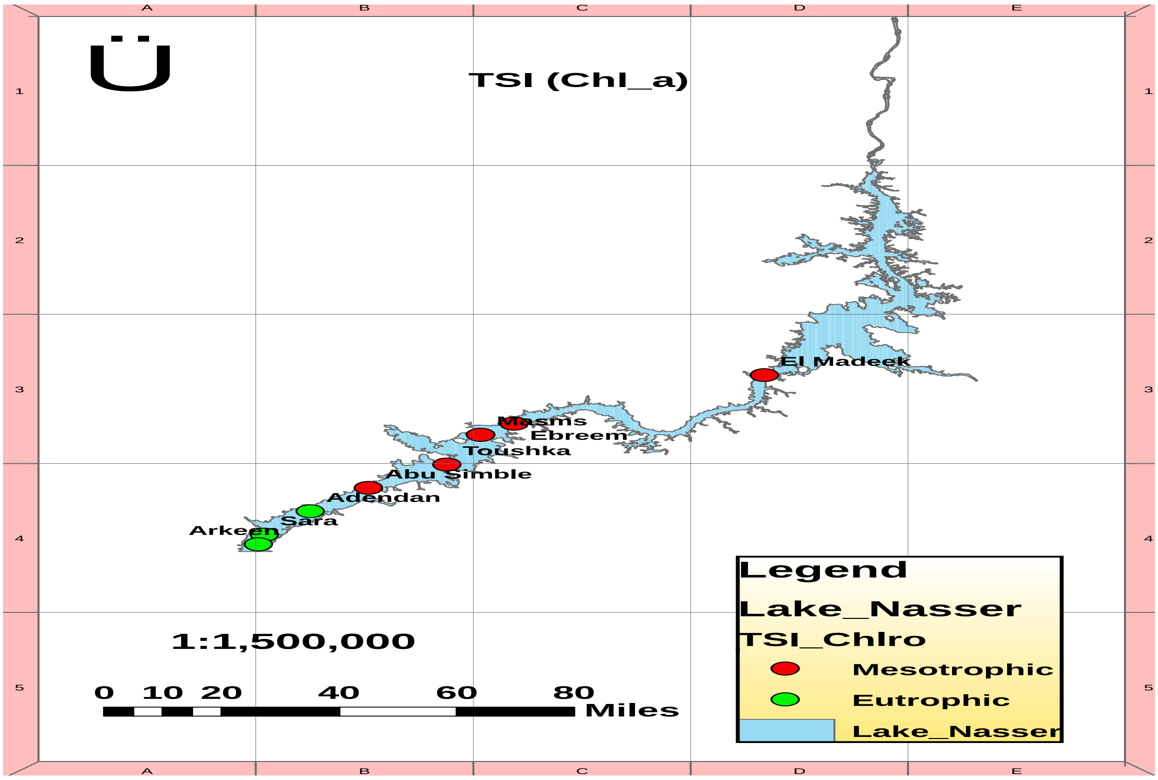

Fig. (10): TSI graduation based on chlorophyll -a concentrations

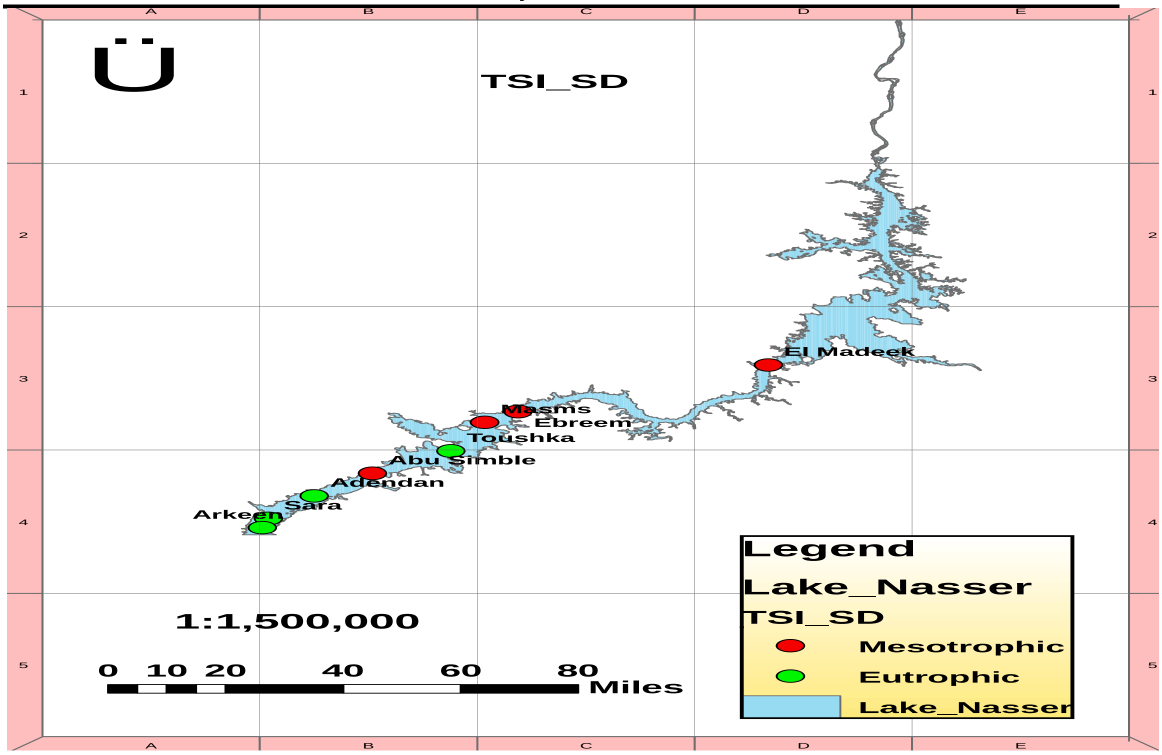

Fig. (11): TSI graduation based on SD values

CONCLUSION AND RECOMMENDATIONS

From the previous results and discussion the following can be concluded:

- Although the concentration and the proportion of bioavailable phosphorus were considerably low compared with total phosphorus concentration, the potential availability and release risk to the overlying water were high.
- TP in sediment has a positive correlation with a number of variables like WSP in sediment, clay and TP in water. However, TP in sediment has strong negative correlation with sand.
- WSP in sediment has a positive correlation with TP in water that gives a reasonably good indication of the WSP from sediment is a part of TP in water.
- Based on Trophic State Index calculation (TSI), Lake Nasser ranged from mesotrophic to light eutrophic state.
- The depletion of dissolved oxygen concentration near the bottom layer may enhance the release of P from the sediments.
- The source of phosphorus is the bed material (internal loading) where there is no definite point source along the Lake.
- There is a temporal variation of total phosphorus concentration in bed sediments along Lake Nasser.

The study recommended that:

- Dredging the surface sediments to have a positive effect in improving water quality where, dredging removes amount of P stored in sediments. Implementation of P reduction goals such as dredging may have significant costs and economic impacts. Dredging of the upper sediment layer would reduce the concentrations of bioavailable P and likely reduce the release of P into the water column.
- The sediment rich phosphorus can be used for agricultural amendment, where Lake Nasser sediments are considered safe for environment based on the previous publications.

- It is also recommended to implement a pilot project to evaluate the characteristics of sediment for its potential use in agricultural land reclamation and to identify how the sediments affect the crop yields**.**

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ARABIC SUMMARY

الفوسفور الكلي والمتاح حيوياً في الرسوبيات ومساهمته في الإثراء الغذائي لبحيرة ناصر، مصر

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يؤدي التفاعل بين الرسوبيات والمياه دوراً هاماً في حركة المغذيات. الفوسفور هو العامل الأهم في النظم البيئية لبحيرة ناصر، فهو يؤثر سلبا على النظام البيئي ويسبب الإثراء الغذائي. ولتقييم درجة الإثراء الغذائي يجب معرفة ليس فقط المحتوى الكلي للفوسفور في الرسوبيات ولكن أيضاً الصور المتاحة حيوياً. تتمثل الأهداف الرئيسية لهذه الدراسة في تقييم توزيع الفوسفور الكلي في رسوبيات القاع على طول بحيرة ناصر، توصيف صور الفسفور المتاحة بيولوجياً في الرسوبيات السطحية، دراسة العلاقة بين تركيز الفوسفور وخصائص الرسوبيات الأخرى وتقييم المساهمة المحتملة للفوسفور المتاح حيوياً في ظاهرة الإثراء الغذائي ببحيرة ناصر. تم جمع عينات الرسوبيات السطحية وعينات المياه على طول بحيرة ناصر خلال شهر مايو ٢٠١٦. تم تحليل الفوسفور الكلي، الفوسفور القابل للذوبان في الماء، الفوسفور المتاح للنبات والتدرج الحبيبي بالنسبة لعينات الرسوبيات. الأكسجين الذائب، الفوسفور الكلي، الكلوروفيل - أ والشفافية بالنسبة لعينات المياه وفقاً للطرق القياسية لكل متغير. وأظهرت النتائج أن الفوسفور الكلي في عينات الرسوبيات تراوحت تركيزاته بين ٥٥٠ ، ٧٠٤ ملجم / كجم وأظهر تبايناً زمنياً مقارنة مع النتائج المسجلة خلال شهر مايو ٢٠٠٩ (P = 0.046). تراوحت تركيزات الفوسفور القابل للذوبان في الماء والفوسفور المتاح للنبات من ١ إلى ٣.٢٥ ملجم / كجم، ١٣.٨ إلى ٢٦.٩ ملجم / كجم على التوالي، والتي تمثل نسبة ٠.١٥٪ - ٠.٤٦٪ ، ٢.٠٦٪ - ٤.٥٩٪ من الفوسفور الكلي على التوالي. تراوح الفوسفور الكلي والشفافية والكلوروفيل-أ في المياه بين ٤٠ إلي ٦٠ ميكروجرام / لتر، من ١.٣ إلى ٢.٨ متر ومن ٢.٤ إلى ٣٢ ميكروجرام / لتر على التوالي. وأظهرت النتائج

أيضاً أن نقص تركيز الأكسجين الذائب بالقرب من الطبقة السفلية (٢.١٥ ملجم / لتر) قد يعزز من إطلاق الفوسفور من الرسوبيات.

أظهرت نتائج التحليل الإحصائي أن هناك إرتباط إيجابي بين الفوسفور القابل للذوبان في الماء والفوسفور الكلي في الماء، ممايدل علي أن جزء من الفوسفور القابل للذوبان في الماء والموجود بالرسوبيات يمكن أن يطلق إلي المياه ويسبب زيادة في تركيز الفوسفور الكلي بالمياه. وبناءاً علي حساب معامل الأوتروفيه، تراوحت حالة بحيرة ناصر من متوسطة الأتروفيه إلي أتروفيه وتوصى الدراسة بتكريك الرسوبيات السطحية من منطقة الترسيب حيث يكون لها أثر إيجابي في تحسين نوعية المياه كما أن التكريك يزيل كمية كبيرة من الفوسفور المخزنة في الرسوبيات. ويمكن استخدام نواتج التكريك لتحسين الأراضي الزراعية حيث أن الرسوبيات خالية من المعادن الخطرة وغنية بالمغذيات.