EGYPTIAN JOURNAL OF AQUATIC RESEARCH 1687-4285
VOL. 31 NO. 2, 2005: 1-15

# PHYSICO-CHEMICAL CHARACTERISTICS OF ABU ZA'BAAL PONDS, EGYPT

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*Keywords: Abu Za'baal Ponds, physical and chemical characteristics, water*

## ABSTRACT

The present study deals with the physical and chemical characteristics of the water of Abu Za'baal Ponds. Determination of physical parameters (air and water temperatures, transparency, electrical conductivity, salinity, total solids, total dissolved solids and total suspended solids) and chemical parameters (pH, DO, BOD, COD, $HCO_3^-$, $CO_3^{--}$, $Cl^-$, $SO_4^{--}$, $Ca^{2+}$, $Mg^{2+}$, $Na^+$, $K^+$, $NO_2^-$, $NO_3^-$, $NH_3$, $PO_4^{--}$, TP and $SiO_2^-$) were carried out to identify the nature and quality of the water of Abu Za'baal Ponds. The present results reveal that the values of most physical and chemical parameters were higher than those of freshwater, lower than those of saline water and in the same range of the brackishwater. Thus, the water of Abu Za'baal Ponds can be classified as brackishwater.

## INTRODUCTION

Abu Za'baal Ponds, circuitous man-made basins, are formed by the fracture and extract rocks. The ponds, inland closed basins, receive their water from the ground and – seepage waters. Recently Abu Za'baal consists of three ponds and a filling phase pond. They occupy the area between Latitudes 30° 16.62' and 30° 17.58' N & Longitudes 31° 20.90' and 31° 21.69' E. The pond waters cover an area of about 608 X $10^3$ $m^2$ (~ 150 feddan). The water storage in the ponds is 5234.075 X $10^3$ $m^3$ (Abd-Ellah, 2003).

Abu Za'baal basins, man-made ponds are located in the north of Qalubia Governorate at Abu Za'baal City, 30 $km^2$ of Cairo. Also, Abd-Ellah, (2003) stated that the ponds were formed and filling as follows, in the fifth decade (the first pond), in the eighth decade (the second pond) and in the ninth decade (the third pond), while the small pond is in a filling phase in the present time. The depths of pond (A) ranging between 6 – 25 m, while pond (B) 1 – 7 m and pond (C) 1 – 5 m, respectively.

The quality of water is now the concern of experts in all countries of the world. The decision of WHO's 29th session (May 1976) emphasizes that water delivered to the consumer should meet the high requirements of modern hygiene and should at least be free from pathogenic organisms and toxic substances. Also, the quality of water depends on the location of the source and the state of environmental protection in a given area. Therefore, the quality and the nature of water are determined by physical and chemical analysis (Voznoya, 1983).

Aquatic ecosystems are much too complex and integrated to be simply regulated by a single nutrient. Metabolism, growth, productivity and behavior are certainly regulated by many organic compounds in addition to traditional macrofactor controls e.g., major nutrients (Wetzel, 2000).

Abd-Ellah, (2003) investigated the physical limnology and determined the water storage in Abu Za'baal Ponds and draw the map of these ponds.

Mohamed and Gad, (2005) studied the level of some heavy metals (Fe, Zn, Mn, Pb,

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Cu and Cd) in the water and several organs (muscles, gills, liver and kidneys) of *O. niloticus, T. zillii* and *C. lazera* collected from Abu Za'baal Ponds. This study evaluatesd the impact of such heavy metals on the muscle, liver, total protein and lipid contents and the histological features of some organs (gills, liver and kidneys) of fish.

## MATERIALS AND METHODS

The present study was done through the research plan of the National Institute of Oceanography and Fisheries, in order to gain information the environmental status of the water Abu Za'baal Ponds.

**Historical back ground**

Abu Za'baal Ponds lies in the Arab EliKate area, north-west of Abu Za'baal City. In this area, there are great amounts of basalt rocks back to Oligocene era, 35 million years ago. This type of rocks has several uses. A company of Mineral Wealth working in the field of fracture and extract basalt rocks and reused in other purposes working in this site. Three years ago extravagancy of use of explosives led to leakage of subsurface water reservoir. In order to avoid the leakage of the water in the working site, the company withdreaw this water by suction pumps and discharge into Ismailia Canal. Then, working stopped in this site since 2.5 years age, the water withdrawal also stopped from quary as it becomes lower than ground surface by approximately 12 meters, recently with increase in rate of water quantities 3 meter/year. Consequently, Abu Za'baal Ponds are considered as artificial ponds “Man Made Ponds” which appeared since three years ago owing to the fractioning in exposures of basalt rocks trapped in sub-surface reservoir (Badawi, 2002).

**Water samples collection and analysis**

The present study was extended from winter 2003 to autumn 2003 during four successive seasons. The sampling stations were chosen to cover the three ponds. In the first pond (A), five stations were selected (I, II, III, IV and V). In the second and third ponds (B and C), one station was selected in the middle of each pond. Also, one water sample was collected from Ismailia Canal as a control. The locations of these sampling stations are represented in Fig 1.

Water samples were collected at 60 cm depth, using polyvinyl chloride Van Dorn bottle. The samples were preserved in an ice-box and returned immediately to the laboratory. The chemical parameters were determined according to the methods described in APHA, (1998). Salinity, electrical conductivity, air and water temperatures, as well as pH values were measured, using Hydrolab, Model “Multi 340I/SET”. The transparency of water was measured in the field, using Secchi-disc (diameter 25 cm).

## RESULTS AND DISCUSSION

The physico-chemical parameters are considered as the most important principles in the identification of the nature, quality and type of the water (fresh, brackish, saline) for any aquatic ecosystem.

**Physico-chemical characteristics**

**Temperature**

Temperature is a factor of great important for aquatic ecosystem, as it affects the organisms, as well as the chemical and physical characteristics of water (Delince, 1992). The recorded temperatures of air ranged from 16.0 – 20.0, 33 – 35, 34 – 36 and 22 – 26 $^{0}$C. The water temperatures varied from 17 – 20, 30 – 32, 30 – 34 and 19 – 24 $^{0}$C during winter, spring, summer and autumn, respectively. As expected the water temperature of the ponds followed more or less that of the air. However, the bottom water temperatures of the pond (A) differed from the surface water by ±10 $^{0}$C. This might be due to the increasing in depths at all stations of this pond. For other ponds (B) and (C), there was no temperature variations, due to the shallowness of these ponds.

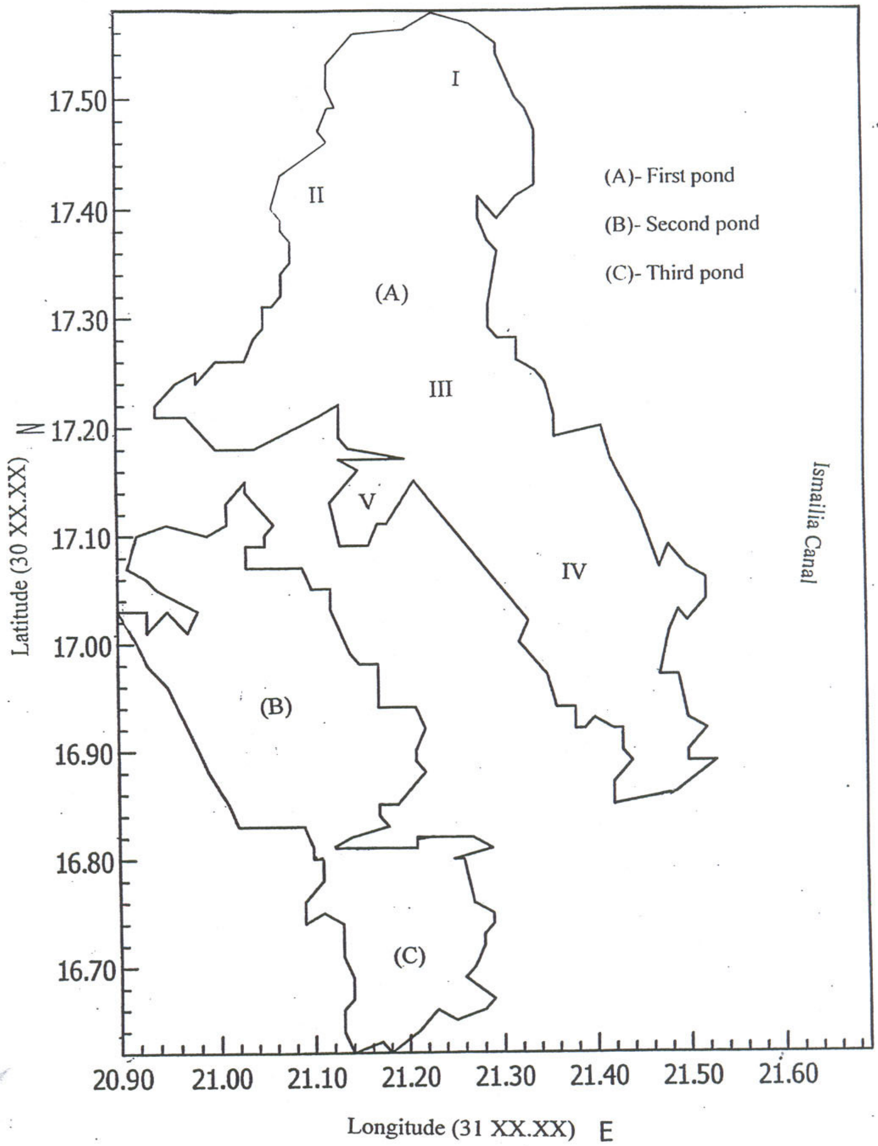


Fig (1): Map showing the sampling stations in Abu Za'baal Ponds

**Transparency**

Seasonal variations of Secchi disc readings in the pond waters indicate that the minimum values were recorded during spring (50 – 95 cm). This might be due to the increasing in water levels of the three ponds. The transparency values of pond (A) were higher than these in Ponds (B) and (C), as shown in Tables (1 – 4). This is attributed strongly to the high difference in depths among them.

**Electrical conductivity (EC)**

The high values of EC were recorded during hot seasons (spring and summer) 470 – 8090 µmohs/cm, while the lower values (337 – 6000 µmohs/cm) were recorded during cold seasons (autumn and winter). The conductivity increased with the increase in total dissolved solids and water temperature (Entz, 1973). The values of EC in the three ponds were higher than the freshwater control (Ismailia Canal) during the investigation period. This means that the water of the three ponds were not fresh. The comparison of the present EC values of the three ponds with other saline Egyptian lakes concluded the Lake Bardawil ranged from (30.8 – 68.7 $mScm^{-1}$) according to Abdel-Satar, (2005). This also means that the water of the three ponds were not saline. On the other hand, the EC values of the three ponds water were found in the same ranges of Lake Manzalah water (brackishwater) from 1930 - 6090 µmohs/cm as reported by Abdel-Satar, (2001). Therefore, Abu Za'baal Pond waters can be classified as brackishwater, due to EC values.

**Salinity**

Salinity is among the most important factors and exerts various effects on the vitality of marine organisms. The salinity of Abu Za'baal Ponds increased in the first pond (A) towards the second and third ponds (B) and (C). The minimum values of salinity was recorded during winter and ranged from 2.80 – 3.90 ‰. However, the maximum values was recorded during summer and ranged from 3.50 – 4.30 ‰. This is mainly attributed to the increase in the evaporation rate, where the temperature influences the rate of rock weathering and the rate of evaporation-precipitation process (Wetzel, 1983). The salinity of the pond (A) was higher than that in the pond (B) and (C) during the investigation period. However, the maximum values reached 4.30, 3.90 and 3.50 ‰ in pond (A), (B) and (C) respectively. This is due to the increase in the concentrations of TDS in pond (A) than (B) and (C), as shown in Tables (1 – 4). The fluctuation in salinity plays a key role in establishing the distribution and dynamics of the chemical water quality. It has a strong influence on the distribution of biological species (Ueda *et al.,* 2000). The values of salinity in the water of Abu Za'baal Ponds were found in the same ranges of Lake Manzalah 614 – 3074 $mgl^{-1}$ as reported by Abdel-Satar, (2001). This is confirms that the water of Abu Za'baal Ponds is brackish.

**Solids (TS, TDS & TSS)**

Solids refer to suspended and dissolved matter in water. They very useful parameters describing the chemical constituents of the water and can be considered as a general of edaphic relations that contribute to productivity within the water body (Goher, 2002).

TS and TDS were found in the same trend of the EC and salinity. However the higher values of TS and TDS were recorded during hot period and they ranged from 4182 – 5624 mg/l and 4062 – 5600 mg/l. The lower values were recorded during cold period and they ranged from 3468 – 5084 mg/l and 3412 – 4988 mg/l. The obvious decrease in the TS and TDS during cold period is mainly due to the decrease in temperature that consequently reduces the evaporation rate. Meanwhile, the higher values recorded during hot period, may be due to the elevation of the water temperature which lead had to the increase in the evaporation rates and the accumulation of the dissolved salts in water. These results are coincident with that reported by Abdel-Satar, (2005).

**Hydrogen ion concentration (pH)**

The pH values of the water ponds was found in the alkaline side (pH > 7.0), as pointed by Goldman and Horne, (1983). Therefore, the water of Abu Za'baal Ponds were on the alkaline side during the investigation period. These results agree with that reported by Abd-Ella, (2003), who studied the same area during November 2002 – December 2002. The higher values of pH were recorded during hot period 8.34 – 8.90, while the lower values were found in the cold period 8.02 – 8.46. The decrease in pH values during cold period, especially in autumn, is mainly related to the high bicarbonate content, while the uptake of $CO_2$ by phytoplankton decreasing as a result of increasing in the concentration of $HCO_3^-$ (El-Wakeel and Wahby, 1970 and Abdel-Satar, 2005).

Krumgalz *et al.,* (1980) and Ezz El-Din, (1990) reported that the seasonal variation in pH was mainly affected by temperature, salinity, carbonate and bicarbonate system, rather than the photosynthetic activity of the primary producers.

**Dissolved oxygen (DO)**

The results of DO present in Tables (1 – 4) show slight seasonal and regional variations in ranging from 6.00 – 9.60, 8.40 – 14.50, 4.40 – 10.80 and 7.20 – 9.60 mg/l during winter, spring, summer and autumn. This means that the water column was oxygenated in the three ponds (A, B and C) during the investigation period.

The distribution of DO is affected by the solubility of many inorganic nutrients, which are governed by seasonal shifts from aerobic to anaerobic environments in some regions of the three ponds (Benson and Krause, 1980). Also, the solubility of DO decreases when salinity increases, if other factors are kept constant (Ezz El-Din, 1990). The ranges of DO values of three ponds were in the same ranges of the water of Ismailia Canal. Thus, under the DO conditions of these three ponds fish culture may be successful in the ponds of Abu Za'baal.

**Biochemical oxygen demand (BOD) and chemical oxygen demand (COD)**

The data of BOD present in Tables (1 – 4) revealed that the lower values were recorded during cold period and found to be from 1.20 – 4.80 mg/l. On the other side, the higher values of BOD were observed during hot period 3.50 – 10.00 mg/l. This may be attributed to the photosynthetic activity and abundance of phytoplankton during hot period, especially spring (Abdo, 2004).

In the same manner of BOD, the COD values increased during hot period and ranged from 10.00 – 18.00 mg/l. The decrease in COD values were recorded during cold period (4.40 – 9.20 mg/l). However, the increase in COD during hot period is mainly attributed to the increase in the air and water temperatures, facilitating the decomposition and oxidation of organic matter (Abdo, 2002).

**BOD/COD ratio**

Concerning the biodegradability condition of the aquatic body of the area under investigation the ratio BOD/COD were taken into consideration. This ratio in the order 1:1 is characteristic of the purified water according to the national standard and the ratio 2:1 to 4:1 is specific crude domestic sewage (Anon, 1975; Siliem, 1993 and Abdo, 1998). Therefore, this ratio in present study varied in the ranges less than that given by the permissible values 0.28 – 0.59, 0.43 – 0.93 and 0.24 – 0.71 in the pond A, B and C during the investigation period. This indicates that, the water of three ponds did not reach the degradation level and were not also biodegradable.

**Major anions**

**Carbonate and bicarbonate alkalinity**

The results of $CO_3^{--}$ and $HCO_3^-$ alkalinity presented in Tables (1 – 4). It is declare that the carbonate values were decreased in winter 2.50 – 30.0 mg/l and increased during spring and summer 17.0 – 30.0 and 7.50 – 20.0 mg/l and not detected in autumn. For bicarbonate the lower values recorded during winter and relative increase during hot period (spring and summer), and the highest values in autumn. The ranges of $HCO_3^-$ were found to be 174.15 – 263.25, 202.5 – 416.8, 210.6 – 445.4 and 324.0 – 453.6 mg/l during the investigation period.

The increase in the bicarbonate during autumn may be attributed to the decrease in air and water temperatures, leading to a decrease in the reaction rate of carbonate direction and vice versa as shown in the following equation:-

$Ca(HCO_3)_2 \rightarrow CaCO_3 + H_2O + CO_2$
$Ca(HCO_3)_2 \leftarrow$ (Ali, 2002).
$Ca(HCO_3)_2$

On the other hand, the increase in the $CO_3^{--}$ values were recorded during spring, may be attributed to the flourishing of phytoplankton and the increase in the photosynthetic process leading to liberation of $CO_2$ which is converted into carbonate as given in the following equation:-

$CO_2\ g == CO_2\ aq + H_2O == H_2CO_3 == H^+ + HCO_3^- == 2H^+ + CO_3^{--}$ (Spotte, 1979).

Also the lower values of $CO_3^{--}$ recorded during winter, and not detected during autumn, this is mainly attributed to the decomposition in the dead phytoplankton leading to liberation of $CO_2$ which dissolves in water and increase in the formation of $HCO_3^-$ accreditation to the following equation:-

$CO_2 + CO_3^{--} + H_2O \rightarrow HCO_3^-$
(Goldman & Horn, 1983).

The values of $HCO_3^-$ in the pond (C) were found higher than (A) and (B), as shown in Tables (1 – 4). This may be related to the lower values in the pH of pond (C) than (A) and (B). Also, the increase in the $CO_3^{--}$ & $HCO_3^-$ values of the three ponds (A, B and C) than the Ismailia Canal water is attributed to the relative increase in the salinity of these ponds than freshwater of Ismailia Canal (Ezz El-Din, 1990).

Generally, the high bicarbonate values of the three ponds indicate, their high productivity and consequently favorable contribution for fish production. These results agree with that finding by Abdel-Satar, (2001) on Lake Manzalah.

**Chloride and sulphate**

The chloride values were fluctuated in the ranges from 1063.50 – 1610.00, 780.00 – 1737.05, 1021.00 – 1744.14 and 1240.75 – 1843.00 mg/l during winter, spring, summer and autumn.

The seasonal variations of sulphate concentrations present in Tables (1 – 4) showing that, the distribution of sulphate during winter, spring and summer are similar to each other. However, the highest values were recorded during autumn.

The relative increase in the chloride and sulphate concentrations during hot period, may be due to the increase in the air and water temperatures followed by the high evaporation rate. These results agree with that reported by Abdel-Satar, (2005).

On the other side, the high values in the sulphate and chloride concentrations unexpected during autumn. This is mainly attributed to the dissolution of some ions especially $Cl^-$, $SO_4^{--}$ from the surrounding rocks and sediment which release into the water of the three ponds.

**Major cations**

**Calcium and magnesium**

The distribution of calcium and magnesium concentrations in the water of Abu Za'baal Ponds were highly fluctuations during different periods. However, the magnesium values were found higher than calcium during winter and spring and vice-versa during summer and autumn, as shown in Tables (1 – 4).

The lower values of the calcium were recorded during spring may be attributed to the uptake of the calcium by microorganisms (Bowling, 1975). However, the high calcium contents were recorded during summer and autumn, may be related to the relative increase in the dissolved oxygen during these periods (Cole, 1979).

Generally, the calcium contents in the water is affected by the adsorption of the calcium ion on the metallic oxides (Wilson, 1975) in addition to, the effect of the microorganisms which play an important role in the calcium exchange between sediment and overlying water (Elewa, 1988).

The present results show the magnesium concentrations in the water ponds were higher than the calcium during winter and spring. This may be attributed to, $MgCO_3$ is partially soluble during these seasons and the magnesium precipitated as $Mg(OH)_3$ (Goher, 2002). On the other hand, the slight variations in the distribution patterns of the magnesium during summer and autumn. This is mainly attributed to its minor biotic demand and high solubility characteristic of they salts that keeps a homogenous distribution and mass balance for magnesium contents during these seasons (Wetzel, 1983). Calcium and magnesium show a close trend as similar as salinity. There is more or less harmony in the decrease or increase in the three parameters (Abdel-Satar, 2005).

**Sodium & potassium**

The present results show a slight variation in the sodium distribution patterns during winter, spring and summer. This is mainly attributed to the high solubility of they salts that keep a homogenous distribution and mass balance for sodium (Wetzel, 1983), as shown in Tables (1 – 3). However, the high values of the sodium contents ranged from 516.05 – 546.66 mg/l during autumn, may be due to the release and the dissolution of the sodium ions from sediment and rocks into the overlying water.

The slight seasonal variations in the potassium of the ponds, indicate that the conservative nature of K. The ranges of $K^+$ were found to be from 13.61 – 15.31, 13.28 – 16.11, 12.87 – 14.76 and 13.28 – 15.50 mg/l during winter, spring, summer and autumn respectively.

The previous mentioned discussion coincident with that reported by Abdel-Satar, (2005) on the Lagoon Bardawil.

Sodium and potassium concentrations of the water ponds followed the same seasonal trend, as shown in Tables (1 – 4). Based on the calculations of the annual average variations of the major cations percentage in Abu Za'baal Ponds. The sodium represents the most abundant cation 55.56 % in the ponds, while the magnesium represent the second order in abundance among the cations 24.20 %, and the calcium occupy the third order 18 %. However, the potassium occupies the fourth and the least order of abundance 2.21 % as reported by Abdel-Satar (2005).

**Nutrient salts**

Nutrient salts ($NO_2^-$, $NO_3^-$, $NH_3^-$, $PO_4^{---}$, T.P and $SiO_2^-$) are plays an important roles in the productivity of the aquatic ecosystems supporting the food chain for phyto and zooplanktons as well as fish (Abdo, 2004).

**Nitrite ($NO_2^-$—N)**

The seasonal variations of nitrite shows that there is a relative increase in the $NO_2^-$ contents during winter and very high during autumn, (Tables 1, 4). This is mainly attributed to the oxidation of existing ammonia, yielding nitrite as intermediate state especially in abundant oxygen during winter (Wetzel, 1983). This explanation is documented by the decrease in the ammonia concentrations during the same period.

On the other side, there is a relative decrease in the nitrite contents during hot period, (Tables 1 - 4). This is probably due to they reduction into ammonia (this is supported by the relative increase in the ammonia concentrations) during this period. As well as, they uptake by the phytoplankton in the surface water.

**Nitrate ($NO_3^-$—N)**

The results of the nitrate present in Tables (1 - 4) revealed that the higher values recorded during cold period, especially winter (306.00 – 1071.12 µg/l) and autumn (176.90 – 312.33 µg/l) respectively. This may be attributed to the oxidation of ammonia by nitrifying bacteria and biological nitrification (Seike *et al.,* 1990). The lower values recorded during summer season (8.41 – 147 µg/l) may be related to the denitrification of $NO_3^-$ into $NO_2^-$ and $NH_3$ by denitrifying bacteria (Merck, 1980).

**Ammonia ($NH_3$—N)**

The ammonia concentrations were slight variations regional and seasonally. The ranges of $NH_3$ were found to be from 2.34 – 3.73, 3.69 – 4.24, 3.22 – 4.89 and 2.38 – 3.65 mg/l during winter, spring, summer and autumn respectively. The relative increase in the ammonia during hot period may be attributed to the high evaporation rate, in addition to the denitrification process by the reduction of $NO_2^-$ and $NO_3^-$ into $NH_3$.

The obtained results confirm those of Diaz *et al* (1998) for Lake Lasalade de Chiprana (Spain); Morales *et al.,* (2001) for Lake Maracaibo (Venezuela) and Ali, (2002) for Lake Qarun. They reported that the ammonia concentrations increase during hot period over cold seasons in oxic condition. The relative decrease in the ammonia concentrations during cold seasons were related to the oxidation of the ammonia by oxygen rich rather than uptake of ammonia by the phytoplankton cells (Shabana, 1999).

**Ortho and total phosphate ($PO_4^{---}$ & TP)**

The cycling of phosphorus within lakes and river is dynamic and complex, involving adsorption and precipitation reactions, interchange with sediments and uptake by aquatic biota (Borberg and Persson, 1988). The seasonal variations of $PO_4^{---}$ concentration were found to be from 41.90 – 73.57, 28.61 – 85.83, 26.57 – 44.96 and 28.61 – 61.30 µg/l during winter, spring, summer and autumn respectively. The decrease in the $PO_4^{---}$ values during summer season were probably due to the distinct drop in phytoplankton biomass, on which nutrient regeneration process depends. Also, the recycling processes of the nutrients depended on the nutritional status of algal cells (Lehman, 1980). In addition to, the weak mixing in the water and sedimentation of the phosphorus at high pH of the ponds (during summer) by combination with iron as ferric phosphate (Mesnage and Picot, 1995). On the other side, the relative increase in $PO_4^{---}$ during winter, can be related to the complete mixing of the water column and more phosphorus release from the sediment, especially in presence of dissolved oxygen as reported by Abdel-Satar, (2005).

The seasonal variations of TP were fluctuated in the ranges from 89.06 – 200.27, 76.63 – 192.10, 100.14 – 455.73 and 75.61 – 209.50 µg/l during winter, spring, summer and autumn respectively. The high values of the TP noticeable during summer especially, pond (C) 455.73 µg/l was probably, due to the increase in the evaporation rate under rises of the air and water temperatures leading to the facilitating of phosphorus release from the decay organisms (Abdo, 2002). The lower values of the TP noticeable during autumn may be due to the sedimentation and renewal rates of water (Marsden, 1989).

**Reactive silicate**

The seasonal variations of reactive silicate in the water of Abu Za'baal Pond were found to be in the ranges from 5.35 - 8.53, 9.07 - 17.06, 13.71 - 18.47 and 13.71 - 18.02 mg/l during winter, spring, summer and autumn respectively. The obvious increase in reactive silicate during hot period, especially summer, may be due to the increase in the dissolution of the diatoms frustules at high temperatures (Shapana, 1999). Consumption and fragmentation of the diatoms frustules can accelerate the dissolution process of silicate by zooplankton (Ferrente and Barker, 1978). In addition to, the alkaline pH of the water accelerates the release of the silicate from sediments to the overlying water (Wetzel, 1983). The pronounced decrease in the reactive silicate of the water ponds during winter may be attributed to the uptake by the diatoms blooms, fungi, algae and phyto and zooplanktons as well as fish.

The comparison between the present results of the silicate with other Egyptians lakes e.g. Lake Qarun (2.15 – 14.86 mg/l) Ali, (2002) and Lake Bardawil (0.45 – 3.3 mg/l) Abdel-Satar, (2005). The concentration of the silicate in Abu Za'baal Ponds were higher than these lakes and Ismailia Canal water, as shown in Tables (1 – 4). This may be related to the nature and chemical composition of the basalt rocks of these ponds.

**Table (1): Physico-chemical parameters of Abu Za'baal Ponds water during winter 2003**

| Parameters \ Stations | pond (A) | | | | | pond (B) | pond (C) | Control |
|---|---|---|---|---|---|---|---|---|
| | I | II | III | IV | V | | | |
| Air Temp. °C | 18.00 | 18.00 | 19.00 | 19.00 | 19.00 | 18.00 | 16.00 | 20.00 |
| Water Temp. °C | 20.00 | 20.00 | 17.00 | 17.00 | 17.00 | 20.00 | 18.00 | 19.00 |
| Trans. Cm | 70.00 | 60.00 | 70.00 | 60.00 | 60.00 | 110.00 | 90.00 | 80.00 |
| EC µmhos/cm | 5800.00 | 5120.00 | 5040.00 | 5920.00 | 6000.00 | 5640.00 | 4000.00 | 390.00 |
| Salinity ‰ | 3.90 | 3.90 | 3.80 | 3.50 | 3.90 | 3.60 | 2.80 | 0.00 |
| TS mg/l | 4796.00 | 4824.00 | 4832.00 | 4888.00 | 4920.00 | 4820.00 | 3468.00 | 600.00 |
| TDS mg/l | 4706.00 | 4700.00 | 4792.00 | 4808.00 | 4836.00 | 4700.00 | 3412.00 | 500.00 |
| TSS mg/l | 90.00 | 124.00 | 40.00 | 80.00 | 84.00 | 120.00 | 56.00 | 100.00 |
| pH | 8.45 | 8.43 | 8.10 | 8.37 | 8.31 | 8.47 | 8.30 | 8.00 |
| DO mg/l | 8.40 | 10.00 | 6.00 | 8.40 | 8.40 | 9.60 | 8.40 | 10.00 |
| BOD mg/l | 1.20 | 4.00 | 1.20 | 2.40 | 2.40 | 3.20 | 4.00 | 5.00 |
| COD mg/l | 6.80 | 7.20 | 8.80 | 9.20 | 7.20 | 6.00 | 5.60 | 10.00 |
| $CO_3^{--}$ mg/l | 25.00 | 15.00 | 2.50 | 20.00 | 15.00 | 30.00 | 20.00 | 5.00 |
| $HCO_3^-$ mg/l | 174.15 | 186.30 | 247.00 | 178.20 | 198.50 | 202.50 | 263.25 | 230.00 |
| $Cl^-$ mg/l | 1595.25 | 1595.25 | 1610.00 | 1600.00 | 1595.25 | 1063.5 | 1063.5 | 36.40 |
| $SO_4^{--}$ mg/l | 332.00 | 334.88 | 335.00 | 334.88 | 339.00 | 355.32 | 322.51 | 35.50 |
| $Ca^{2+}$ mg/l | 60.12 | 80.16 | 72.14 | 60.12 | 60.12 | 60.12 | 40.08 | 46.50 |
| $Mg^{2+}$ mg/l | 217.16 | 195.20 | 203.00 | 220.10 | 197.64 | 168.36 | 170.80 | 22.20 |
| $Na^+$ mg/l | 306.43 | 307.44 | 307.77 | 306.77 | 308.45 | 306.43 | 246.22 | 44.40 |
| $K^+$ mg/l | 15.31 | 13.68 | 13.76 | 13.61 | 14.94 | 14.65 | 14.45 | 6.20 |
| $NO_2^-$ µg/l | 16.55 | 15.30 | 14.81 | 18.10 | 17.20 | 26.30 | 14.81 | 7.50 |
| $NO_3^-$ µg/l | 517.60 | 522.37 | 396.85 | 555.71 | 571.66 | 1071.12 | 306.00 | 70.10 |
| $NH_3^-$ mg/l | 2.90 | 3.50 | 3.44 | 3.45 | 3.73 | 2.34 | 3.43 | 2.50 |
| $PO_4^{---}$ µg/l | 42.91 | 43.94 | 41.90 | 48.00 | 56.20 | 73.57 | 57.22 | 50.50 |
| TP µg/l | 143.00 | 96.05 | 89.06 | 161.40 | 200.27 | 194.17 | 171.66 | 150.50 |
| $SiO_2^-$ mg/l | 8.45 | 7.80 | 7.71 | 7.74 | 6.87 | 8.53 | 5.35 | 4.50 |

**Table (2): Physico-chemical parameters of Abu Za'baal Ponds water during spring 2003**

| Stations / Parameters | pond (A) | | | | | pond (B) | pond (C) | Control |
|---|---|---|---|---|---|---|---|---|
| | I | II | III | IV | V | | | |
| Air Temp. °C | 34.00 | 33.00 | 35.00 | 35.00 | 34.00 | 35.50 | 35.00 | 34.00 |
| Water Temp. °C | 30.00 | 30.00 | 31.00 | 31.00 | 30.00 | 30.50 | 31.00 | 32.00 |
| Trans. Cm | 60.00 | 50.00 | 60.00 | 50.00 | 50.00 | 95.00 | 80.00 | 70.00 |
| EC µmhos/cm | 7860.00 | 7950.00 | 8010 | 7930.00 | 7670.00 | 6520.00 | 5860.00 | 400.00 |
| Salinity ‰ | 3.90 | 3.90 | 3.90 | 3.90 | 3.90 | 3.90 | 2.90 | 0.00 |
| TS mg/l | 5532.00 | 5140.00 | 5240.00 | 5160.00 | 5200.00 | 4556.00 | 4182.00 | 672.00 |
| TDS mg/l | 5464.00 | 5068.00 | 5196.00 | 5092.00 | 5152.00 | 4420.00 | 4062.00 | 562.00 |
| TSS mg/l | 68.00 | 72.00 | 44.00 | 68.00 | 48.00 | 190.00 | 118.00 | 110.00 |
| pH | 8.76 | 8.73 | 8.71 | 8.72 | 8.70 | 8.90 | 8.34 | 8.05 |
| DO mg/l | 14.00 | 10.00 | 12.00 | 12.00 | 8.40 | 11.20 | 9.60 | 12.00 |
| BOD mg/l | 6.00 | 8.00 | 6.00 | 10.00 | 3.50 | 5.20 | 5.60 | 5.00 |
| COD mg/l | 18.00 | 15.20 | 16.00 | 10.80 | 16.40 | 12.00 | 10.40 | 9.20 |
| $CO_3^{--}$ mg/l | 30.00 | 25.00 | 22.50 | 25.00 | 25.00 | 30.00 | 17.60 | 5.00 |
| $HCO_3^-$ mg/l | 226.80 | 202.50 | 210.60 | 243.00 | 243.00 | 226.80 | 416.80 | 226.80 |
| $Cl^-$ mg/l | 1737.05 | 1737.05 | 1719.32 | 1719.32 | 1737.05 | 780.00 | 886.25 | 35.45 |
| $SO_4^{--}$ mg/l | 338.00 | 340.83 | 338.23 | 334.52 | 342.32 | 370.30 | 323.75 | 35.65 |
| $Ca^{2+}$ mg/l | 60.12 | 60.12 | 60.12 | 60.12 | 60.12 | 64.13 | 52.10 | 46.00 |
| $Mg^{2+}$ mg/l | 207.40 | 219.60 | 214.72 | 207.40 | 212.28 | 190.32 | 195.20 | 24.40 |
| $Na^+$ mg/l | 241.34 | 274.60 | 267.43 | 298.10 | 247.86 | 274.00 | 254.38 | 45.66 |
| $K^+$ mg/l | 13.28 | 13.50 | 16.11 | 13.27 | 13.42 | 14.47 | 14.55 | 6.19 |
| $NO_2^-$ µg/l | 8.71 | 8.50 | 13.30 | 8.71 | 14.38 | 49.00 | 7.20 | 7.40 |
| $NO_3^-$ µg/l | 56.05 | 52.24 | 40.91 | 48.02 | 41.85 | 483.14 | 86.17 | 79.45 |
| $NH_3^-$ mg/l | 4.10 | 4.22 | 4.10 | 4.24 | 4.16 | 3.69 | 3.86 | 2.60 |
| $PO_4^{---}$ µg/l | 85.83 | 63.35 | 32.70 | 68.46 | 33.72 | 28.61 | 51.10 | 51.10 |
| TP µg/l | 180.86 | 192.10 | 114.44 | 102.18 | 76.63 | 97.10 | 168.60 | 173.71 |
| $SiO_2^-$ mg/l | 15.80 | 15.80 | 15.76 | 15.63 | 15.20 | 17.06 | 9.07 | 4.76 |

**Table (3): Physico-chemical parameters of Abu Za'baal Ponds water during summer 2003**

| Stations / Parameters | pond (A) | | | | | pond (B) | pond (C) | Control |
|---|---|---|---|---|---|---|---|---|
| | I | II | III | IV | V | | | |
| Air Temp. °C | 35.00 | 35.00 | 36.00 | 36.00 | 36.00 | 34.00 | 34.00 | 36.00 |
| Water Temp. °C | 31.00 | 31.00 | 32.00 | 32.00 | 32.00 | 30.00 | 30.00 | 34.00 |
| Trans. Cm | 140.00 | 135.00 | 150.00 | 130.00 | 120.00 | 80.00 | 100.00 | 80.00 |
| EC µmhos/cm | 8090.00 | 7940.00 | 7950.00 | 8060.00 | 7910.00 | 6660.00 | 6330.00 | 470.00 |
| Salinity ‰ | 4.30 | 4.30 | 4.30 | 4.30 | 4.30 | 3.30 | 3.50 | 0.00 |
| TS mg/l | 5624.00 | 5544.00 | 5620.00 | 5664.00 | 5524.00 | 4668.00 | 4600.00 | 588.00 |
| TDS mg/l | 5532.00 | 5500.00 | 5568.00 | 5600.00 | 5456.00 | 4556.00 | 4540.00 | 480.00 |
| TSS mg/l | 92.00 | 44.00 | 52.00 | 64.00 | 68.00 | 112.00 | 60.00 | 108.00 |
| pH | 8.80 | 8.80 | 8.76 | 8.73 | 8.75 | 8.61 | 8.57 | 8.60 |
| DO mg/l | 10.80 | 10.40 | 8.00 | 9.20 | 10.40 | 8.80 | 4.40 | 11.60 |
| BOD mg/l | 5.20 | 4.80 | 2.80 | 4.40 | 4.40 | 5.60 | 2.40 | 5.20 |
| COD mg/l | 12.00 | 12.00 | 10.00 | 10.40 | 10.40 | 12.00 | 10.00 | 4.00 |
| $CO_3^{--}$ mg/l | 20.00 | 20.00 | 17.50 | 17.50 | 17.50 | 20.00 | 7.50 | 4.00 |
| $HCO_3^-$ mg/l | 243.00 | 218.70 | 210.60 | 210.60 | 210.60 | 243.00 | 445.40 | 311.00 |
| $Cl^-$ mg/l | 1701.60 | 1744.14 | 1744.14 | 1701.60 | 1701.60 | 1276.20 | 1021.00 | 42.54 |
| $SO_4^{--}$ mg/l | 322.63 | 323.38 | 324.27 | 324.37 | 322.63 | 643.78 | 369.10 | 58.68 |
| $Ca^{2+}$ mg/l | 155.00 | 147.00 | 152.30 | 155.00 | 149.63 | 152.30 | 133.60 | 48.10 |
| $Mg^{2+}$ mg/l | 104.10 | 106.00 | 102.50 | 100.85 | 87.84 | 53.68 | 113.80 | 19.52 |
| $Na^+$ mg/l | 313.77 | 315.12 | 315.56 | 317.82 | 318.27 | 284.96 | 284.06 | 41.00 |
| $K^+$ mg/l | 13.00 | 13.12 | 13.67 | 12.87 | 13.00 | 14.93 | 14.76 | 5.66 |
| $NO_2^-$ µg/l | 2.40 | 3.05 | 4.14 | 4.36 | 4.14 | 37.25 | 5.88 | 2.40 |
| $NO_3^-$ µg/l | 12.66 | 11.00 | 8.41 | 13.21 | 10.92 | 147.00 | 39.80 | 16.67 |
| $NH_3^-$ mg/l | 3.35 | 3.66 | 4.13 | 3.22 | 3.48 | 3.56 | 4.89 | 2.26 |
| $PO_4^{---}$ µg/l | 35.76 | 26.57 | 31.68 | 34.74 | 35.76 | 44.96 | 38.83 | 41.90 |
| TP µg/l | 150.20 | 98.10 | 139.00 | 100.14 | 138.00 | 140.00 | 455.73 | 139.90 |
| $SiO_2^-$ mg/l | 15.20 | 16.36 | 15.37 | 15.23 | 14.72 | 18.47 | 13.71 | 5.80 |

Table (4): Physico-chemical parameters of Abu Za'baal Ponds water during autumn 2003

| Stations / Parameters | pond (A) | | | | | pond (B) | pond (C) | Control |
|---|---|---|---|---|---|---|---|---|
| | I | II | III | IV | V | | | |
| Air Temp. °C | 24.00 | 23.00 | 22.00 | 23.00 | 24.00 | 25.00 | 24.00 | 26.00 |
| Water Temp. °C | 20.00 | 20.00 | 19.00 | 20.00 | 20.00 | 20.00 | 20.00 | 24.00 |
| Trans. Cm | 170.00 | 130.00 | 170.00 | 150.00 | 110.00 | 100.00 | 90.00 | 80.00 |
| EC µmhos/cm | 5470.00 | 5520.00 | 5400.00 | 5500.00 | 5600.00 | 4840.00 | 4860.00 | 377.00 |
| Salinity ‰ | 4.10 | 4.10 | 4.10 | 4.10 | 4.10 | 3.70 | 3.60 | 0.00 |
| TS mg/l | 5024.00 | 5084.00 | 5064.00 | 5108.00 | 5068.00 | 4584.00 | 4944.00 | 526.00 |
| TDS mg/l | 4932.00 | 4988.00 | 4868.00 | 4896.00 | 4900.00 | 4500.00 | 4868.00 | 416.00 |
| TSS mg/l | 92.00 | 96.00 | 196.00 | 212.00 | 168.00 | 84.00 | 76.00 | 110.00 |
| pH | 8.04 | 8.03 | 8.02 | 8.06 | 8.02 | 8.03 | 8.03 | 8.01 |
| DO mg/l | 8.80 | 9.20 | 7.60 | 7.60 | 7.20 | 9.60 | 8.00 | 10.80 |
| BOD mg/l | 3.20 | 4.00 | 2.00 | 2.40 | 2.80 | 4.80 | 2.80 | 5.60 |
| COD mg/l | 5.20 | 4.80 | 4.40 | 5.20 | 4.80 | 5.20 | 5.60 | 2.40 |
| $CO_3^{--}$ mg/l | N.D | N.D | N.D | N.D | N.D | N.D | N.D | N.D |
| $HCO_3^-$ mg/l | 324.00 | 356.40 | 372.00 | 340.20 | 356.40 | 388.8 | 453.60 | 251.10 |
| $Cl^-$ mg/l | 1808.00 | 1772.50 | 1772.50 | 1772.50 | 1843.40 | 1418.00 | 1240.75 | 48.00 |
| $SO_4^{--}$ mg/l | 488.28 | 546.00 | 511.06 | 540.80 | 512.55 | 568.50 | 664.83 | 59.70 |
| $Ca^{2+}$ mg/l | 212.42 | 204.41 | 200.4 | 200.40 | 200.40 | 176.35 | 176.35 | 48.10 |
| $Mg^{2+}$ mg/l | 114.68 | 107.36 | 92.72 | 97.60 | 134.20 | 136.64 | 124.44 | 19.52 |
| $Na^+$ mg/l | 537.92 | 542.30 | 546.66 | 542.30 | 544.48 | 516.05 | 532.45 | 51.00 |
| $K^+$ mg/l | 13.60 | 13.74 | 13.40 | 13.57 | 13.28 | 15.50 | 15.43 | 6.11 |
| $NO_2^-$ µg/l | 189.74 | 185.39 | 162.08 | 161.86 | 163.82 | 150.10 | 46.00 | 8.71 |
| $NO_3^-$ µg/l | 264.60 | 241.83 | 312.33 | 238.80 | 237.80 | 176.90 | 194.30 | 20.41 |
| $NH_3^-$ mg/l | 3.65 | 3.19 | 2.43 | 2.38 | 2.46 | 2.47 | 3.48 | 2.27 |
| $PO_4^{---}$ µg/l | 28.61 | 35.76 | 53.13 | 31.72 | 61.30 | 29.67 | 50.07 | 29.63 |
| TP µg/l | 75.61 | 97.07 | 95.03 | 81.75 | 104.22 | 122.62 | 209.50 | 165.53 |
| $SiO_2^-$ mg/l | 14.60 | 14.50 | 14.10 | 14.52 | 14.60 | 13.71 | 18.02 | 2.03 |

## CONCLUSIONS AND RECOMMENDATIONS

Abu Za'baal Ponds have a unique ecosystem and they considered as an oligotrophic lakes and brackishwater. The main factors affecting in the distribution and the concentrations of the different physical and chemical parameters of water ponds are:-

1- The changes in the environmental conditions e.g. air and water temperatures, evaporation rates and change in bathymetry.

2- The water storage in the each pond.

The study was concerning limnology and Environmental Impacts Assessment (EIA) of Abu Za'baal Ponds. So, the author recommend continuous studies on the ponds to arrive the favourite conditions for fish predation improvement.

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